PERFECT HARMONY DRIVE

BCC CONTRACT NO. S.20/95/963

VOLUME 4

CHAPTER 1 to 16

SCSQ

WEIR ENGINEERING PTY LTD
A.C.N. 000 373 339

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Volume 4
Chapter 1 to 16.

BRISBANE CITY COUNCIL

DEPARTMENT OF WATER SUPPLY AND SEWAGE

PUMPWELL NO. 1
EAGLE FARM PUMP STATION

OPERATION AND MAINTENANCE
INSTRUCTION MANUAL

WEIR ENGINEERING JOB NO. 15140
BCC CONTRACT NO. S.20/95/963

WEIR ENGINEERING PTY LTD
A.C.N. 000 373 339
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Amendment List		Topic/Set	*Amendment Effect	Amended By	Date
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BRISBANE CITY COUNCIL
Department Water Supply and Sewerage
Eagle Farm Pump Station Upgrade

BCC Contract No. S.20/95/96
Pumpwell No. 1 Speed Control Equipment

PERFECT HARMONY SERIES
ADJUSTABLE SPEED AC MOTOR DRIVE
CELL SIZES 00-05 (AIR COOLED)
(400 hp through 3000 hp)
USER'S MANUAL

Manual Number: 902330
November 1997

Version 3.1

ROBICON

A Subsidiary of High Voltage Engineering Corporation

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Version 3.1 (902330) 11 NOV 97

This user's manual applies to all air-cooled ROBICON Perfect Harmony adjustable-speed AC motor drives that are rated from 400 HP through 3000 HP. For information on liquid-cooled Perfect Harmony Drives, refer to manual number 902463. This manual assumes the typical configuration in which power cells accept 460/480 VAC input. These are called *low voltage cells*. Perfect Harmony units rated at 4800 VAC output use cells which accept 690 VAC. These inputs are called *high voltage cells*. The manual text identifies those cases in which the *high voltage cell* information differs from the *low voltage cell* counterparts.

This manual corresponds to Perfect Harmony software version 1.10

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Edited by: David Shutts

Perfect Harmony User's Manual (Air-cooled)
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Rev 1.0	07/12/95 (Appendix A only)
Rev 2.0	03/22/96
Rev 3.0	08/29/97
Rev 3.1	11/11/97

Guarantee and Product and Liability

Robicon's "standard" warranty policy is listed as follows. When in doubt, consult the factory.

All products are warranted for a period of 18 months from the date of original receipt, not to exceed 1 year from the date of Start-Up, against defects in materials or workmanship. Guarantee repairs are to be performed FOB Robicon factory to qualify for no charges. Robicon's liability and customer's exclusive remedy under this warranty are expressly limited to repair, or replacement, or repayment of the purchase price. Whether there shall be repair, replacement, or repayment is to be exclusively Robicon's decision. Robicon is not liable for incidental and consequential damages.

If guarantee repairs are performed in the field, a per-diem charge will be made for the serviceman or engineer's travel, living expenses and all time short of the repair time required.

This warranty shall not apply to major devices or equipment such as transformers and motors not manufactured by the seller or to equipment or parts which shall have been repaired or altered by others than the seller so as, in its judgment, to affect adversely the same, or which shall be subject to negligence, accident, or damage by circumstances beyond the seller's control. For equipment and parts not manufactured by the seller, the warranty obligations of the seller shall in all respects conform and be limited to the warranty extended to the seller by the supplier.

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For **all** repair service at Robicon, you will need a Repair Service Order (SO) number. Call **(412) 339-9307** and request a Repair Service Order (SO) number. Please reference this number when making any inquiries.

Shipping instructions: Our shipping address is:

Robicon
500 Hunt Valley Drive
New Kensington PA 15068
Attention: Repair Department/SO # (   )

Prepay the shipment and include the following information if you are not using a Robicon Return Repair Tag: the Repair Service Order (SO) number, part number, a description of the problem, contact phone number, a technical contact phone number (if different) and any additional comments. Put the Repair Service Order (SO) number on the label.

Warranty Repairs: In addition to securing Repair Service Order (SO) number, please supply the **System CO number** (found on the system), whenever possible.

Non-Warranty Repairs: Secure a Repair Service Order (SO) number from Robicon. Secure your Purchase Order for $500 per item being returned. You will be contacted if the estimated repairs exceed the Purchase Order amount. Include this Purchase Order with the part. Expedited services are available upon request.

> Before sending a printed circuit board to Robicon for repair, please make a list of parameter values first.

Terms and Conditions

Warranty

- Repairs will be at Robicon's expense. Acts of God and use outside of design specification are excluded. Determination will be made by Robicon.
- Standard warranties are two (2) years for Heating and Reg., except 1 Khz power supplies and Turbos, one (1) year from startup OR 18 months from shipment for all others. **Exceptions: Units with valid extended warranty or preventive maintenance agreements.**
- Decisions to repair or replace with **NEW** or voided warranties will be determined by Robicon.
- Call tags will be issued as necessary.
- A repair will be warranted for the remainder of the original equipment warranty.

  A minimum evaluation fee of $110 per unit will be billed for each unit that is evaluated and which proves to be non-defective.
- A 25% restocking fee will be assessed for any units that are returned to Robicon stock for credit to you.

Non-warranty

- Decision of repairability will be determined by Robicon.
- The warranty on repairs is 30 days from date of repair.
- Shipping will be prepaid and billed.
- A minimum evaluation fee of $110 per unit will be billed for each unit evaluated. *This fee will be credited to the order if a new unit is purchased. No evaluation fee will be assessed for units that are repaired.*
- Repair system testing at your site may be required.
- If, after best effort, a unit is found to be "beyond economical repair" (BER), it will be returned immediately after you are contacted. You may request the unit be scrapped at Robicon. With your approval, a fully tested, refurbished unit maybe purchased (based on availability) in place of a repair. A 90-day warranty will apply to the refurbished unit.

Expedited Service

- The feasibility of expedited service will be determined by Robicon after examining the unit. *Expedited service cannot be promised for all units.*

Expedited Service may be available at the following levels: one (1) day, (2) day, (3) day or one (1) business week.

- A refurbished unit may be substituted for the returned unit pending availability and your approval.

Subject to change.

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This warranty shall not apply to major devices or equipment such as transformers and motors not manufactured by the seller or to equipment or parts which shall have been repaired or altered by others than the seller so as, in its judgment, to affect adversely the same, or which shall be subject to negligence, accident, or damage by circumstances beyond the seller's control. For equipment and parts not manufactured by the seller, the warranty obligations of the seller shall in all respects conform and be limited to the warranty extended to the seller by the supplier.

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Before sending a printed circuit board to Robicon for repair, please make a list of parameter values first.

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- Standard warranties are two (2) years for Heating and Reg., except 1 Khz power supplies and Turbos, one (1) year from startup OR 18 months from shipment for all others. **Exceptions: Units with valid extended warranty or preventive maintenance agreements.**
- Decisions to repair or replace with **NEW** or voided warranties will be determined by Robicon.
- Call tags will be issued as necessary.
- A repair will be warranted for the remainder of the original equipment warranty.

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- The warranty on repairs is 30 days from date of repair.
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- Repair system testing at your site may be required.
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CHAPTER 1: INTRODUCTION

In This Section:

1.1. Introduction to the Perfect Harmony

Perfect Harmony is a series of pulse-width modulated, variable frequency AC motor drives designed and manufactured by ROBICON. The Perfect Harmony drive system addresses the following power quality issues:

- providing clean power input
- providing a high power factor
- providing nearly perfect sinusoidal output.

Figure 1-1, Figure 1-2 and Figure 1-3 illustrate hardware lineups of typical Perfect Harmony drive systems. Both sectional and compartment types are available.

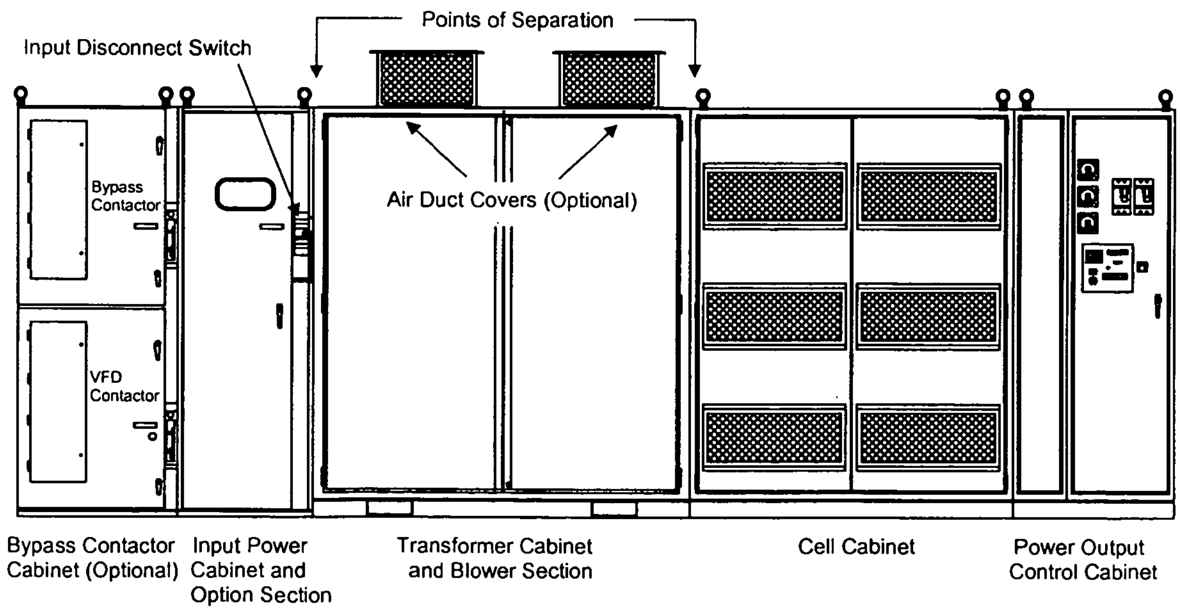

Figure 1-1. Typical Perfect Harmony VFD Lineup - Sectional Type

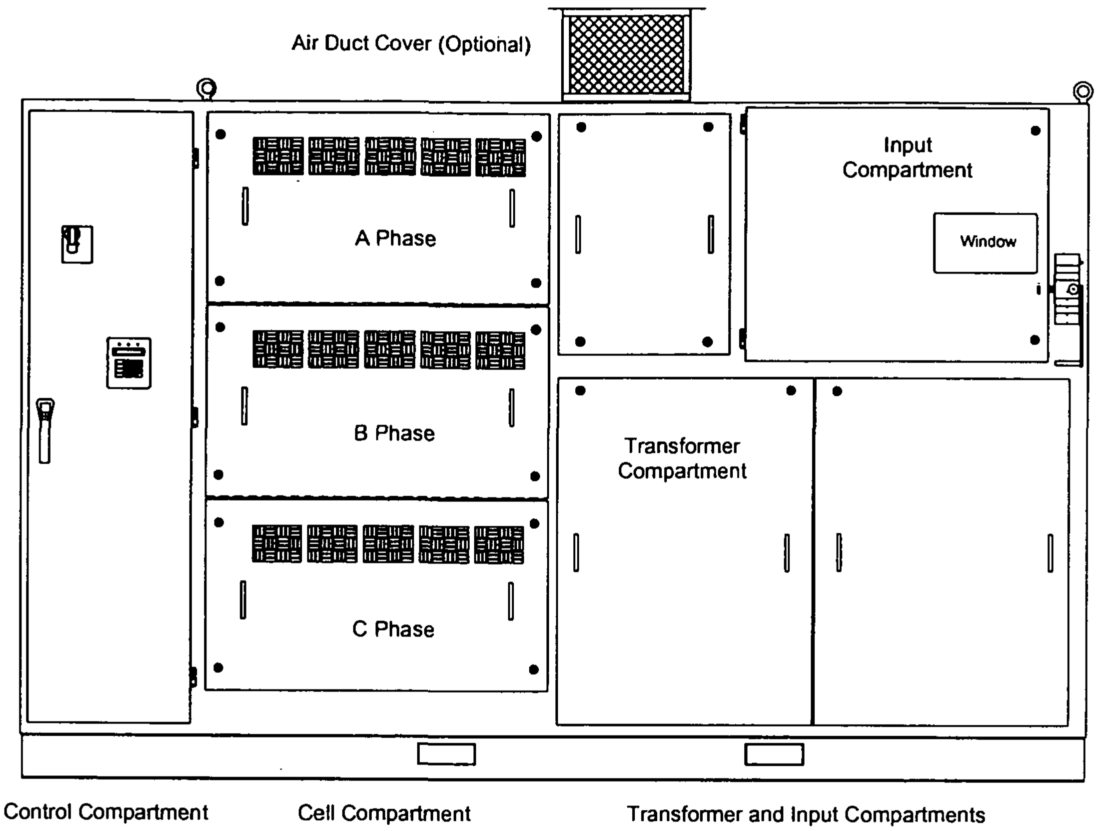

Figure 1-2. Typical Perfect Harmony VFD Lineup - Compartment Type (600 Hp or Less)

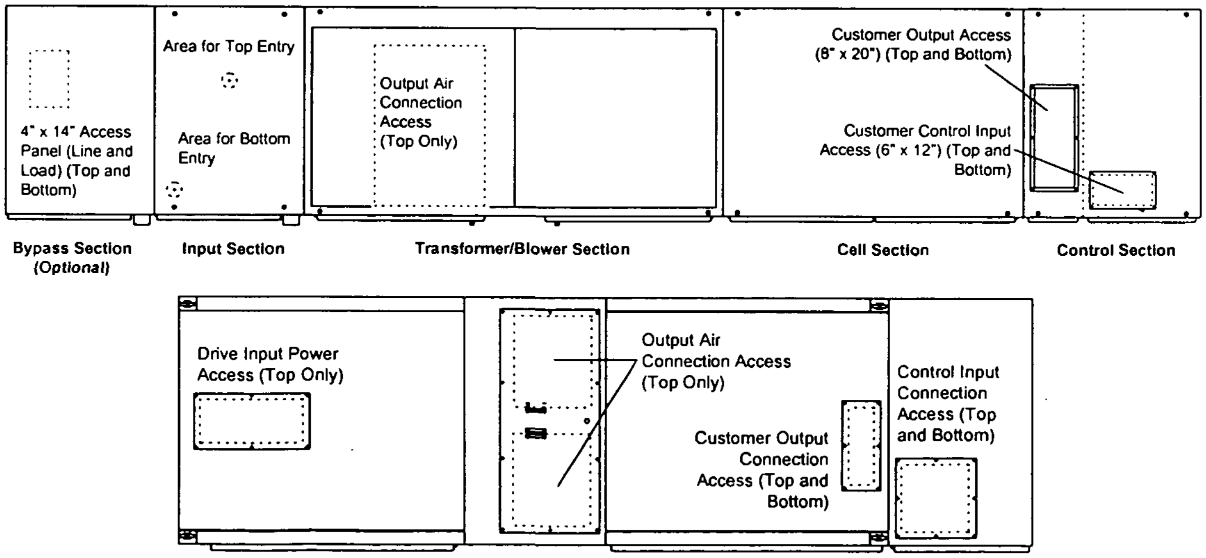

Figure 1-3. Top Views of Typical Sectional and Compartment Types Showing Key Access Panels

1.1.1. Clean Power Input

The Perfect Harmony drive series meets the most stringent IEEE 519 1992 requirements for voltage and current harmonic distortion, even if the source capacity is no larger than the drive rating. This series protects other on-line equipment (such as computers, telephones, and lighting ballasts) from harmonic disturbances. Perfect Harmony also prevents "cross talk" with other variable speed drives. Clean power input eliminates the need for time-consuming harmonic/resonance analyses and costly harmonic filters. Figure 1-4 illustrates input wave forms for typical 6-pulse, 12-pulse and Perfect Harmony series drives.

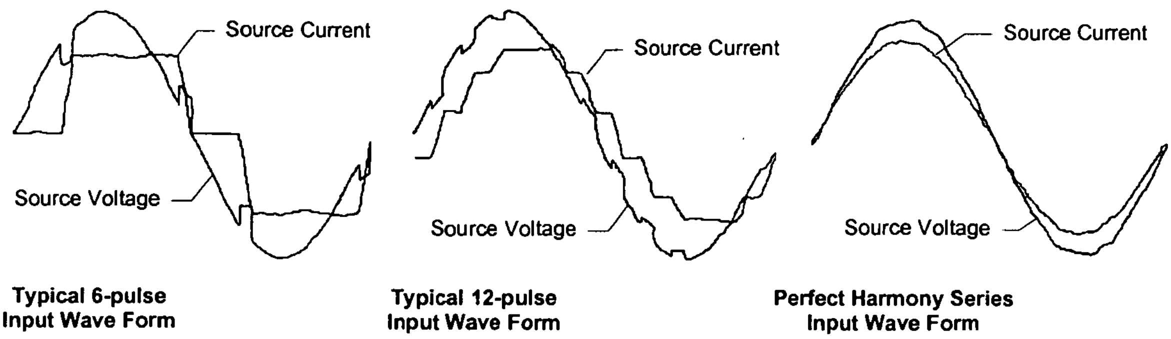

Figure 1-4. Harmonic Distortion Wave Form Comparisons (6-pulse, 12-pulse and Perfect Harmony)

Total harmonic distortion of the source current is 25% for the 6-pulse, 8.8% for the 12-pulse, and 0.8% for the Perfect Harmony series drive. The corresponding voltage distortions with a typical source impedance are 10%, 5.9% and 1.2%, respectively.

> The above comparisons were done using a typical 1,000 hp current source drive (6-pulse and 12-pulse modes) and a Perfect Harmony series drive operating from a 1100 kVA, 5.75% impedance source.

1.1.2. High Power Factor, Nearly Perfect Sinusoidal Input Currents

Power factor is a measure of the fraction of current which produces real power to the load. Typically, power factor is given as a percentage. A high power factor VFD (e.g., 95%) makes much better use of its input line current demand in producing real power to the motor than a VFD operating at a low power factor (e.g., 30%). VFD's having low operating power factor often generate square-wave shaped line currents. This can lead to harmonics and other associated resonance problems.

The Perfect Harmony series draws nearly perfect sinusoidal input currents having a power factor that exceeds 95% throughout the entire speed range without the use of external power factor correction capacitors. This eliminates utility penalties for power factor and demand charges, and improves voltage regulation. In addition, feeders, breakers and transformers are not overloaded with reactive power. Low speed applications specifically benefit from the Perfect Harmony series since a high and stable power factor is maintained throughout the entire speed range using standard induction motors. Figure 1-5 compares graphs of power factor versus percent speed for the Perfect Harmony series and a typical phase-controlled SCR drive.

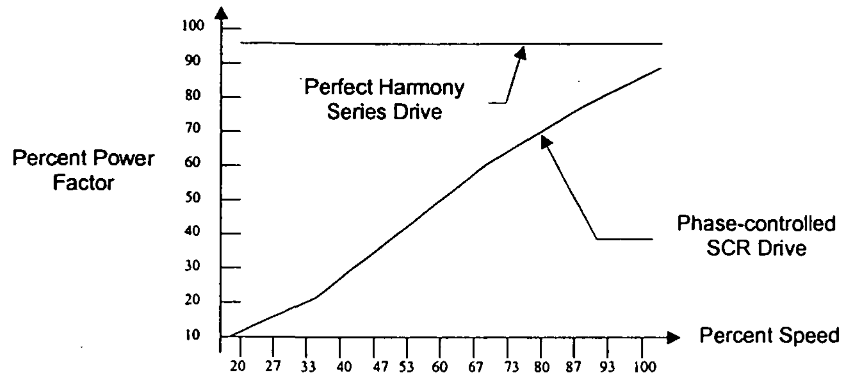

Figure 1-5. Plot of Power Factor vs. Percent Speed Comparing Perfect Harmony and a Typical Phase-controlled SCR Drive

1.1.3. Nearly Perfect Sinusoidal Output Voltages

The design of the Perfect Harmony series of variable frequency drives inherently provides a sinusoidal output without the use of external output filters. This means that the drive provides a low distortion output voltage wave form that generates no appreciable audible motor noise. In addition, there is no need to derate motors (the drive can be applied to new or existing 1.0 service factor motors). In fact, Perfect Harmony drives eliminate harmful VFD-induced harmonics which cause motor heating. Similarly, VFD-induced torque pulsations are eliminated (even at low speeds), thereby reducing the stress on mechanical equipment. Common mode voltage stress and dV/dt stress are also minimized. A typical graph of the output current from a Perfect Harmony drive is illustrated in Figure 1-6.

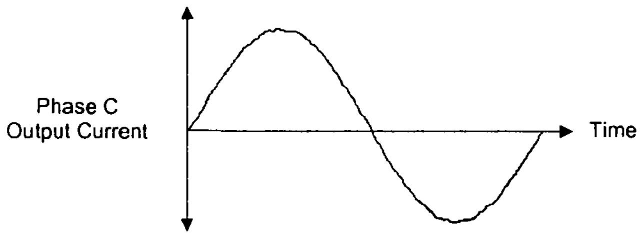

Figure 1-6. Nearly Sinusoidal Wave Form of the Output Current from a Perfect Harmony Drive

1.2. Hardware Overview

Figure 1-1 depicts a typical sectional type cabinet line-up. Each VFD normally consists of 4 cabinet sections. These sections are:

- the Bypass Contactor Cabinet (optional)
- the Input Power and Option Cabinet
- the Transformer/Blower Cabinet
- the Cell Cabinet(s)
- the Power Output/Control Cabinet.

For 600 hp and below (see Figure 1-2), the Perfect Harmony drive is available in a single cabinet with compartments for all of the sections shown above. These drives have lifting bolts and fork truck lifting tubes for proper handling.

Hardware torque specifications are given in Chapter 6: Installation and Setup.

The ***Bypass Contactor Cabinet*** is an optional cabinet that provides all necessary control and hardware for full voltage bypass operation.

The ***Input Power and Option Cabinet*** houses the input terminals, the disconnect switch and fuses. Various input/output options are also supplied in this section (e.g., meters and associated hardware).

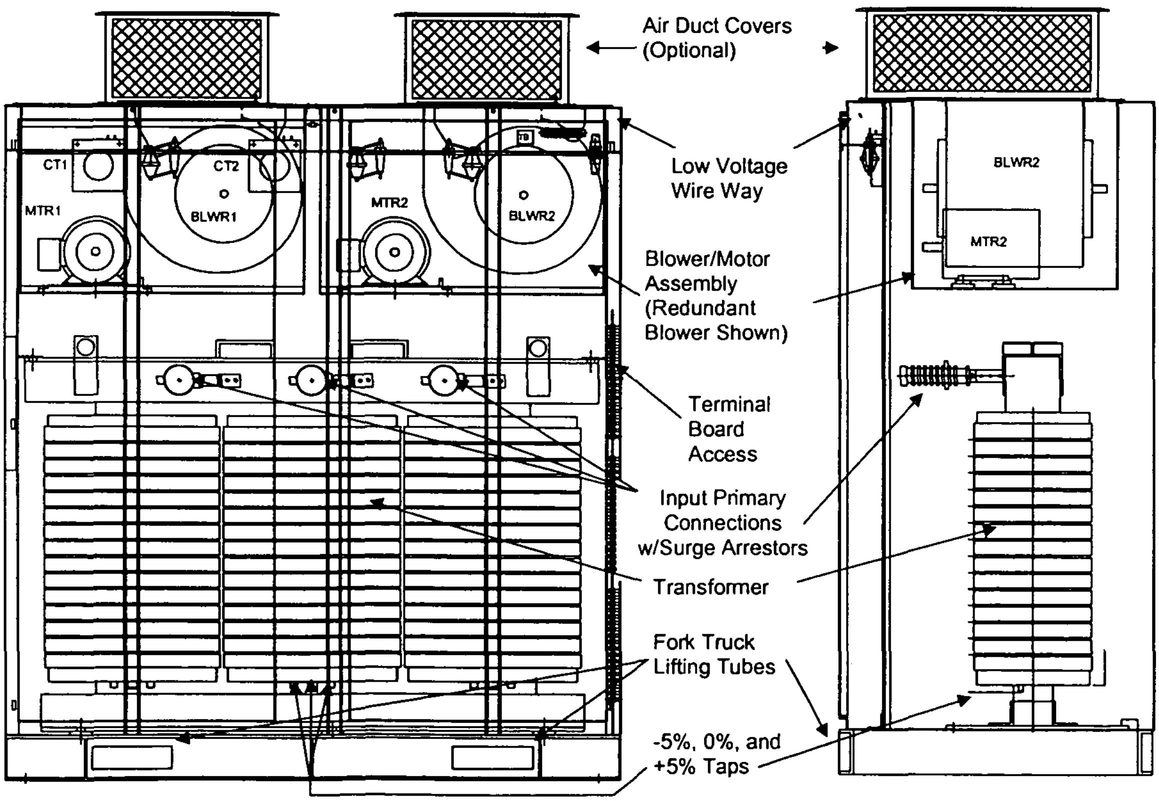

Figure 1-7a. Inside View of Typical Transformer/Blower Cabinet (Sectional Type)

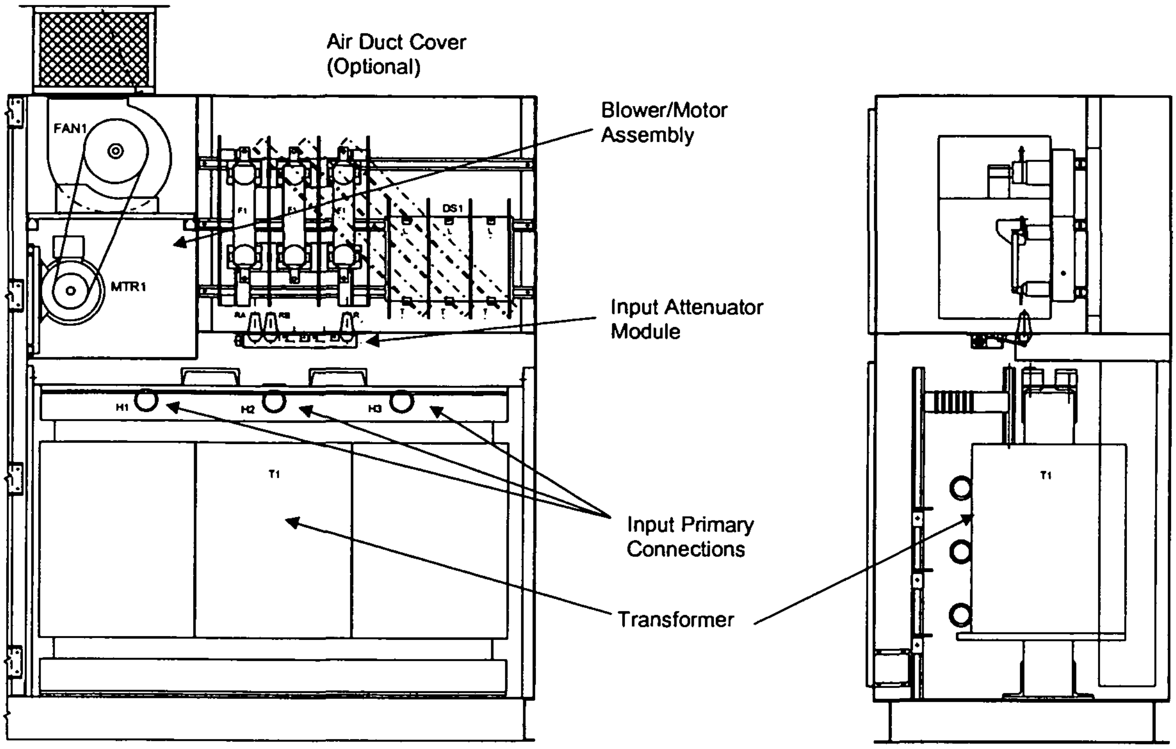

Figure 1-7b. Inside View of Typical Transformer/Blower Cabinet (Compartment Type)

The ***Transformer/Blower Cabinet*** houses the input phase shifting transformer and surge suppression which supplies 3-phase voltages to the output cells (refer to Figure 1-7). In sectional drives, this cabinet contains a secondary tap board which is used as a connection point between the various secondary windings and the output cells. This tap board is supplied so that the Transformer Cabinet can be easily separated from the Cell Cabinet. Surge suppression is supplied as a standard in this cabinet. The cooling blowers are also supplied in this section.

The ***Cell Cabinet*** houses between 3 and 6 cells per output phase (possibly including a redundant cell option). Each output phase voltage is the series sum of the horizontal cell voltages (refer to Figure 1-8 and Figure 1-9). Each cell can be disconnected and removed from the cabinet by disconnecting the 3-phase input power, the two output connections, the fiber optic cable and a retaining bolt. All cells are electrically and mechanically identical, so that they may be interchanged. Each cell contains its own control boards which communicate with the system through an isolated link using fiber optic cables.

The ***Power Output/Control Cabinet*** houses the control boards (refer to Figure 1-10 on page 1-9 and Figure 1-11 on page 1-10) as well as the VFD output connections.

> In some sectional drives, the blower must be removed/replaced from the top of the drive cabinet. In these installations, be sure to allow ample vertical clearance for fan servicing (and removal) between the top of the cabinet and the ceiling (approximately 26.5 inches). To remove the fan(s), the optional air duct cover must be removed and the fan "tub" assembly must be lifted vertically from the cabinet. If the optional duct covers are not used, then plenum/duct connections must be removable to allow proper access for servicing and replacement of fans and associated components.

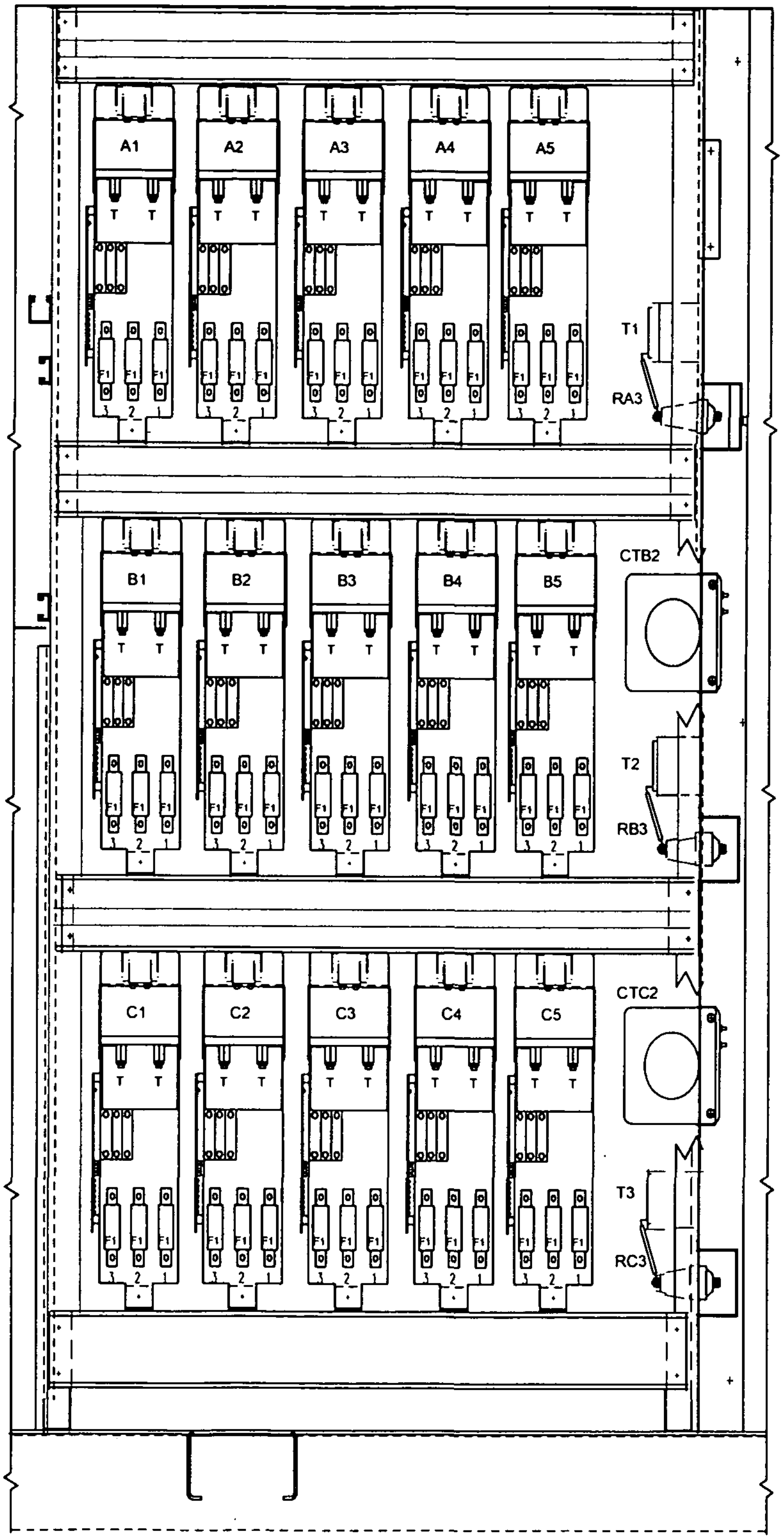

Figure 1-8. Inside View of a Typical Cell Compartment (Cell Sizes 00 or 0, Compartment Type)

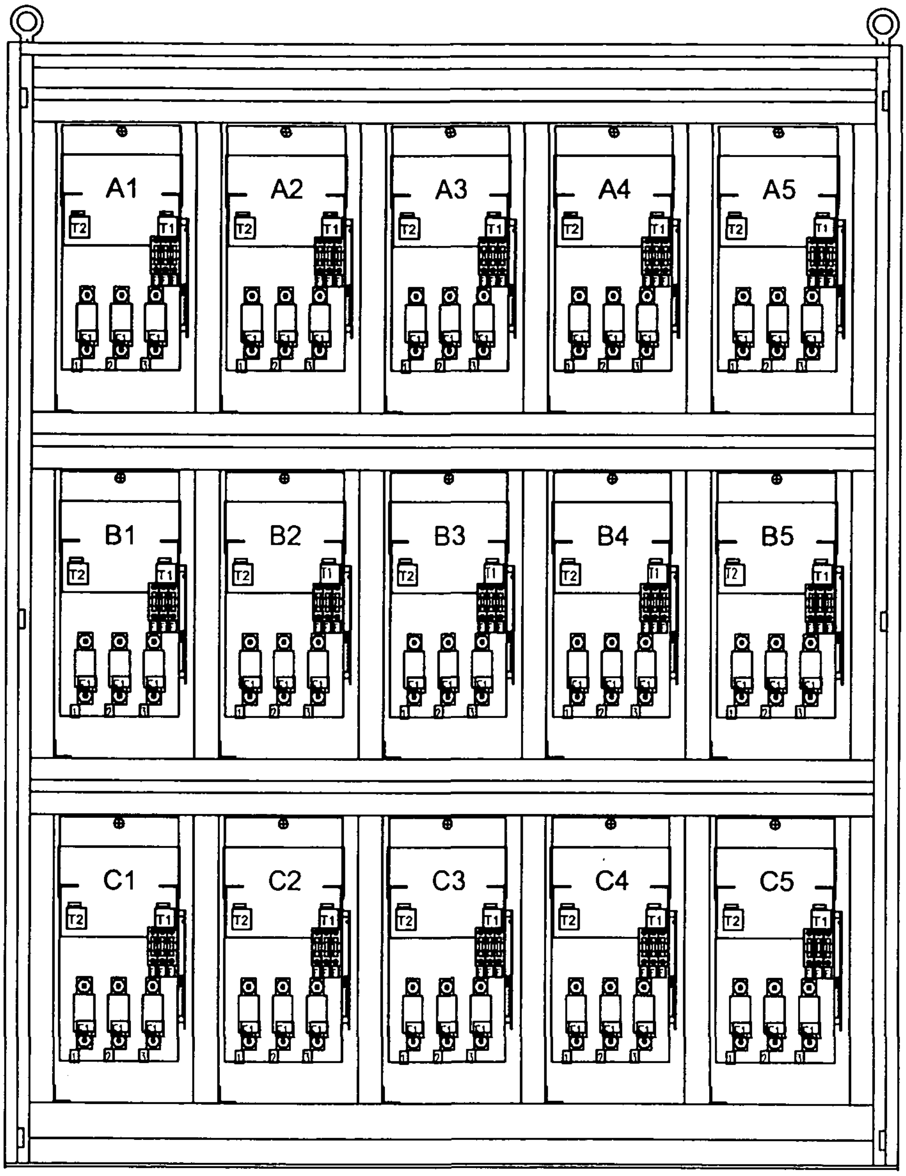

Figure 1-9. Inside View of a Typical Cell Cabinet (Cell Sizes 1 or 2, Sectional Type)

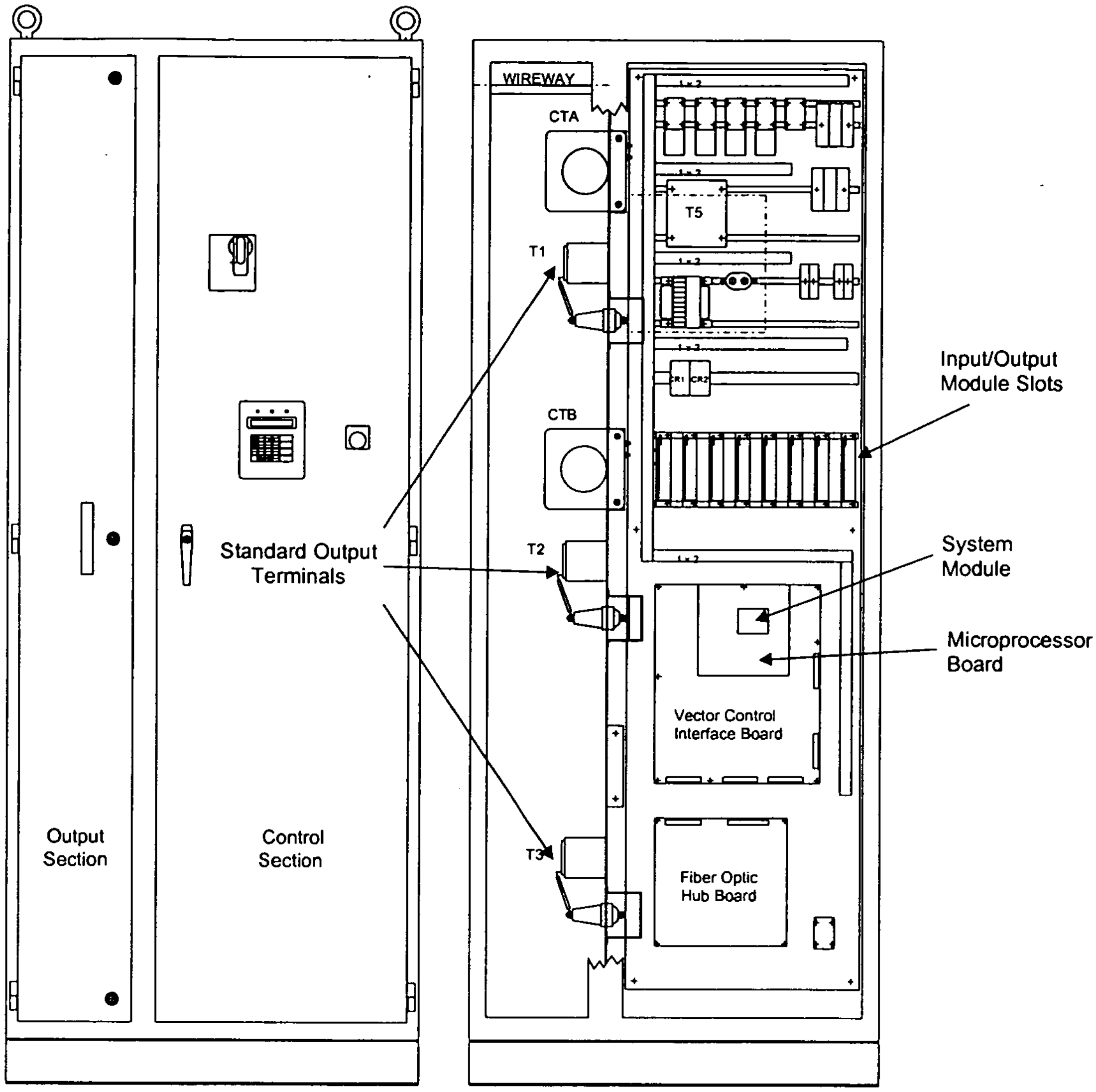

Figure 1-10. External and Internal Views of a Typical Power Output/Control Cabinet (Sectional Type)

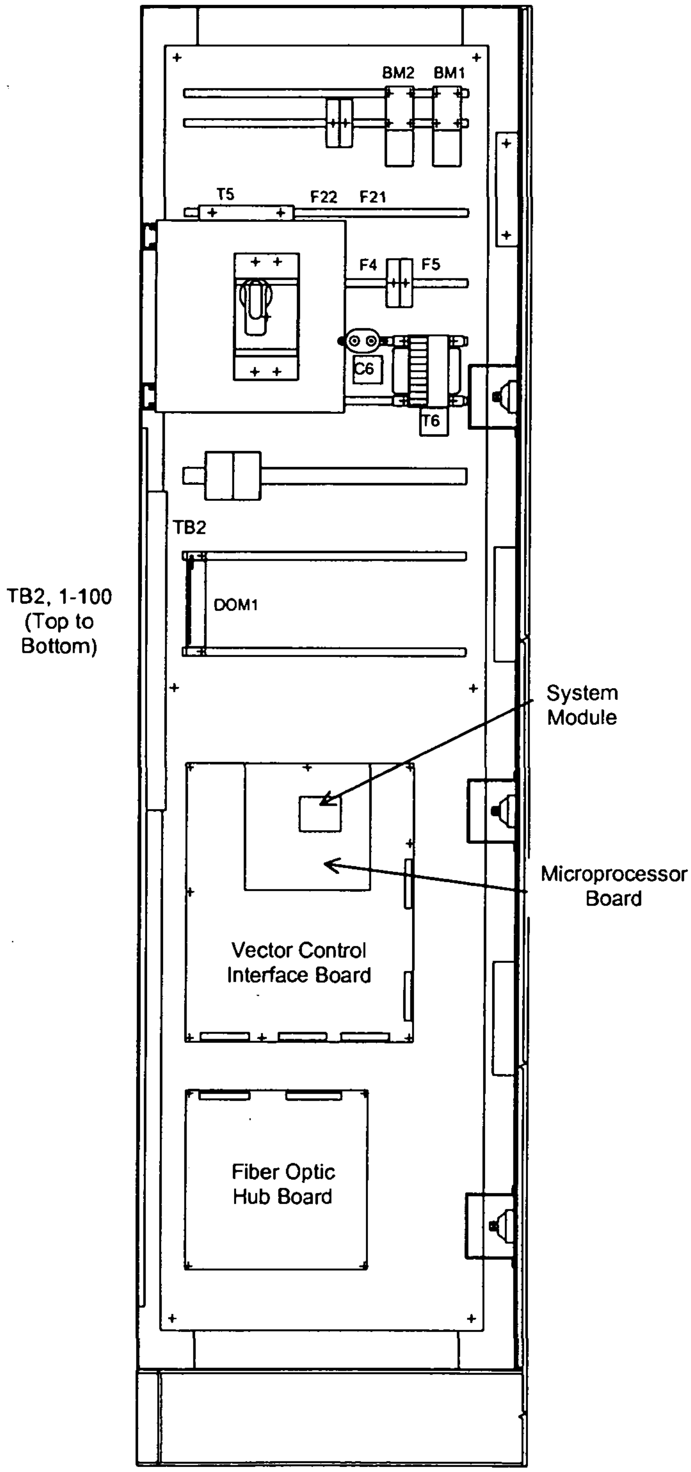

Figure 1-11. Internal View of a Typical Control Compartment (Compartment Type)

1.3. Cell Specifications

ROBICON's Perfect Harmony AC drive system is offered in 7 basic cell sizes (current ratings), grouped to provide output operating voltages of 2,400 VAC (3 cells in series), 3,300 VAC (4 cells in series), 4,160 VAC (5 cells in series), or 4,800 VAC (6 in series). Table 1-1, Table 1-2, Table 1-3 and Table 1-4 (starting on page 1-12) provide the basic specifications associated with all cell combinations.

The Perfect Harmony is offered in two additional cell sizes (current ratings) for higher voltage applications. These high voltage cells are grouped to provide operating voltages of 6,000 VAC (5 cells in a series - 15 total) and 6,600 VAC (6 cells in a series - 18 cells total). Refer to Table 1-5 and Table 1-6 for 6,000 VAC and 6,600 VAC cell specifications.

> Output current ratings are a function of the selected cell size. Input current ratings are a function of the transformer size associated with each hp rating. Note that all specifications are subject to change without notice.

The individual output cells are located in the Cell Section. All cells are electrically and mechanically identical, so that they may be interchanged. Each cell contains its own control boards which communicate with the system through a fiber optic link. This link is the only connection between the cells and the master control located in the Control Section, thus each cell is fully isolated from the main control.

A switch mode power supply located on the Cell Control Board (refer to Figure 1-12) allows the control power to be derived from the individual 3-phase secondary connections of the transformer. This power supply is fully operational between 250 and 510 VAC.

> For high-voltage cells, the power supply is fully operational between the values of 375 VAC and 750 VAC.

The Control Section contains PC boards which provide central control of the Harmony drive system. The Control Section is physically and electrically isolated from all medium voltage for safety.

Control for each of the output cells is provided via a fiber optic communications link between the Master Control System and the Cell Control Board located within each output cell.

Table 1-1 through Table 1-4 give length and weight information for many common configurations of sectional Harmony drives, based on 60 Hz input power at the voltages listed. In some cases, a non-sectional package is also available. Data for these packages are shown in parentheses.

If applications require inputs at 50 Hz or voltages above 5 kV, sizes and weights may increase. The non-sectional compartmental package is not available above 5 kV input.

Table 1-1. 2,400 VAC Cell Specifications (9 Cells Total, 3 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
200	44 / 50	20,000	6,500 (4,200)	186 (144)	6,559 (5,456)	00
300	66 / 75	30,000	6,500 (4,200)	186 (144)	6,998 (6,046)	0
400	88 / 100	40,000	6,500 (4,200)	198 (144)	8,035 (6,450)	1
500	110 /150	50,000	6,500 (4,200)	198 (144)	8,307 (7,009)	2
600	131 / 150	60,000	6,500 (4,200)	198 (144)	8,557 (7,259)	2
700	153 / 200	70,000	6,500	222	9,526	3
800	175 / 200	80,000	6,500	222	9,786	3
900	197 / 200	90,000	6,500	222	10,051	3
1,000	220 / 300	100,000	6,500	222	10,481	4
1,250	273 / 300	125,000	6,500	222	11,431	4
1,500	327 / 400	150,000	10,000	282	13,380	5
1,750	382 / 400	175,000	10,000	282	14,305	5

Table 1-2. 3,300 VAC Cell Specifications (12 Cells Total, 4 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
300	49 / 50	30,000	6,500 (4,200)	198 (144)	7,383 (6,097)	00
400	64 / 75	40,000	6,500 (4,200)	198 (144)	7,918 (6,620)	0
500	80 / 100	50,000	6,500	210	8,619	1
600	96 / 100	60,000	6,500	210	8,869	1
700	112 / 100	70,000	6,500	210	9,127	2
800	128 / 150	80,000	6,500	210	9,387	2
900	144 / 150	90,000	6,500	210	9,652	2
1,000	160 / 200	100,000	6,500	246	11,189	3
1,250	199 / 200	125,000	6,500	246	12,139	3
1,500	239 / 300	150,000	10,000	282	14,162	4
1,750	279 / 300	175,000	10,000	282	15,087	4
2,000	319 / 400	200,000	10,000	306	16,954	5
2,250	358 / 400	225,000	10,000	306	17,079	5

Table 1-3. 4,160 VAC Cell Specifications (15 Cells Total, 5 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
300	38 / 50	30,000	6,500 (4,200)	198 (144)	7,506 (6,256)	00
500	63 / 75	50,000	6,500 (4,200)	198 (144)	8,253 (6,955)	0
600	75 / 75	60,000	6,500 (4,200)	198 (144)	8,503 (7,205)	0
700	89 / 100	70,000	6,500	222	9,424	1
800	101 / 150	80,000	6,500	222	9,804	2
900	114 / 150	90,000	6,500	222	10,069	2
1,000	126 / 150	100,000	6,500	222	10,319	2
1,250	158 / 200	125,000	6,500	270	12,877	3
1,500	189 / 200	150,000	10,000	306	14,686	3
1,750	221 / 300	175,000	10,000	306	15,911	4
2,000	252 / 300	200,000	10,000	306	16,836	4
2,250	284 / 300	225,000	10,000	306	16,961	4
2,500	315 / 400	250,000	10,000	342	19,223	5
3,000	378 / 400	300,000	13,200	372	21,875	5

Table 1-4. 4,800 VAC Cell Specifications (18 Cells Total, 6 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
400	44 / 50	40,000	6,500	222	8,650	00
500	55 / 75	50,000	6,500	222	8,922	0
600	66 / 75	60,000	6,500	222	9,172	0
700	77 / 100	70,000	6,500	246	10,132	1
800	88 / 100	80,000	6,500	246	10,392	1
900	99 / 100	90,000	6,500	246	10,657	1
1,000	109 / 150	100,000	6,500	246	11,051	2
1,250	137 / 150	125,000	6,500	246	12,001	2
1,500	164 / 200	150,000	10,000	330	15,424	3
1,750	191 / 200	175,000	10,000	330	16,349	3
2,000	218 / 300	200,000	10,000	330	17,634	4
2,250	246 / 300	225,000	10,000	330	17,759	4
2,500	273 / 300	250,000	10,000	330	18,584	4
3,000	327 / 400	300,000	13,200	396	22,799	5
3,500	382 / 400	350,000	13,200	396	24,524	5

Table 1-5. 6,000 VAC Cell Specifications (15 Cells Total, 5 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
500	44 / 100	50,000	6,500	222	9,239	1H
800	70 / 100	80,000	10,000	258	11,423	1H
1000	88 / 100	100,000	10,000	258	12,463	1H
1250	109 / 200	125,000	10,000	316	15,791	3H
1500	131 / 200	150,000	13,200	336	17,738	3H
2000	176 / 200	200,000	13,200	336	19,938	3H
2500	220 / 300	250,000	13,200	372	23,915	4H
3000	264 / 300	300,000	13,200	396	24,465	4H

Table 1-6. 6,600 VAC Cell Specifications (18 Cells Total, 6 Cells in Series)

Hp [3]	In [4]/Out [5] Amps	Losses [6] (BTU/Hr)	Req CFM	Length [7] (in)	Weight [8] (lbs)	Cell Size [9]
500	40 / 100	50,000	10,000	282	10,705	1H
800	64 / 100	80,000	10,000	282	12,155	1H
1000	80 / 100	100,000	10,000	282	13,195	1H
1250	100 / 100	125,000	10,000	282	14,615	1H
1500	120 / 200	150,000	13,200	360	18,536	3H
2000	160 / 200	200,000	13,200	384	21,286	3H
2500	200 / 200	250,000	13,200	384	23,136	3H
3000	240 / 300	300,000	13,200	420	27,177	4H
3500	284 / 300	350,000	13,200	420	28,477	4H

[3] Motor nameplate hp may not exceed the drive rated hp.
[4] Drive rated input current is the transformer rated current.
[5] Drive rated output current is the maximum cell current.
[6] BTU/hr losses are based on a loss of 3 kW per 100 hp.
[7] Represents lineup minimum length, subject to change.
[8] Represents estimated minimum weight of lineup, subject to change.
[9] The cell sizes for each hp rating are based on motors with at least 95% efficiency and at least 85% power factor.

1.4. Removing and Installing Cells

To remove or install a cell, refer to Figure 1-8 (on page 1-7) and Figure 1-13 (on page 1-16), then follow the instructions below.

> **Lethal Voltages - DANGER!!** Verify that the input power is fully locked in the off position and that the bus LED on each cell is off. This takes approximately 3 minutes after removal of input power.

1. Disconnect the 3-phase **input connections** at the bottom of F11, F12, and F13. These cable connections are factory placed so that the A, B and C phase connections match the termination designations on the transformer secondary, however individual cell phase sequence is not important to operation.
2. Disconnect the **output** connections between adjacent cells on T1 and T2.
3. Disconnect the **fiber optic** connection on the cell control board.
4. Each cell can be accessed without removing it from the cabinet by extending the slide rails. Detent locks on the slides must be pressed in four locations simultaneously (two on each slide) to remove a cell.

> **Do not** bend or kink the fiber optic cables.

1.5. Features

Additional features of the Perfect Harmony drive include reliability, modular construction, surge arrestors, fiber optic control circuitry, soft start protection, multi-motor operation, high efficiency, dual performance operation modes, trip-free operation, undervoltage ride-through, spinning load restart, cell back-up, on-line diagnostics, power cell check, reports, serial port, keypad, digital display module, advanced diagnostics, English messages, on-line operation while tuning, micro PLC capabilities, and industry standard communication.

1.6. Safety Precautions and Warnings

The Perfect Harmony drives are designed with considerable thought to personal safety. However, as with any piece of high power equipment, there are numerous internal connections that present potentially lethal voltages. In addition, the heat sinks and many other internal components are thermally hot to the touch. The warnings shown below should be followed when working in or near the Perfect Harmony system.

> Always follow the proper lock-out/tag-out procedures before beginning any maintenance or troubleshooting work on the drive.

> **Only** qualified individuals should install, operate, troubleshoot, and maintain this drive. A qualified individual is "one familiar with the construction and operation of the equipment and the hazards involved."

> **Never** touch anything within the Perfect Harmony cabinets until verifying that it is neither thermally hot nor electrically energized.

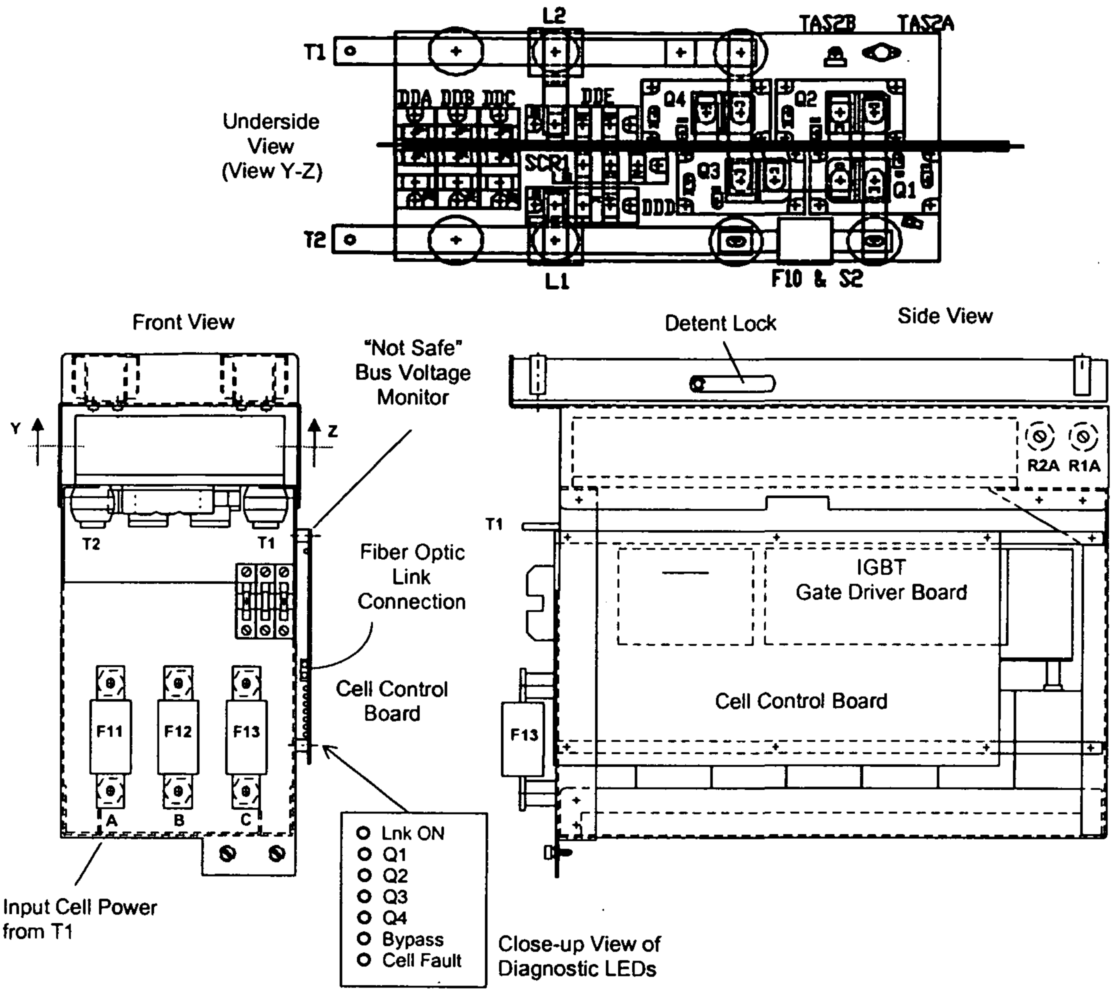

Figure 1-12. Typical Air-cooled Harmony Cell (Top, Side and Front Views)

The Bus Voltage Monitor (shown in Figure 1-12) remains illuminated down to at least 50 VDC.

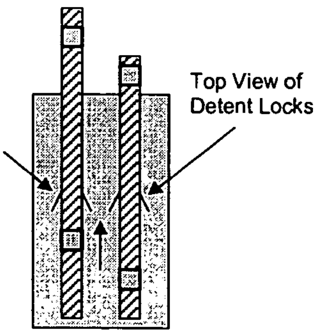

Figure 1-13. Typical Rack Out Power Cell (Top View) Showing Detent Locks

Always work with one hand, wear insulated or rubber safety shoes, and wear safety glasses. Also, always work with another person present.

Never connect any grounded (i.e., non-isolated) meters or oscilloscopes to the Perfect Harmony system.

When transporting the Perfect Harmony drive system, the truck bed must be even and flat. Before unloading, be sure that the concrete pad is level for storage as well as permanent positioning.

When using fork trucks to move the Perfect Harmony drive or its components, be sure to use the lifting tubes designed for this purpose. Never use fork trucks to lift cabinets that are not equipped with lifting tubes. Be sure that the fork truck tines are the appropriate length.

Never connect or disconnect any meters, wiring or printed circuit boards while the drive is energized.

Always be aware of electrostatic discharge (ESD) when working near or touching components inside the Perfect Harmony cabinet. The printed circuit boards contain components that are sensitive to static electricity. Handling and servicing of components that are sensitive to ESD should be done only by qualified personnel and only after reading and understanding proper ESD techniques. The following ESD guidelines should be followed. Following these rules can greatly reduce the possibility of ESD damage to PC board components.

- Make certain that anyone handling the Perfect Harmony printed circuit boards is wearing a properly grounded static strap. The wrist strap should be connected to ground through a 1 megohm resistor. Grounding kits are available commercially through most electronic wholesalers.
- Static charge buildup can be removed from an object by touching the object to a properly grounded piece of metal.
- Always transport static sensitive equipment in antistatic bags.
- When handling a PC board, always hold the card by its edges.
- Do not slide printed circuit boards across any surface (e.g., a table or work bench). If possible, perform PCB maintenance at a workstation that has a conductive covering which is grounded through a 1 megohm resistor. If a conductive tabletop cover is unavailable, a clean steel or aluminum tabletop is an excellent substitute.
- Avoid plastic, Styrofoam, vinyl and other non-conductive materials. They are excellent static generators and do not give up their charge easily.
- Always use a soldering iron that has a grounded tip. Also, use either a metallic vacuum-style plunger or copper braid when desoldering.
- When returning components to ROBICON, always use static-safe packing. This limits any further component damage due to ESD.

Never assume that by switching off the input disconnect, that all of the voltage is removed from inside the cabinet. Voltage is still present on the terminals of the input disconnect. Also, there may be voltages present that are applied from other external sources.

Never remove safety shields (marked with a **HIGH VOLTAGE** sign) or attempt to measure points beneath the shields.

Never store flammable material in, on or near the drive enclosure. This includes equipment drawings and manuals.

Always use extreme caution when handling or measuring components that are inside the enclosure. Be careful to prevent meter leads from shorting together or from touching other terminals.

For safety, **never** run the drive with cabinet doors open. Also, **never** leave the Transformer Cabinet doors open - it reduces cooling to the drive.

Never shut off the blower power and leave the main power on. This may cause the drive to overheat and cause severe damage to the system.

Additional safety precautions and warnings appear throughout this manual. These important messages should be followed to reduce the risk of personal injury or equipment damage.

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CHAPTER 2: DESCRIPTION OF EQUIPMENT

In This Section:

2.1. Introduction

The basic electrical diagrams for all Perfect Harmony systems are similar. One critical component of all Perfect Harmony drives is the *output cell*. Depending on the operating voltages, either 3, 4, 5 or 6 output cells are operated in series to develop the required output operating voltage (refer to Figure 2-1 and Figure 2-2). Table 2-1 provides cell specification details for the Perfect Harmony system.

Table 2-1. Cell Specification Details

Number of Output Cells Per Phase	Line-to-line Voltages (VAC)	Total Number of Cells in Drive (Without Spares)	Hp Range	Available Cell Sizes [1]
3	2,400	9	200-1,750	00, 0, 1, 2, 3, 4, 5
4	3,300	12	300-2,250	00, 0, 1, 2, 3, 4, 5
5	4,160	15	300-3,000	00, 0, 1, 2, 3, 4, 5
5	6,000	15	500-3,000	1H, 3H, 4H
6	4,800	18	400-3,500	00, 0, 1, 2, 3, 4, 5
6	6,600	18	500-3,500	1H, 3H, 4H

[1] - *Additional "high-voltage" cell sizes (denoted with the "H" suffix) will be available in the future.*

2.2. The Cell Control System

All Perfect Harmony cells are controlled in exactly the same manner. The Cell Control Boards reside within the output cell (refer to Figure 2-4 and illustrations in Chapter 1) and accept all communication from the Master Link Boards in the Control Cabinet via fiber-optic links. The IGBT Gate Driver Board (refer to Figure 2-4 and illustrations in Chapter 1) interfaces the cell control board to the IGBT power switches.

Depending on the options ordered with the basic drive, a bypass SCR Driver Board (refer to Figure 2-4 and illustrations in Chapter 1) may also be resident to each cell. This option allows an individual cell to be bypassed due to a fault condition, so that the remaining cells in each series leg can be operated at a reduced (combined) output voltage level. This bypass feature is implemented automatically following a VFD shutdown due to a cell fault condition as long as communication with the cell is maintained.

The Bypass SCR Driver Board is identical for all sizes of Perfect Harmony cells.

Control power for all cell boards is supplied from a switch mode power supply resident on the Cell Control Board.

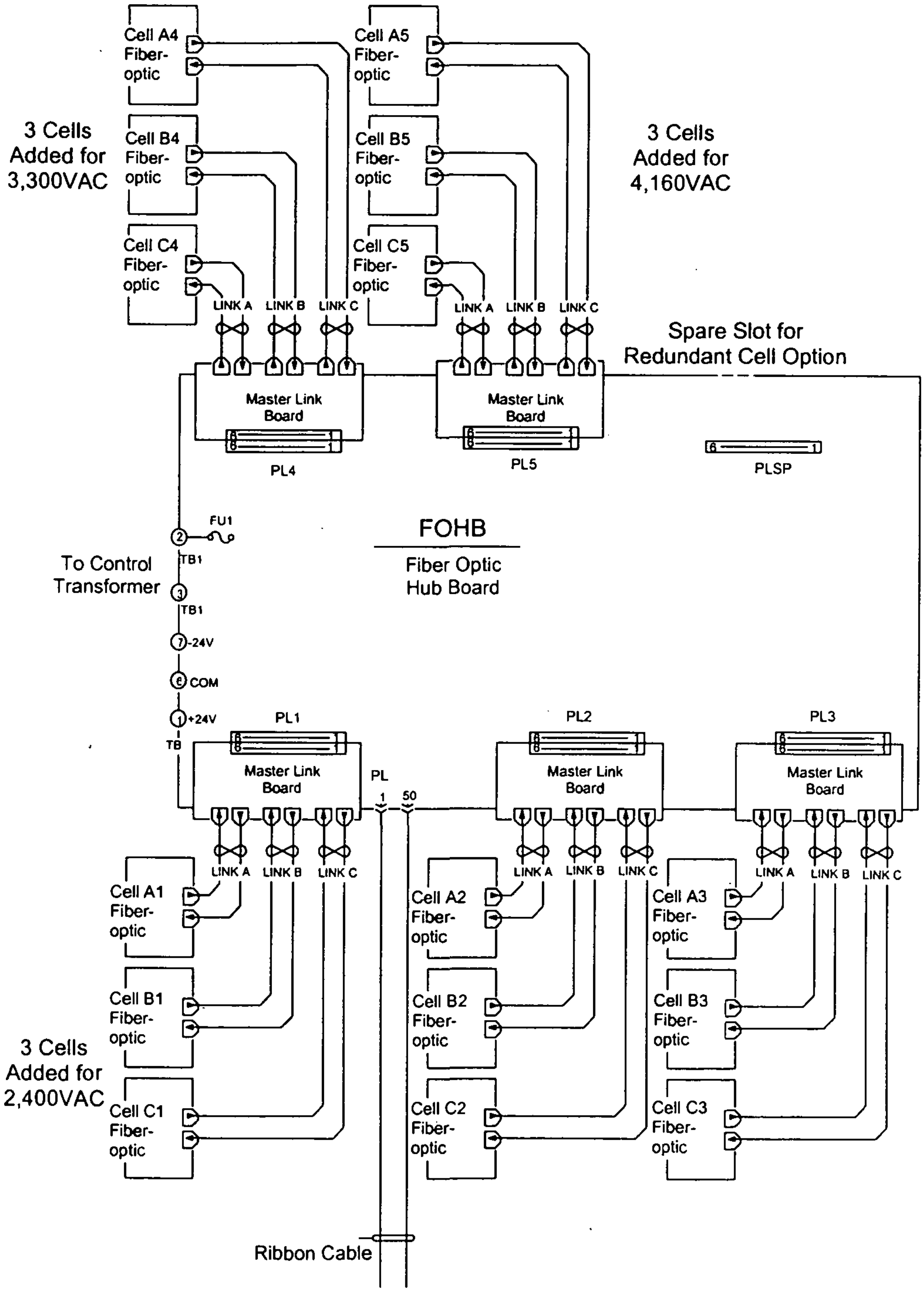

Figure 2-1. Typical HUB Board/Master Link Board Connection Diagram

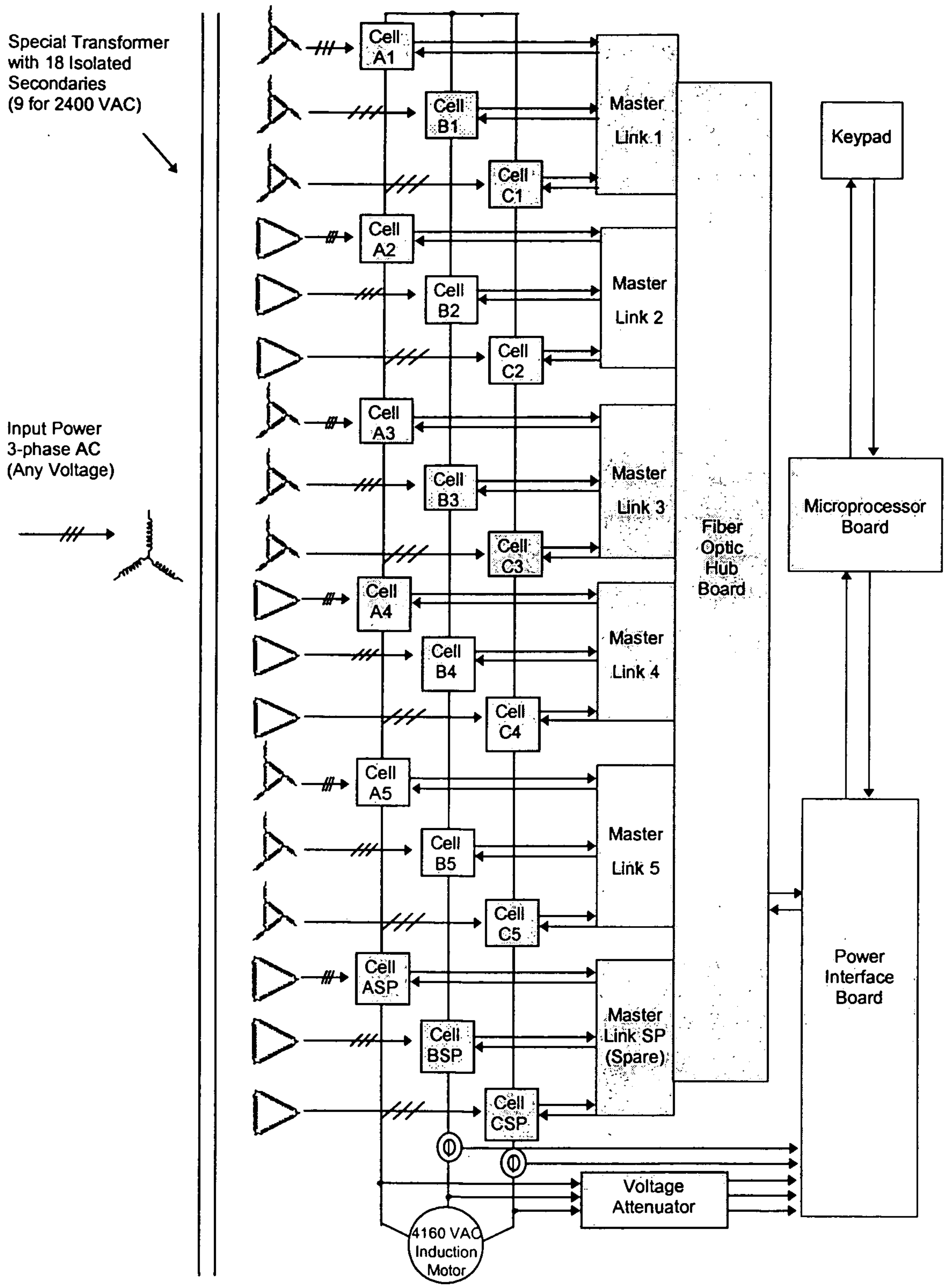

Figure 2-2. Typical Perfect Harmony Power Circuit

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2.3. The Master Control System

The Master Control located within the Control Cabinet consists of three basic component groups. The Power Interface Board contains a "piggy back" Microprocessor Control Board which monitors and controls the overall operation of the system. Control power for both Power Interface Board and Microprocessor Board is supplied from a switch mode power supply on the Power Interface Board. Refer to Figure 2-3 and illustrations in Chapter 1.

Contained on the Microprocessor Board is a "piggy back" System Module, which may be disconnected from the Microprocessor Board if it ever needs to be replaced. The System Module contains all the specific parameter information and system program for the VFD and therefore, allows the Microprocessor Board to be replaced without the need to re-program the VFD.

> **NOTE!!** If the Microprocessor Board is replaced, both the system module (EEPROM) and **IC39** (EPROM) should be moved to the new board (see Figure 2-3).

The communication between the Microprocessor/Power Interface Board group and the individual Cell Control Boards is accomplished by the Fiber Optic Hub Board (FOHB). This board may contain from 3 to 6 plug-in Master Link Boards depending on the output operating voltage of the drive (refer to Figure 2-2 on page 2-3 and illustrations in Chapter 1). These boards contain the fiber-optic transmitter/receiver system used for communication between the cells and the system. A separate switch mode power supply in the FOHB supplies all necessary power to the FOHB and Master Link Boards.

For each line voltage (2,400 VAC through 6,600 VAC), the number of cells per output phase are shown in Table 2-1 on page 2-1. This corresponds to the same number of Master Link Boards that are used by the system. Note that for 2,400 VAC rated systems, 3 Master Link Boards are used. For 3,300 VAC rated systems, 4 Master Link Boards are used.. For 4,160 VAC rated systems, 5 Master Link Boards are used. For 4,800 VAC rated systems, 6 Master Link Boards are used. For 6,000 VAC rated systems, 5 Master Link Boards are used. For 6,600 VAC rated systems, 6 Master Link Boards are used. An extra slot is also available on the Hub Board for an optional redundant cell operating feature. Refer to Figure 2-1 (on page 2-2) and Figure 2-2 (on page 2-3).

> Although each PC slot (**PL1** through **PL5**) on the FOHB is dedicated to particular cell inputs (see Figure 2-1), the five Master Link Boards themselves are identical.

2.4. The Power Circuit

The basic power schematic for a three cell (2,400 VAC) system is shown in Figure 2-2. Besides the direct operating information received from each cell by the Fiber Optic System, input voltage, output voltage, and current are also directly monitored. Input and output voltage information is supplied to the Power Interface Board by an attenuator system consisting of a voltage divider and voltage clamps.

Output motor current is sensed by 2 low burdened 2000:5 ratio CTs placed on output phases B and C. Polarity and burden resistor values must always be maintained.

Each secondary of the power transformer T1 serves one cell only. Each cell receives modulation information through the Fiber Optic System in a way that develops the required output voltage and frequency demanded by the load. Unlike standard PWM systems, the voltage applied to the motor leads is developed in many small steps instead of through a few large steps. This provides two distinct advantages: the voltage stress on the motor leads is dramatically reduced and, the quality of the motor currents is dramatically increased.

> **DANGER!!** Although each cell by itself develops no more than 480 VAC (for low-voltage cells) or 720 VAC (for high-voltage cells), the voltage to ground can increase to the output rating at full speed.

Since each cell is fed from T1 with varying degrees of phase shift (see Figure 2-2), the input VFD current distortion is dramatically reduced. Input power factor is always maintained greater than 0.95 lagging. See Chapter 3 for more information on the theory of operation.

Each Perfect Harmony VFD cell within a specific system is identical. Figure 2-4 depicts the basic schematic for a typical power cell (also refer to illustrations in Chapter 1). Larger and smaller versions of power cells differ in the size or quantity of input diodes, filter capacitors and IGBTs.

At a minimum, each cell contains a Cell Control Board and an IGBT Gate Driver Board. All communication and control for each cell is performed by the Cell Control Board.

Each cell contains a thermal sense unit (**TAS2B**) which senses the heat sink temperature and will allow automatic thermal rollback if a problem develops in the VFD cooling system.

A typical operating interface for the Perfect Harmony series VFD is shown in Figure 2-3. Usually two modes of operation exist. A local mode is available for "Manual" operation. In this mode, on/off and speed setpoint control is available through the keypad controls.

> If certain drive options are ordered, a Panel Expansion Module (PEM) is included with the keypad. If a standard drive is ordered, an SMT keypad is provided.

In auto mode, on/off control is usually accomplished through an external contact connected to the AUX 1 input on the Power Interface Board (PIB). Speed setpoint is usually programmed to use the 4-20 mA analog input on the Power Interface Board (PIB). In both cases, a contact connected to the **CR3** input must be closed in order to enable the VFD.

The **CR1** input is usually configured to accept seal in contacts from external bypass equipment.

> **NOTE!!** All the analog and digital input and output interfaces shown on the PEM and PIB boards of Figure 2-3 can be configured using the system program environment described in Chapter 7 (with the exception of the **CR3** input).

A typical system program which might be written for the system depicted in Figure 2-3 is shown in Chapter 7.

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TB4 Wiring

Cell Size	Rb (ohm)	Jumper
1	3.0	open
2	2.0	open
3	2.0	closed
4	1.0	open
5	1.0	closed
6	2x1.0	open
7	2x1.0	closed

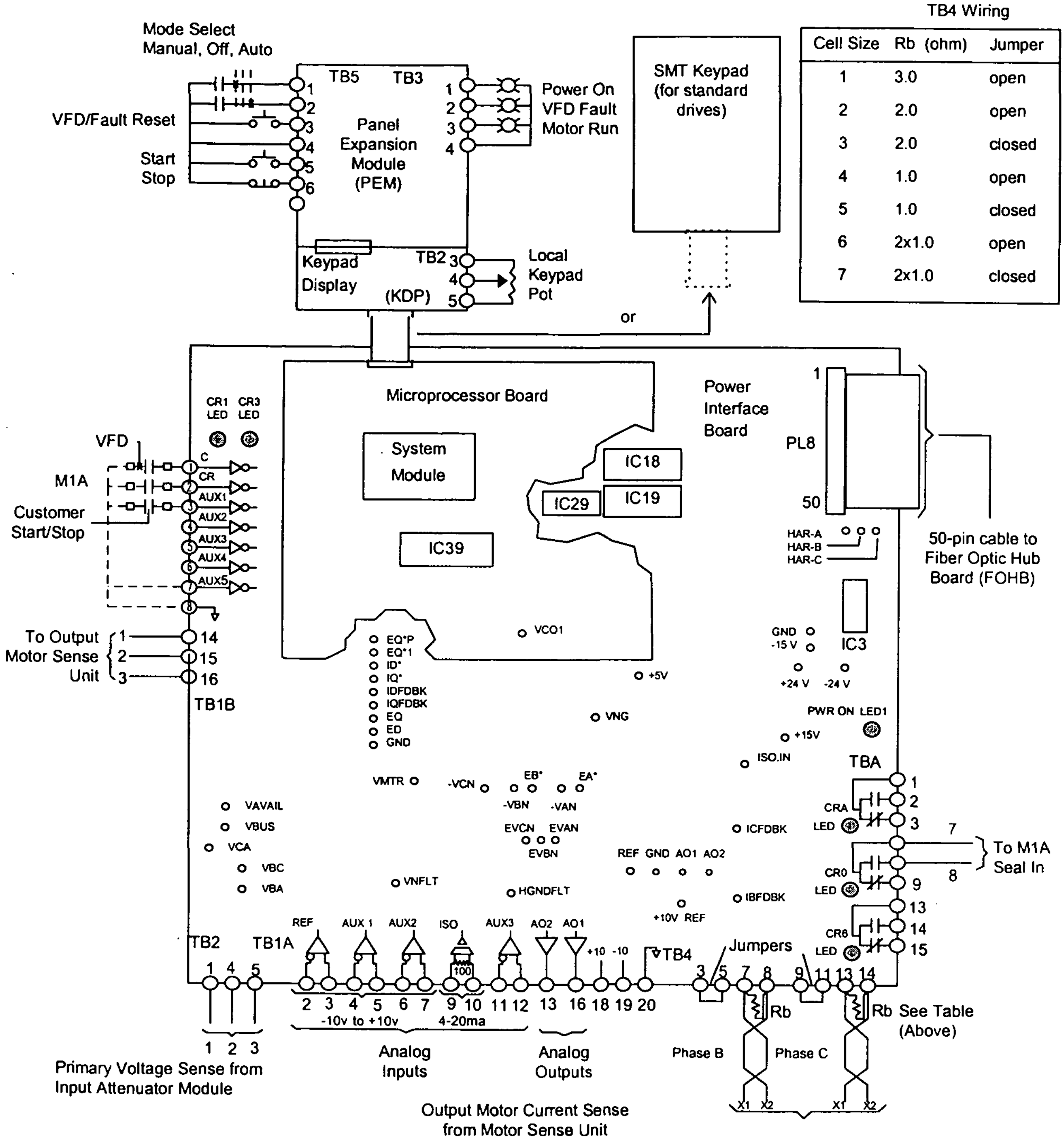

Figure 2-3. Typical System Control Schematic

NOTE: Each semiconductor is shown as one device for simplicity, but may actually be several parallel devices.

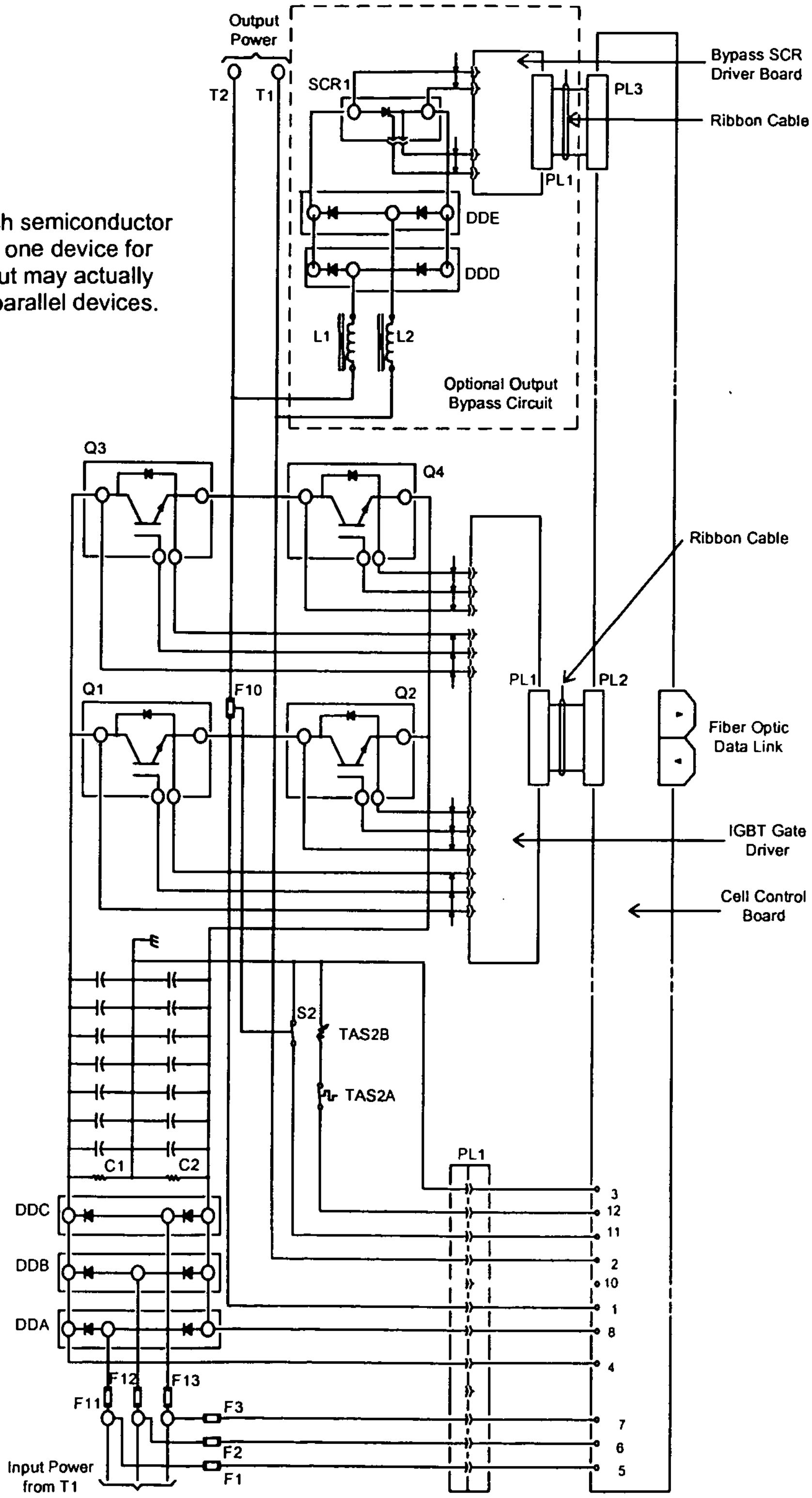

Figure 2-4. Typical Low-voltage Power Cell with Optional Bypass

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2.5. Specifications

Table 2-2 lists common electrical (and mechanical) specifications for all standard Perfect Harmony systems. Note that Perfect Harmony specifications may be changed without notice.

Table 2-2. Common Specifications for Standard Perfect Harmony Systems

Item	Description
Hp range	200-1,750 hp (2,400 VAC) 300-2,250 hp (3,300 VAC) 300-3,000 hp (4,160 VAC) 400-3,500 hp (4,800 VAC) 500-3,000 hp (6,000 VAC)[1] 500-3,500 hp (6,600/7,200 VAC)[1]
Input voltage tolerance	+10%, -5% from nominal 3-phase at rated output
Input power factor	0.95 at all speeds
Output frequency drift	±0.5%
Speed range	0-120 Hz (motor dependent)
Overload capability	110% for 1 minute
Acceleration/deceleration time range	0.5-3,200 sec (load dependent)
Output torque	0-60 Hz variable, 5-60 Hz constant (motor limited)
Enclosure	NEMA 1 ventilated
Ambient temperature	0-40° C
Humidity	95% non-condensing
Altitude	3,300 feet above mean sea level or less
Dust contamination	<100 micron @ 6.5 mg/cu. ft.
Gas contamination	<4 PPB reactive chlorides and sulfides

[1] - *High voltage cells*

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CHAPTER 3: Design Criteria And Process Description

In This Section:

3

3.1. Introduction

The Perfect Harmony series of drives from ROBICON is intended for use with standard medium-voltage three-phase AC induction motors. This type of motor is widely used due to its robust and simple construction, its tolerance for bad environments, and its low cost. However, when operated from the utility supply at a fixed frequency (60 or 50 Hz), the induction motor runs at a single fixed speed. The Perfect Harmony series of drives allows variable speed operation, without sacrificing any of the other desirable properties of the induction motor.

The Perfect Harmony series of drives provides variable speed operation by converting utility power at fixed frequency and fixed voltage to variable frequency, variable voltage power. This conversion is done electronically, without moving parts. Unlike older drive types, the Perfect Harmony series does not force the user to accept unpleasant by-products of this conversion process. Specifically:

- Perfect Harmony drives do not inject significant harmonic distortion into the plant's distribution system. No power filters are required. No interference to sensitive equipment or resonance problems with power factor capacitors will occur.
- Perfect Harmony drives present a high power factor to the utility, typically 95% or better throughout the speed range. No power factor correction is required.
- Perfect Harmony drives do not require any derating of the motor due to output harmonics. No additional motor heating is produced versus operation directly from the utility.
- Perfect Harmony drives do not produce torque pulsations which can excite mechanical resonances.
- Perfect Harmony drives cause no noticeable increase in acoustic noise from the motor, versus operation directly from the utility.
- Perfect Harmony drives cause no appreciable additional stress to the motor insulation, versus operation directly from the utility.
- Perfect Harmony drives allow unrestricted use of rated motor torque throughout the speed range, subject only to the thermal limitations of the motor.

- Perfect Harmony drives are virtually silent in operation if liquid-cooled. If air-cooled, the blower noise is typically less than 75 DBA, so that normal conversation is possible next to drives running at full power.
- Perfect Harmony drives are completely modular in construction, so that if necessary, a defective module can be replaced in minutes. Sophisticated microprocessor-based diagnostics pinpoint the location of any defects.

3.2. Theory - The Power Circuitry

3

> Note: The examples used in this section refer to drives having low-voltage cells. High-voltage cell systems will have different values.

The Perfect Harmony series of drives achieves this uncompromised performance by employing well-proven technology in a new configuration. Medium voltage levels are obtained by adding together the outputs of multiple low-voltage power cells. The low-voltage power cells are simplified variations of standard PWM motor drives, which have been built in high volume for many years.

Figure 3-1 shows the power circuit topology for a 2,400 volt Perfect Harmony series drive. Each motor phase is driven by 3 power cells connected in series. The groups of power cells are wye connected with a floating neutral. Each cell is powered by an isolated secondary winding of an integral isolation transformer. The 9 secondaries are each rated for 480 VAC at one ninth of the total power. The power cells and their secondaries are insulated from each other and from ground for the full output voltage of the drive.

For a 3,300 volt drive, Figure 3-1 would be extended to have 4 power cells in series in each phase, with 12 secondaries on the integral isolation transformer. For a 4,160 volt drive, there would be 5 power cells in series in each phase, with 15 secondaries on the integral transformer.

Each cell is a static power converter. It is capable of receiving input power at 480 VAC 3-phase, 50/60 Hz and delivering that power to a single-phase load at any voltage up to 480 VAC and at any frequency up to 120 Hz.

With 3 power cells in series per phase, a Perfect Harmony series drive can produce as much as 1,440 VAC line-to-neutral. With 5 power cells in series per phase, the drive can produce as much as 2,400 VAC line-to-neutral, or 4,160 VAC line-to-line.

The power cells all receive commands from one central controller. These commands are passed to the cells over fiber optic cables in order to maintain the 5 KV class isolation.

The transformer secondaries that supply the power cells in each output phase are wound to obtain a small difference in phase angle between them. This cancels most of the harmonic currents drawn by the individual power cells, so that the primary currents are nearly sinusoidal. The power factor is always high - typically 95% at full load.

The schematic of a typical power cell is shown Figure 3-3. In this example, a 3-phase diode rectifier, fed by the 480 VAC secondary, charges a DC capacitor bank to about 600 VDC. The DC voltage feeds a single-phase H-bridge of IGBTs.

At any instant of time, each cell has only three possible output voltages. If Q1 and Q4 are on, the output will be +600 volts from T1 to T2. If Q2 and Q3 are on, the output will be -600 volts. Finally, if either Q1 and Q3 or Q2 and Q4 are on, the output will be 0 volts.

With 3 power cells per phase, the circuit of Figure 3-3 can produce 7 distinct line-to-neutral voltage levels (±1800, ±1200, ±600, or 0 volts). With 5 cells per phase, 11 distinct voltage levels are available. The ability to generate many different voltage levels allows the Perfect Harmony to produce a very accurate approximation to a sinusoidal output wave form.

Figure 3-2 shows how these wave forms are generated for the case of 3 cells per phase. First, a reference signal is created for each phase. These signals are scaled-down replicas of the ideal wave form to be approximated. In Figure 3-2, **RA** is the reference signal for phase A. This reference signal is then compared with 3 triangular carrier signals, oscillating at 600 Hz. Figure 3-2 shows conditions when the output frequency is 60 Hz, so that there are exactly 10 carrier cycles per reference cycle. The 3 carriers are identical except for successive phase shifts of 60 degrees (based on the carrier frequency). Phase shift is computed based on the following equation.

Phase Shift = (180 degrees) / (# of cells per phase)

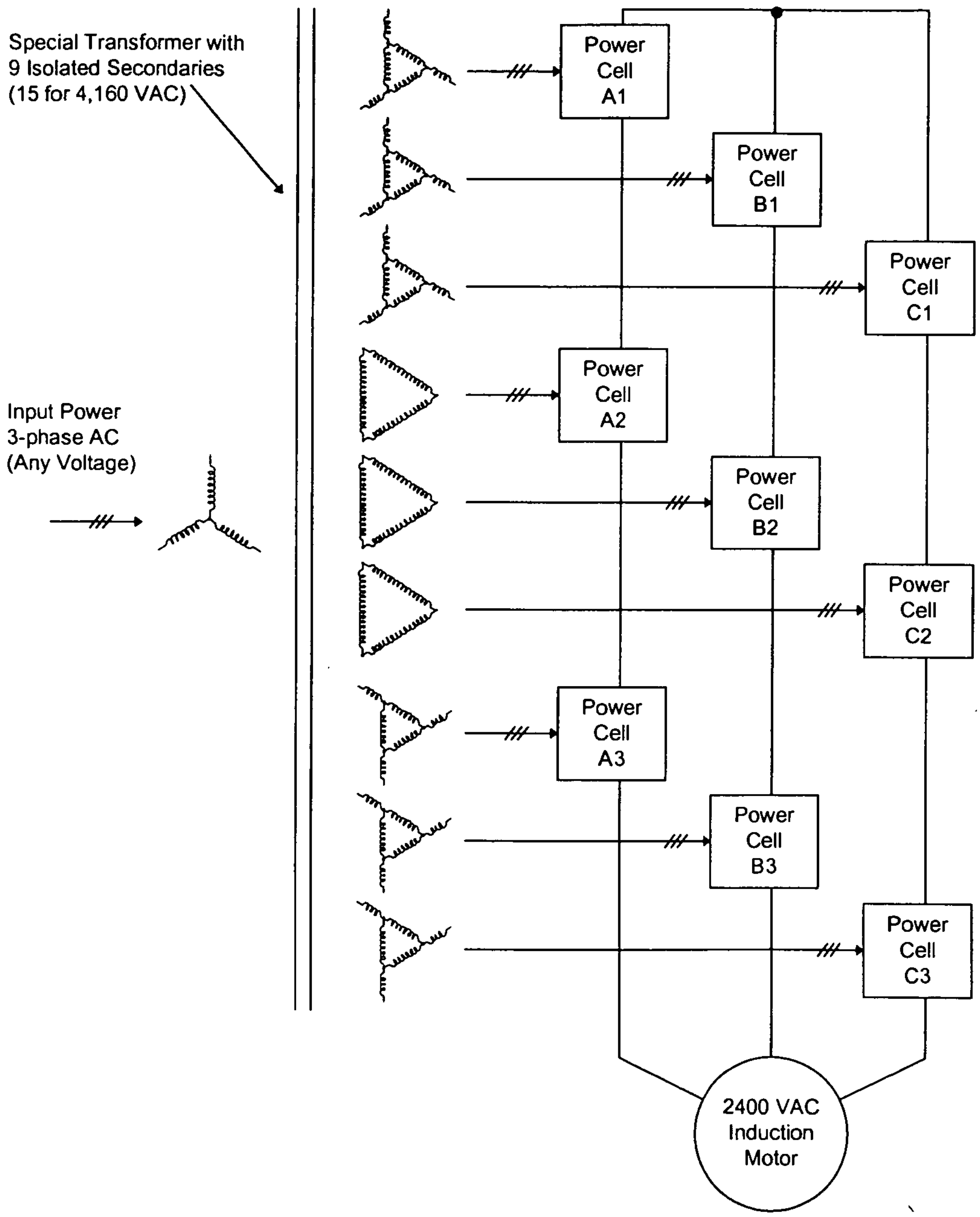

Figure 3-1. Topology of Perfect Harmony VFD (3 Cells, 2,400 VAC)

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Whenever the reference is greater than the first (unshifted) carrier, the signal **L1** is high; otherwise **L1** is low. **L1** is used to control the pair of transistors **Q1** and **Q2** in cell **A1** (see the left pair of transistors in Figure 3-3). Whenever the reference is greater than the inverse of the first carrier, the signal **R1** is low; otherwise **R1** is high. **R1** is used to control the pair of transistors **Q3** and **Q4** in cell **A1** (see the right pair of transistors in Figure 3-3).

The difference between **L1** and **R1** gives the output wave form of cell **A1**, shown in Figure 3-2 for Phase A as **A1**.

In a similar manner, the reference signal is compared with the second carrier (shifted 60 degrees) and its inverse to generate control signals **L2** and **R2** for the transistors in cell **A2**. The output wave form of cell **A2** is shown as **A2**.

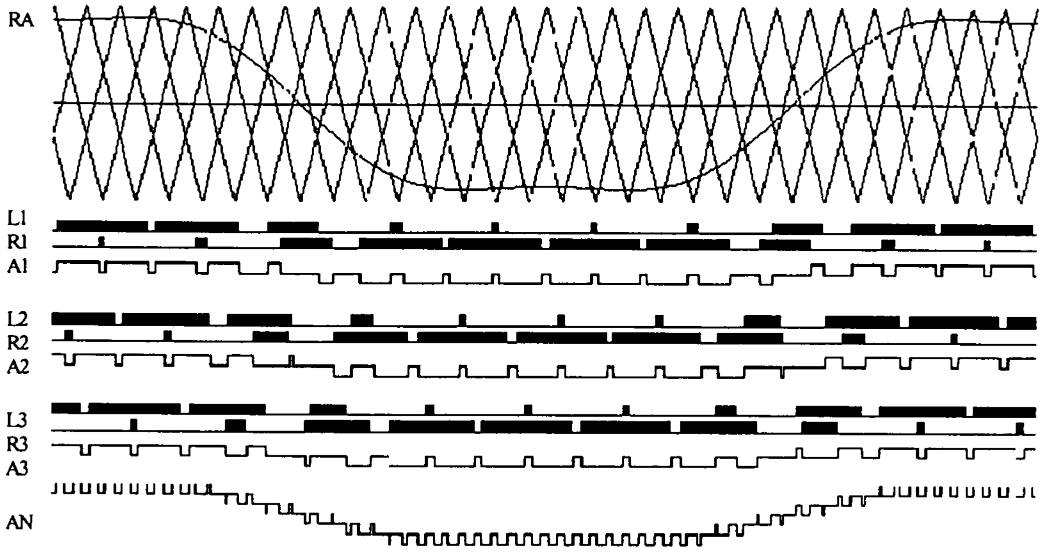

Figure 3-2. Wave Forms for Phase A

Finally, the reference signal is compared with the third carrier (shifted 240 degrees) and its inverse to generate control signals **L3** and **R3** for the transistors in cell **A3**. The output wave form of cell **A3** is shown as **A3**.

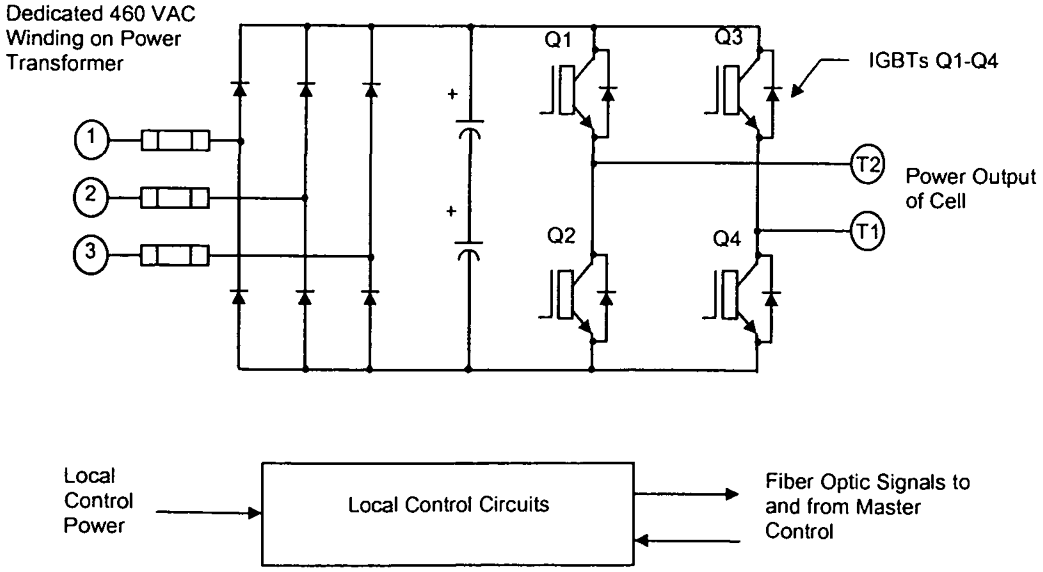

Figure 3-3. Schematic of a Typical Power Cell

The sum of the output voltages from cells **A1**, **A2** and **A3** produces the A-to-neutral output voltage of the drive, shown in Figure 3-2 as **AN**. There are seven distinct voltage levels. Note that this voltage is defined between terminal A and the floating neutral inside the drive, not the motor neutral.

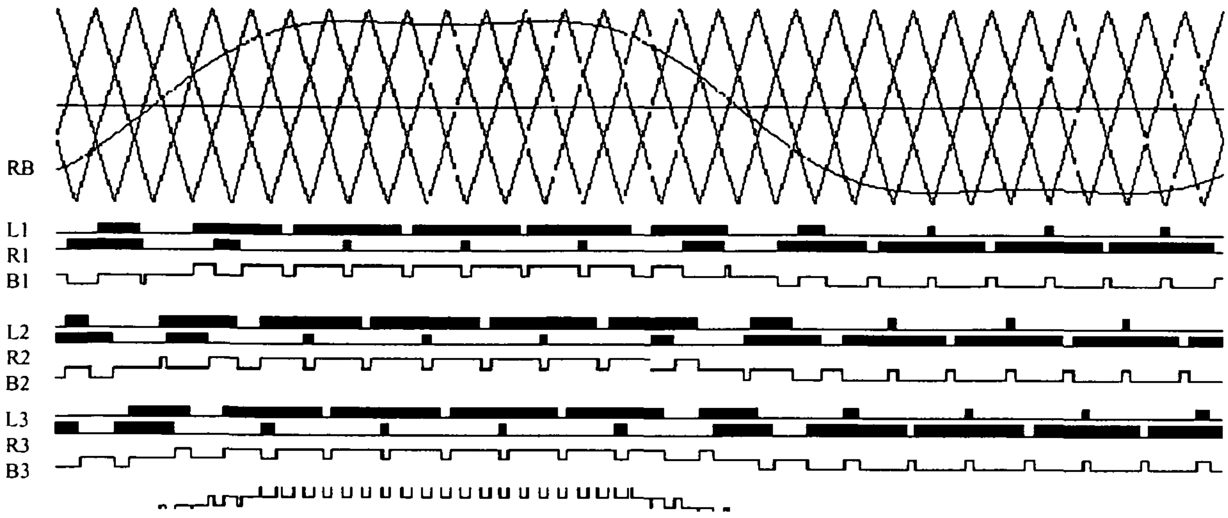

Figure 3-4. Wave Forms for Phase B

Figure 3-4 shows the same signals for Phase B. The 3 carriers are identical to Figure 3-2. The reference **RB** is also identical to Figure 3-2, except that it is delayed by 120 degrees (at the reference frequency).

The sum of the output voltages from cells **B1**, **B2** and **B3** produces the B-to-neutral output voltage of the drive, shown in Figure 3-4 as **BN**.

Figure 3-5 repeats the two line-to-neutral voltages **AN** and **BN**. The numerical difference between **AN** and **BN** forms the line-to-line voltage impressed on the motor, and is shown in Figure 3-5 as **AB**.

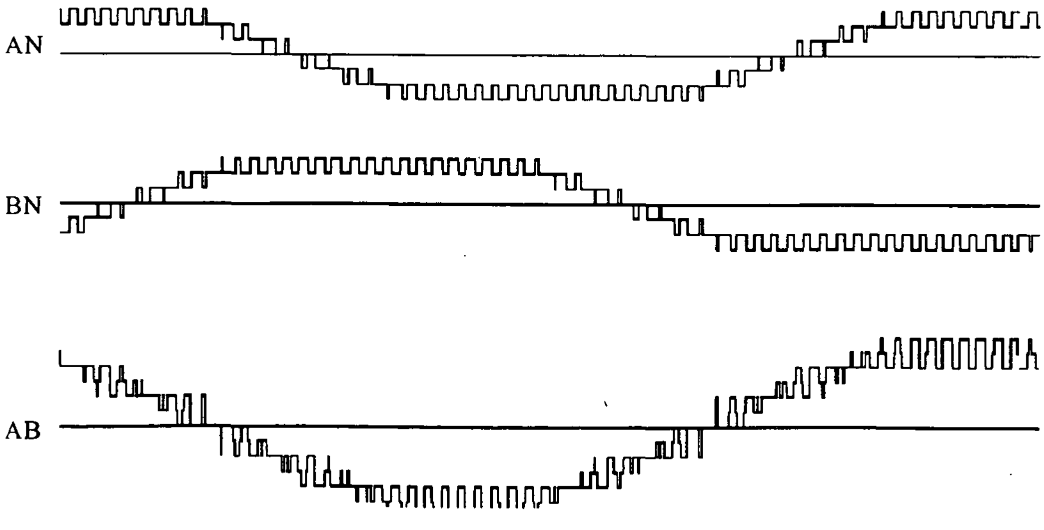

Figure 3-5. Wave Forms for Line-to-line Voltage

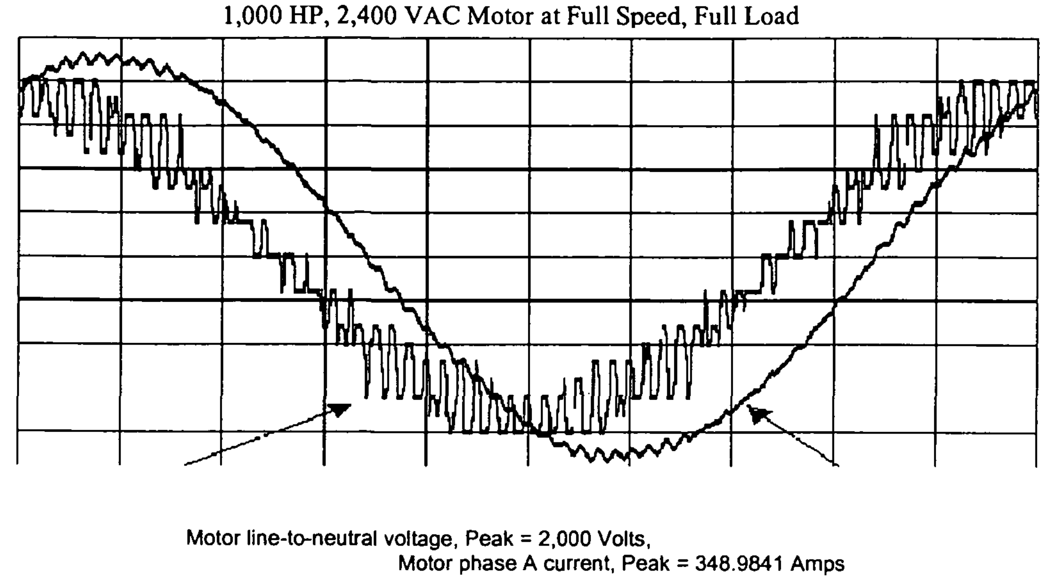

Figure 3-6. Perfect Harmony Output Wave Forms, 2,400 Volt Drive at Full Load

Figure 3-6 shows motor voltage and current wave forms for a 2,400 VAC Perfect Harmony drive rated at 1,000 hp. The voltage shown is between phase A and the motor neutral (not the same as the drive neutral). The motor current is in phase A during full-load operation. Anyone familiar with such wave forms for other types of static drives will appreciate how accurately they approximate true sine waves. A quantitative measure of the wave form quality is its Total Harmonic Distortion, or THD. The THD of the motor currents with a Perfect Harmony series drive is always less than 5 percent.

Figure 3-7 shows the input voltage and current wave forms for the same drive as in Figure 3-6, under the same conditions. The perfect sine wave in Figure 3-7 is the voltage into the special input transformer, measured between phase A and the neutral of the wye-connected primary. The other wave form is the current into phase A of the same winding.

The currents drawn from the power source by the Perfect Harmony are also good approximations to true sine waves, due to the harmonic cancellation obtained with the phase-shifted secondary windings of the transformer. The THD of the input currents with a Perfect Harmony series drive is also always less than 5 percent.

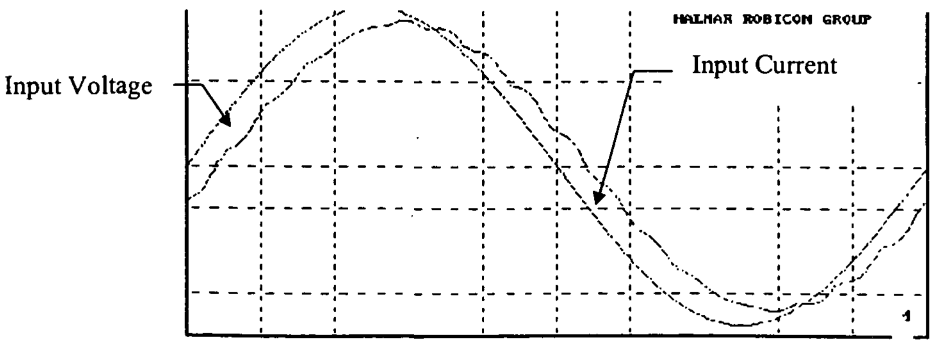

Figure 3-7. Input Wave Forms for a 2,400 Volt Drive at Full Load

Note in Figure 3-7 that the input current lags behind the input voltage by less than 15 degrees at full load. This represents a power factor better than 96 percent. Perfect Harmony drives always maintain a high power factor, typically better than 95 percent throughout the speed and load range.

The wave forms shown in Figure 3-3 through Figure 3-7 represent the worst case for a Perfect Harmony series drive when there are only 3 cells per phase. When the number of cells increases, as in 3,300 volt drives and higher, the wave forms become considerably better. Figure 3-8 shows the motor voltage and current for a 4,160 volt Perfect Harmony drive at full power, while Figure 3-9 shows the input voltage and current for the same drive and load.

Figure 3-8. Motor A-B Voltage and Current in Phase C at Full Load for a 4,160 Volt Perfect Harmony Drive

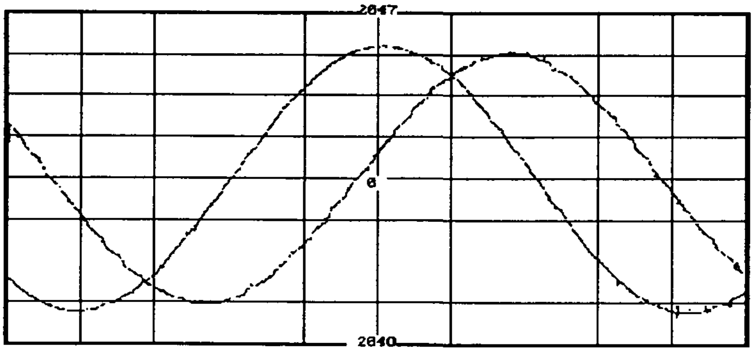

Figure 3-9. Input A-B Voltage and Current in Phase C at Full Load for a 4,160 Volt Perfect Harmony Drive

The block diagram in Figure 3-10 shows how the Perfect Harmony control circuits are organized. The power cells receive commands and return status information via duplex fiber optic cables, using serial communication at a speed of 5 MBaud. The local communication circuits in each power cell are slaves, and only transmit in response to an incoming message. These messages originate on one of the Master Link Boards, which can initiate a transmission. Each Master Link Board has 3 communication channels and controls 3 power cells, one in each output phase. The 3 power cells connected to one Master Link Board have all the same stage number. Master link #1 controls power cells **A1**, **B1** and **C1**, while master link #2 controls power cells **A2**, **B2** and **C2**, and so forth.

The Master Link Boards all plug into a single motherboard called the Fiber Optic Hub Board. The Hub Board has slots for as many as 6 Master Link Boards, which will accommodate a 4,160 VAC drive with spare cells as shown. Drives with fewer than 18 power cells will have one or more vacant slots on the Hub Board.

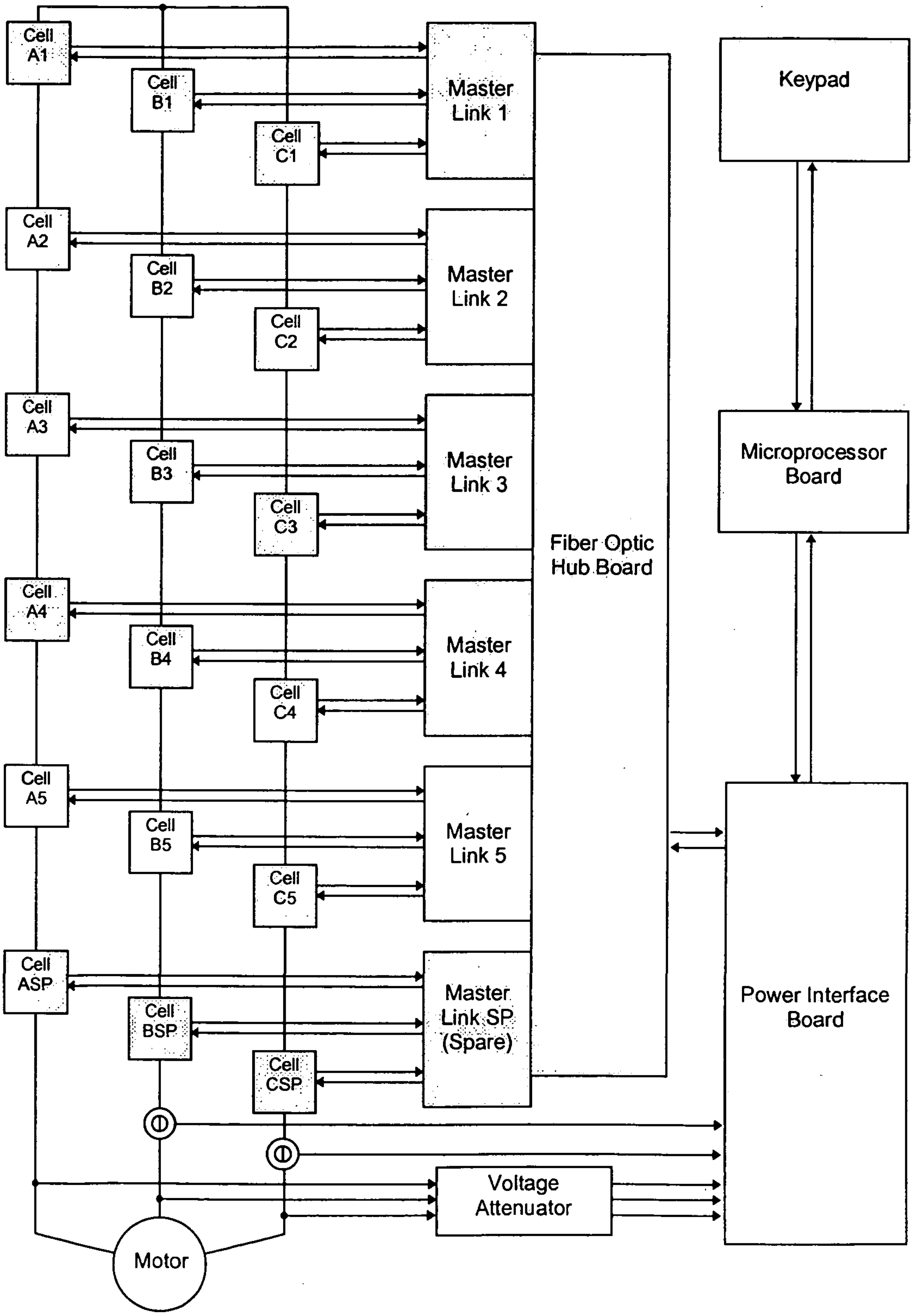

Figure 3-10. Block Diagram of Perfect Harmony Control Structure for 4,160 V Drive with Spare Cells

The Hub Board provides +5 volt DC power to the Master Link Boards, and also a set of timing signals derived from a crystal oscillator. These timing signals cause all of the Master Link Boards to transmit simultaneously, once every 10.4 microseconds. The transmitted message contains 11 bits (2 start bits, 8 data bits, and 1 stop bit), and is delivered in less than 4 microseconds. The power cells then send back a similar message in response, which arrives within an additional 4 microseconds. During the remaining 2.4 microseconds, the Master Link Boards check that every transmission is complete, and has the correct parity. If an error is detected a link fault is generated.

For a 4,160 volt drive with 5 power cells per phase, there are 5 pairs of carrier waves displaced by multiples of 36 degrees. For a 2,400 volt drive with 3 power cells per phase, there are 3 pairs of carrier waves displaced by multiples of 60 degrees. The carrier waves are compared with reference signals to generate PWM control signals for the power cells.

The Hub Board also contains several digital registers, which store data determining the drive configuration. Such data include (1) the phase displacement needed for the carrier waves, (2) the power cells that have been bypassed, and (3) which power cells are being replaced by spares.

The Hub Board contains a multiplexing scheme that allows the microprocessor to interrogate each power cell in sequence, for diagnostics.

The Hub Board connects by ribbon cable to the Digital Vector Control Board, which in turn connects to the Analog Vector Control Board and the Microprocessor Board. The Analog Vector Control Board collects analog feedback signals, such as the motor voltages and currents.

3

3.3. Multiple Motors

Perfect Harmony drives can be used to control multiple motors. Such applications are used to proportionally control a series of motors one motor at a time.

Consider the following example. A reservoir is being filled with liquid at an unknown, variable rate. Up to three pumps can be used to remove the liquid to keep the reservoir level at a certain setpoint (this is the external process). As the external system error (i.e., the positive or negative deviation from the setpoint) continues for an external process (e.g., the feedback value rises above a setpoint value), the first motor (a pump, for example) is controlled by the drive to attempt to correct the error and bring the reservoir level back to its setpoint level. If the error from the external process continues (i.e., the reservoir level remains above its setpoint value), the first pump may be unable to reach or maintain the level setpoint - even at 100% speed. If this occurs, the first pump is smoothly transferred to line voltage (at 100% speed), and the drive begins to control a second pump. If the error of the external process remains, the second pump can then be operated in addition to the first pump (at 100%) using straight line voltage, while a third motor is brought on line and controlled by the drive. This transfer of drive control from one motor to the next can occur with a single Perfect Harmony drive and any number of motors. Refer to

Figure 3-11.

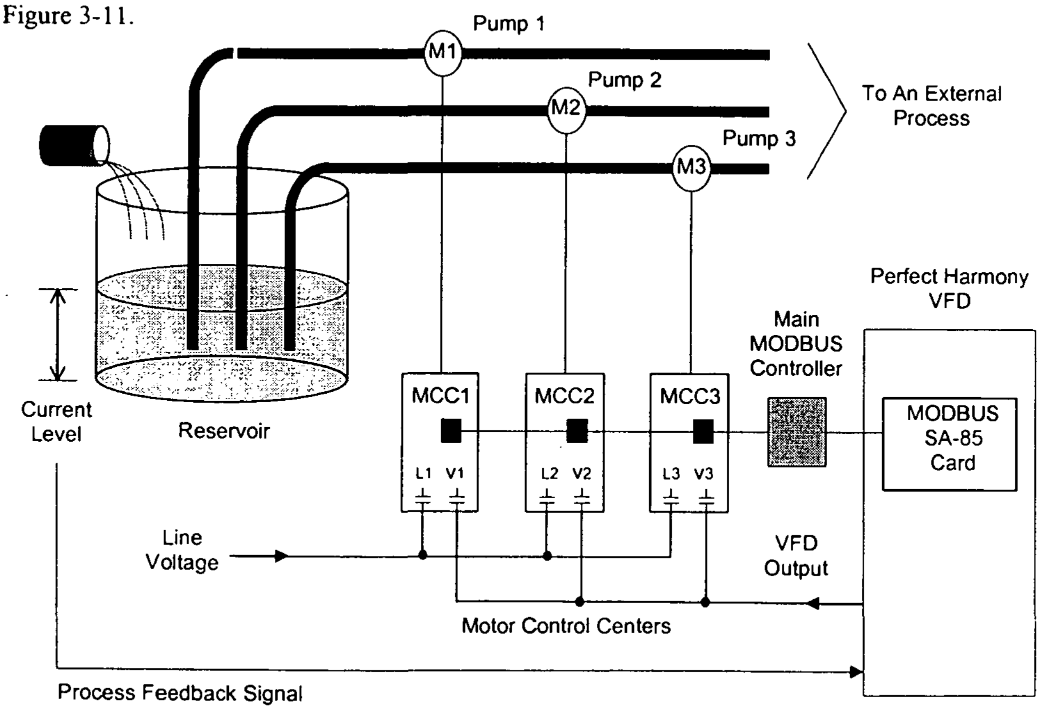

Figure 3-11. Overview of a Sample Transfer Application

Figure 3-11 shows a reservoir being emptied by pumps 1, 2 and 3 (which use induction motors M1, M2 and M3, respectively). As the tank fills past the setpoint level (monitored by an external feedback signal), the drive controls motor M1 (via motor control center MCC1) to maintain the level. As the tank level continues to increase, the motor on pump 1 will eventually reach 100% speed. If the tank level continues to increase, the Perfect Harmony initiates an "up transfer". This process involves electronically switching control of motor M1 to line control (rather than VFD control). This process is done smoothly using a serial communications network (MODBUS Plus protocol) and a pair of electronically controlled contactors (L1 for line control and V1 for VFD control). With motor M1 running at 100% (line voltage), motor M2 (on pump 2) is switched from an idle state into VFD control using PLC commands and contactor V2. This process continues with additional motors until the external process feedback indicates that the tank level is at its setpoint. This entire process works in the reverse order (called a "down transfer") when a negative error occurs (i.e., the feedback signal shows that the measured value is below the setpoint value). An "up transfer" process is illustrated graphically in Figure 3-12. A "down transfer" process is illustrated graphically in Figure 3-13. These graphs show motor output percentages as functions of time with either continued demand (positive error) for "up" transfers or no demand (negative error) for "down" transfers.

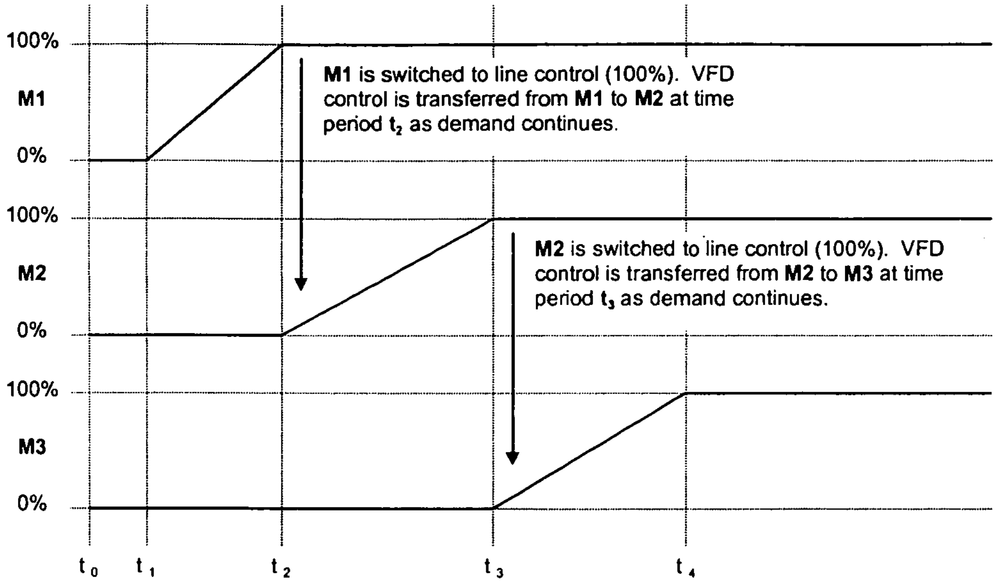

Figure 3-12. Graphical Representation of a Sample "Up Transfer" with Continued Demand

Note that the graphs in Figure 3-12 and Figure 3-13 show very "clean" proportional ramps. These ramps are for illustration purposes only and do not include any integral or derivative control action. A continued demand throughout time period t_4 is assumed in Figure 3-12 and no demand is assumed throughout time period t_0 in Figure 3-13. An overview of the control states of the motors used in example Figure 3-12 is given in Table 3-1. A similar overview for Figure 3-13 is given in Table 3-2.

> The state machines for up and down transfers reside in the Perfect Harmony's control program. These interface with the control system integrator's PLC network via the VFD system operating program to handle handshaking between each motor control center (MCC) and the VFD. All controls for the VFD and line reactors are controlled from the system integrator's PLC.

Table 3-1. Control States of Motors in a Sample "Up Transfer"

Time	M1	M2	M3
T_0	VFD (0-100%)	Off (0%)	Off (0%)
T_1	VFD (0-100%)	Off (0%)	Off (0%)
T_2	Line (100%)	VFD (0-100%)	Off (0%)
T_3	Line (100%)	Line (100%)	VFD (0-100%)
T_4	Line (100%)	Line (100%)	VFD (100%)

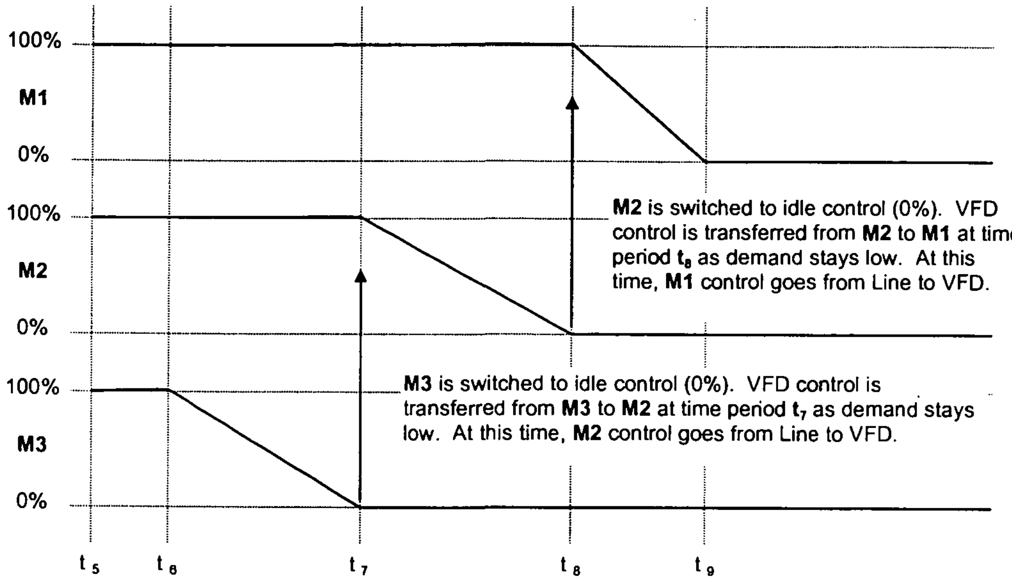

Figure 3-13. Graphical Representation of a Sample "Down Transfer" with No Demand

Table 3-2. Control States of Motors in a Sample "Down Transfer"

Time	M1	M2	M3
T_5	Line (100%)	Line (100%)	VFD (100%)
T_6	Line (100%)	Line (100%)	VFD (100-0%)
T_7	Line (100%)	VFD (100-0%)	Off (0%)
T_8	VFD (100-0%)	Off (0%)	Off (0%)
T_9	VFD (100-0%)	Off (0%)	Off (0%)

3.4. The PLC Interface

All VFD control is accomplished over a RS485 serial communications network using a supported communications protocol (e.g., Modicon Corporation's MODBUS Plus communications protocol). For example, a Modicon-compatible PLC interface is located at each motor control center. These PLCs are networked to a main MODBUS controller (e.g., a PC) and a Modicon SA-85 communications board on the Perfect Harmony drive. Refer to Figure 3-14.

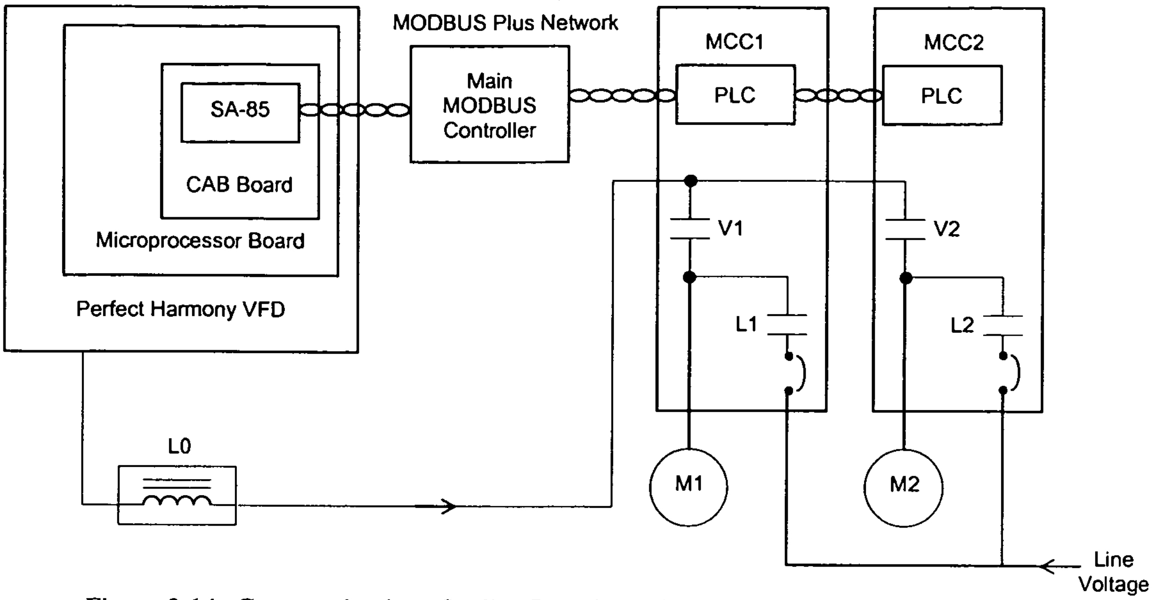

Figure 3-14. Communications Outline Drawing using a Modbus Plus Network Configuration

PLC interface refers to Modicon's MODBUS Plus Serial interface only.

3.5. The "Up" Transfer (from VFD to Line Control)

The "up" transfer process (refer to Figure 3-12) consists of the following steps.

1. The Modbus PLC issues a request for an "up transfer" by setting *upxfer_req_f* to true.
2. The VFD ramps to 60 Hz.
3. The Modbus PLC enables the Perfect Harmony VFD to synchronize its output to the line frequency.
4. The Perfect Harmony drive issues a *do_up_xfer_f* command to the Modbus PLC.
5. The PLC closes the line contactor (e.g., L1).
6. The PLC sends a signal to the VFD indicating the line contactor (e.g., L1) is closed.
7. The VFD receives the line contactor signal and sends an *upxfer_complete_f* message to the Modus PLC.
8. The PLC disables the *upxfer_req_f* input.
9. The PLC disables the VFD by removing the *run_req_f* input signal.
10. The PLC clears the "line contactor closed" signal to the VFD.
11. New motor parameters are loaded through the Modicon PLC interface for the next operation (or stays idle).

3.6. The "Down" Transfer (from Line to VFD Control)

The "down" transfer process consists of the following steps.

1. The Modicon PLC loads the correct motor parameters into the drive system.
2. The Modicon PLC issues *dnxfer_req_f*.
3. The Perfect Harmony VFD ramps to 60 Hz open circuit.
4. The Modbus PLC enables the Perfect Harmony VFD to synchronize its output to the line frequency.
5. The Perfect Harmony drive issues a *do_dn_xfer_f* command to the PLC.
6. The VFD contactor (e.g., V1) is closed by the PLC.

7. The PLC sends a signal to the VFD indicating the VFD contactor (e.g., V1) is closed.
8. The PLC checks the status of the VFD fault signal.
9. The line contactor (e.g., L1) is opened.
10. The PLC removes the *dnxfer_req_f* flag.
11. The VFD sends the *dnxfer_complete_f* message to the PLC.
12. The VFD follows the process setpoint from the PLC.

3.7. Required Signals

Table 3-3 lists descriptions of signals that are required for synchronous transfer operation. Table 3-4 lists required program flags with their respective functions.

3

Table 3-3. Required Signals and Descriptions

Signal	Description
Upxfer_req_f	Input signal from PLC used to request transfer from VFD to Line.
Dnxfer_req_f	Input signal from PLC used to request transfer from Line to VFD.
Vfd_con_ack_f	Input from PLC to indicate that the VFD output contactor is closed.
line_contactor_ack_f	This contact closes during the up transfer sequence to indicate the line contactor for the motor being driven from the VFD has closed. This signal needs to be masked for multiple motor applications.
Do_up_xfer_f	This will indicate that the VFD is running in sync with the line sync signal and is ready to transfer the motor to the line.
Do_dn_xfer_f	This will indicate that the VFD is running in sync with the line sync signal and is ready to transfer the motor to the VFD.

Table 3-4. Program Flags and Descriptions

Flag	Reference Address	Function
Upxfer_req_f	2042 0 1	Begins a closed up transfer
Dnxfer_req_f	2044 0 1	Begins a closed down transfer
Xfer_flt_rst_f	2250 0 1	Transfer fault reset
Upxfer_flt_f	2252 0 1	Up transfer fault flag
Upxfer_timeout_f	2254 0 1	Up transfer time-out flag
Do_up_xfer_f	2256 0 1	Up transfer output flag
Dnxfer_flt_f	2258 0 1	Down transfer fault flag
Do_dn_xfer_f	225A 0 1	Down transfer output flag
Dnxfer_timeout_f	225C 0 1	Down transfer time-out flag
Upxfer_complete_f	2270 0 1	Up transfer complete flag
Dnxfer_complete_f	2272 0 1	Down transfer complete flag
Line_con_ack_f	225E 0 1	Line contactor closed flag
Vfd_con_ack_f	226E 0 1	VFD contactor closed flag

3.8. Additional Parameter Descriptions

Transfer Menu (200) is used exclusively for synchronous transfer applications. The menu items and descriptions for this menu are listed in Table 3-5. This information is also available in Chapter 3 of this manual.

Table 3-5. Transfer Menu (200)

Parameter	Range (Min, Max)	Default Value	Description	Sec. Level	HMPD Codes
Phase I gain	0, 15	1	Specifies the integral gain of the phase lock loop. The speed at which the drive will integrate the phase error is determined by the following calculation: Phase I Gain * 1/T where T is the sampling rate (e.g., 2.7 ms).	7	1000
Phase P shift	1, 12	8	Specifies the proportional gain of the phase lock loop. The proportional term is determined using the following equation: $(0.5)^{\text{Phase P Shift}}$ (0.5 raised to the "Phase P Shift" power).	7	1000
Phase offset	0.0, 180.0	0.0 deg	Specifies the phase angle setpoint expressed in degrees leading.	7	1000
Hardware offset	-180.0, 180.0	0.0 deg	Correction factor for aligning synchronization (+ is leading, - is lagging).	7	1000
Phase error threshold	0.0, 5.0	0.0 deg	Specifies the phase synchronization error. This parameter adjusts the amount of error allowed and is expressed in degrees.	0	0001
Line sync source	0, 2	0	This parameter specifies the hardware line synchronization interrupt: 0 - Off 1 - Local 2 - Remote 3 - Microprocessor Board.	7	1001

∇ ∇ ∇

CHAPTER 4: INSTALLATION AND PRECOMMISSIONING

In This Section:

4.1. Introduction

IMPORTANT! Before installing the Perfect Harmony drive, be sure to read and understand the Installation Practices section that follows.

When installing Perfect Harmony drives, it is essential to understand the proper techniques associated with the following procedures.

- Receiving
- Shipping splits
- Off-loading
- Weight estimates
- Handling
- Location
- Anchoring
- Re-connecting wiring.

Each of these procedures is discussed in the sections and subsections that follow.

4.2. Installation Practices

4.2.1. Receiving

The proper receiving procedure consists of the following steps:

- Verify that the proper items have been shipped
- Inspect all shipments for damage that may have occurred during shipping
- File a claim with the shipping carrier if any damage is present.

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NOTE: Depending on cell size, wood shipping blocks may be mounted between the cell support structure and the cells. These should be removed during installation.

4.2.2. Shipping Splits

A typical Perfect Harmony drive consists of a transformer, power cells, and a control cabinet. Usually the transformer is shipped as a separate component. The power cells and control cabinets are usually shipped bolted together as a single component.

The number and sizes of shipped Perfect Harmony components may vary based on the ratings of the drive and included options. Some small VFDs are shipped as a single cabinet.

The Cell Cabinet and Control Cabinet are usually shipped as a single cabinet. All low voltage connections between Control and the Transformer and Bypass sections are via the cable way located at the top of the Cell Cabinet.

4.2.3. Off-loading

Due to the size and weight of Perfect Harmony components, it is important to carefully plan all handling operations. Off-loading from the truck is often the most critical operation because of the limited access. Advance planning and coordination between the manufacturer, the carrier, the installation contractor, and the owner are vital.

4.2.4. Weight Estimates

Because the Perfect Harmony drive system is a customizable system, exact weights of systems will vary based on the ratings of the drive and included options. However, approximate dimensions and weight estimates for Perfect Harmony drives are given in tables in Chapter 1.

4.2.5. Handling

Perfect Harmony enclosures are provided with heavy duty base structures that contain transverse tubes to accept fork-lift tines. There are four possible methods of handling cabinets that contain fork lift tubes:

- Overhead Crane Lifting
- Fork Lift Truck Lifting
- Roller Dollies
- Pipe Rollers.

These methods are summarized below.

> **DANGER!!** Never attempt to support the Transformer Cabinet using only the upper cabinet structure. Never use eyebolts for lifting any cabinets.

> **CAUTION!!** The Transformer Section has female threads in the four top corners for lifting eye bolts (not provided). These are used in the factory to handle the empty cabinet only. They are not capable of lifting the assembled transformer.

> The Perfect Harmony drive contains many cable entry and exist locations. Refer to the system drawings supplied with the drive for complete details.

4

- Overhead Crane Lifting - The best method if an overhead crane is available is to pass fabric slings through the base tubes, and lift as shown in Figure 4-1. Key points are the length and strength of the slings. The slings must be long enough that the crane hook is at least 4 feet above the enclosure top to prevent buckling of the drive cabinets. If this distance cannot be maintained, spreader bars of appropriate strength must be used. The strength of the slings must be adequate for the weight given on the drawings (or estimated in Chapter 1).

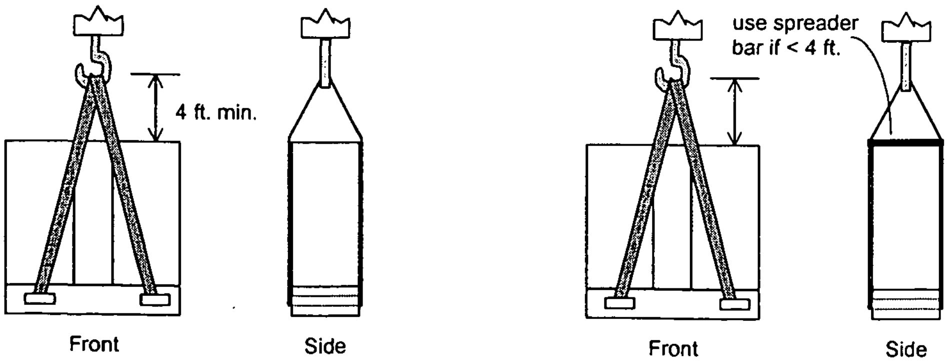

Figure 4-1. Proper Handling Using the Sling Lifting Technique

- Fork Lift truck - A second handling method is to use a suitable fork lift truck. The truck must be rated for the weight to be lifted. The tines of the truck must be at least 40" long, and no greater than 10" wide or 2.5" thick. Transformer cabinets will accept tines that are up to 2.75" thick. The tine spacing must be adjustable from 30" to 50".

Be careful that the fork lift does not damage the front surface of the enclosure. It is a good idea to place a wooden stop block in the corner of the tines as shown in Figure 4-2. The center of gravity of the Perfect Harmony enclosure is approximately midway between the front and back surfaces.

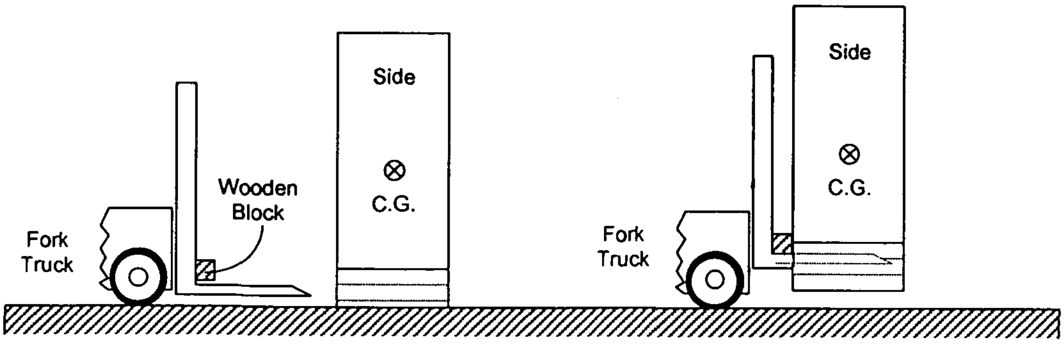

Figure 4-2. Proper Handling Using a Fork Lift Truck

- Roller dollies - If roller dollies are used, they should be placed under the front and rear channels of the base, just outside the fork tubes as shown in Figure 4-3.

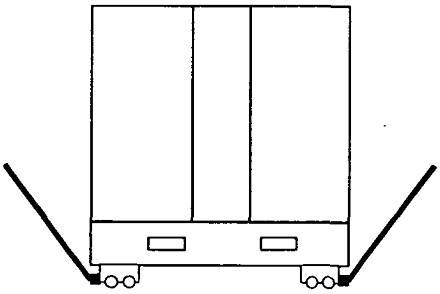

Figure 4-3. Proper Placement of Roller Dollies

- Pipe rollers - This is the least preferred method of handling. It is possible to set the enclosure on many parallel pipe sections placed on the floor and move it by rolling.

If pipe rollers are used, the pipes must be no less than 2" in diameter and at least 48" in length. The pipes must be spaced no more than 18" apart. Refer to Figure 4-4.

4.2.6. Location

When choosing the location for the Harmony drive be sure the area is clean, flat, dry, and the front of the drive is easily accessible with the drive doors open.

WARNING! If the mounting surface is not flat, the metal cabinets of the Perfect Harmony drive may buckle, causing the cabinet doors to be misaligned and/or not open and close properly.

All cooling air for both the Cell and Transformer Cabinets is drawn through the front doors of the Cell Cabinets, into the Transformer Cabinet by centrifugal blowers located at the top of the Transformer Cabinet. Output air is ejected at the roof of the Transformer Cabinet. The final placement of the drive should permit appropriate air circulation.

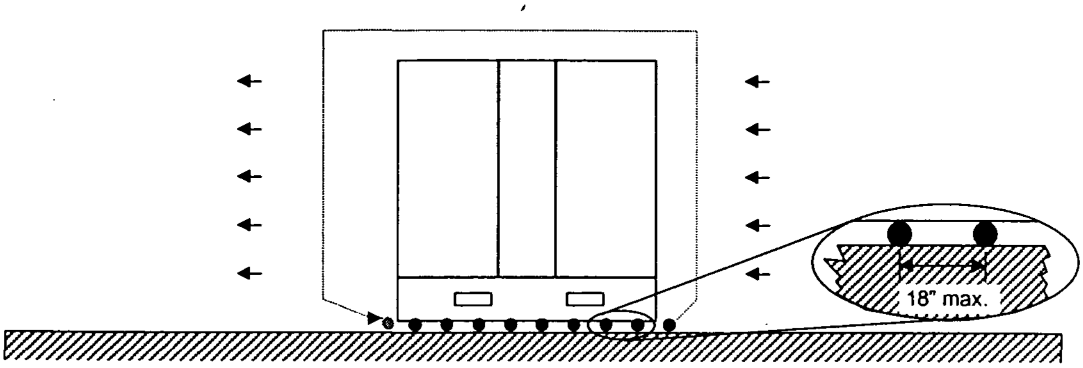

Figure 4-4. Proper Use of Pipe Rollers in Handling Perfect Harmony Cabinets

Refer to tables in Chapter 1 for rated losses and CFM requirements of drives.

NOTE!! The centrifugal blower performance is strongly effected by output plenum pressure and air resistance.

NOTE!! Verify the proper AC input phasing to the Control door circuit breaker. Improper phasing will cause the blower motor(s) to run in reverse.

WARNING!! Verify that all rear cabinet plenum connections between Transformer and Cell Cabinets are securely connected so that any gaps are not large enough to reduce the cooling airflow through the cell and transformer of significant cooling air. Gaps should be less than 1/8".

4.2.7. Anchoring Cabinets to Floors and Walls

Holes for anchor bolts are located on the base mounting channel for each cabinet section (see Figure 4-5).

It is recommended that when anchoring the unit to the floor, the installer should use cemented J-bars on all corners. Holes in the base of the drive cabinets are 0.81" in diameter and easily accept 0.5" threaded J-bars. If the drive is mounted against a wall, top angles may be used to secure the drive to the back wall in lieu of the rear J-bar connections to the floor. Refer to Figure 4-5 for an overview. Exact dimensions are given in the system drawings supplied with the drive.

Tie bolts are used to connect the individual cabinets to each other, such as the transformer cabinet and the cell cabinet. Holes for tie bolts are located along the front and back edge of each cabinet section. Six bolts must be installed to secure the cabinets to each other - 3 bolts (top, middle and bottom) in the front and 3 bolts in the backs. Nuts are welded to the Transformer Cabinet in all six rear locations to facilitate the process. The front connections can be made easily using a 3/8-16 hex-head bolt with a Belleville washer for each of three locations. The installation of the bolts in the rear portion of the cabinet is more involved and is explained below. Each section should be bolted to the next so as to prevent air gaps greater than 1/8".

Before using any hand tools, tie strings to the tools to prevent loss should they be dropped into unit.

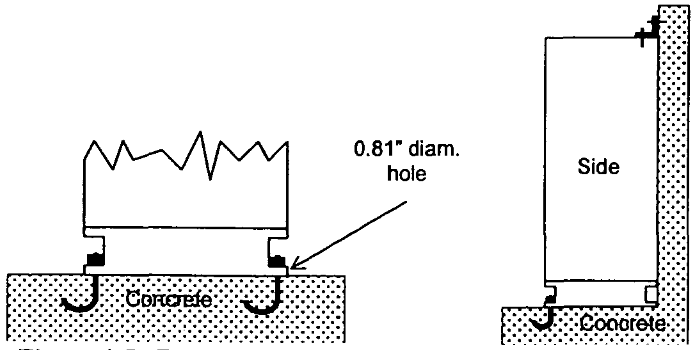

Figure 4-5. Proper Anchoring Techniques for Perfect Harmony Cabinets

- Remove the cells on the left side of the cell cabinet as shown in Figure 4-6.
- The plenum wall behind the cells has a rectangular opening for airflow. The tie bolt holes are located at the same height as these openings, to the left.
- Reach through the air openings and locate each of the three rear anchoring holes in the cell cabinet (top, middle and bottom) and the corresponding welded nuts in the Transformer Cabinet.
- Install a 3/8-16 hex-head bolt with a Belleville washer in each location and secure the bolts.
- Replace the cells.

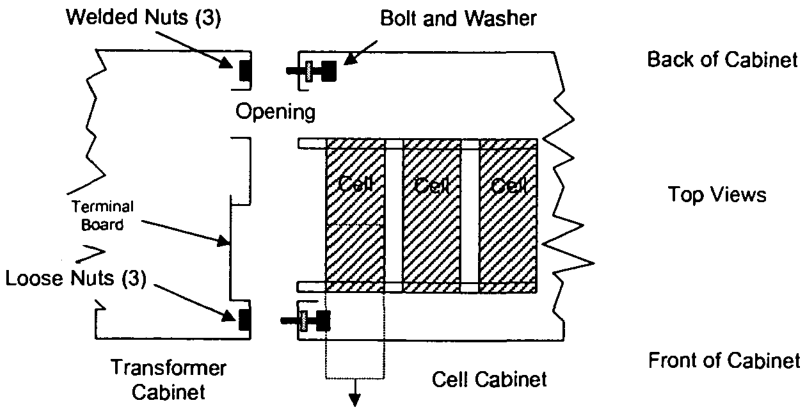

Figure 4-6. Connecting and Anchoring the Transformer and Cell Cabinets

4.2.8. Re-connect Wiring

The Cell Cabinet is pre-wired with cables located at the left for easy connection to the Transformer Cabinet. The transformer has a built-in terminal (tap) board located on the right side of the cabinet (refer to Figure 4-7). The cables from the cells (3 each) are secured to an angled guide bar made of fiber-glass, which holds the wires in proper order and prevents them from touching any metal surfaces. The guide bar must be aligned to the Transformer Cabinet as shown in Figure 4-7. The 3-phase cell cables connect to the secondary of the transformer.

All cell cables are labeled to match the corresponding stud on the terminal board. It is vital that these connections are made to their appropriate studs on the terminal board. Note that not all studs are used in all Perfect Harmony drives, so there may be additional studs on the terminal board after all the cell wiring is complete.

WARNING ! Each secondary must connect to the corresponding cell.

Control wiring is also pre-wired and located in a wireway at the top front of the cabinet. Ensure that the wiring is re-connected at each shipping split.

Harmony drives are wired to have correct blower rotation for R-S-T phase sequencing. Wire all phases according to standard codes, that is, wire the phases from left to right (T1-T2-T3 or R-S-T) for proper operation. Check blower rotation at start-up.

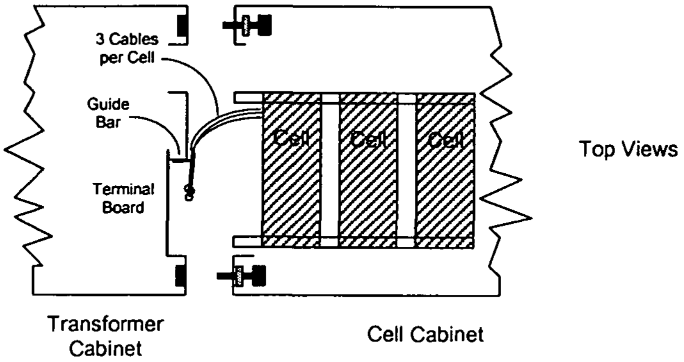

Figure 4-7. Top View of Guide Bar, Cell Wiring and Terminal Board

Located at the bottom of the transformer is a set of ±5% voltage taps for compensating the primary voltage source. The VFD is shipped with the +5% taps connected. This means that the VFD secondary cell voltages are at the nominal 460 VAC (for example) for an input voltage of 5% above primary nominal rating. Do not change taps unless operating experience requires it.

IMPORTANT! All low voltage connections between Control and the high voltage Cell, Transformer, Input, and Output sections are via the cable way located at the bottom of the Cell Cabinet.

DANGER!! Note that all low voltage control connections between the Input, Output, and Control sections must be run through the low voltage section of this cable way.

NOTE: Depending on cell size, wood shipping blocks may be mounted between the cell support structure and the cells. These should be removed during installation.

In some cases, the individual power cells may be shipped separately from the Cell Cabinet. After installing the cells, verify that the input power wire and fiber optic cables are connected properly.

If the Control Cabinet and Cell Cabinet are shipped separately, verify that the fiber optic leads between the individual cells and the Master Link Boards are properly terminated and connected.

Customer-supplied AC power for both control and blowers enters an access plate in the top or bottom of the Control Cabinet section (refer to Chapter 1). Customer-supplied medium voltage power enters an access plate in the top or bottom of the Input Section (refer to Chapter 1).

WARNING!! For cooling considerations, always maintain the appropriate blower power when medium voltage is applied to the VFD.

DANGER!! Ground bonding jumpers are factory made. Re-connect ground bonding between cabinets at shipping split(s). Ensure that the entire system is earth grounded at one of its grounding points.

Torque specifications for the Perfect Harmony drive are listed in Table 4-1.

Table 4-1. Torque Specifications for the Perfect Harmony

Standard Torque Chart	
Fastener Size English (Metric)	**Tightening Torque**
2-56 (M2)	3.0 in-lb
4-40 (M3)	6.0 in-lb
6-32 (M3.5)	12.0 in-lb
8-32 (M4)	22.0 in-lb
10-32 (M5)	36.0 in-lb
1/4-20 (M6)	70.0 in-lb
1/4-20 (M6) elec	100.0 in-lb
1/4-28	70.0 in-lb
5/16-18	155.0 in-lb
(M8)	80.0 in-lb
3/8-16, 3/8-24	275.0 in-lb
(M10)	180.0 in-lb
1/2-13 (M12)	672.0 in-lb
5/8-11	112.0 ft-lb
3/4-10	198.0 ft-lb
1	500.0 ft-lb

Deviations to Standard Torque Specifications	
Perfect Harmony Connectors	**Tightening Torque**
All Green Connectors	6.0 in-lb
Receptacle GRND	36.0 in-lb
Panel GRND	22.0 in-lb
F4, F5, F21, F22	22.0 in-lb
F23, F24, F25	36.0 in-lb
3MI	9.0 in-lb
TB2, TBAMA, B, C, Metal Cover	12.0 in-lb
T6, Relays, Receptacle Wiring	12.0 in-lb
Transformer GND (T5)	70.0 in-lb
PB and Light Switches (Door)	9.0 in-lb
RTM	4.0 in-lb
Keypad	6.0 in-lb
Breaker (Wiring) Lugs	36.0 in-lb
CTB and CTC Terminals	12.0 in-lb

4.2.9. Power-up Check List

The following is a minimum check list which should be followed **before** applying power to the VFD.

- ☐ Verify integrity of all cabinet seals between cabinet air plenums (especially between transformer and cell cabinet sections).
- ☐ Verify that all low voltage control wiring is properly connected and located in appropriate conduit or cable ways separate from high voltage cable.
- ☐ Verify all transformer secondary/cell connections on the Transformer Cabinet Tap Board.

- ☐ If the Control Cabinet was shipped separate from the Cell Cabinet, and/or if cell(s) were removed from the Cell Cabinets, then verify the integrity of all fiber optic connections.
- ☐ Verify proper operation of the cooling system. Input air flow through the doors and filters of the Cell cabinet should be strong enough to cause a small piece of notebook paper to stick to the filters when the blowers are running.
- ☐ Verify all cabinets are earth grounded.

4

CHAPTER 5: START UP & SHUT DOWN PROCEDURES

In This Section:

5

5.1. Introduction

The menu system is the software program that allows operators to navigate through hierarchical structures (menus) which contain related menu items. Menu items include parameters, pick lists, functions and submenus ("nested" menus). These menu items allow the operator to configure a drive to his particular needs.

It is important to understand the mechanism through which the menu system operates. This mechanism is the front panel keypad and display interface. The display interface is a 24-by-2 character back-lit LCD. The keypad provides numerical keys for entering data and arrow keys for scrolling through the menu structure of the Perfect Harmony drive.

Two keypad versions are available on Perfect Harmony drives - a standard surface mount technology (SMT) keypad and the expanded function keypad for engineered applications. The standard (SMT) keypad has built-in buttons for fault reset, auto mode, manual start, and manual stop functions. Three diagnostic LEDs (power on, fault status and run) are built in to the standard keypad. The expanded function has only the standard menu buttons. Diagnostic LEDs and control switches are optional for engineered jobs and are specified by the customer.

Normally, the keypad and display interface is mounted permanently to the drive. However, the keypad/display module need not be mounted for normal operation. It can be plugged in as an external module for set-up and diagnostic purposes only. This can be used to provide extra parameter security.

> This chapter focuses primarily on the standard SMT keypad used for Perfect Harmony drives. Most illustrations in this chapter depict this standard interface. The expanded function keypad (used for engineered applications) is discussed later in this chapter.

The Perfect Harmony system provides a fully-programmable, multi-level security system that assures menu access and modification capabilities by only authorized personnel.

5.2. The Standard Keypad

The Perfect Harmony series contains a user-friendly keypad and display interface. This keypad/display interface is located on the front of the Perfect Harmony Drive Control Cabinet. The Keypad and Display Interface is illustrated in Figure 5-1.

The Keypad and Display Interface is used to access the control parameters and functions of the Perfect Harmony drive. Parameters are organized into logical groups using a menu structure. To view or edit parameters, the operator must maneuver through the menu structure to the desired parameters. This is accomplished using special key sequences. A summary of these key sequences is given later in this chapter.

5

The [Shift] key (which is used in conjunction with the 10 numeric keys and the [Enter] key) is provided to access 9 common system menus, a help display function and a [Cancel] button. The keypad is used to navigate through the menu system, activate control functions, reset the system after faults have occurred, edit parameter values, enter security access codes, and place the system in either automatic, manual or stop (auto/hand/off) mode.

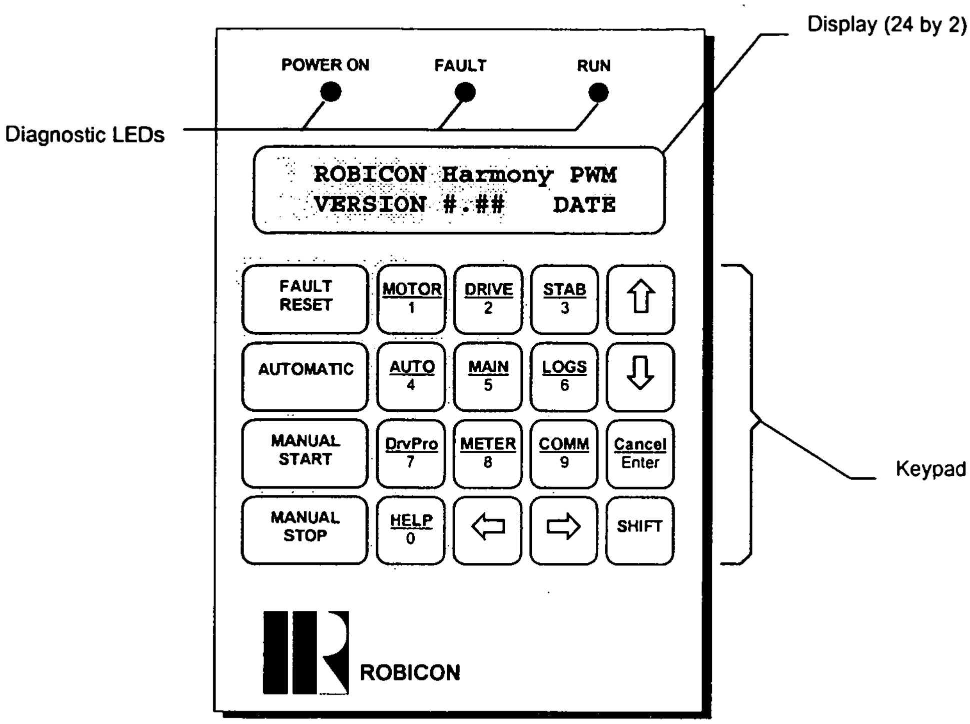

Figure 5-1. The Keypad and Display Interface of the Perfect Harmony Series

> The standard drive start-up message is replaced with "ROBICON **Vector PWM**" for Perfect Harmony drives containing the vector control option.

> Parameter values are stored in EEPROM - a non-volatile memory area. When a parameter value is changed, the new value is saved internally. Even after a power failure, the value remains intact and can be recalled.

The standard Perfect Harmony keypad contains 20 keys. Each of these keys has at least one function associated with it. Some keys are used for 2 or more functions. The following sections give descriptions and uses for each of the keys on the keypad, as well as the diagnostic LEDs and the built-in display.

5.2.1. Fault Reset Button

The [Fault Reset] button is located in the top left corner of the keypad and is used to clear fault conditions that may occur in the Perfect Harmony system. Faults refer to errors that have been detected by both the hardware and software. The current fault status of the drive is displayed by the Fault indicator located above the keypad and display (refer to Figure 5-1).

When a fault condition occurs, the fault indicator glows red. To reset the system (that is, acknowledge fault conditions), the operator must:

- Determine the cause of the fault (see the display or check the fault logger table)
- Correct conditions that may have caused the fault, if appropriate
- Reset the system by pressing the [Fault Reset] button on the keypad.

5.2.2. Automatic Button

The [Automatic] button is located below the [Fault Reset] button on the keypad and is used to put the Perfect Harmony drive into automatic mode. In automatic mode, the standard speed setting for the drive is obtained from the 4-20 mA input and through speed profile parameters located in the Speed Profile Menu (26).

> Using the default system configuration, the Perfect Harmony will not enter automatic mode if the jog digital input switch is pressed. Automatic mode can be customized to suit particular application needs by modifying the appropriate I/O parameters from the keypad and display interface. Modification of the standard system program of the Perfect Harmony is also a viable option, although it requires an understanding of the system program format, the compilation process and downloading techniques.

5.2.3. Manual Stop Button

The [Manual Stop] button is used to place the Perfect Harmony into stop mode. Stop mode shuts down the drive in a controlled manner, regardless of its current state (manual, remote or automatic). During manual remote mode, the operator may press a user-supplied, digital input switch that is programmed as a manual stop input. This input (which is only valid during manual remote mode) is assigned to input DI7 by default, but can be changed either through the front keypad or through modification of the system program.

> Modification of the standard system program of the Perfect Harmony requires an understanding of the system program format, the compilation process and downloading techniques.

5.2.4. Manual Start Button

The [Manual Start] button is located below the [Automatic] button on the left side of the keypad. [Manual Start] is used to put the Perfect Harmony system into manual control mode.

There are two varieties of manual mode: local and remote. These varieties are distinguished by the sources of the velocity demand. In local manual mode, the desired velocity is selected *manually* using the up and down arrow buttons ([⇧] and [⇩]) on the system keypad. In remote manual mode, the desired velocity is selected *manually* using a user-supplied potentiometer connected to the system. Remote manual mode is activated by pressing the momentary digital input assigned to manual start mode. A simplified flow diagram of manual mode is illustrated in Figure 5-2.

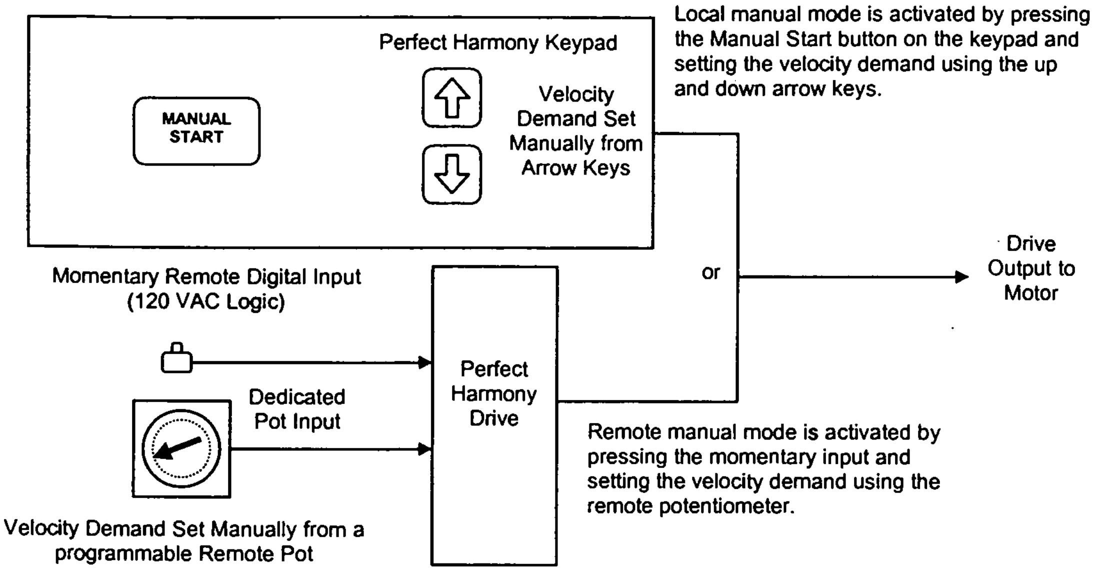

Figure 5-2. Comparison of the Two Manual Control Modes

5.2.5. The 0-9 Buttons

Numeric buttons are centrally located on the keypad of the Perfect Harmony system. These 10 buttons (labeled 0 through 9) provide the following functions:

- entry of security access codes
- *speed menu* (direct access to 10 basic menus according to assigned menu names [in green text above each numeric key])
- direct access to all menus and submenus (with proper security) based on menu numbers
- ability to change the values of parameters.

One function of the numeric buttons of the Perfect Harmony keypad is to enter a 4-digit security access code. The security code consists of any combination of digits 0 through 9 and hexadecimal digits "A" through "F".

> *Hexadecimal* (or hex) is a method of representing numbers using base 16 (digits 0-9, A, B, C, D, E and F) rather than the more common base 10 (digits 0-9). Hex digits "A" through "F" can be entered from the keypad by pressing the [Shift] button followed by the numbers [1] through [6], respectively. Hexadecimal digits may also be required to make changes to parameters that use hexadecimal format. The keystrokes required to enter hex values "A" through "F" are listed in Table 5-1. Decimal equivalents are also listed.

Another function of the numeric buttons is the *speed menu* feature. Speed menu allows the operator to access 10 common menus within the system using the pre-programmed numeric keys. Each of the numeric buttons has an associated menu name printed in green (on top of each numeric button). To access one of these 10 menus, the operator uses the [Shift] button followed by the appropriate numeric button (e.g., [Shift]+[1] to access the Motor menu, [Shift]+[2] to access the Drive menu, etc.). Refer to Figure 5-3.

Table 5-1. Hexadecimal Digit Assignments on the Perfect Harmony Keypad

Key Combination	Hex Value	Decimal Equivalent
SHIFT + Motor 1	A	10
SHIFT + Drive 2	B	11
SHIFT + Stab 3	C	12
SHIFT + Auto 4	D	13
SHIFT + Main 5	E	14
SHIFT + Logs 6	F	15

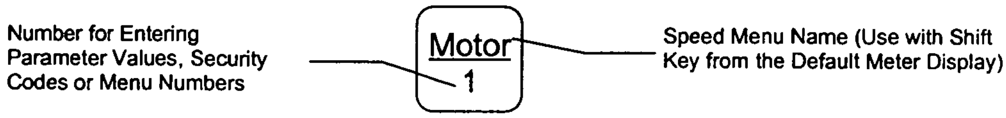

Figure 5-3. Anatomy of a Numeric Keypad Button

> The speed menu feature is available only from the main meter display on the LCD. The hexadecimal entry feature is available only during security code entry and parameter value modification. Therefore, the results of [Shift]+[1] through [Shift]+[6] key combinations depends on the context in which they are used.

In addition to the speed menu feature, a second menu access feature is available for all remaining menus in the Perfect Harmony system. While this second method requires more keystrokes to access target menus, the operator can gain access to *all* security approved menus rather than just the 10 most common menus. Accessing menus in this manner requires that the operator know the menu number associated with the target menu. This menu number can be a one, two or three digit number. To access a menu using its menu number, press the [Shift] key followed by the right arrow key [⇨]. The display prompts the operator for the desired menu number. Using the numeric buttons on the keypad, the operator enters the desired menu number then presses the [Enter] button. If the number was a valid menu number and the current security level permits access to that menu, then the desired menu will be displayed. Refer to Figure 5-4.

If the operator requests access to a menu number that is assigned a higher security level than the current security level, the drive will prompt the operator for the appropriate security level code.

Finally, the numeric buttons on the keypad can also be used to change the value of system parameters. Once a parameter is selected for modification, the leftmost digit of the parameter value is underlined and is called the *active* digit. The active digit can be changed by pressing a numeric key. This method automatically advances the underline to the next digit to the right. The operator continues pressing numeric keys until the desired value is displayed. The [Enter] key is used to accept the new value.

> When editing parameter values, be sure to pad significant digit fields with zeroes where appropriate. For example, to change the value of a 4-digit parameter from 1234 to 975, the operator must enter 0975.

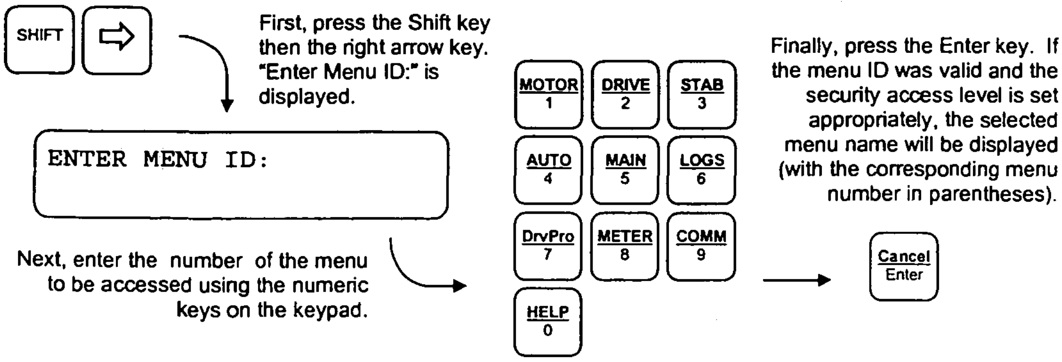

Figure 5-4. Accessing Menus Using Menu Numbers

> In the case of signed parameters (parameter values that can be either positive or negative), the first active digit is actually the sign of the value. The sign is changed by using the up [⇧] and down [⇩] arrow keys when the leftmost (sign) position of the value is underlined (i.e., it is the active "digit"). Either a "+" or a "-" will be displayed during the editing process. After the new value is accepted (using the [Enter] key), positive values are displayed without the "+" sign. Negative values always show the "-" sign unless the negative sign is implied in the parameter name itself.

5.2.6. The Enter/Cancel Button

The [Enter] button is located below the up and down arrow keys on the right side of the keypad. This key is similar to the Return or Enter key on a standard PC keyboard. It is used to choose/accept a selection or confirm an operation. For example, after locating and displaying a parameter within the Perfect Harmony menu structure, the operator may use the [Enter] key to edit the parameter's value. Common functions of the [Enter] key include:

- Selecting a submenu
- Enter edit mode for a selected parameter value
- Accept a new parameter value after editing.

By using the [Shift] key, the [Enter] key can be used as a cancel function. The [Cancel] function is used to abort the current operation or return to the previous menu display. Common functions of the [Cancel] key include:

- Returning to the previous menu
- Rejecting any modifications to a parameter value in edit mode.

5.2.7. Shift Function Buttons

The [Shift] button is located in the bottom right corner of the keypad on the Perfect Harmony system. This button is used to access a second set of functions using existing buttons on the keypad. Keypad buttons that can be used with the [Shift] key have two labels (one on top and one on the bottom of the button). The standard (un-shifted) function of the button is listed on the bottom half of the button and has a white background. The shifted function of the button is shown on the top of the button and has a green background (matching the green background of the [Shift] button to identify that they are used together).

When the Perfect Harmony prompts the operator for a numerical value (e.g., during entry of the security access code, parameter modification, etc.), the [Shift] function of numerical buttons 1 through 6 changes from quick menus to hexadecimal numbers "A" through "F" respectively. Refer to Table 5-1 on page 0-5 for more information.

It is not necessary to simultaneously press the [Shift] button and the desired function key. The operator must press the [Shift] key first then press the desired function key. When the [Shift] key is pressed, the word SHIFT appears in the lower right corner of the interface display (indicating that the Perfect Harmony is waiting for the second key to be pressed). After a key is pressed, the word SHIFT is removed from the LCD. Refer to Figure 5-5.

```
                              SHIFT
```

Figure 5-5. Location of Shift Mode Indicator on the Perfect Harmony Display

Common functions of the [Shift] key include:

- Entering "speed menus" ([Shift] plus appropriate "speed menu" key from main meter display)
- Using the [Cancel] function ([Shift] + [Enter] sequence)
- Entering hex values "A" through "F" ([Shift] + [1] through [Shift] + [6] when editing values or entering security code)
- Accessing menus based on menu numbers ([Shift] + [⇨])
- Returning to the top of the current menu/submenu ([Shift] + [⇧])
- Going to the bottom of the menu or submenu ([Shift] + [⇩])
- Resetting the current security level to 0 ([Shift] + [⇦] + [Shift] + [⇦] + [Shift] + [⇦] from the main meter display).

A summary of [Shift] button key sequences is listed in Table 5-2.

5.2.8. Arrow Buttons

There are four yellow arrow buttons on the Perfect Harmony keypad. The up and down arrow buttons ([⇧] and [⇩]) are located in the upper right corner of the keypad. The left and right arrow keys ([⇦] and [⇨]) are located on the lower row of the keypad. Common uses of the arrow keys include:

- Navigating through the menu structure
- Scrolling through lists of parameters
- Incrementing/decrementing parameter values (when in edit mode)
- Manually advancing to the next digit (when in edit mode)
- Increasing (up arrow [⇧]) and decreasing (down arrow [⇩]) the desired velocity demand of the drive (when in local manual mode)
- Clearing security level (press [Shift] + [⇦] 3 times from the default meter display)
- Entering menu access mode ([Shift] + [⇨]).

The left and right arrow keys ([⇦] and [⇨]) can be used to navigate through the menu structure of the Perfect Harmony system. In general, the right arrow [⇨] is used to penetrate deeper into the menu structure and the left arrow [⇦] is used to back out of the menu structure. For example, from the main display, the operator can press the right arrow key [⇨] to access the Main menu.

The up and down arrow keys ([⇧] and [⇩]) can be used to scroll through lists of items. For example, after using the right arrow key [⇨] to reach the Main menu, the operator may select the down arrow key [⇩] to scroll through the list of options within the Main menu. These options may be parameters, pick lists, or submenus. Refer to the next section for information about the structure of the menu system.

The up and down arrows ([⇧] and [⇩]) can be used to increment or decrement the desired velocity demand when the system is in local manual mode (refer to Section 5.2.4: Manual Start Button on page 5-3). As the up and down arrow keys are pressed, the changes in desired velocity demand can be viewed from the main display on the LCD. Refer to Figure 5-6.

> The velocity demand field (DEMD) on the front panel display is assigned by default. This display assignment (and the other three) can be changed from the menu system.

Table 5-2. Summary of Common Shift Button Key Sequences

Key Combination	Description
[SHIFT] [Motor 1]	Speed menu to the Motor menu (from the default meter display) Enters hexadecimal "A" (from value edit and security prompts)
[SHIFT] [Drive 2]	Speed menu to the Drive menu (from the default meter display) Enters hexadecimal "B" (from value edit and security prompts)
[SHIFT] [Stab 3]	Speed menu to the Stability menu (from the default meter display) Enters hexadecimal "C" (from value edit and security prompts)
[SHIFT] [Auto 4]	Speed menu to the Auto menu (from the default meter display) Enters hexadecimal "D" (from value edit and security prompts)
[SHIFT] [Main 5]	Speed menu to the Main menu (from the default meter display) Enters hexadecimal "E" (from value edit and security prompts)
[SHIFT] [Logs 6]	Speed menu to the Logs menu (from the default meter display) Enters hexadecimal "F" (from value edit and security prompts)
[SHIFT] [DrPro 7]	Speed menu to the Drive Protect menu (from the default meter display)
[SHIFT] [Meter 8]	Speed menu to the Meter menu (from the default meter display)
[SHIFT] [Comm 9]	Speed menu to the Communications menu (from the default meter display)
[SHIFT] [HELP 0]	Speed menu to a context sensitive Help menu (from anywhere except the default meter display)
[SHIFT] [cancel enter]	Cancels/aborts the current action/keystroke or returns to the previous menu
[SHIFT] [⇨]	Enters "numerical menu access mode". The operator is then prompted to enter the 1, 2 or 3 digit number for the associated menu.
[SHIFT] [⇧]	Returns to the top of the current menu or submenu.
[SHIFT] [⇦] [SHIFT] [⇦] [SHIFT] [⇦]	Restores the security level back to 0. The [Shift] + [⇦] key sequence must be entered three times in succession from the default meter display to restore the security level back to 0.
[SHIFT] [⇩]	Jumps to the bottom of the menu or submenu.

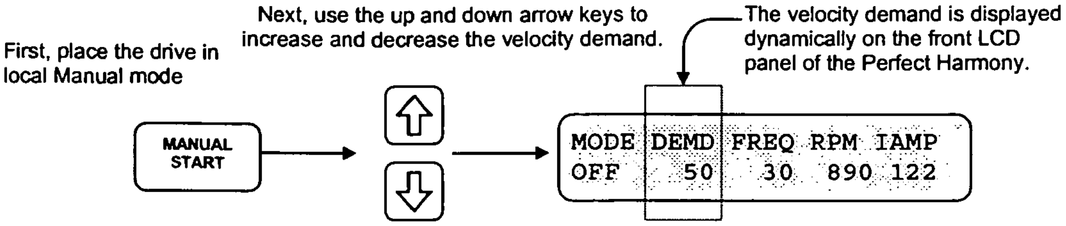

Figure 5-6. Using the Up and Down Arrow Keys to Control Velocity Demand

Another feature of the arrow keys is that they can be used to edit the values of parameters. To edit a parameter value, the operator must first navigate through the menu structure (using the arrow keys) and located to parameter to be changed. With the parameter displayed on the LCD, the operator must press the [Enter] key. This places the selected parameter into edit mode. Once in edit mode, an underscore is displayed beneath the first (i.e., the most significant) position of the parameter value. Changing the value of that position can be accomplished by pressing the desired numeric key or by using the up and down arrow keys ([⇧] and [⇩]) to scroll (and wrap around) through the numbers 0 through 9 for that position. When the up and down arrow keys are used, the operator must press the right and left arrow keys ([⇦] and [⇨]) to move to the next (or previous) position in the number to be edited (unlike using the number keys which automatically shift the underscore to the next digit in the number). The operator must press the [Enter] key to accept the new value or press the [Shift] + [Enter] (i.e., [Cancel]) to abort the change.

A feature unique to the left arrow key (with the [Shift] key) is its ability to cancel the current security mode and return to level 0. An operator can increase the security access level (by entering the appropriate security codes), but cannot lower the security access level using the standard "Change Security Code" option of the Main menu. If an experienced user enters level 7 (or any other security level) then wishes to return to level 0 when he is finished (for security reasons), he may reset the drive by pressing a reset button (**PB1** or **PB2**), toggling power to the drive or using the [Shift] + [⇦] sequence three times from the main display (i.e., ([Shift] + [⇦] + [Shift] + [⇦] + [Shift] + [⇦]). The latter method is a convenient way to reset the security level to 0 without interrupting the operation of the drive. When the security level is reset, the display shows a "Security Level Cleared" message. Refer to Figure 5-7.

```
MODE DEMD FREQ RPM IAMP
Security Level Cleared.
```

Figure 5-7. Security Level Cleared Message on the Perfect Harmony Display

The [Shift] + [⇦] + [Shift] + [⇦] + [Shift] + [⇦] key sequence is valid only when performed from the default meter display.

The right arrow key [⇨] is also used in conjunction with the [Shift] key to provide a menu access feature. The operator can gain access to *all* security approved menus. Accessing menus in this manner requires that the operator know the menu number associated with the target menu. This menu number can be a one, two or three digit number. To access a menu using its menu number, press the [Shift] key followed by the right arrow key [⇨]. The display prompts the operator for the desired menu number. Using the numeric buttons on the keypad, the operator enters the desired menu number then presses the [Enter] button. If the number was a valid menu number and the current security level permits access to that menu, then the desired menu will be displayed. Refer to Figure 5-4 on page 5-6. Some common arrow key sequences are listed in Table 5-3.

Table 5-3. Summary of Common Arrow Key Sequences

Key Combination	Description
[⇦] or [⇨]	Used individually to navigate through the menu structure. Also used to change the active digit of a parameter value (when in edit mode).
[⇧] or [⇩]	Used individually to scroll through lists of menu options, lists and parameters. Used to change velocity demand (from default meter display). Increments/decrements parameter values (when in edit mode).
[SHIFT] [⇨]	Enters "numerical menu access mode". The operator is then prompted to enter the 1, 2 or 3 digit number for the associated menu.
[SHIFT] [⇧]	Returns to the top of the currently selected menu or submenu.
[SHIFT] [⇦] [SHIFT] [⇦] [SHIFT] [⇦]	Restores the security level back to 0. The [Shift]+[⇦] (left arrow) key sequence must be entered three times in succession from the default meter display to restore the security level back to 0.
[SHIFT] [⇩]	Going to the bottom of the menu or submenu.

5.2.9. Diagnostic Indicators

The standard keypad and display interface also contains 3 diagnostic indicators that are located above the display: Power On, Fault and Run. The Power On indicator is lit when power is supplied to the system. The Run indicator lights to show when the drive is running. The Fault indicator is lit when one or more system errors have occurred (e.g., boot-up test failure, overvoltage fault, etc.). The [Fault Reset] key must be pressed to clear any existing fault conditions and restore the system to normal operation. Refer to Figure 5-1 for the location of the 3 diagnostic indicators.

5.2.10. The Display

The following illustrations depict the 2-line, 24-character display in various modes of access as the operator attempts to locate and change the "spd fwd lim" (speed forward limit) parameter.

Figure 5-8 depicts the display immediately following power up or system reset. Note that the first three variable displays (from the right) can be selected from a pick list using the Display Variable Menu (37).

The Mode display will show 1 of 8 possible VFD conditions depending on the operating control and conditions of the VFD. These modes are summarized in Table 0-4.

[SHIFT] [cancel/enter] →

```
Mode Demd Freq RPM  Itot
Hand 70   70   1260 40
```

Figure 5-8. Status Display After [Shift] [Enter] (Cancel) Key Sequence

The Demd display (refer to Figure 5-8) shows the "commanded speed reference" in percent. Figure 5-9 depicts the display following a [Shift]+[2] (Drive) key combination. The nine standard menus listed in Table 5-2 can then be selected using the up/down arrow keys ([⇧] and [⇩]).

Figure 5-10 depicts the display prior to the selection of the Speed Setup Menu (15). If the [Enter] or right arrow key ([⇨]) is pressed at this display, the Speed Setup Menu (15) will be entered. Figure 5-11 depicts the display following down arrow keystrokes to the Speed Setup Menu (15). The down arrow key ([⇩]) was pressed three times to obtain this display. Figure 5-12 depicts the display once the "spd fwd lim" (speed forward limit) parameter in the Speed Setup Menu (15) is entered. The left/right arrow keys ([⇦] and [⇨]) can be used to position the cursor under the desired digit (or sign) to be changed. The digit can be set by either using the number keys or incremented/decremented using the up/down arrow keys ([⇧] and [⇩]). The sign can be changed using the up/down arrow keys. The parameter is selected into memory once the [Enter] or right arrow key ([⇨]) is pressed. Figure 5-13 depicts the display if +300 is attempted to be entered for the "spd fwd lim" parameter. Since the range of the variable is 0-200%, an error message will be displayed.

[SHIFT] [Drive 2] →

```
Drive Menu          (2)
(Arrow keys select)
```

Figure 5-9. Status Display After [Shift]+[2] Key Sequence

[⇩] →

```
  Drive Param Menu   (14)
→ Speed Setup        (15)
```

Figure 5-10. Status Display After [⇩] Key Sequence

[cancel enter] [⇩] →

```
  Ratio Control    1.000
→ Spd Fwd Lim      100%
```

Figure 5-11. Status Display After [Enter] Key and Multiple ⇩ Key Sequences

[cancel enter] →

```
  Spd Fwd Lim     ±100
→ Forward Speed Limit
```

Figure 5-12. Status Display After [Enter] Key to Change a Parameter

```
  Spd Fwd Lim     +300%
     OUT OF RANGE
```

Figure 5-13. Status Display Upon Entering a Value Beyond the Range of the System

The status display has a dynamic decimal point feature. This feature adds more precision to percentage display items that have values less than 10%. In these cases, the Perfect Harmony adds a decimal point in the display. For example, ten percent would be displayed as 10, while a slightly smaller percentage would be displayed as 9.9.

Table 0-4. Summary of Operation Mode Displays

Display	Meaning	Description
Slim	Speed Limit	The inner torque loop integrator is clamped in limit (*std_trq_lim_f*). Check the settings of "spd fwd lim" or "spd rev lim". The drive cannot produce the requested torque. If left unchecked, the speed loop integrator will wind-up until the torque command is clamped at the dynamic torque limit (*pos_limit*).
Frst	Fault Reset	The drive fault reset flag (*drv_flt_rst_f*) is enabled and the drive is inhibited.
CR3	CR3 Relay	**CR3** relay is not picked. The drive is inhibited (*cr2_picked* is not TRUE).
Tlim	Torque Limit	The output of the speed regulator (the torque command) is a torque limit. This is the dynamic limit clamped at the motor or regen limit and possibly smaller based on other drive restraints (see Output Current Limit in Section 7 for troubleshooting tips).
Ovld	Overload	An overload fault is imminent due to the output current exceeding the "I overload" parameter in the Overload Menu (34).
Byps	Bypass	VFD is operating at reduced output voltage capability due to operation of the optional bypass system following a cell fault.
Rgen	Regeneration	VFD is decreasing output speed due to a change in the speed command.
Inh	Inhibit	VFD is unable to enter the Run State D due to software emergency stop switch *sw_estop_f*, the drive fault flag *drv_flt_f* or an open **CR3** input *cr3_f*. See system program example in Section 8.0. (See the Troubleshooting section for descriptions of *sw_estop_f* and *drv_fit_f*).
Rlbk	Rollback	VFD is attempting to limit output speed due to torque output limitations.
Off	Off	Indicates that the VFD is in Idle State A.
Auto	Automatic	Normal Operating Mode if the *auto_f* switch in the system program is set to "true". Usually indicates operation resides from remote (customer contacts) control.
Hand	Hand	Normal Operating Mode if the *auto_f* switch in system program is set to "false". Usually indicates that operation is controlled from the front cabinet.

5.3. The Expanded Function Keypad and Display

Engineered (i.e., customized) Perfect Harmony drives are normally provided with a Panel Control Unit, usually mounted on the door of the enclosure. The PCU communicates with the main processor via a high-speed serial link called the Panel Control Link (PCL), and can be located as far as 300 feet away. Perfect Harmony drives can support two PCUs, designated "Local" and "Remote". This allows duplicate operator interfaces on the enclosure door and in the process control room, for example.

> The remote keypad is available only with engineered drives.

Figure 5-14 shows the PCU when viewed from the front. The back-lit LCD display is capable of showing two lines of 24 characters each. A 16 button keypad with the numerals 0 through 9; arrows for up ([⇧]), down ([⇩]), right ([⇨]), and left ([⇦]); an Enter/Cancel button ([Enter]), and a Shift button ([Shift]) are available for editing system parameters. Finally, a 25-pin D connector for RS232 communications is available for serial communications.

The front surface of the PCU is a polycarbonate membrane bonded to an aluminum backplate. The keypad buttons are separately sealed. This construction makes the PCU resistant to contamination.

The PCL cable from the main processor is connected to **PL5** of the PCU located on the right edge. A trim pot labeled **P1**, and located in the top left corner, adjusts the brightness of the LCD display. A switch labeled **SW2**, and located near the center of the top edge, selects RUN or TEST mode. It should normally be left in the RUN position. A plug labeled **PL1**, and located in the bottom left corner, brings in 18 VAC power. A push-button labeled **SW1**, and located left of center along the bottom edge, allows the PCU microprocessor to be reset. A pluggable terminal strip labeled **TB1**, and located right of center along the bottom edge, allows a local speed potentiometer and a local reset button to be connected. A ribbon cable labeled **PL6**, and located near the bottom right corner, carries the RS232 signals from the 25-pin D connector.

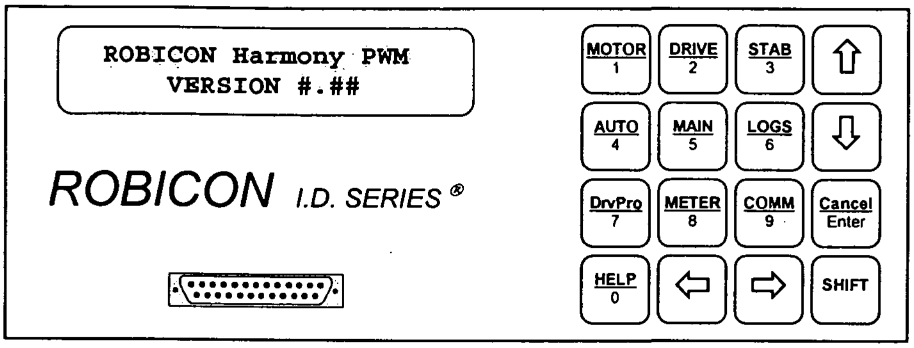

Figure 5-14. Panel Control Unit (Keypad and Display) for Engineered Applications

When the PCU is located on the door of the Perfect Harmony drive enclosure, the 18 VAC power to PL1 is normally supplied from the control power transformer on the drive panel. When the PCU is located remote from the drive, the 18 VAC power is normally supplied from a small local transformer. This transformer should be rated at least 1 A if no I/O Expansion Board is provided, and up to 6 A with the I/O Expansion Board (depending on how many pilot lights and contact closures are connected). The transformer current rating can be estimated by the formula:

$$\text{Amperes} = 1 + \frac{(\text{\# of inputs}) + (\text{total lamp wattage})}{10}$$

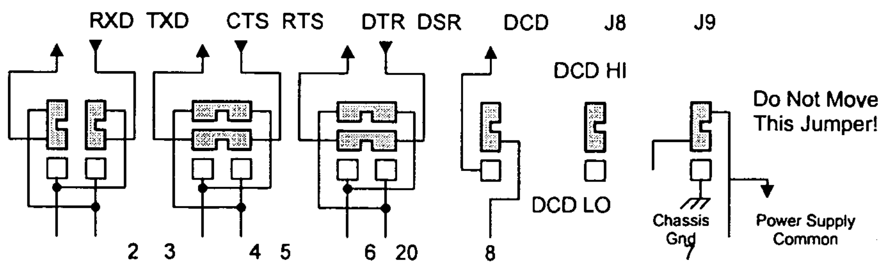

Figure 5-15. RS232 Configuration Jumpers

> The actual jumper configurations of existing drives may differ slightly from the illustration in Figure 5-15. Specifically, jumper pairs 4/5 and 6/20 are shown in the preferred configuration. It may be the case that the top two sets of jumpers are placed vertically (i.e.,) rather than horizontally (i.e.,) on these jumper pairs. Communications will work properly in both configurations, however the configuration shown in Figure 5-15 is preferred.

A group of jumpers located above **PL6** allow the RS232 port to be reconfigured to match the requirements of the target communications device. The factory setting of these jumpers is correct for communicating with an IBM (or compatible) PC. These jumpers are shown in greater detail in Figure 5-15. In order to modify the jumpers, it will be necessary to temporarily remove the optional I/O Expansion Board (if present).

1. The first pair of jumpers allow **RXD** and **TXD** to be interchanged on pins 2 and 3. These jumpers are installed at the factory opposite as shown, with **RXD** on pin 2 and **TXD** on pin 3.
2. The second pair of jumpers allow **CTS** and **RTS** to be interchanged on pins 4 and 5, or to be tied together bypassing the target device. These jumpers are installed at the factory as shown, with **RTS** on pin 4 and **CTS** on pin 5.
3. The third pair of jumpers allow **DTR** and **DSR** to be interchanged on pins 6 and 20, or to be tied together bypassing the target device. These jumpers are installed at the factory as shown, with **DSR** on pin 6 and **DTR** on pin 20.
4. The fourth pair of jumpers allow pin 8 to be configured. If the **DCD** jumper is low, pin 8 is connected to signal **DCD**. If the **DCD** jumper is high as shown, then pin 8 is connected to jumper **J8**. If **J8** is high as shown, pin 8 will be logic one (HI) permanently. If **J8** is low, pin 8 will be a logic zero (LO) permanently.
5. The last jumper **J9** allows pin 1 to be configured. If **J9** is high as shown, pin 1 is connected to signal ground. If **J9** is low, pin 1 is connected to the local cabinet ground (specifically, to the PCU front plate). If **J9** is removed, pin 1 will have no connection.

> Uploading and downloading functions are available with the Perfect Harmony. These functions are found in the software menuing system. To perform an upload or download function, review the following steps:
>
> - Set the appropriate communication variables on the printer or PC software (see above)
> - Connect the appropriate serial port to the **DB25** connector using a 25-pin serial cable that has the appropriate connectors
> - Enable the printer or communications software (puts the PC or printer in the ready state)
> - Select the desired upload or download function from the Communications Menu (9).

> The RS232 serial communications port is configured at 9600 baud, 8 data bits, 1 stop bit and no parity. Serial connections to printers or PCs should reflect these settings.

The optional I/O Expansion Board (shown in Figure 5-16) mounts over the right-hand half of the PCU board, so that **PL7** of the I/O Expansion Board aligns with **PL7** of the PCU Board. The I/O Expansion Board allows many control and instrumentation circuits to access the Perfect Harmony main processor through the PCU. Typical examples are pilot lights, push-buttons, thumb wheel switches, analog meters, and digital meters. These functions are available on both the "Local" and "Remote" PCU, if present.

> The I/O Expansion Board has three groups of pluggable terminal strips, and one ribbon cable header for I/O. Digital meters are available only with engineered keypads.

TB3 provides 8 output drivers for analog meters, with 1 mA DC D'Arsonval movements (i.e., movements that produce torque proportional to the average current value). Terminals 9 and 10 of **TB3** provide signal ground for the common return from the meters. Terminals 11 and 12 provide an alternate return for zero-center meters.

TB4 provides 24 output drivers capable of controlling 24 VDC pilot lights (type 757 bulb or equivalent). Terminals 4, 11, 18, and 25 of **TB4** provide +24 VDC power for the common feed to the lights. The 24 outputs are active low, capable of sinking 0.25 A each (the total load at any time should not exceed 3 A).

TB5 provides 24 inputs for contact closures at 24 VDC. Each input has a 500 Ohm load to the +24 VDC supply built into the I/O Expansion Board, to provide enough contact load to conform to NEMA Standard ICS2-125.21. Terminals 4, 11, 18, and 25 of **TB5** provide signal ground for the common return from the contacts.

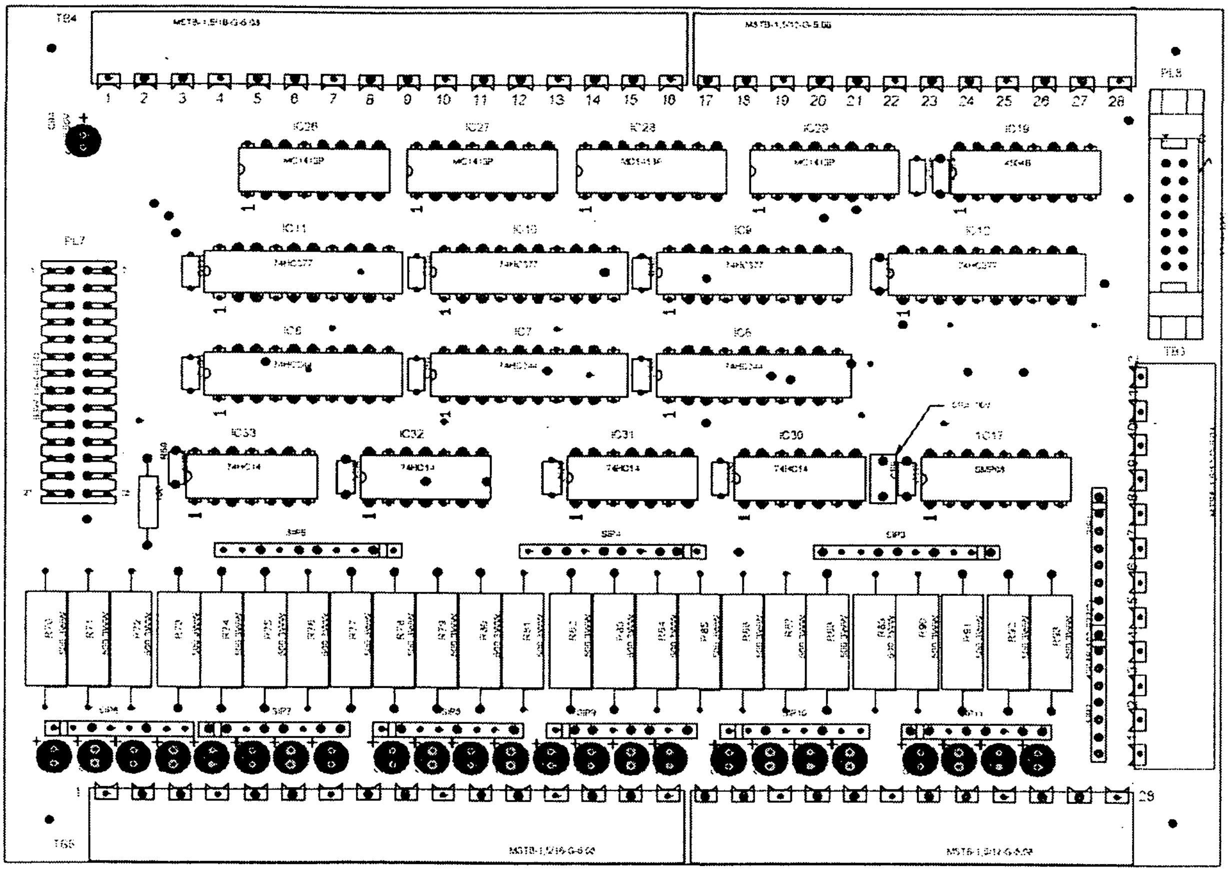

Figure 5-16. I/O Expansion Board (Printed Circuit Layout)

▽ ▽ ▽

CHAPTER 6: COMMISSIONING

In This Section:

6.1. Set-up

The following procedure assumes that significant changes or disassembly have occurred between final factory test and commissioning. If this is the case, the following procedure can be used to re-qualify the Perfect Harmony for full power operation. If system integrity after installation is not felt to be an issue, then this section may be skipped.

> Proper drive setup will require the use of a DC voltmeter, an AC voltmeter and a dual-trace oscilloscope for testing purposes.

6.1.1. Initial Set-up Procedure for Re-qualification of Perfect Harmony VFD

Before proceeding, refer to the check list in the previous section.

- ☐ Lock out the incoming medium voltage feeder that feeds the Transformer Cabinet. (Follow the standard lock out tag procedures to verify the unit is safe.) Also make sure the Perfect Harmony's output contactor (if any) is locked open.
- ☐ Extend all cells and visually inspect all internal mechanical and electrical connections.
- ☐ Visually inspect all cabinets and verify there is no damage due to shipping.

Power and Control connection verification:

- ☐ Verify the mechanical integrity of all the electrical connections, especially output connections between cells and cell input connections from the transformer.
- ☐ Verify all connections between cabinets, especially connections for current feedback, motor voltage feedback, and line voltage feedback.
- ☐ Check transformer secondary connections to the cells. Ohm check input cell connections to secondary of the transformer.

Customer interconnection verification:

- ☐ Ensure that all the customer connections at **TB2A** are properly terminated.

> If an unloaded motor is used for these tests, set the appropriate parameters in Motor Menu (11) for nameplate values. If an unloaded motor is not available, verify that the motor voltage parameter is set to the rated output voltage of the drive.

- ☐ Turn on the control power (e.g., 480 VAC). Verify that the microprocessor initializes and the blower rotation is correct. If blower rotation is incorrect, change the incoming phasing at the control cabinet circuit breaker.
- ☐ In the Drive Menu (14), drive current should be set to the cell rating used in the system:

Table 6-1. Drive Current Settings for Various Cell Sizes

Size	Current	Size	Current
Size 00	50 A	Size 4, 4H [1]	300 A
Size 0, 0H [1]	75 A	Size 5	400 A
Size 1, 1H [1]	100 A	Size 6	600 A
Size 2, 2H [1]	150 A	Size 7	800 A.
Size 3, 3H [1]	200 A		

[1] - Consult factory for availability.

- ☐ In the Ramp Menu (17), set the "fwd accel" and "fwd decel" parameters to no less than 10 seconds. Set the "jerk rate" parameter to 0.1 second.
- ☐ In the Cell Menu (21), set the "installed stages" parameter to the number of series cells in the system, i.e., 3-7.
- ☐ Set the following parameters in the Standard Control Setup Menu (24):

Table 6-2. Parameter Settings for Standard Control Setup Menu (24)

Parameter	Setting	Parameter	Setting
Volt P gain	0.000	Vel I gain	4.000
Volt I gain	0.000	Trq P gain	1.000
Vel P gain	5.000	Trq I gain	0.000

- ☐ Jumper the test point **HGNDFLT** to **GND** on the Power Interface Board (refer to Figure 2-3: Typical System Control Schematic).
- ☐ Disconnect the blower and jumper the blower interlocks.

6.1.2. Modulator and Power Circuit Test for Low Voltage Cells Only

This test is intended for systems that use low voltage cells and can be performed with a single 30 amp, 3-phase, 460 VAC variac. Full voltage can be supplied to all cells. The auxiliary AC control power to the Control Cabinet can be used for this purpose if it is 460 VAC.

- ☐ Disconnect the series connections between **T1** and **T2** of all adjacent cells. Disconnect the motor leads or open the motor contactor. Connect a 3-phase variac to the input of cell B1, in addition to the existing cables from the transformer. Refer to Appendix E: Solid-state Variac Option.

DANGER!! During this test, the Perfect Harmony transformer will be excited from one of the secondary windings. This will cause rated voltage to appear on the primary terminals. The input disconnect should be open and/or input fuses pulled and/or input wiring disconnected to prevent medium voltage from backfeeding the input power system.

WARNING!! If the neutral connections between cells A1, B1, and C1 are also disconnected, all cell structures (except B1) can be earth grounded for added safety. Be sure to remove these earth grounds before medium voltage is switched on!

> **WARNING!!** The current demand on the variac should be monitored during the following tests. Do not exceed the variac current rating. The variac should be fused.

- ☐ Connect an AC voltmeter to the input of any cell. Turn on the control power at the Control Cabinet and verify that the Microprocessor Board properly initializes.
- ☐ Turn on the variac and slowly increase the variac's output voltage to about 75 VAC. Measure all cell input voltages to make sure they are all receiving approximately the same voltage. The "Not Safe" LED should be lit on each Cell Control Board (see Figure 1-12: Typical Air-cooled Harmony Cell).
- ☐ If all cell voltages are OK, continue increasing the variac to 230 VAC and make sure all of the switch-mode power supplies are working (the Lnk ON and cell fault LED's on the cell control boards should be on) (see Figure 1-12: Typical Air-cooled Harmony Cell).
- ☐ Continue increasing the voltage to 460 VAC. Push the VFD Fault Reset Button on the door of the VFD. All power cell faults should be reset and the normal keypad display should appear (see Figure 4-1: The Keypad and Display Interface of the Perfect Harmony Series).
- ☐ With a DC voltmeter, check the shared capacitor voltage on the + and - bus of each cell to common (heat sink of cell). Voltages should be within 12 volts DC of each other.

At 460 VAC, check the following test points on the PIB with a scope:

- ☐ At rated primary voltage, DC voltage on **VAVAIL** test point on Power Interface Board (see Figure 2-3: Typical System Control Schematic) should be approximately 4.0 VDC with <0.5 vpp ripple at 360 Hz (see Figure 6-1).

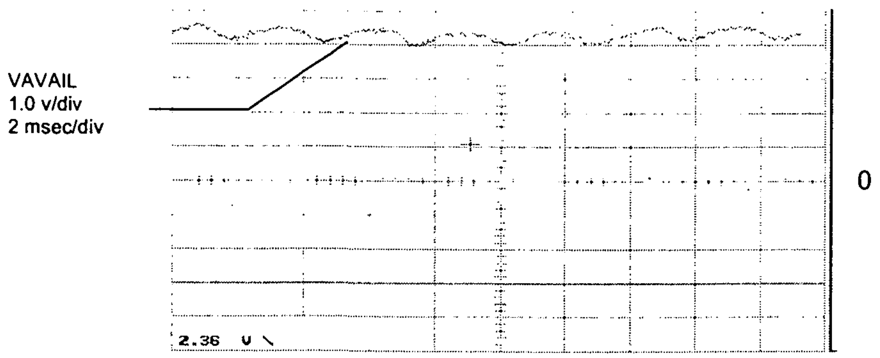

Figure 6-1. VAVAIL TP at Rated Primary Voltage (Unloaded)

- ☐ AC voltage on test points **VBA**, **VBC**, **VCA** (see Figure 2-3: Typical System Control Schematic) should be 8 volts pp @ 60 Hz.

The previous steps verify that the main power transformer is OK and the Attenuator Module in the Transformer Cabinet is properly connected.

Trim offsets on test points **IcFDBK** and **IbFDBK** (see Figure 2-3: Typical System Control Schematic).

- ☐ Using a DC millivolt meter on the above test points, use the parameters Ic offset adjust and Ib offset adjust in Menu (20) to trim offsets to less than ±1.0 mVDC. Verify that VFD is in off mode (state A).

Check modulation at the outputs of all cells by placing the VFD in the run mode (state D).

- ☐ Verify that the 4 LED's (Q1-Q4) on each Cell Control Board should illuminate (see Figure 1-12: Typical Air-cooled Harmony Cell).

Shut down the AC supply to the control and variac. Disconnect the variac.

Remove the jumper between **HGNDFLT** to **GND** on the Power Interface Board (see Figure 2-3: Typical System Control Schematic).

6.1.3. Modulator and Power Circuit Test for High Voltage Cells Only

This test is intended for systems that use high voltage cells. Full voltage can be supplied to all cells.

> ROBICON recommends using a variable 0-690 VAC source for testing high voltage cell systems.

- ☐ Disconnect the series connections between T1 and T2 of all adjacent cells. Disconnect the motor leads or open the motor contactor. Connect a 3-phase variac to the input of cell B1, in addition to the existing cables from the transformer.

> **DANGER!!** During this test the Perfect Harmony transformer will be excited from one of the secondary windings. This will cause rated voltage to appear on the primary terminals. The input disconnect should be open and/or input fuses pulled and/or input wiring disconnected to prevent medium voltage from backfeeding the input power system.

> **WARNING!!** If the neutral connections between cells A1, B1, and C1 are also disconnected, all cell structures (except B1) can be earth grounded for added safety. Be sure to remove these earth grounds before medium voltage is switched on!

> **WARNING!!** The current demand on the variac should be monitored during the following tests. Do not exceed the variac current rating. The variac should be fused.

- ☐ Connect an AC voltmeter to the input of any cell. Turn on the control power at the Control Cabinet and verify that the Microprocessor Board properly initializes.
- ☐ Turn on the variac and slowly increase the variac's output voltage to about 75 VAC. Measure all cell input voltages to make sure they are all receiving approximately the same voltage. The "Not Safe" LED should be lit on each Cell Control Board (see Figure 1-12: Typical Air-cooled Harmony Cell).
- ☐ If all cell voltages are OK, continue increasing the variac to 340 VAC and make sure all of the switch-mode power supplies are working (the Lnk ON and cell fault LED's on the cell control boards should be on) (see Figure 1-12: Typical Air-cooled Harmony Cell).
- ☐ Continue increasing the voltage to 480 VAC. Push the VFD Fault Reset Button on the door of the VFD. All power cell faults should be reset and

the normal keypad display should appear (see Figure 5-1: The Keypad and Display Interface of the Perfect Harmony Series).

- ☐ With a DC voltmeter, check the shared capacitor voltage on the + and - bus of each cell to common (heat sink of cell). Voltages should be within 12 volts DC of each other.

At 480 VAC, check the following test points on the PIB with a scope:

- ☐ At rated primary voltage, DC voltage on **VAVAIL** test point on Power Interface Board (see Figure 3-3: Typical System Control Schematic) should be approximately 4.0 VDC with <0.5 vpp ripple at 360 Hz (see Figure 6-1).
- ☐ AC voltage on test points **VBA**, **VBC**, **VCA** (see Figure 3-1) should be 8 volts pp @ 60 Hz.

The previous steps verify that the main power transformer is OK and the Attenuator Module in the Transformer Cabinet is properly connected.

Trim offsets on test points **IcFDBK** and **IbFDBK** (see Figure 3-3: Typical System Control Schematic).

- ☐ Using a DC millivolt meter on the above test points, use the parameters Ic offset adjust and Ib offset adjust in Menu (20) to trim offsets to less than ±1.0 mVDC. Verify that VFD is in off mode (state A).

Check modulation at the outputs of all cells by placing the VFD in the run mode (state D).

- ☐ Verify that the 4 LED's (Q1-Q4) on each Cell Control Board should illuminate (see Figure 1-12: Typical Air-cooled Harmony Cell).

Shut down the AC supply to the control and variac. Disconnect the variac.

Remove the jumper between **HGNDFLT** to **GND** on the Power Interface Board (see Figure 3-3: Typical System Control Schematic).

6.1.4. Hardware Voltage Regulator Test

- ☐ Reconnect the series connections between T1 and T2 of all adjacent cells, plus the neutral connections between cells A1, B1 and C1.
- ☐ Secure all doors to the Cell and Transformer Cabinets.
- ☐ Enable the blower motor and remove any interlock jumpers.

Energize the medium voltage feeder. Re-energize the AC control power and check the follow test point voltages in the run mode (state D).

- ☐ Increase speed potentiometer until 4.25 VDC is on test point **ID***, then check the following test points with a scope (see Figure 6-2).

> An asterisk (*) following a variable name means that the variable is a reference variable (e.g., **EB*** is the B-phase reference voltage).

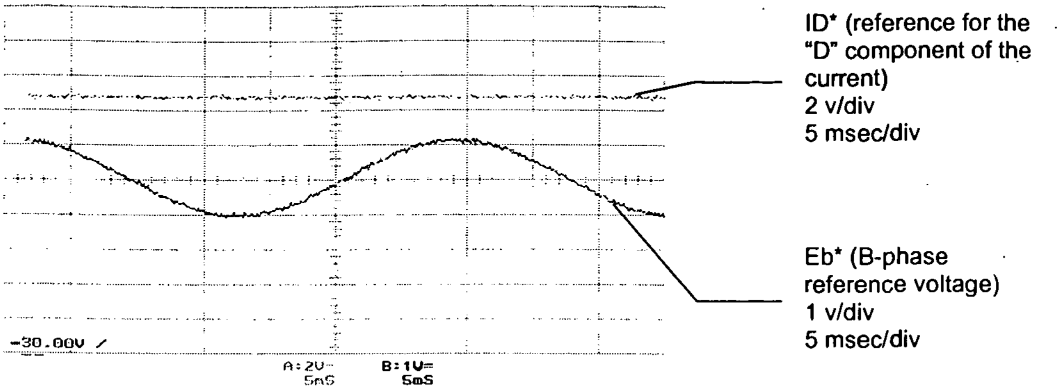

Figure 6-2. ID* and EB* at 30 Hz (Unloaded)

- ☐ AC voltage on test points **Ea***, **Eb*** and **Ec*** should be about 1.1 vpeak (see Figure 6-2 above).
- ☐ AC voltage on test points **HAR-A**, **HAR-B** and **HAR-C** should be 3.3 vpeak with slight dip at center (see Figure 6-3).

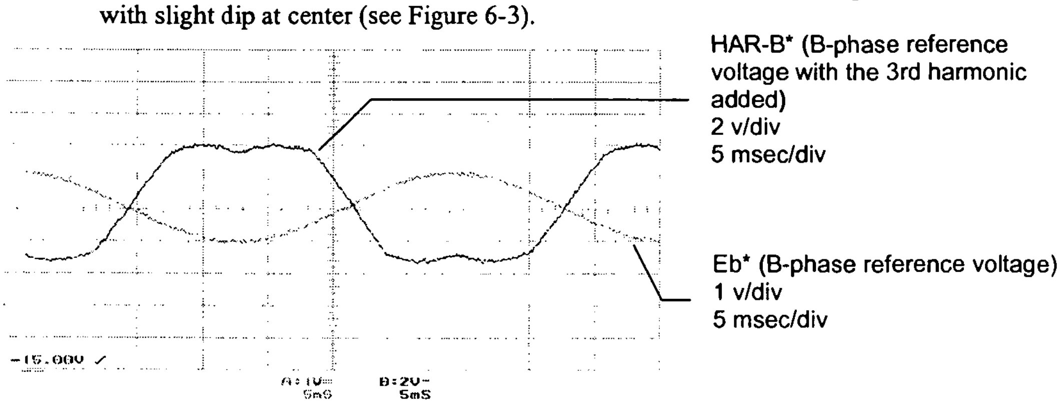

Figure 6-3. Eb* and HAR-B at 30 Hz (Unloaded)

Figure 6-4 may be used to indicate imbalances in either the modulator or power circuit. AC voltages on test points **Eb*** and **-VBN** should be 180 degrees out of phase to each other. The signal on test point **Eb*** should be slightly less than 50% of the signal on test point **-VBN**. Check test points **Ea***, **-VAN**, **Ec*** and **-VCN** in the same manner.

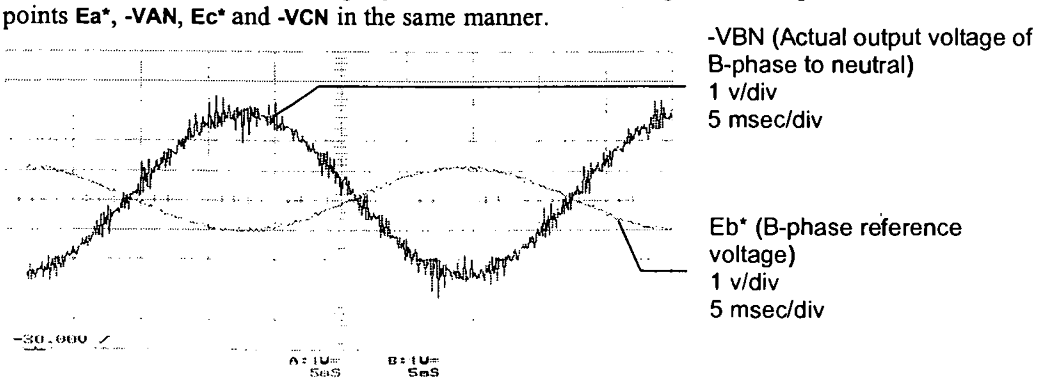

Figure 6-4. Eb* and -VBN at 30 Hz (Unloaded)

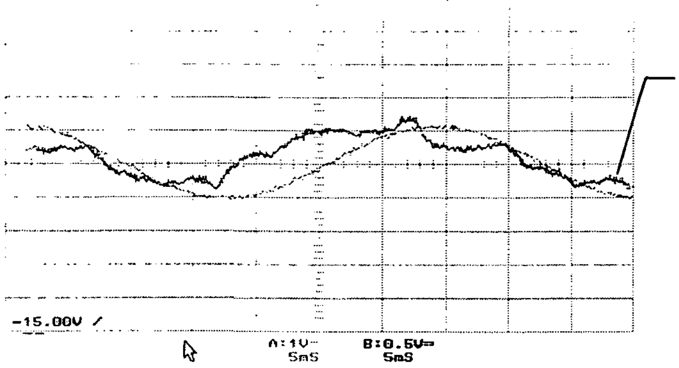

Figure 6-5. Eb* and eVBN at 30 Hz (Unloaded)

- ☐ If imbalances are suspected, the modulator can be ruled out by verifying that voltages on test-points **VA***, **VB*** and **VC*** (as compared to the triangle wave forms ±CAR1-5) appear as depicted in Figure 6-6.

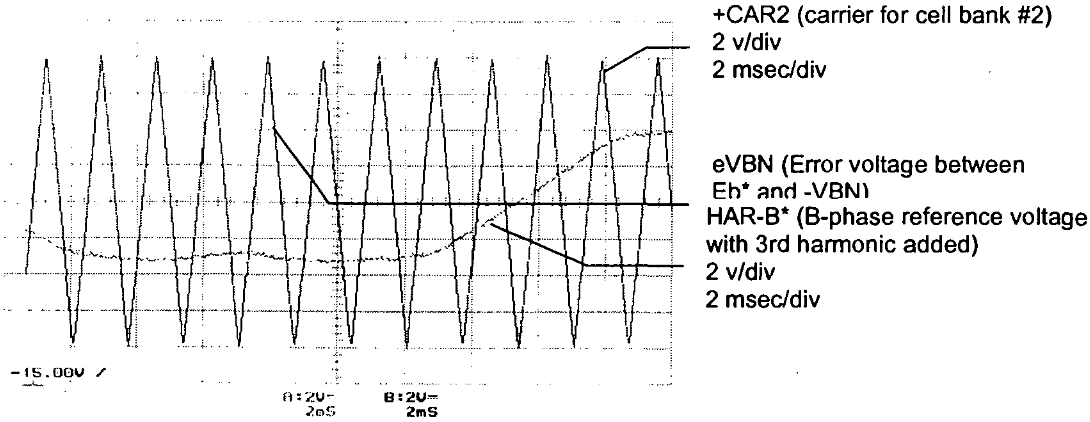

Figure 6-6. HAR-B* and +CAR2 at 30 Hz (Unloaded)

6.1.5. Scaling Adjustments

NOTE!! All scaling adjustments are set from the factory. There should be no need to change these parameters unless changes are made to system hardware.

To scale for proper voltage feedback, choose the "motor terminal voltage" from the Display Variable Menu (37) for one of the keypad displays.

- ☐ In the Hardware Scalar Menu (20), to adjust "mot V fb" so that the display matches the rated motor voltage when the system is operated at 60 Hz. Set speed pot for a measured actual motor voltage. Measure VMTR feedback signal on the PIC. Set "mot V fb vv" = Actual Motor Voltage/VMTR. Display should read the actual motor voltage. This scales the drives internal voltage feedback to the resistor divide ratio.

To scale for rated flux, adjust the keypad pot so the output frequency is exactly 60 Hz. In the Standard Control Setup Menu (24), "std volts/Hz" should be set to 1.000. Verify that the "volt P gain" and "volt I gain" in this menu are set to 0.000.

- ☐ In the Hardware Scalar Menu (20), adjust the "std mot V trim" for the rated output voltage on the motor. The nominal value is 8.00 V. If external output PTs are available, then verify proper voltage at each operating point using the table below.

Table 6-3. Proper Output Line Voltage Settings

Speed Dmd (%)	Freq (Hz) (60 Hz std.)	Output Line Voltages for Selected Motor Ratings				
		2300 VAC	3300 VAC	4160 VAC	6000 VAC	6600 VAC
0	0	0	0	0	0	0
25	15	600	825	1040	1500	1650
50	30	1200	1650	2080	3000	3300
75	45	1800	2475	3120	4500	4950
100	60	2300	3300	4160	6000	6600

If PTs are not available, connect an AC voltmeter between tests points **-VAN** and **-VBN**. Verify proper voltage at each operating point below.

Table 6-4. Proper Test Point Voltages

Speed Dmd (%)	Freq (Hz) (60 Hz std.)	-Van to -Vbn for Selected Motor Ratings				
		2300 VAC	3300 VAC	4160 VAC	6000 VAC	6600 VAC
0	0	0	0	0	0	0
25	15	1.7	1.7	1.7	1.8	1.7
50	30	3.3	3.5	3.5	3.6	3.5
75	45	5.0	5.2	5.2	5.4	5.2
100	60	6.7	6.9	6.9	7.1	6.9

To scale for proper line voltage, choose the "available line voltage" from the Display Variable Menu (37) for one of the keypad displays.

- ☐ In the Hardware Scalar Menu (20), to adjust line voltage display. The Line V fb vv = Actual Line Voltage/V_{AVAIL}. The display should read the actual line voltage. This scales the drive's internal voltage feedback to the resistor divide ratio. This is a factory set adjustment.

6.1.6. Closed Loop Operation

At this point, the VFD is ready for the actual motor operation.

- ☐ Reconnect motor leads or enable motor contactor.

Energize the 480 VAC control circuit breaker. The following parameter settings should be initially used to verify proper operation of the VFD under loaded conditions.

☐ Set the following parameters in the Standard Control Setup Menu (24):

Table 6-5. Standard Control Setup Menu (24) Parameter Settings for Closed Loop Operation

Parameter	Setting	Parameter	Setting
Volt P gain	0.5000	Vel I gain	4.000
Volt I gain	0.5000	Trq P gain	0.025
Vel P gain	5.000	Trq I gain	0.300

☐ In the Ramp Setup Menu (17) set the ramp rates appropriately for the application.

☐ Energize the medium voltage feed to the VFD. Push the fault reset button on the VFD. Jog the motor and observe proper rotation.

To test for proper current feedback polarity, check the voltage feedback signal on **-VBN** against the motor line current signal on **IbFDBK**.

☐ The **IbFDBK** signal must lag **-VBN** by 90 degrees for proper polarity (see Figure 6-7). Also, check test points **-VCN** and **IcFDBK** in same manner.

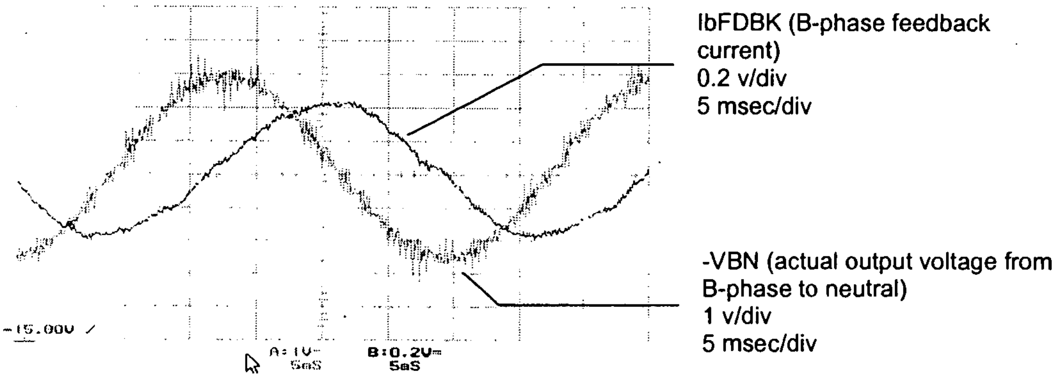

Figure 6-7. -VBN and IBFDBK at 30 Hz (Unloaded)

Check the DC signals on test points **IDFDBK** and **IQFDBK**. These test points represent the magnetizing (**IQFDBK**) and torque producing (**IDFDBK**) currents.

☐ Under unloaded conditions, **IDFDBK** should stay at least 0.1 VDC while **IQFDBK** should stay at approximately 0.5 VDC when **ID*** is varied between 1 and 2.5 VDC (see Figure 6-8).

6.1.7. Full Load Operation

Operate the drive over the speed range of the motor. Once the VFD is successfully loaded, re-check the following test points.

☐ The **IbFDBK** signal should significantly increase in magnitude over the unloaded condition shown in Figure 6-7, but lag **-VBN** by only about 30 degrees (see Figure 6-8). Also re-check test points **-VCN** and **IcFDBK**.

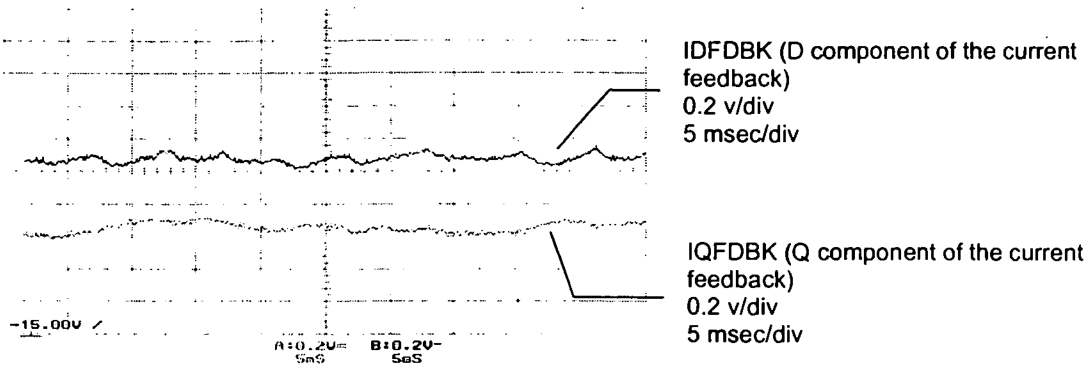

Figure 6-8. IQFDBK and IDFDBK at 30 Hz (Unloaded)

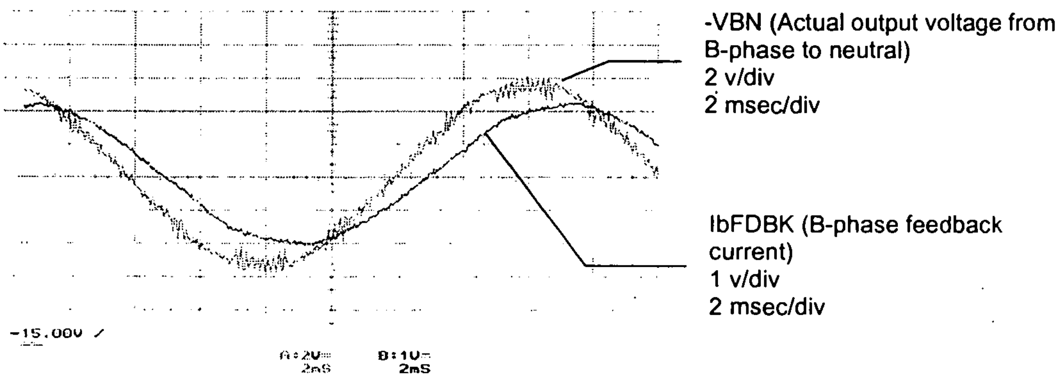

Figure 6-9. -VBN and IbFDBK at 60 Hz (Fully Loaded)

- ☐ The **IDFDBK** signal should increase to about 2 volts DC under a fully loaded condition. **IQFDBK** should increase only slightly (see Figure 6-10).

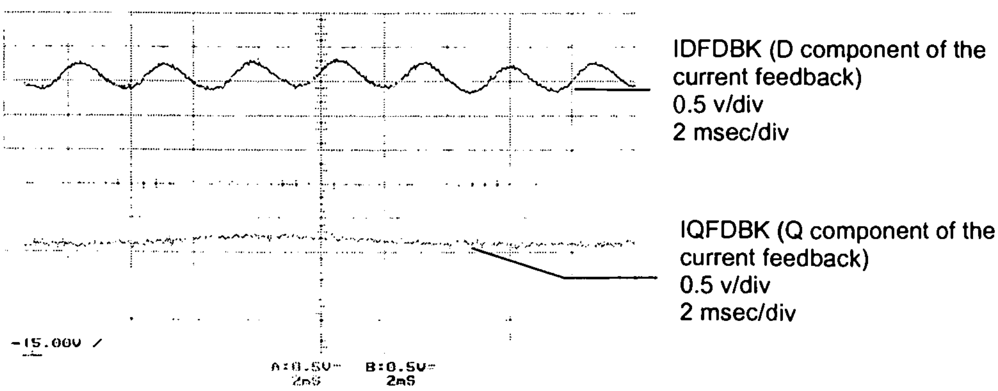

Figure 6-10. IQFDBK and IDFDBK at 60 Hz (Fully Loaded)

- ☐ Recheck the signals on test points **Eb*** and **eVBN**. Under normal operating conditions, these voltages should appear as shown in Figure 6-11.

comm_f11_0	2244 0 8	XCL COMM FLAG 11 bitflags
comm_f11_1	2244 1 8	
comm_f11_2	2244 2 8	
comm_f11_3	2244 3 8	
comm_f11_4	2244 4 8	
comm_f11_5	2244 5 8	
comm_f11_6	2244 6 8	
comm_f11_7	2244 7 8	
comm_f11_8	2245 0 8	
comm_f11_9	2245 1 8	
comm_f11_10	2245 2 8	
comm_f11_11	2245 3 8	
comm_f11_12	2245 4 8	
comm_f11_13	2245 5 8	
comm_f11_14	2245 6 8	
comm_f11_15	2245 7 8	
comm_f12_0	2246 0 8	XCL COMM FLAG 12 bitflags
comm_f12_1	2246 1 8	
comm_f12_2	2246 2 8	
comm_f12_3	2246 3 8	
comm_f12_4	2246 4 8	
comm_f12_5	2246 5 8	
comm_f12_6	2246 6 8	
comm_f12_7	2246 7 8	
comm_f12_8	2247 0 8	
comm_f12_9	2247 1 8	
comm_f12_10	2247 2 8	
comm_f12_11	2247 3 8	
comm_f12_12	2247 4 8	
comm_f12_13	2247 5 8	
comm_f12_14	2247 6 8	
comm_f12_15	2247 7 8	
comm_f13_0	2248 0 8	XCL COMM FLAG 13 bitflags
comm_f13_1	2248 1 8	
comm_f13_2	2248 2 8	
comm_f13_3	2248 3 8	
comm_f13_4	2248 4 8	
comm_f13_5	2248 5 8	
comm_f13_6	2248 6 8	
comm_f13_7	2248 7 8	
comm_f13_8	2249 0 8	
comm_f13_9	2249 1 8	
comm_f13_10	2249 2 8	
comm_f13_11	2249 3 8	
comm_f13_12	2249 4 8	
comm_f13_13	2249 5 8	
comm_f13_14	2249 6 8	
comm_f13_15	2249 7 8	
comm_f14_0	224A 0 8	XCL COMM FLAG 14 bitflags
comm_f14_1	224A 1 8	
comm_f14_2	224A 2 8	
comm_f14_3	224A 3 8	
comm_f14_4	224A 4 8	
comm_f14_5	224A 5 8	
comm_f14_6	224A 6 8	
comm_f14_7	224A 7 8	
comm_f14_8	224B 0 8	
comm_f14_9	224B 1 8	
comm_f14_10	224B 2 8	
comm_f14_11	224B 3 8	
comm_f14_12	224B 4 8	
comm_f14_13	224B 5 8	
comm_f14_14	224B 6 8	

```
comm_f14_15      224B 7 8

comm_f15_0       224C 0 8   XCL COMM FLAG 15 bitflags
comm_f15_1       224C 1 8
comm_f15_2       224C 2 8
comm_f15_3       224C 3 8
comm_f15_4       224C 4 8
comm_f15_5       224C 5 8
comm_f15_6       224C 6 8
comm_f15_7       224C 7 8
comm_f15_8       224D 0 8
comm_f15_9       224D 1 8
comm_f15_10      224D 2 8
comm_f15_11      224D 3 8
comm_f15_12      224D 4 8
comm_f15_13      224D 5 8
comm_f15_14      224D 6 8
comm_f15_15      224D 7 8

comm_f16_0       224E 0 8   XCL COMM FLAG 16 bitflags
comm_f16_1       224E 1 8
comm_f16_2       224E 2 8
comm_f16_3       224E 3 8
comm_f16_4       224E 4 8
comm_f16_5       224E 5 8
comm_f16_6       224E 6 8
comm_f16_7       224E 7 8
comm_f16_8       224F 0 8
comm_f16_9       224F 1 8
comm_f16_10      224F 2 8
comm_f16_11      224F 3 8
comm_f16_12      224F 4 8
comm_f16_13      224F 5 8
comm_f16_14      224F 6 8
comm_f16_15      224F 7 8

! XCL Communication Monitoring and Fault Control flags
! --------------------------------------------------
cab_pres             227A 0 1        CAB board present flag (XCL)
xcl_status_fail      227E 0 1        PLC Network status
cab_hw_fail          2280 0 1        CAB hardware status
xcl_data_fail        2282 0 1        XCL data transfer status
xcl_status_fail_log  2284 0 1        PLC Network failure trip
cab_hw_fail_log      2286 0 1        CAB hardware failure trip
xcl_data_fail_log    2288 0 1        XCL data transfer failure trip

! New Dual MODBUS control flags
! --------------------------
plc_a_select_f               228A 0 1  Select CAB PLC channel A as active (low adrs)
plc_b_select_f               228C 0 1  Select CAB PLC channel B as active (high adrs)
plc_unique_adrs_f  228E 0 1  Force Unique PLC addresses when available
xcl_override_f               2290 0 1  Allow PLC port change to cancel xcl data xfers

plc_a_active_f               2292 0 2  PLC A active
plc_b_active_f               2292 1 2  PLC B active
plc_a_net_down_f  2292 2 2  PLC A network down
plc_b_net_down_f  2292 3 2  PLC B network down
plc_a_fault_f                2292 4 2  PLC A fault
plc_b_fault_f                2292 5 2  PLC B fault
plc_spare_f                  2292 6 2  not used
plc_same_adrs_f   2292 7 2  Both PLCs have same address
! plc_baud_f
plc_baud_1200                2294 0 2  1200  baud plc communications
plc_baud_2400                2294 1 2  2400  baud plc communications
plc_baud_4800                2294 2 2  4800  baud plc communications
plc_baud_9600                2294 3 2  9600  baud plc communications
plc_baud_19200               2294 4 2  19200 baud plc communications
```

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```
plc_baud_38400              2294 5 2  38400  baud plc communications
plc_baud_115200   2294 6 2  115200 baud plc communications
plc_baud_spare              2294 7 2  spare plc baud rate

! duplicate baud rates for non std communication speeds
plc_baud_1                  2294 0 2  plc communication baud rate
plc_baud_2                  2294 1 2          plc communication baud rate
plc_baud_3                  2294 2 2          plc communication baud rate
plc_baud_4                  2294 3 2          plc communication baud rate
plc_baud_5                  2294 4 2          plc communication baud rate
plc_baud_6                  2294 5 2          plc communication baud rate
plc_baud_7                  2294 6 2          plc communication baud rate
plc_baud_8                  2294 7 2          plc communication baud rate

plc_2_stop_bits     2296 0 2  plc commumication w/2 stop bits (default = 1)
plc_odd_parity_f    2296 1 2  odd parity for plc communications
plc_even_parity_f   2296 2 2  even parity for plc communications
plc_protocol_3              2296 3 2  spare
plc_protocol_4              2296 4 2  spare
plc_protocol_5              2296 5 2  spare
plc_protocol_6              2296 6 2  spare
plc_protocol_7              2296 7 2  spare

plc_data_format_f   2298 0 1  use to modify plc data format

! User Module Digital Input flags
! ----------------------------
umdi00_f        0010 0 11    user modules Digital inputs Address 0
umdi00_e        0010 1 11
umdi00_d        0010 2 11
umdi00_c        0010 3 11
umdi00_b        0010 4 11
umdi00_a        0010 5 11
umdi01_f        0011 0 11    Digital inputs Address 1
umdi01_e        0011 1 11
umdi01_d        0011 2 11
umdi01_c        0011 3 11
umdi01_b        0011 4 11
umdi01_a        0011 5 11
umdi02_f        0012 0 11    Digital inputs Address 2
umdi02_e        0012 1 11
umdi02_d        0012 2 11
umdi02_c        0012 3 11
umdi02_b        0012 4 11
umdi02_a        0012 5 11
umdi03_f        0013 0 11    Digital inputs Address 3
umdi03_e        0013 1 11
umdi03_d        0013 2 11
umdi03_c        0013 3 11
umdi03_b        0013 4 11
umdi03_a        0013 5 11
umdi04_f        0014 0 11    Digital inputs Address 4
umdi04_e        0014 1 11
umdi04_d        0014 2 11
umdi04_c        0014 3 11
umdi04_b        0014 4 11
umdi04_a        0014 5 11
umdi05_f        0015 0 11    Digital inputs Address 5
umdi05_e        0015 1 11
umdi05_d        0015 2 11
umdi05_c        0015 3 11
umdi05_b        0015 4 11
umdi05_a        0015 5 11
umdi06_f        0016 0 11    Digital inputs Address 6
umdi06_e        0016 1 11
umdi06_d        0016 2 11
umdi06_c        0016 3 11
```

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umdi06_b	0016 4 11	
umdi06_a	0016 5 11	
umdi07_f	0017 0 11	Digital inputs Address 7
umdi07_e	0017 1 11	
umdi07_d	0017 2 11	
umdi07_c	0017 3 11	
umdi07_b	0017 4 11	
umdi07_a	0017 5 11	
umdi08_f	0018 0 11	Digital inputs Address 8
umdi08_e	0018 1 11	
umdi08_d	0018 2 11	
umdi08_c	0018 3 11	
umdi08_b	0018 4 11	
umdi08_a	0018 5 11	
umdi09_f	0019 0 11	Digital inputs Address 9
umdi09_e	0019 1 11	
umdi09_d	0019 2 11	
umdi09_c	0019 3 11	
umdi09_b	0019 4 11	
umdi09_a	0019 5 11	
umdi10_f	001A 0 11	Digital inputs Address 10
umdi10_e	001A 1 11	
umdi10_d	001A 2 11	
umdi10_c	001A 3 11	
umdi10_b	001A 4 11	
umdi10_a	001A 5 11	
umdi11_f	001B 0 11	Digital inputs Address 11
umdi11_e	001B 1 11	
umdi11_d	001B 2 11	
umdi11_c	001B 3 11	
umdi11_b	001B 4 11	
umdi11_a	001B 5 11	
umdi12_f	001C 0 11	Digital inputs Address 12
umdi12_e	001C 1 11	
umdi12_d	001C 2 11	
umdi12_c	001C 3 11	
umdi12_b	001C 4 11	
umdi12_a	001C 5 11	
umdi13_f	001D 0 11	Digital inputs Address 13
umdi13_e	001D 1 11	
umdi13_d	001D 2 11	
umdi13_c	001D 3 11	
umdi13_b	001D 4 11	
umdi13_a	001D 5 11	
umdi14_f	001E 0 11	Digital inputs Address 14
umdi14_e	001E 1 11	
umdi14_d	001E 2 11	
umdi14_c	001E 3 11	
umdi14_b	001E 4 11	
umdi14_a	001E 5 11	
umdi15_f	001F 0 11	Digital inputs Address 15
umdi15_e	001F 1 11	
umdi15_d	001F 2 11	
umdi15_c	001F 3 11	
umdi15_b	001F 4 11	
umdi15_a	001F 5 11	
umdo00_d	0010 2 12	Digital Outputs Address 0
umdo00_c	0010 3 12	
umdo00_b	0010 4 12	
umdo00_a	0010 5 12	
umdo01_d	0011 2 12	Digital Outputs Address 1
umdo01_c	0011 3 12	
umdo01_b	0011 4 12	
umdo01_a	0011 5 12	
umdo02_d	0012 2 12	Digital Outputs Address 2
umdo02_c	0012 3 12	

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umdo02_b	0012 4 12	
umdo02_a	0012 5 12	
umdo03_d	0013 2 12	Digital Outputs Address 3
umdo03_c	0013 3 12	
umdo03_b	0013 4 12	
umdo03_a	0013 5 12	
umdo04_d	0014 2 12	Digital Outputs Address 4
umdo04_c	0014 3 12	
umdo04_b	0014 4 12	
umdo04_a	0014 5 12	
umdo05_d	0015 2 12	Digital Outputs Address 5
umdo05_c	0015 3 12	
umdo05_b	0015 4 12	
umdo05_a	0015 5 12	
umdo06_d	0016 2 12	Digital Outputs Address 6
umdo06_c	0016 3 12	
umdo06_b	0016 4 12	
umdo06_a	0016 5 12	
umdo07_d	0017 2 12	Digital Outputs Address 7
umdo07_c	0017 3 12	
umdo07_b	0017 4 12	
umdo07_a	0017 5 12	
umdo08_d	0018 2 12	Digital Outputs Address 8
umdo08_c	0018 3 12	
umdo08_b	0018 4 12	
umdo08_a	0018 5 12	
umdo09_d	0019 2 12	Digital Outputs Address 9
umdo09_c	0019 3 12	
umdo09_b	0019 4 12	
umdo09_a	0019 5 12	
umdo10_d	001A 2 12	Digital Outputs Address 10
umdo10_c	001A 3 12	
umdo10_b	001A 4 12	
umdo10_a	001A 5 12	
umdo11_d	001B 2 12	Digital Outputs Address 11
umdo11_c	001B 3 12	
umdo11_b	001B 4 12	
umdo11_a	001B 5 12	
umdo12_d	001C 2 12	Digital Outputs Address 12
umdo12_c	001C 3 12	
umdo12_b	001C 4 12	
umdo12_a	001C 3 12	
umdo13_d	001D 2 12	Digital Outputs Address 13
umdo13_c	001D 3 12	
umdo13_b	001D 4 12	
umdo13_a	001D 5 12	
umdo14_d	001E 2 12	Digital Outputs Address 14
umdo14_c	001E 3 12	
umdo14_b	001E 4 12	
umdo14_a	001E 5 12	
umdo15_d	001F 2 12	Digital Outputs Address 15
umdo15_c	001F 3 12	
umdo15_b	001F 4 12	
umdo15_a	001F 5 12	

! System Program Counters (count False to True transitions)
! --

counter00	F000 0 6	Counters
counter01	F001 0 6	
counter02	F002 0 6	
counter03	F003 0 6	
counter04	F004 0 6	
counter05	F005 0 6	
counter06	F006 0 6	
counter07	F007 0 6	
counter08	F008 0 6	
counter09	F009 0 6	

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```
counter10     F00A 0 6
counter11     F00B 0 6
counter12     F00C 0 6
counter13     F00D 0 6
counter14     F00E 0 6
counter15     F00F 0 6

! System Program Timers
! ----------------
! usage - timer01(2.3) = <logic statement>;
! time is reset when the statement evaluates False
! (max time = 91.0 seconds)
timer00       E000 0 5  Timers
timer01       E001 0 5
timer02       E002 0 5
timer03       E003 0 5
timer04       E004 0 5
timer05       E005 0 5
timer06       E006 0 5
timer07       E007 0 5
timer08       E008 0 5
timer09       E009 0 5
timer10       E00A 0 5
timer11       E00B 0 5
timer12       E00C 0 5
timer13       E00D 0 5
timer14       E00E 0 5
timer15       E00F 0 5
timer16       E010 0 5  Timers
timer17       E011 0 5
timer18       E012 0 5
timer19       E013 0 5
timer20       E014 0 5
timer21       E015 0 5
timer22       E016 0 5
timer23       E017 0 5
timer24       E018 0 5
timer25       E019 0 5
timer26       E01A 0 5
timer27       E01B 0 5
timer28       E01C 0 5
timer29       E01D 0 5
timer30       E01E 0 5
timer31       E01F 0 5


! Counter reset control flags
! --------------------------
cntr_reset00  F000 0 7  Counter Resets
cntr_reset01  F001 0 7
cntr_reset02  F002 0 7
cntr_reset03  F003 0 7
cntr_reset04  F004 0 7
cntr_reset05  F005 0 7
cntr_reset06  F006 0 7
cntr_reset07  F007 0 7
cntr_reset08  F008 0 7
cntr_reset09  F009 0 7
cntr_reset10  F00A 0 7
cntr_reset11  F00B 0 7
cntr_reset12  F00C 0 7
cntr_reset13  F00D 0 7
cntr_reset14  F00E 0 7
cntr_reset15  F00F 0 7

! Interface board Digital I/O
```

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```
! ----------------------
15v_dig_ok    0084 0 9 Programmable port 1 PA0 (IC18) input Do Not Use!
cr1_f         0084 1 9 Programmable port 1 PA1 (IC18) input
cr3_f         0084 2 9 Programmable port 1 PA2 (IC18) input
pib_aux1_f    0084 3 9 Programmable port 1 PA3 (IC18) input
pib_aux2_f    0084 4 9 Programmable port 1 PA4 (IC18) input
pib_aux3_f    0084 5 9 Programmable port 1 PA5 (IC18) input
pib_aux4_f    0084 6 9 Programmable port 1 PA6 (IC18) input
pib_aux5_f    0084 7 9 Programmable port 1 PA7 (IC18) input

dummy         0086 0 9 Programmable port 1 PC0 (IC18) input
dummy         0086 1 9 Programmable port 1 PC1 (IC18) input
dummy         0086 2 9 Programmable port 1 PC2 (IC18) input
dummy         0086 3 9 Programmable port 1 PC3 (IC18) input
dummy         0086 4 3 Programmable port 1 PC4 (IC18) output
cr6_fin       0086 5 3 Programmable port 1 PC5 (IC18) output
cra_fin       0086 6 3 Programmable port 1 PC6 (IC18) output
cr0_fin       0086 7 3 Programmable port 1 PC7 (IC18) output

cr6_f         206C 0 1 Programmable port 1 PC5 (IC18) output
cra_f         2006 0 1 Programmable port 1 PC6 (IC18) output
cr0_f         206A 0 1 Programmable port 1 PC7 (IC18) output

dummy         008A 0 9 Programmable port 1 PC0 (IC19) input
dummy         008A 1 9 Programmable port 1 PC1 (IC19) input
dummy         008A 2 9 Programmable port 1 PC2 (IC19) input
dummy         008A 3 9 Programmable port 1 PC3 (IC19) input
dummy         008A 4 9 Programmable port 1 PC4 (IC19) input
hsot_input    008A 5 9 Programmable port 1 PC5 (IC19) input
dummy         008A 6 9 Programmable port 1 PC6 (IC19) input
dummy         008A 7 9 Programmable port 1 PC7 (IC19) input

! End of System Address Directory
! ---------------------------
```

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CHAPTER 8: TROUBLESHOOTING AND MAINTENANCE

In This Section:

8.1 Introduction

The Perfect Harmony variable speed drive is designed, built and tested for long, trouble-free service. Periodic maintenance is required to keep the drive working reliably and to minimize

> **DANGER - Lethal Voltages!** Always switch off the main input power to the equipment before attempting inspection or maintenance procedure.

> **WARNING!!** Only qualified service personnel should maintain Perfect Harmony equipment and systems.

8.2 Six Month Inspection

- ☐ Since the cooling system of the Perfect Harmony VFD draws air through the cell heat sinks, dirt will tend to collect at the inputs of the cell heat sinks. If significant collection is noted, these cells should be removed and cleaned (see Chapter 1).
- ☐ Thoroughly clean the inside and outside of all enclosures using a vacuum cleaner fitted with a plastic nozzle. Keeping the equipment free from dirt and dust allows proper heat dissipation.
- ☐ Inspect the belts and blower motor in the Blower/Transformer Cabinet. Blowers are located above the transformer.
- ☐ If the Cell Cabinets are fitted with air filters, these filters can be cleaned and replaced.

> **WARNING!!** Filter orientation must be noted so that air flow is from outside to inside of the cabinet.

- ☐ Use touch-up paint as required on any rusty or exposed parts.
- ☐ Inspect all electrical connections in the Cell and Transformer Cabinets for tightness (especially during the first 6 months from start-up) and re-tighten if necessary.

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- ☐ Verify proper operation of cooling system by placing a single sheet of standard ply notebook paper over the cabinet air intakes. The paper should stick to the cabinet.

It is strongly recommended that the power connections be re-tightened after the first few days of operation and checked monthly for tightness during the first few months of operation, then every 6 months thereafter. Other important connections are:

- ☐ All input power and output series connections within the Cell Cabinet (see illustrations in Chapter 1).
- ☐ All secondary and primary transformer connections within the Transformer Cabinet (see illustrations in Chapter 1).

8.3. Replacement of Parts

Replacement of component parts may be the best method of troubleshooting when spare parts are available. Use troubleshooting guidelines found later in this chapter when attempting to locate a failed sub-assembly. When any sub-assembly is to be replaced, always check that the part number of the new unit matches that of the old unit (including the dash number).

- ☐ Failures traced to individual PC boards within the Control Cabinet are best serviced by replacement of the entire board.
- ☐ Failures traced to individual power cells are best serviced by replacement of the entire cell.

> Spare parts are available through the ROBICON Customer Service Center by calling (412) 339-9501.

8.4. Interpreting Keypad Display Fault Messages

Faults as displayed on the keypad can be grouped into two categories:

- Drive Faults
- Cell Faults.

Drive Faults are system faults sensed by the Master Control circuitry in the Control Cabinet (refer to Section 2.3: The Master Control System).

Cell Faults are faults sensed by the control logic located on the Cell Control Board in each output power cell. Each power cell has its own sense circuitry (refer to Section 2.2: The Cell Control System).

Faults are ranked according to their level of severity as follows:

- Level A (Major Fault)
- Level B (Fault)
- Level C (Warning).

Drives respond differently to different fault classes. These responses are summarized in Table 8-1.

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Table 8-1. Drive Responses to Fault Classes

Fault Class	Drive Response
Level A(Major Fault)	All IGBT gate drives are inhibited, motor coasts to stop, the fault is logged in the Fault Log Menu (33) or Cell Fault Log Menu (21) and displayed on the front panel.
Level B(Fault)	Motor either ramp stops or coast stops depending on the switch setting in Menu 14 or the content of the System Program (see Chapter 7: System Programming). The fault is displayed on front panel and logged into the fault log.
Level C (Warning)	Drive does not necessarily revert to the idle state via a coast or ramp stop unless specifically required to do so by the system program.

Depending on the fault condition, faults are reset in one of two possible ways:

- Manual Reset
- Automatic Reset.

The fault reset push-button on the front panel or the Enter for Fault Reset function in Menu 34 can be used to *manually reset* the fault. The drive must be returned to the run condition by manual start or by forcing the *run_req_f* equal to "true" (see system program example in Section 8).

The fault can be reset *automatically* up to 4 times if enabled by the Auto Reset Enable function in Menu 14. If reset is successful, then drive will return to the run state automatically only if the *run_req_f* flag is maintained at the value "true" (see system program example in Section 8).

8.5. Drive Faults

All drive faults are sensed by circuits located on the Power Interface Board (PIB) (see Figure 2-1 and Figure 2-2) and the Fiber Optic Hub Board (FOHB) (see Figure 1-11, Figure 2-1 and Figure 2-2). Table 8-2 can be used as a quick troubleshooting guide to locate the cause of the fault condition.

Table 8-2. Drive Faults

Fault Display (Fault Class*)	Potential Causes and Possible Corrective Actions
Over Voltage Fault (A)	**Cause:** Signal from **VMTR** test point on Power Interface Board exceeds threshold set by "Motor Trip Volts" in Menu 34. This fault is usually caused by an improperly set-up or tuned drive. **Actions:** Verify that the motor and drive nameplate settings match the corresponding parameters in Motor Menu (11) and Drive Parameter Menu (14). Verify that the signals on the **VMTR** and **VPKAC** test points on the Power Interface Board match proper voltage levels indicated in Appendix B, sheet 5. If an incorrect voltage is noted, check the voltage divider in the Motor Sense Unit (see Appendix B, sheet 5, zone 2R) or replace the Power Interface Board.

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Fault Display (Fault Class*)	Potential Causes and Possible Corrective Actions
±15 VDC Supply (A)	**Cause:** Zero (0) volt level from A8 pin 3 or 2 on Power Interface Board into fault GAL IC28 pin 4 due to low voltage on **+5**, **+15**, and **-15** test points. Usually this is the result of a defective Power Interface Board. **Action:** If DC voltages on **+5**, **+15**, and **-15** test points on the Power Interface Board are OK (see Figure 1-11 and Figure 2-1), replace the Power Interface Board.
Overload Fault (A)	**Cause:** Incorrect signals from **IDFDBK** and **IQFDBK** test points on Power Interface Board. This fault is usually caused by an improperly set-up or tuned drive - specifically the result of an incorrect "I overload" setting in Menu 34. **Actions:** Verify that the motor and drive nameplate settings match parameters in Motor Menu (11) and Drive Parameter Menu (14). Verify that the signals on test points **IcFDBK** and **IbFDBK** (see Appendix 2, sheet 5, Figure 1-11 and Figure 2-1) on the Power Interface Board match the percentage of full scale signals indicated on sheet 5. If these signals are incorrect, then replace the Power Interface Board.
Ground Fault (C)	**Cause:** >1 v peak AC signal on test point **VNFLT** on the Power Interface Board resulting in 5v logic signal on **HGNDFLT** test point. This fault is usually caused by an output ground fault condition. **Action:** Verify proper symmetry of voltages on test points **-VCN**, **-VBN**, and **-VAN** (see Figure 4-12 and Figure 4-18). With the VFD operating, all voltages should appear as in Figure 5-13. If ground faults are not a problem, check the divider resistors in the Motor Sense Unit (Figure 2-3) or replace the Power Interface Board. Check if the motor is disconnected from VFD (output contactor open in drive run state).
Drive IOC (A)	**Cause:** Signal from **A16** pin 14 on Power Interface Board exceeds level set by the "Drive IOC Setpt" parameter in Menu 34. **Actions:** Verify that the motor and drive nameplate settings match parameters in Motor Menu (11) and Drive Parameter Menu (14). Verify that the signals on test points **IcFDBK** and **IbFDBK** (see Appendix 2, sheet 5, Figure 1-11 and Figure 2-1) on the Power Interface Board match the percentage of full scale signals indicated on sheet 5. If these signals do not match, then replace the Power Interface Board.

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Fault Display (Fault Class*)	Potential Causes and Possible Corrective Actions
Transformer Overtemp (C)	**Cause:** Logic high signal on **TB1B-11** on PIB resulting from open thermal switch. **Actions:** Check cooling system for proper temperatures and flows. Inspect all transformer cooling paths for leaks or collapsed hoses. Be sure all transformer manifolds are fully open. If the source of the problem is not found, then replace the Power Interface Board, then the Microprocessor Board. See Figure 1-11 and Figure 2-1.
Hub Loss of Enable (A)	**Cause:** Logic low signal on **IC29** pin 18 on Fiber Optic Hub Board usually resulting from unlatched cell fault. Signal is monitored by pin 11 of **IC19** on Power Interface Board. This fault is usually caused by an improperly set-up or tuned drive. If this fault is verified to be latched low on pin 18 of **IC29** on the FOHB, but no cell fault is displayed using the "Display Cell Fault" parameter in Menu (21), then the problem is an unlatched fault sent by one of the power cells. Since this fault is not latched in the cell control, the cell sending the fault signal cannot be identified by the diagnostic system. Future revisions of the Master Link Board will include an LED on the board to indicate which cell sent a fault signal. This condition is usually the result of a defective Cell Control Board. **Actions:** On existing versions, the problem cell can be located by using the following procedure. Disconnect motor leads. Configure the system for one less cell by completely removing the rightmost Master Link Board from the Hub Board (see Figure 1-11, Figure 2-2 and Figure 2-3) and reducing the "installed stages" parameter in Menu 21 to one less cell. Reset the system (or re-energize 480 VAC control). If the problem goes away, then the problem cell is one of the cells connected to the disconnected link board. If the problem persists, then swap each of the remaining link boards with the disconnected board and repeat the procedure. Once the cell has been traced to one of the three possible cells connected to the Master Link Board, then the individual cell can be located by swapping individual fiber optic connections from the disconnected board to one of the active boards. **WARNING!!** Always swap within a phase group (**A2** with either **A1**, **A3**, **A4** or **B2** with either **B1**, **B3**, **B4**). For instance, **NEVER** **A2** with **B3** or **C3**.

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Fault Display (Fault Class*)	Potential Causes and Possible Corrective Actions
Medium Voltage Supply Fault (A)	**Cause:** Logic high signal on pin 10 of **IC19** on Power Interface Board usually resulting from disconnected **PL8** connection between PIB and FOHB or Loss of +24, +15, +5 on the FOHB. **Action:** If the source of the problem is not found, then do the following. Ensure that the **PL8** connection between the Power Interface Board (PIB) and the Fiber Optic Hub Board (FOHB) is secure. Verify **+24**, **+15**, and **+5 V** signals on the FOHB. Replace Power Interface Board, then the Microprocessor Board. (See Figure 1-11, Figure 2-1 and Figure 2-3).
CAB Hardware Fault (A)	**Cause:** Network or software fault associated with XCL interface card plugged into **P6** on the Microprocessor Board. **Action:** If the source of the problem is not found, then replace the CAB Board and/or the Microprocessor Board. (See Figure 1-11 and Figure 2-1).
XCL Comm Status Fault (A)	**Cause:** Drive not on active PLC network. **Actions:** If the source of the problem is not found, then replace the CAB Board and/or the Microprocessor Board. (See Figure 1-11, Figure 2-1 and Table 3-47: XCL Send Setup Menu).
Power Cell Fault (A)	**Cause:** Logic low signal on pin 12 of **IC18** on FOHB caused by latched fault condition detected in one or more power cells. **Action:** Refer to the section on Cell Faults (on page 8-7).
Overspeed Fault (A)	**Cause:** The *mmf_spd_abs* flag in control software exceeds "Overspeed setting" in Menu 34. This fault is usually caused by an improperly set-up or tuned drive. **Actions:** Verify that the motor and drive nameplate settings match parameters in the Motor Menu (11) and Drive Parameter Meter (14).
User Fault #1-16 (B)	**Cause:** The *user_fault1* through *user_fault16* flags set by the value "true" by system program. See system program example in Section 8. **Actions:** Refer to the section on User Faults (on page 8-10).
24 VDC Supply Fault (A)	**Cause:** Logic low signal on pin 8 of **IC3** on the Power Interface Board usually caused by a short on the 24 VDC supply. Usually caused by defective Power Interface Board or User Modules. **Actions:** If the source of the problem is not found, then replace Microprocessor Board. (See Figure 2-1).

* Fault Class designations (in parentheses) are explained in Table 8-1 on page 8-3.

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8.6. Cell Faults

Cell faults are logged by the Microprocessor Board following a power cell fault indication. These faults are available for inspection through the "display cell fault" parameter in the Cell Menu (21). See the appropriate tables in Chapter 9.

All cell faults are generated by circuitry located on the Cell Control Board (CCB) of each power cell and are received by the Microprocessor Board through circuitry on the Master Link Boards which plug into the Fiber Optic Hub Board FOHB. Table 8-3 can be used as a troubleshooting guide to locate the cause of the fault condition. All cell faults are initiated by the Cell Control Board (CCB) located in each power cell (see Figure 1-12 and Figure 2-4).

> The Perfect Harmony has a reduced voltage operation mode. This feature allows reduced voltage operation under normal conditions, but bypasses the entire stage (with no reduction in output voltage) on the occurrence of a cell fault. If a second cell fault occurs, the voltage is then reduced. No spare cells are used in this mode of operation. ***Care must be exercised in setting the output voltage in this mode to prevent cell voltages that are higher than recommended for the cell!*** Under normal conditions, a 5 stage drive will output 4160 volts. Under this mode of operation the same drive must be configured as a 4 stage drive (i.e., 3300 volts). Failure to do so will result in the individual cells supporting 600 volts instead of the 480 volt share of the phase voltage. This mode is enabled by selecting the "Reduced Voltage Oper" parameter in the Drive Parameter Menu (14). Refer to Chapter 9.

Table 8-3. Cell Faults

Fault Display (Fault Class*)	Causes	Sec. Ref.
AC Fuse(s) Blown (A)	A Cell Control Board has detected that the DC voltage in its cell is abnormally low (i.e., the signal on test point **VDC** is <3.5 VDC) while the incoming AC voltage is acceptable (i.e., the signal on test point **VAVAIL** is >5 VDC). This usually indicates a loss of one or more power fuses (**F11**, **F12**, and **F13**) at the cell input. Refer to Figure 1-12.	7.6.1
Cell Overtemp (A)	Each cell sends a PWM signal (on **A11** pin 7) related to heat sink temperature to the FOHB. The **TEMP** test point on the FOHB is an indication of the highest-temperature cell. If this signal falls below 2.0 VDC, an excessive heat sink temperature is indicated (see Figure 1-12). If this fault occurs, check the condition of the blowers. Also check for restrictions in air flow or leaks in the air duct system.	7.6.2
Control Power Fault (A)	One or more of the local power supplies (+24, +15, +5, -5 VDC) on a Cell Control Board has been detected out of specification (i.e., a logic high signal on pin 13 of **A5**). If this occurs, the Cell Control Board should be repaired or replaced.	7.6.1
Device OOS (Out of Saturation) (A)	Each Gate Driver Board includes circuits which verify that each IGBT has fully turned on. This fault may indicate a shorted IGBT, an open IGBT, or a failure in the detection circuitry. The cell's power components and Gate Driver Board should be checked.	7.6.1

Fault Display (Fault Class*)	Causes	Sec. Ref.
Overvoltage (A)	The bus voltage in a cell has been detected over 800 VDC (low-voltage cells) or 1200 VDC (high-voltage cells). This is usually caused by a regeneration limit that is too high, or improper tuning of the drive.	7.6.3
Cap Shr Fault (A)	The voltage on an individual capacitor in a cell has been detected over 425 VDC. This usually indicates a broken bleeder resistor/wire or a failed DC link capacitor (C1 and/or C2). Refer to Figure 1-12 and Figure 2-4.	7.6.1
Cell Comm. Fault (A)	An error in the optical communications was detected by a cell (i.e., a logic low signal is detected on pin 13 of IC37). This is usually a parity error caused by noise, but can also be a time-out error caused by a faulty communications channel between the Cell Control Board and its Master Link Board.	7.6.4
Output Fuse Blown (A)	The S2 trigger fuse is open on a cell. This is usually caused by failure of bypass fuse F10 (bypass option only). See Figure 1-12 and Figure 2-4. This type of fault could also be caused by loose connections in the cell harness.	7.6.1
Q1-Q4 OOS (A)	Individual annunciation of Q1, Q2, Q3, and Q4 Out of Saturation Fault. See also Device OOS fault above.	7.6.1
Link Fault (A)	An error in the optical communication channel was detected by the Master Link Board. This is usually a parity error caused by noise, but can also be a time-out error caused by a faulty communications channel. See Figure 1-12 and Figure 2-2.	7.6.4
Bypass Failed (A)	Improper handshaking signal received by the Cell Control Board (i.e., logic low signal exists on pin 6 of IC27) from the Bypass Board. This is usually caused by a malfunctioning Bypass Board. See Figure 1-12 and Figure 2-4.	7.6.1
VDC Undervoltage (A)	The DC bus voltage detected in a cell is abnormally low (signal on test point VDC on the Cell Control Board is <3.5 VDC). If this symptom is reported by more than one cell, it is usually caused by a low primary voltage on the main transformer T1.	7.6.1
Device Failure (A)	Refer to Table 8-3 for information.	*n/a*

* *Fault Class designations (in parentheses) are explained in Table 8-1 on page 8-3.*

The following cell faults will occur only during the cell diagnostic mode (immediately following initialization or reset). All IGBTs in each cell are sequentially gated and checked for proper operation.

Table 8-3. Diagnostic Cell Faults

Fault Displayed	Rank	Causes	Reference
Blocking Failure	A1	Voltages across power transistors Q1-Q4 are low while the transistors are **not** gated. Usually caused by a defective Gate Drive Board or Cell Control Board. (See Figure 1-12 and Figure 2-4.)	8.6.1
Switching Failure	A1	Voltages across power transistors Q1-Q4 are high while the transistors **are** gated. Usually caused by defective Gate Drive Board or Cell Control Board. (See Figure 1-12 and Figure 2-4.)	8.6.1

8.6.1. Troubleshooting General Cell and Power Circuitry Faults

The types of faults addressed in this section include the following:

- AC Fuse(s) Blown Faults
- Control Power Faults
- Device Out of Saturation (OOS) Faults
- Cap Shr Faults
- Output Fuse Blown Faults
- Q1-Q4 OOS Faults
- Bypass Failed Faults
- VDC Undervoltage Faults
- Blocking Failure Faults
- Switching Failure Faults.

Cell fault indications of this variety usually indicate circuit failures within the cell power or control circuitry. If this is the case, and no bypass or redundant cell option was ordered, the Perfect Harmony can still be configured to run, but at a reduced output voltage rating using the following procedure:

- Locate faulted cell and remove all fuses (F11, F12, and F13) in that cell and both vertically adjacent cells in the remaining phases, i.e., A4 and B4, if C4 failed (see Figure 1-9 and Figure 1-12).
- Short output of disconnected cells by placing a 5 KV high voltage bypass cable between the **T1** and **T2** connections. This connection must be of a suitable current rating for the cell rating of the Perfect Harmony drive (see Table 5-1 for these ratings).
- Remove the Master Link Board which connects the fiber optic cables of the bypassed cells from the Fiber Optic Hub Board (see Figure 1-10 and Figure 2-1).
- Left justify the remaining Master Link Boards so that all boards fill the left most slots of the FOHB.
- In the Cell Menu (21), reduce the "installed stages" parameter by 1 (new number of operating cells in series).
- Set appropriate "motor voltage" in Menu 11.

8.6.2. Troubleshooting Cell Overtemperature Faults

Check for adequate cooling air by placing a standard ply 8.5″×11″ sheet of notebook paper against the input louver of the cell cabinet.

- If the paper fails to stick, then air is probably inadequate. Check for excessive output pressure in the plenum or reverse the phase power on the blower motor.
- Check for a loose or broken belt on the blower.

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8.6.3. Troubleshooting Overvoltage Faults

This fault is usually caused by an improperly set-up or tuned drive.

- Verify that the motor and drive nameplate settings match parameters in the Motor Menu (11) and Drive Parameter Menu (14).
- Reduce "regen trq limit" parameter in Menu 24.
- Reduce "trq P gain" and "trq I gain" parameters in Menu 24.
- If failure is occurring in bypass mode, increase "energy saver" parameter in Menu 24 to at least 50%.
- If the measured signals seem to be correct, change the Power Interface Board.

8.6.4. Troubleshooting Cell Communication and Link Faults

Faults of this variety can be the result of circuit failures on either the Master Link Board or Cell Control Board.

- If the fault indication persists after replacing the Master Link Board, see Section 8.3.1 above.

8.7. User Faults

User faults originate due to conditions defined by the system program. User faults are displayed on the keypad in the form of user defined fault #n, where n equals 1 to 16. The faults can also be displayed through user defined text strings (see Section 8). Most user defined faults are written to respond to various signals from the user module interface such as the Analog Input Module (through the use of comparators) as well as the Digital Input Module.

A copy of the system program is required to specifically define the origin of the fault. In the example program in Section 7, the *user_fault1* flag is used to display the event of a blower fault. Note that the *user_text_1* string pointer is used to display the specific fault message. If this string pointer is not used, then the fault displayed would be "user defined fault #1".

8.8. Output Limitations with No Apparent Fault Message

In some cases, the Perfect Harmony VFD will revert to operating conditions which limit the amount of output current, output speed, or output voltage, but with no apparent fault condition displayed. The most usual causes of these conditions are described below.

The mode display shown in Table 5-4 and described in Section 5 can sometimes be used to troubleshoot the cause of the output limitation.

8.8.1. Output Voltage Limit

If the mode display shows Byps (bypass), then the Perfect Harmony VFD has placed one or more series cells in the bypass mode due to a cell fault. Inspect the Display Cell Fault menu item in Menu 21 for the cells bypassed and the reason for bypass.

If the mode display shows Hand or Auto (normal modes), check the "energy saver" parameter in Menu 24. Any setting above 0% will limit the rated output voltage until full load current is attained.

Check all motor and drive nameplate ratings against parameters set in the Motor Parameter Menu (11) and Drive Parameter Menu (14).

8.8.2. Output Current Limit

If the mode display shows Tlim (Torque Limit), then the Perfect Harmony VFD has reduced the motor torque limit due to a loss of input phase (or cell phase) or has received a cell overtemperature warning flag from one of the output cells (see *mv_ot_warning_f* flag in Appendix 1).

- Normal acceleration rates with high inertial loads (fans) or high acceleration rates with low inertial loads (pumps) will normally cause the Tlim display to occur.
- Low setting of "torque I gain" (< 0.3) in Menu 24 (Standard Performance Mode), will also cause this mode to display during accelerations.

If no Tlim (Torque Limit) is displayed, check all motor and drive nameplate ratings against the parameter set in Motor Parameter Menu (11) and Drive Parameter Menu (14).

8.8.3. Output Speed Limit

If the mode display shows Rlbk (Rollback), then the Perfect Harmony VFD is attempting to reduce the output speed due to a torque limit condition. Check "mot trq limit" parameter in Menu 24, or check all motor and drive nameplate ratings against parameters set in Motor Parameter Menu (11) and Drive Parameter Menu (14).

8.9. Diagnosing Inhibit Mode

The Inh operating mode (see Section 3.0) can be caused by a combination of conditions involving the *sw_estop_f* and *drv_flt_f* (the emergency stop and drive fault software flags). Addresses for these flags can be found in the HARMONY.LOC and DRCTRY.PWM files, respectively.

If the *sw_estop_f* is set "true", but the *drv_flt_f* is "false", then the *estop_f* has been set by equations in system program. Inspect the system program to find the reason.

If the *sw_estop_f* and *drv_flt_f* are set "true", then one or more of the following conditions may have occurred:

- ☐ EEPROM checksum failure
  - System program checksum
  - Incompatible DRCTRY.PWM file (version is too old or too new for installed software).
- ☐ Incorrect CAB software version
- ☐ 15 volt encoder supply fault (Power Interface Board)
- ☐ Cell overtemperature (see Table 8-3) (Harmony only)
- ☐ Hardware drive fault
  - Analog power supply fault (±15 volts on Power Interface Board)
  - Drive IOC (Instantaneous Overcurrent)
- ☐ Medium voltage loss of enable (see Table 8-2)
- ☐ Medium voltage power supply fault (see Table 8-2)
- ☐ ±15 VDC supply (see Table 8-2)
- ☐ Cell power fault (see Table 8-3)
- ☐ Illegal cell count
- ☐ Fault in motor voltage feedback (voltage > 20% when drive disabled)
- ☐ Cell hardware fault (indeterminate)
- ☐ Software generated faults (see Table 8-2)
  - Overspeed
  - User module 24 V power supply
  - Overload (current & time) motor overvoltage
- ☐ Analog Data Acquisition System (DAS) failed to initialize
- ☐ XCL communication faults when triggered through system program.

If the *drv_flt_f* is set "true", but the *sw_estop_f* is set "false", then any one or more of the following conditions may have occurred:

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- RAM checksum failure
- *drv_flt_f* set by an equation in the system program
- DCL communication faults when enabled through system program
- User faults (see Section 8.1.2).

If neither the *sw_estop_f* or *drv_flt_f* flags are set "true", then one or more of the following conditions may have occurred:

- Ground fault - sets the system program flag *ground_flt_f* in system program (see Table 8-2)
- Transformer overtemperature - sets the system program flag *therm_ot_f* (see Table 8-2).

8.10. Filter Maintenance

The drives have air filters bolted onto the front of the cell cabinet doors.

Before the filters can be cleaned, they have to be removed from the drive doors, by unbolting the filter frame.

The filters can be cleaned by a low pressure water stream

Ensure the filters are thoroughly dry before installing them onto the drive doors.

The frequency of filter cleaning will depend on how clean the environment is, in which the drive is located.

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CHAPTER 9: FAULT PROTECTION AND RECTIFICATION

In This Section:

9.1. Introduction

The following sections contain a condensed description of all parameter items available in the Perfect Harmony menu structure (software version 1.10). Table 9-1 depicts main menus and submenus of the system. Each menu and submenu is associated with a number (shown in parentheses). The key sequence [Shift]+[⇨] ([Shift] plus the right arrow key) and up/down arrow keys ([⇧] and [⇩]) as described above can be used to directly access each menu item.

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> Table 9-1 lists menu and submenu names only. Parameters and functions found in these menus are described in detail in the sections that follow. Use the associated table and page numbers from Table 9-1 to quickly locate the section of the chapter that explains all of the associated menu items.

> Menus highlighted by an $^{H/V}$ superscript (in Table 9-1) denote menus available only for High Performance or Vector Control Mode. These menus are displayed only if the *std_cntrl_f* flag is set to "false". Menus highlighted by an ^{Std} superscript denote menus available only for Standard Performance Mode. These menus are displayed only if the *std_cntrl_f* flag is set to "true".

> System drawing 479333 (sheets 1-8, located in Appendix 2) references many of these menu items as they relate to VFD control and configuration.

Table 9-1. Perfect Harmony Menu and Submenu Summary

Menu	#	Submenu Names	#	Table	Page	Description
Motor Menu	(1)	Motor Parameter Menu	(11)	Table 9-2	9-3	Used to enter specific motor and encoder data.
		Encoder [H/V] Menu	(12)	Table 9-3	9-4	
		Motor Flux [H/V] Menu	(13)	Table 9-4	9-4	
Drive Menu	(2)	Drive Parameter Menu	(14)	Table 9-5	9-5	Used to configure the VFD for various load conditions and drive applications.
		Speed Setup Menu	(15)	Table 9-6	9-7	
		Torque Ref Menu	(16)	Table 9-7	9-8	
		Ramp Setup Menu	(17)	Table 9-8	9-9	
		Pot Setup Menu	(18)	Table 9-9	9-11	
		Timebase Setup Menu	(19)	Table 9-10	9-11	
		Hardware Scale Menu	(20)	Table 9-11	9-12	
		Cell Menu	(21)	Table 9-12	9-13	
		Transfer Menu	(200)	Table 9-13	9-14	
Stability Menu	(3)	Current Loop Setup [H/V] Menu	(22)	Table 9-14	9-15	Used to adjust the VFD's various torque and velocity loop gains.
		Vector Control Tune Menu	(23)	Table 9-15	9-15	
		Std Control Setup [Std] Menu	(24)	Table 9-16	9-16	
		Control Loop Test Menu	(25)	Table 9-17	9-19	
Auto Menu	(4)	Speed Profile Menu	(26)	Table 9-18	9-20	Used to configure various speed setpoint, profile, and critical speed avoidance parameters. PID Select Menu contains setup parameters for the process PID loop.
		Speed Setpoint Menu	(27)	Table 9-19	9-22	
		Critical Speed Menu	(28)	Table 9-20	9-22	
		Comparator Setup Menu	(29)	Table 9-21	9-23	
		PID Select Menu	(48)	Table 9-24	9-24	
Main Menu	(5)	Motor Menu	(1)	*see above*		
		Drive Menu	(2)	*see above*		
		Stability Menu	(3)	*see above*		
		Auto Menu	(4)	*see above*		
		Log Control Menu	(6)	*see below*		
		Drive Protect Menu	(7)	*see below*		
		Meter Menu	(8)	*see below*		
		Communications Menu	(9)	*see below*		
		Security Edit Menu	(0)	Table 9-26	9-26	Configures security features.
Log Control Menu	(6)	Memory Functions Menu	(30)	Table 9-27	9-26	Used to configure and inspect the diagnostic, historic, and fault logs of the VFD.
		Diagnostic Log Menu	(31)	Table 9-28	9-27	
		Historic Log Menu	(32)	Table 9-30	9-28	
		Fault Log Menu	(33)	Table 9-31	9-29	
Drive Protect Menu	(7)	Overload Menu	(34)	Table 9-32	9-29	Adjusts setpoint limits for critical VFD variables.
		Limit [H/V] Menu	(35)	Table 9-33	9-30	
Meter Menu	(8)	Analog I/O Setup Menu	(36)	Table 9-34	9-31	Used to configure and scale the various meters and analog outputs available to the user.
		Display Variable Menu	(37)	Table 9-38	9-34	
		Trim Analog Meters Menu	(38)	Table 9-36	9-33 3	
		Loc. Alg. Meters Menu	(39)	Table 9-	9-33 3	
		Loc. Dig. Meters Menu	(40)	Table 9-	9-36 6	
Communications Menu	(9)	RS232 Functions Menu	(41)	Table 9-	9-37 7	Used for configuring the various I/O interface features of the VFD.
		Remote I/O Menu	(42)	Table 9-46	9-38 8	
		XCL Send Setup Menu	(43)	Table 9-	9-39 9	
		XCL Recv Setup Menu	(44)	Table 9-53	9-42	

9.2. Motor Menu (1) Options

The Motor Menu (1) consists of the following menu options:

- Motor Parameter Menu (11)
- Encoder Menu (12)$^{H/V}$
- Motor Flux Menu (13)$^{H/V}$.

The contents of these menus are explained in tables that follow.

> Note that the Encoder Menu (12) and the Motor Flux Menu (13) are high performance/ vector control menus which are visible from the Motor Menu (1) only if the *std_cntrl_f* flag in the system program is set to "false".

Table 9-2. Motor Parameter Menu (11)

Parameter	Range (Min)	Range (Max)	Typical Value[1]	Description
Motor Frequency (Hz)	15	120	60	Specifies the frequency (in Hz) of the motor being driven. Usually found on the name plate of the motor.
Number of Poles	2	36	4	Specifies the number of poles in the motor being driven. If this information is not listed, typical catalog data may be substituted.
Motor Efficiency	0.60	0.99	0.93	Specifies the efficiency rating of the motor being driven. For more information, refer to zone (1T) of sheet 5 on drawing 479333.
Full Load Speed	1	7200	1780	Specifies the speed (rpm) that the motor attains (with rated load connected) while delivering the rated output at the rated speed. Usually found on the name plate of the motor.
Motor Voltage (V_{rms})	380	9000	4160	Specifies the voltage (V_{rms}) at which the motor is rated. Usually found on the name plate of the motor.
Full Load Current (A_{rms})	12	1500	100	Specifies the motor current (A_{rms}) of the motor operated at its full load torque. Usually found on the name plate of the motor.
Motor KW	10	10,000	373 kW	This parameter must be set to the motor's rated kW ($0.746 \times hp_{rated}$).

[1] - *Typical values are based on a 4-pole, 4,160 VAC, 500 hp machine.*

> If the "number of poles" is not given on the motor, it can be determined using the equation:
> Poles = 120 × Frequency/Motor Synchronous Speed.
> If the motor synchronous speed is not known, the full load speed can be used, but the resulting value for "poles" must be rounded to the nearest whole number of poles.

Table 9-3. Encoder Menu (12) (Vector Control Only)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Encoder 1 PPR Resolution (pulses per rev)	1	4000	720	Configures the resolution of the *feedback* encoder input on **TB3** (terminal numbers 9-8) of the Vector/ Harmony Interface Board. The value is given in pulses per revolution of the encoder. See Figure 9-1 and sheet 5 (zone 0S) of drawing 479333.
Encoder 2 PPR Resolution (pulses per rev)	1	4000	720	Configures the resolution of the *reference* encoder input on **TB3** (terminal numbers 9-12) of the Vector/ Harmony Interface Board. The value is given in pulses per revolution of the encoder. See Figure 9-1.

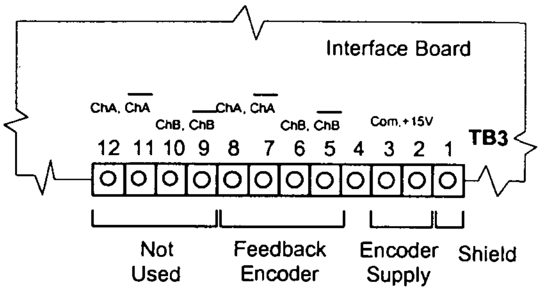

Figure 9-1. Encoder Connections on TB3 of the Perfect Harmony Interface Board

Table 9-4. Motor Flux Menu (13) (Vector Control Only)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Motor V Trim	0.05	2.000	1.000	Scales the slip speed which is computed from the "full load speed" parameter and the torque command. See zone (2K) of sheet 4 on drawing 479333.
Volts/Hz Gain	0.00	10.00	1.00	Scales the flux reference sent to the flux regulator. See zone (6J) of sheet 4 on drawing 479333.
Mag Current	0.1 A	1500.0 A	25.0 A	Provides for the initial magnetizing current level when under base speed or when the "extended enable" parameter is used to disable extended speed compensation. See zone (5K) of sheet 4 on drawing 479333.
Extended Enable	0	1	0	Enables and disables the extended speed compensation feature. The value 0 = disabled, 1 = enabled. See zone (4L) of sheet 4 on drawing 479333.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Flux Pause Level	0%	100%	10%	Adjusts the level of the magnetizing current circulated in the motor, as a percentage of the motor full load rated current, before the motor is commanded to produce torque (during flux pause mode). See zone (6P) of sheet 4 on drawing 479333.
Flux Pause Enable	0 sec	8.00 sec	1.00 sec	Adjusts the time the motor is allowed to build up the flux before torque is commanded (i.e., the flux pause state duration). See zone (6K) of sheet 6 on drawing 479333.

See Table 9-16: Standard Control Setup Menu (24) on page 9-16 for Standard Performance Information.

9.3. Drive Menu (2) Options

The Drive Menu (2) consists of the following submenus:

- Drive Parameter Menu (14)
- Speed Setup Menu (15)
- Torque Reference Menu (16)
- Ramp Setup Menu (17)
- Pot Setup Menu (18)
- Timebase Setup Menu (19)
- Hardware Scale Menu (20)
- Cell Menu (21)
- Transfer Menu (200).

These contents of these menus are explained in the tables that follow.

Table 9-5. Drive Parameter Menu (14)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Drive Current (Amps)	12	1500	100	Enter the rated VFD drive current.
Drive Rated Out (Volts)	200	15000	4160	Enter the rated VFD drive output voltage.
Drive Input Voltage (Volts)	200	15000	4160	Enter the rated VFD input voltage.
Auto Reset Enable	0	1	0	Enables (=1) or disables (=0) the auto reset function. When enabled (=1), the VFD will attempt up to 4 automatic resets (after a fault has occurred) with the specified time delay between resets (see "auto reset time" parameter).
Auto Reset Time (seconds)	1.00	120.00	1.00	Will attempt to reset up to 4 times for each possible resettable drive fault with "auto reset time" delay between reset attempts. Specifies the delay time between successive reset attempts when the auto reset feature is enabled ("auto reset enable" = 1).

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Parameter	Range (Min)	Range (Max)	Typical Value	Description
Spinning Load Select	0	1	0	Enables (1) or disables (0) the spinning load feature if not controlled by the system program.
Vector Control Select	0	1	0	Enables (1) or disables (0) vector control mode.
Ramp Stop Select	0	1	1	Enables (1) or disables (0) ramp stop mode of the drive.
Hall Effect Select	0	1	0	Selects the type of current feedback transducer: 0 = Hall effect, 1 = CTs.
Reduced Voltage Operation	0	1	0	Enables (1) or disables (0) reduced voltage operation mode. This mode provides redundant cell operation of the drive. See Chapter 1 for a overview of this feature.
Display Version Number	*function*			Function used to display the current version of the drive software. This number is printed on each report and log.
Customer Order	0	999999	123456	Six digits for entering the original customer order number to be displayed on all reports and logs.
Customer Drive	0	20	1	Number used to distinguish different drives at a common site. This value is displayed in all reports and logs.

Operation of the reduced voltage feature (also called redundant cell operation) of the Perfect Harmony is summarized below.

- The spare slot on the hub board is no longer used.
- The redundant cell group link board will instead be located in the left most slot next to the highest cell group (for instance, **PL6** for 4.1 KV, **PL5** for 3.3 KV, **PL4** for 2.4 KV).
- All cells function in normal operation. A new transformer design allows for increased input pulse performance if the redundant cell option is ordered (for instance, 24-pulse for 2.4 KV, 30-pulse for 3.3 KV, and 36-pulse for 4.1 KV).
- The redundant cell option is not available for 4.8 KV.
- If a cell in any group (including the redundant cell) fails, the unit will continue to run (after system reset) at the nominal output voltage.
- If another cell failure occurs after the first cell fault, the system will respond in the usual bypass performance mode (proportional is lost in output voltage, but full output capability remains).

Table 9-6. Speed Setup Menu (15)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Ratio Control	-125.000	+125.000	1.000	Controls the gain of analog references connected to terminal block **TB1A** (terminal numbers 2-12) on the PWM Vector/Harmony Interface Board or the XCL speed references (pointers 09-08) as selected by the system program. See zone (2B) of sheet 1 on drawing 479333.
Speed Forward Limit	0%	200%	100%	Directly limits the forward velocity reference to the PI speed regulator as a percentage of the "full load speed". See zone (2C) of sheet 2 on drawing 479333.
Speed Reverse Limit	-200%	0%	-100%	Directly limits the reverse velocity reference to the PI speed regulator as a percentage of the "full load speed". See zone (2E) of sheet 2 on drawing 479333.
Zero Speed	0%	100%	1%	Percentage of the "full load speed" at which the VFD will go from run mode to idle mode when a normal stop is commanded. Note that the ramp stop select parameter in the Drive Parameter Menu (14) must be set to 1 (i.e., ramp stop mode enabled).
Analog Speed Scalar	0%	250%	100%	Controls the gain of the analog references connected to **TB1A** (terminal numbers 2-12) on the PWM Vector/Harmony Interface Board when these inputs are selected before the Critical Speed and Speed Profile process blocks. The system program controls which inputs are used. See zone (5C) of sheet 1 on drawing 479333.
Auxiliary Speed Scalar	0%	250%	100%	Controls the gain of the analog references connected to **TB1A** (terminal numbers 2-12) on the PWM Vector/ Harmony Interface Board when these inputs are selected directly to the PI speed regulator reference. The system program controls which inputs are used. See zone (7C) of sheet 2 on drawing 479333.
Speed Forward Limit 2	0%	200%	100%	Multiple parameter set #2. Set switch *vl_sw1* to the value "true" in the system program to use this limit. See zone (3C) of sheet 2 on drawing 479333.
Speed Reverse Limit 2	-200%	0%	-100%	Multiple parameter set #2. Set switch *vl_sw7* to the value "true" in the system program to use this limit. See zone (3E) of sheet 2 on drawing 479333.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Speed Forward Limit 3	0%	200%	100%	Multiple parameter set #3. Set switch *vl_sw8* to the value "true" in the system program to use this limit. See zone (3C) of sheet 2 on drawing 479333.
Speed Reverse Limit 3	-200%	0%	-100%	Multiple parameter set #3. Set switch *vl_sw9* to the value "true" in the system program to use this limit. See zone (3E) of sheet 2 on drawing 479333.
Encoder Filter Adjust	0	6	0	Adjusts the time constant of the filter base on ($2^n \times \tau$), where $\tau = 2.78$ ms and n is the input. If $n = 0$, the filter is disabled.

Table 9-7. Torque Reference Menu (16)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Analog Torque Scalar	0%	250%	100%	Controls the gain of the analog references connected to **TB1A** (terminal numbers 2-12) on the PWM Vector/Harmony Interface Board when these inputs are selected before the Torque Ramp process block. The system program controls which inputs are used. See zone (5F) on sheet 2 of drawing 479333.
Auxiliary Torque Scalar	0%	250%	100%	Controls the gain of the analog references connected to **TB1A** (terminal numbers 2-12) on the PWM Vector/Harmony Interface Board when these inputs are selected directly to the PI Torque regulator reference. The system program controls which inputs are used. See zone (6S) on sheet 2 of drawing 479333.
Torque Setpoint	0%	250%	50%	This parameter can be used to set a torque reference directly to the input of the torque regulator. The system program must be configured to use this input. See zone (7E) on drawing 479333.
Holding Torque	-250%	250%	0%	Used to set an auxiliary holding torque reference which can be summed to velocity loop error. This parameter can be set from the keypad. See zone (5M) on drawing 479333.
Analog Holding Torque Scalar	0%	250%	0%	Used to control the holding torque in the Conditional Run state of the VFD. This parameter adjusts the gain of hold torque signals supplied to **TB1A** (terminal numbers 2-12). The system program controls which inputs are used and when they are used. See zone (6N) on drawing 479333.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Torque Ramp Increase	0.00	999.99	1.00 sec	Controls the increasing rate of change of the torque reference signals as supplied from the Torque Test mode and Analog Torque reference sections. See zone (5J) on drawing 479333.
Torque Ramp Decrease	0.00	999.99	1.00 sec	Controls the decreasing rate of change of the torque reference signals as supplied from the Torque Test mode and Analog Torque reference sections. See zone (5J) on drawing 479333.

Table 9-8. Ramp Setup Menu (17)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Forward Accel (sec)	0.0	3200.0	5.0	Used with the "zero speed" and "full load speed" settings to determine the "forward acceleration" rate: $+\text{Accel} = \frac{\text{FL Speed - Zero Speed}}{\text{Forward Acceleration}}$
Forward Decel (sec)	0.0	3200.0	5.0	Used with the "zero speed" and "full load speed" settings to determine the "forward deceleration" rate: $+\text{Decel} = \frac{\text{Zero Speed - FL Speed}}{\text{Forward Deceleration}}$
Reverse Accel (sec)	0.0	3200.0	5.0	Used with the "zero speed" and "full load speed" settings to determine the reverse acceleration rate: $-\text{Accel} = \frac{\text{FL Speed - Zero Speed}}{\text{Reverse Acceleration}}$
Reverse Decel (sec)	0.0	3200.0	5.0	Used with the "zero speed" and "full load speed" settings to determine the reverse deceleration rate: $-\text{Decel} = \frac{\text{Zero Speed - FL Speed}}{\text{Reverse Deceleration}}$
Jerk Rate (sec)	0.00	78.12	0.10	Determines the rate of change of the acceleration or deceleration: $\text{Jerk} = \pm \frac{\text{Accel or Decel}}{\text{Jerk Rate}}$
2 Stage Ramp Enable	0	1	0	When set to 1 (enabled), divides forward and reverse speed ramp rates by 4 between demand speeds of -9 Hz and +9 Hz. The ramp stop select parameter in the Drive Parameter Menu (14) must be set to 1 (i.e., ramp stop mode enabled).

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Forward Accel 2 (sec)	0.0	3200.0	5.0	Multiple parameter sets of forward/reverse, accel/decel parameters that are enabled/disabled using software switches in the system program.
Forward Decel 2 (sec)	0.0	3200.0	5.0	Parameter set # 2 is active when switch *acc_sw4* is set to the value "true" in the system program.
Rev Accel 2	0.0	3200.0	5.0	When *acc_sw1* is set to the value "true" in the system program (default), then parameter set #1 (shown above) is active.
Rev Decel 2	0.0	3200.0	5.0	
Fwd Accel 3	0	32000	50	Multiple parameter sets of forward/ reverse, acceleration/ deceleration parameters that are enabled/disabled using software switches in the system program.
Fwd Decel 3	0	32000	50	Active when *acc_sw5* = "true" in system program.
Rev Accel 3	0	32000	50	When *acc_sw1* = "true" in the system program (default), then parameter set #1 (shown above) is active.
Rev Decel 3	0	32000	50	See sheet 1 (zone 3R) of drawing 479333.

Table 9-9. Potentiometer Setup Menu (18)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Set Maximum Positive	0%	200%	100%	Sets full-scale control of the keypad potentiometer as a percentage of the "full load speed". Speed = %Wiper (SMP + SMN) where: SMP is "set max positive" and SMN is "set max negative". If "set max pos" = "set max neg" = 150%, then: mid pot = 0 speed full CW = 150% full CCW = -150%.
Set Maximum Negative	-200%	0%	-100%	See zones (4H) and (8B) on drawing 479333.
4-20 mA Maximum	1.0%	150.0%	100.0%	Sets full scale control of 4-20 mA input on TB1A (terminal numbers 2-12) as percentage of "full load speed". See zone (8B) on drawing 479333.
4-20 mA Dropout (mA)	0.0	10.0	4.0	Sets the threshold at which *signal_loss_f* goes "true" due to a loss of input signal. See zone (8C) on drawing 479333.

Table 9-10. Timebase Setup (19)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Conditional Stop Timer	0.0	999.9	0.8 sec	Specifies (in seconds) the "time to true" of the *c_s_timeout_f* flag (in Cond Stop State F) when the Stop state (as defined by the system program) is entered. Refer to the state diagram on sheet 6 of drawing 479333 (Appendix 2).
Conditional Run Timer	0.0	999.9	0.8 sec	Specifies (in seconds) the "time to true" of the *c_r_timeout_f* (in Cond Run State C) flag when the run state (as defined by the system program) is entered. Refer to the state diagram on sheet 6 of drawing 479333 (Appendix 2).
Cycle Timer	0	10,000	0 hrs	This parameter allows the user to set the desired time period (in hours) for the redundant pumps to be cycled into service. The Perfect Harmony keeps track of time lapses even when not in the Run mode, but does not cycle anything until the drive is in the Run mode.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Hour Meter Setup (50)	*n/a*	*n/a*	*n/a*	Setup submenu for the kWh meter. See Table 9- on page 9-44.
Set the Clock Time	*function*			Function used to set the VFD's real time clock.

Table 9-11. Hardware Scale Menu (20)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Motor Voltage Feedback	1	3000	1000 v/v	Scales the motor voltage feedback to the PI voltage (flux) regulator. See zone (8R) of sheet 3 on drawing 479333.
Line Voltage Feedback	1	9000	1000 v/v	Scales the available voltage feedback used for the dynamic torque limits used in standard performance mode. See zones (0B) and (1B) of sheet 3 on drawing 479333.
Ib Offset Adjust	00	FF	7F	Offset value (specified in hex format) which is used to eliminate the DC components to the DQ transformation chip IC41 on the Power Interface Board. This value is factory set. See sheet 5, zone (5P) on drawing 479333, and Chapter 6. Since this value is factory set, it should not be changed unless the CTs/Hall effects of the Power Interface Board are changed.
Ic Offset Adjust	00	FF	7F	Offset value (specified in hex format) which is used to eliminate the DC components to the DQ transformation chip IC41 on the Power Interface Board. This value is factory set. See sheet 5, zone (6P) on drawing 479333, and Chapter 6. Since this value is factory set, it should not be changed unless the CTs/Hall effects of the Power Interface Board are changed.
Standard Motor Voltage Trim	0.000	10.000	8.000	Value (specified in volts) used to scale the final output voltage reference to the IDQ transformation chip from the flux regulator. See zone (7S) of sheet 3 on drawing 479333.

Table 9-12. Cell Menu (21)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Installed Stages	3	7	5	Specifies the number of stages in the drive. Set to 5 for 4160 VAC drives. See zones (2H) and (0P) of sheet 5 on drawing 479333.
Minimum Stage Count	1	6	3	This parameter limits the number of cells that can be bypassed as a result of a cell failure. See zone (1P) of sheet 5 on drawing 479333.
Auto Bypass Enable	0	1	0	Enables/disables the auto bypass feature. Setting to 1 enables the bypass feature (if supplied) upon a cell failure. 0 = disabled, 1 = enabled.
Print Cell Status	*function*			Function that sends a detailed cell fault log to the RS232 port to a terminal emulator. The current status of each cell is listed, including bypass and fault information. For prior fault status, see "display cell fault(s)" and "print cell fault(s)" functions.
Display Cell Fault(s)	*function*			Function that reports a detailed cell fault log to the LCD display of the drive, most recent fault first, including fault time and date.
Print Cell Fault(s)	*function*			This function prints the cell fault log to the RS232 output buffer.
RS232 Diag Bypass	0	1	1	Enables/disables the diagnostic information sent out the RS232 port while in cell diagnostic mode (during cell fault detection or reset). Should be disabled (set to 0) under normal conditions to speed reset.

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Table 9-13. Transfer Menu (200)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Phase I Gain	0	15	1	Integral gain for the phase lock loop.
Phase P Shift	1	12	4	Proportional gain setting for the phase lock loop, where $P = (2^n)^{-1}$.
Phase Offset	0.0	180.0	0.0 deg	Offset adjustment to allow the setting of a leading angle to prevent regeneration on transfer.
Hardware Offset	-180.0	180.0	0.0 deg	Used to correct for the offsets caused by hardware tolerances and inherent phase shifts between the feedbacks.
Phase Error Threshold	0.0	5.0	2.0 deg	Sets the threshold of phase error allowed before advancing in transfer. Acts as a transfer enable.
Line Sync Source	0	2	0	Determines the source of the line sync detection circuitry. Local (0) is from the PIB, while remote (1) comes from the overcurrent board used with transfer. Normally, remote is used when transfer is available, and setting zero (0) disables the function for non-transfer applications.

9.4. Stability Menu (3) Options

The Stability Menu (3) consists of the following menu options:

- Current Loop Setup Menu (22)$^{H/V}$
- Vector Control Tune Menu (23)
- Standard Control Setup Menu (24)^{Std}
- Control Loop Test Menu (25).

These menus are explained in tables that follow.

> Note that the Current Loop Setup Menu (22) is a high performance/vector control menu which is visible from the Stability Menu (3) only if the *std_cntrl_f* flag in the system program is set to "false". Similarly, the Standard Control Setup Menu (24) is a standard menu that is visible from the Stability Menu (3) only if the *std_cntrl_f* flag in the system program is set to "true".

Table 9-14. Current Loop Setup Menu (22) (Vector Control Only)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
I Quad Integral Gain	0.000	0.996	0.000	These parameters adjust the individual D and Q axis PI gains for the hardware current regulators resident on the Vector/ Harmony Interface Board. Refer to zone (5H) of sheet 5 on drawing number 479333.
I Quad Proportional Gain	0.000	0.996	0.000	The quad gains control the flux producing current response. Refer to zone (5H) of sheet 5 on drawing number 479333.
I Direct Integral Gain	0.000	0.996	0.000	The direct gains (integral and proportional) control the torque producing current response of the induction machine.
I Direct Prop Gain	0.000	0.996	0.000	Refer to zone (5J) of sheet 5 on drawing number 479333.

See Table 9-16: Standard Control Setup Menu (24) on page 9-16 for standard performance information.

Table 9-15. Vector Control Tune Menu (23)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Velocity Proportional Gain	0.000	127.996	5.000	Adjusts the proportional error compensation of the PI speed regulator when the VFD is operating in vector control mode. See sheet 2, zone (2N) of drawing 479333.
Velocity Integral Gain	0.000	255.996	4.000	Adjusts the integral error compensation of the PI speed regulator when the VFD is operating in vector control mode. See sheet 2, zone (4M) of drawing 479333.
Imag Proportional Gain	0.000	127.996	0.062	Proportional gain used in a PI flux regulator which adjusts output voltage when output load condition is less than 30%. See sheet 4, zone (6M) of drawing 479333.
Imag Integral Gain	0.000	127.996	0.933	Integral gain used in a PI flux regulator which adjusts output slip when output load conditions are less than 30%. See sheet 4, zone (7M) of drawing 479333.
Slip Proportional Gain	0.000	127.996	0.062	Proportional gain used in a PI regulator which adjusts motor slip ω_s when load condition is greater than 30%. See sheet 4, zone (7M) of drawing 479333.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Slip Integral Gain	0.000	127.996	0.933	Integral gain used in a PI flux regulator which adjusts motor slip ω_s when output load condition is greater than 30%. See sheet 4, zone (7M) of drawing 479333.
Velocity P Gain 2	0.000	127.996	5.000	Multiple parameter sets which allow different velocity gains depending on flags set in the system program:
Velocity I Gain 2	0.000	255.996	4.000	*vel_gain_set_1 = true* (default allows above gain set to be active).
Velocity P Gain 3	0.000	127.996	5.000	*vel_gain_set_2 = true* allows set 2 to be active, etc.
Velocity I Gain 3	0.000	255.996	4.000	Also see the system program example in Chapter 7.

A state control diagram of the Perfect Harmony is available on sheet 6 of drawing 479333 in Appendix 2.

Table 9-16. Standard Control Setup Menu (24) (Standard Performance Mode Only)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Standard Volts/Hz	-127.996	127.996	1.000	Adjusts the motor voltage level for proper flux under base speed. See zone (6M) on sheet 3 of drawing 479333.
Volt Proportional Gain	-127.996	127.996	0.312	These parameters adjust proportional and integral compensation of the flux regulator which controls the proper terminal voltage as a function of speed.
Volt Integral Gain	-127.996	127.996	0.312	See sheet 3, zone (7N) of drawing 479333.
Velocity Proportional Gain	0.000	127.996	5.000	Adjusts the velocity regulator's proportional and integral gains which control the reference to the Torque regulator as required to control the commanded speed.
Velocity Integral Gain	0.000	255.996	4.000	See sheet 2, zone (2M) of drawing 479333.
Torque Proportional Gain	0.000	127.96	0.011	Adjusts the inner loop torque regulator's proportional and integral gains which control the proper flux speed and motor voltage as required to satisfy the commanded torque.
Torque Integral Gain	0.000	255.996	0.300	See sheet 3, zones (5J) and (7J) of drawing 479333.

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Voltage Minimum Boost	0.0%	6.0%	0.0%	This parameter provides a voltage boost at low motor speeds for starting high inertial loads (e.g., extruder applications). A value of 0.0 disables this feature. Note: This parameter replaces the "full load boost" parameter in previous software versions. See sheet 3, zone (7M) of drawing 479333.
Slow Ramp Time	0.00	9.99	3.00 sec	Upon achieving the initial Run State B, a 240 second velocity ramp is initialized to allow the AC machine to achieve rated flux. This ramp is disabled when either the mmf speed attains 0.5 Hz or the interval set by "slow ramp time" is achieved. See sheet 1, zone (3R) of drawing 479333. See sheet 6 for information on the state diagram.
Motor Torque Limit	0%	300%	100%	Provides absolute monitoring and generative limits to the torque command as a percentage of "full load current". See sheet 3, zone (4A) of drawing 479333.
Regen Torque Limit	0.2%	10.0%	3.0%	Provides absolute monitoring and regenerative limits to the torque command as a percentage of Full Load Current. See sheet 3 (4C) of drawing 479333.
Energy Saver	0%	100%	0%	When "energy saver" is set to 0%, the output voltage is linear with respect to speed. When "energy saver" is set to > 0%, the output voltage will approach the rated value as a function of load torque. For pump or fan loads, "energy saver" = 100% will cause the output voltage to attain the rated value exponentially with speed at the rated torque. See sheet 3, zone (7L) of drawing 479333.
Flux Shape	0.01	1.10	1.00	This parameter is used to reduce the flux at lower speeds for use on machines with low slip. This parameter is the starting "per unit" value of flux. Setting this value to 1.00 disables the function. Setting a value greater than 1.00 adds a little boost. This feature replaces the energy saver when active.
Spin Load Threshold	0.0%	50.0%	4.3%	Sets the percentage of total current that the drive must go down to in order to switch from scanning the frequency to holding frequency while ramping to full flux during spinning load pick-up. Enabled by "spinning load select" in Menu (14).

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Parameter	Range (Min)	Range (Max)	Typical Value	Description
Spin Flux Scale	1.00%	15.00%	6.25%	Adjusts the Volts per Hz (V/Hz) scaling during spinning load. Prior to the release of software version 1.10, this ratio was fixed at 1/16 (6.25%, the new default value).
Flux Ramp	0.1 sec	15.0 sec	7.0 sec	Sets the rate of change for the flux ramp during the initial and final flux reference changes during spinning load pick-up. The slope is based on the time to go from zero to rated flux reference. Enabled by "spinning load select" in Menu (14).
Frequency Scan Rate	1.5	9.0	5.0 sec	Sets the rate of change (slope) of the frequency scan for spinning load detection. Five seconds is normal, while higher values may be required on low-slip machines.
Frequency Drop Level %	0.0	12.0	5.0%	Used when the drive attempts to catch a spinning load, this parameter specifies a cutoff frequency (as a percentage of the base frequency) at which point the drive will assume zero speed and simply start to ramp up the drive speed. Typically this parameter is used in high inertia, low slip applications. Increasing this parameter will produce smoother starts. Note that a value that is too high could cause an IOC trip, while a value that is too low could cause an unstable condition with current oscillation.
Velocity Proportional Gain 2	0.000	127.996	5.000	Multiple parameter set 2 for "vel P gain" and "vel I gain" parameters. See sheet 2, zone (3N). Enabled from system program by setting *vel_gain_set_2* flag to "true".
Velocity Integ Gain 2	0.000	255.996	4.000	See also system programming and control drawings.
Velocity Prop Gain 3	0.000	127.996	5.000	Multiple parameter set 3 for "vel P gain" and "vel I gain" parameters. See sheet 2, zone (3N) of drawing 479333. Enabled from system program by setting *vel_gain_set_3* flag to "true".
Velocity Integ Gain 3	0.000	255.996	4.000	See also system programming and control drawings.
Torque Prop Gain 2	0.000	127.996	0.011	Multiple parameter set 3 for "torque P gain" and "torque I gain" parameters. See sheet 3, zone (6J). Enabled from system program by setting *trq_gain_set_2* flag to "true".
Torque Integ Gain 2	0.000	255.996	0.300	Also see system programming and control drawings.
Torque Prop Gain 3	0.000	127.996	0.011	Multiple parameter set 3 for "torque P gain" and "torque I gain" parameters. See sheet 3, zone (6J) of drawing 479333. Enabled from

Parameter	Range (Min)	Range (Max)	Typical Value	Description
				system program by setting *trq_gain_set_3* flag to "true".
Torque Integ Gain 3	0.000	255.996	0.300	Also see system programming and control drawings.
Motor Torque Lim 2	0%	300%	100%	Multiple parameter set 2 for "motor torque limit" parameters. See sheet 3, zone (5B) of drawing 479333. Enabled from system program by setting *ai_swi7* flag to "true".
Regen Torque Lim 2	0.2%	10.0%	3.0%	Also see system programming and control drawings.
Motor Torque Lim 3	0%	300%	100%	Multiple parameter set 3 for "motor torque limit" parameters. See sheet 3, zone (5B) of drawing 479333. Enabled from system program by setting *ai_swi9* flag to "true".
Regen Torque Lim 3	0.2%	10.0%	3.0%	Also see system programming and control drawings.

See Table 9-15: Vector Control Tune Menu (23) on page 9-15 for high performance vector control information.

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Table 9-17. Control Loop Test Menu (25)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Speed Test Positive	-200%	200%	30%	Sets the positive speed reference of square wave test as a percentage of "full ld spd". "Spd fwd lim" and "spd rev lim" override these setpoints.
Speed Test Negative	-200%	200%	-30%	Sets the negative speed reference of square wave test as a percentage of "full ld spd". "Spd fwd lim" and "spd rev lim" override these setpoints.
Speed Test Time	0.0	500.0	30.1 secs	Sets time period (in seconds) of the test envelope defined by speed test pos and speed test neg parameters.
Begin Speed Loop Test		*function*		Function used to start the speed loop test. VFD must be in State A (idle) (see state diagram in Appendix 2). See zone (0B) of sheet 1 on drawing 479333.
Stop Speed Loop Test		*function*		Function used to stop the speed loop test. VFD must be in State A (idle) (see state diagram in Appendix 2). See sheet 1, zone (0B) on drawing 479333.
Torque Test Positive	-200%	200%	23%	Positive torque reference of square wave test as a percentage of "full load curr".

Parameter	Range (Min)	Range (Max)	Typical Value	Description
				"Mot trq limit" and "regen trq limit" override these setpoints.
Torque Test Negative	-200%	200%	-23%	Negative torque reference of square wave test as a percentage of "full load curr". "Mot trq limit" and "regen trq limit" override these setpoints.
Torque Test Time	0.00	91.00	0.67	Sets time period (in seconds) of the test envelope defined by the torque test positive and torque test neg parameters.
Begin Torque Loop Test	*function*			These functions start and stop torque loop test. VFD must be in State (A) (see state diagram in Appendix 2). Parameters are replicated in Diagnostic Log Menu (31). See sheet 2, zone (5E) on drawing 479333.
Stop Torque Loop Test	*function*			
Start Diagnostic Log	*function*			This function is used to start the diagnostic log. The Diagnostic log can also be selected and enabled through the system program by setting the following flags: *diag_log_select* = true *log_done* = true. Also see Appendix A and Chapter 8.
Select Diagnostic Log	*function*			Function used to select the Diagnostic Log as the current log feature. See Diagnostic Log Menu (31) for a description.
Diagnostic Log Upload	*function*			Function used to upload diagnostic log information through the RS-232 port on the door or on the Microprocessor Board.

A state control diagram of the Perfect Harmony is available on sheet 6 of drawing 479333 in Appendix 2.

9.5. Auto Menu (4) Options

The Auto Menu (4) consists of the following menu options:

- Speed Profile Menu (26)
- Speed Setpoint Menu (27)
- Critical Speed Menu (28)
- Comparator Setup Menu (29)
- PID Select Menu (48).

Table 9-18. Speed Profile Menu (26)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
Entry Point	0.0	150.0	0.0%	Determines percentage of full input reference signal at which VFD will operate at the minimum "entry speed" as percentage of the "full load speed". See zones (3H) and (1F) of sheet 1 on

Parameter	Range (Min)	Range (Max)	Typical Value	Description
				drawing 479333.
Exit Point	0.0	150.0	150.0%	Determines percentage of full input reference signal at which VFD will operate at the maximum "exit speed" as percentage of the "full load speed". See zones (3H) and (1F) of sheet 1 on drawing 479333.
Entry Speed	0.0	150.0	0.0%	Determines the starting speed at which the drive will run at entry point. See zones (3H) and (1F) of sheet 1 on drawing 479333.
Exit Speed	0.0	150.0	150.0%	Determines the final speed at which the drive will run at exit point. See zones (3H) and (1F) of sheet 1 on drawing 479333.
Auto Off	0.0	100.0	0.0%	Sets the threshold of velocity reference below which the drive is disabled (off). This setting must be ≤ Auto On to operate normally. This parameter is specified as a percentage.
Delay Off	0.5	100.0	0.5	"Delay off" sets delay time to VFD off when the "auto off" percentage of "full load speed" is satisfied. This parameter is specified in seconds. See zones (3H) and (1F) of sheet 1 on dwg 479333.
Auto On	0.0	100.0	0.0%	Sets the threshold of velocity reference at which the drive is disabled (in run). This setting must be greater than or equal to Auto Off to operate normally. This parameter is specified as a percentage.
Delay On	0.5	100.0	0.5	"Delay on" sets delay time to VFD on when the "auto on" percentage of "full load spd" is satisfied. This parameter is specified in seconds. See zones (3H) and (1F) of sheet 1 on drawing 479333.

Figure 9-2 illustrates the advantages of using speed profiling control. This method of control provides an increased "usable control range" for the motor. Ultimately, the speed of the motor can be adjusted in much finer increments when speed profiling is used.

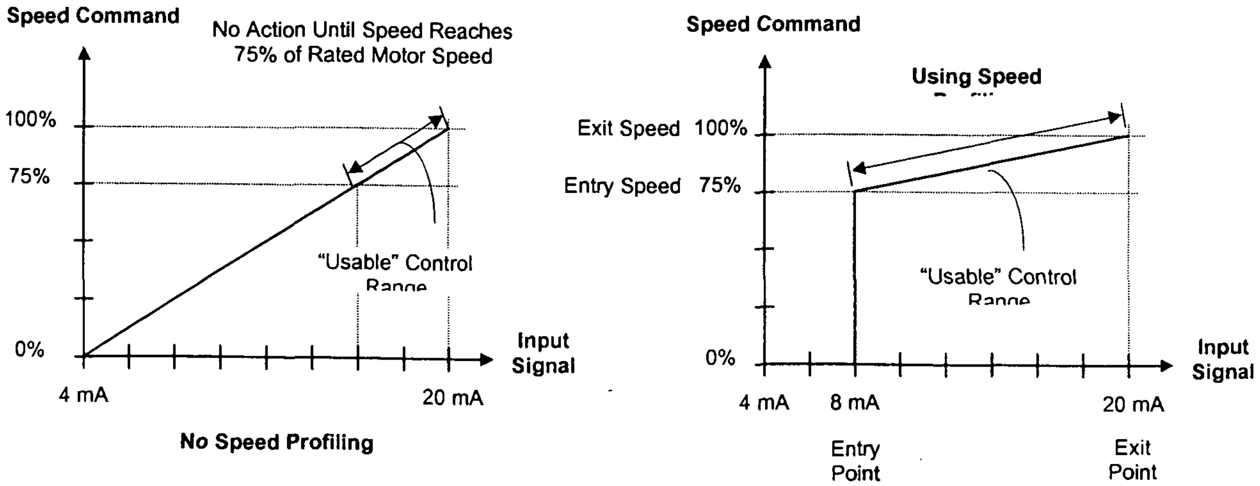

Figure 9-2. Advantages of Using Speed Profiling Control

Table 9-19. Speed Setpoint Menu (27)

Parameter	Range (Min)	Range (Max)	Default Value	Description
Speed Setpoint *n* (*n* = 1-7)	-9999	9,999	0 rpm	Programmable speed setpoints (given in rpm) set by system program switches *vd_sw7* through *vd_sw13*, respectively. For example *vd_sw13* = *true* in the system program enables "speed setpoint 7". See zone (5J) of sheet 1 on drawing 479333. Also see system programming.

Table 9-20. Critical Speed Menu (28)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Skip Freq *n* (*n* = 1-3)	0.0 Hz	120 Hz	15.0 Hz 30.0 Hz 45.0 Hz	Skip frequencies 1-3 set the center frequency and skip bands 1-3 set respective bandwidths of the speed reference signals for critical speed avoidance. Typical values are 15.0 Hz, 30.0 Hz, and 45.0 Hz, respectively. See zones (3L) and (1K) on sheet 1 of drawing 479333.
Skip Band *n* (*n* = 1-3)	0.0 Hz	6.0 Hz	0.0 Hz 0.0 Hz 0.0 Hz	Activated by setting *csa_sw* equal to "true" in the system program. See also control drawings. Skip band is equal to ± value around skip frequency. Typical values are 0.0 Hz for each skip band. See zones (3L) and (1K) on sheet 1 of drawing 479333.

The critical speed feature (sometimes called resonance avoidance) is accomplished using skip frequencies and skip bands as defined in Table 9-20. This is illustrated in Figure 9-3.

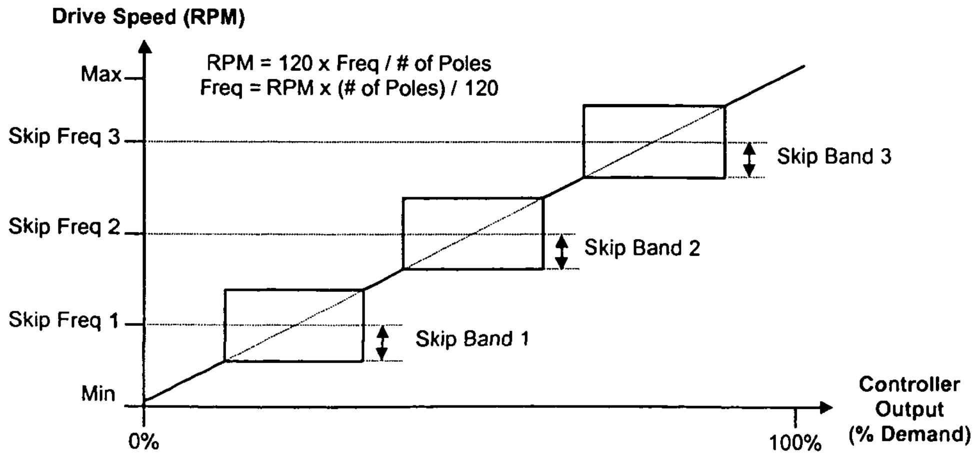

Figure 9-3. Critical Speed (Resonance Avoidance) Parameters

Table 9-21. Comparator Setup Menu (29)

Submenu	Description
Compare *n* Setup (*N*) (where *n* = 1-16 and *N* = 121-136)	Submenus that contain 16 sets of comparators for custom use in the system program. Each comparator set (Compare 1 through Compare 16) consists of three parameters that are located in setup menus 121 through 136. Comparators are system program flags (*compar_1_f* through *compar_16_f*) which can be used anywhere within the system program environment to control software switches. Refer to Table 9-22 that follows and the example system program later in this document.

Table 9-22. Compare 1-16 Setup Menu (121-136) Parameter Descriptions

Menu Item	Typical Value	Description
Comp *n* A in variable select (list) (*n*=1-16)	empty	"Comp *n* A" and "Comp *n* B" are the programmable variables that are compared to one another. These inputs can be selected from the list in Table 9-23.
Comp *n* B in variable select (list) (*n*=1-16)	empty	The corresponding comparator flag *compar_n_f* (where *n=1-16)* in the system program is set true if "Comp *n* A in" > "Comp *n* B in".
Compare *n* type (list) (n=1-16)	off	"Compare *n*" can be set to the following: signed (e.g., 10 > -50) magnitude (e.g., -50 > 10) disabled (no compare is done).

Table 9-23. Variable Pick List for Compare Setup Submenus (121-136) and AO Variables

Raw Speed Input Signal	Torque Command	Analog Aux3 Input
Speed Reg Command	Torque Curr Fb	Gnd Fault Offset Lev
Speed Command Abs	Torq Regulator Feedback	Analog Module Input 1
Spd fbk Abs Val	Available Line Voltage	Analog Module Input 2
Speed Regulator fdbk	Peak Line Voltage	Analog Module Input 3
Encoder Speed fdbk	Total current feedback	Analog Module Input 4
Frequency Demand	Slip Speed	Analog Module Input 5
Mtr voltage command	MMF output speed	Analog Module Input 6
Mtr voltage feedback	VCO Analog Value	Analog Module Input 7
Quad Current Command	VCO Delta Count	Analog Module Input 8
Quad Current Output	Phase Lock Loop Error	Enter Address Manually
Quadrature Curr Fb	Output power in kW	Enter Fixed Value
Direct Current Command	Analog Ref Input	Enter Fixed Percentage
Direct Current Output	Analog Aux1 Input	
Direct Current Fb	Analog Aux2 Input	

Also see Appendix 2 for complete cross reference of variable names and variable descriptions.

> The "Enter Address Manually" function can be used to select a variable not listed in the table. Hexadecimal addresses can be found using the locator file HAR*b_bb*.LOC (the *b_bb* corresponds to the software version installed in the drive). For example, version 1.15 software has the locator file HAR1_15.LOC.

> The "Enter Fixed Value" and "Enter Fixed Percentage" are used for selecting constant values for comparison.

Table 9-24. PID Select Menu (48)

Parameter	Range (Min)	Range (Max)	Typical Value	Description
PID scalar 1	-127.996	127.996	0.390	Selects the scaling for the PID process variables 1 and 2 in the PID controller.
PID scalar 2	-127.996	127.996	-0.390	See Appendix 2, sheet 1, zone (7C).
PID P Gain	0	98.996	0.390	Sets the PID loop Proportional (P),
PID I Gain	0	98.996	0.390	Derivative (D) and Integral (I) gains.
PID D Gain	0	98.996	0.000	See Appendix 2, sheet 1, zone (7C).
PID Min Clamp	-200%	200%	0%	Sets the minimum and maximum values for the PID loop integrators.
PID Max Clamp	-200%	200%	100%	See Appendix 2, sheet 1, zone (7C).
PID Setpoint	-200%	200%	0%	Sets a value to be used as the reference setpoint for the external PID loop. The value is set as a percent of the full scale.

9.6. Main Menu (5) Options

The Main Menu (5) consists of the following menu options:

- Motor Menu (1)
- Drive Menu (2)
- Stability Menu (3)
- Auto Menu (4)
- Log Control Menu (6)
- Drive Protect Menu (7)
- Meter Menu (8)
- Communications Menu (9)
- Enter Security Code Function
- Change Security Code Function
- Security Edit Menu (0).

The contents of submenus 1-4 have already been explained earlier in this chapter. The contents of submenus 6-9 are explained later in this chapter. All of these submenus can be accessed directly using the keypad or from the Main Menu (5). Refer to the appropriate sections elsewhere in this chapter for descriptions of menu options within these submenus.

Main Menu (5) functions and submenus are explained in Table 9-25.

The Perfect Harmony has a security system which has several useful features. These include the display of parameters, but limiting access for changes, blocking the display of menu entries, preventing the printout of submenu or menu items during a parameter dump, and preventing the changing of parameters while the drive is running. The code settings are printed on the right side of each item on a parameter dump. They are under the heading "lev hmpd". Entries beneath the "lev" heading list the security level for each item. In order to change the parameter, the security level must be set to this level or higher. Entries in the "hmpd" column are the security bits which are set (1) or not set (0) for each item. The meanings of each bit are listed below.

- **h** Hide the menu item until the security level is set to its level or higher.
- m Submenu print lockout (does not print the menu on a parameter dump).
- p Print lockout (does not print the item on a parameter dump)
- d Drive running lockout (will not allow parameter changes while drive is running).

Table 9-25. Main Menu (5) Options

Parameter	Type	Description
Motor Menu (1)	Submenu	Provides access to the Motor Menu. See page 9-3.
Drive Menu (2)	Submenu	Provides access to the Drive Menu. See page 9-5.
Stability Menu (3)	Submenu	Provides access to the Stability Menu. See page 9-14.
Auto Menu (4)	Submenu	Provides access to the Auto Menu. See page 9-20.
Log Control (6)	Submenu	Provides access to the Log Control Menu. See page 9-26.
Drive Protect Menu (7)	Submenu	Provides access to the Drive Protect Menu. See page 9-29.
Meter Menu (8)	Submenu	Provides access to the Meter Menu. See page 9-31.
Communications Menu (9)	Submenu	Provides access to the Communications Menu. See page 9-377.
Enter Security Code	Function	Allows user to change security level for menu access to critical drive parameters. The drive is shipped with the following default codes: Level 0 (none) none Level 1 (lowest) 1111 Level 2 2222 : : Level 7 (highest) 7777 Once the new code is entered, any menu item which has a security level less than or equal to the new level will become accessible (i.e., visible to the user). All menu items having a security level greater than the current level will not be visible to the user.
Change Security Code	function	Codes can be changed using the "change security code" function (only available in level 2 through level 7). Codes can only be changed for a particular security level (or lower) after the VFD is configured for that security level.
Security Edit (0)	submenu	Provides access to the Security Edit Menu.

There are seven levels of security for the customer's use. When the drive is initially powered up, or the microprocessor is reset, the security level defaults to "0", which is "no security".

To change the security level, scroll down through the Main Menu to the "enter security code" function. Selecting this item will prompt the user with "Enter Security Code", at which time the code for the desired security level is entered. The security code is a 4-digit number consisting of the alphanumeric set "0" through "9" and "A" through "F".

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When the security level is set to level 7, the Security Edit (0) Menu appears. This menu is used to set the security level for the menu items, to "hide" menu items, to customize the parameter printout, and to prevent changes to specified parameters while the drive is running.

Upon entering any of the following functions, an "Enter Menu #" prompt will appear on the display. If the menu number is known, it can be entered at this point. If the menu number is not known, press ENTER and the display will default to the top of the Main Menu, allowing the user to scroll to the menu item to be changed.

> An asterisk character (*) appears on the left of the display to indicate that the menu or submenu is in the security edit feature mode, and not the normal mode.

When the operator reaches the menu item to be changed, he must press [Enter] followed by either a "0" (the [0] key) to disable or a "1" (the [1] key) to enable the selected edit feature. To leave the "change security level" function, press [Cancel]. Available edit features are outlined in Table 9-26. To clear security access press the left arrow key (⇦) three times.

Table 9-26. Security Edit (0) Functions

Parameter	Description
Change Security Level	"Change security level" prohibits access to menu or menu items until "enter security level" is set to that level or higher.
Hide Till Clearance Set	Allows submenus or items in menus from being displayed until a security level equal to or greater than that item's level is entered.
Submenu Print Inhibit	Allows the parameter dump to be customized for the particular application. If certain menus of the drive are not used, then they can be set so they are not printed in a parameter dump.
Block From Printout	Performs the same function as "submenu print inhibit" except on individual menu items.
Drive Running Inhibit	Prohibits certain parameters from being changed when drive is in the Run State (D).

> A state control diagram of the Perfect Harmony is available on sheet 6 of drawing 479333 in Appendix 2.

9.7. Log Control Menu (6) Options

The Log Control Menu (6) consists of the following menu options:

- Memory Functions Menu (30)
- Diagnostic Log Menu (31)
- Historic Log Menu (32)
- Fault Log Menu (33).

The contents of these menus are explained in the tables that follow.

Table 9-27. Memory Functions (30)

Function	Description
Read Memory Byte	Reads contents of RAM address *bbbb* (hex) and returns data byte *xx* (hex).
Read Memory Word	Reads contents of RAM address *bbbb* (hex) and returns data word *xxxx* (hex).
Write Memory Byte	Writes (sends) the data byte *xx* (hex) to the RAM address *bbbb* (hex).

Function	Description
Write Memory Word	Writes (sends) the data word *xxxx* (hex) to the RAM address *bbbb* (hex).
Copy from RAM to EEPROM	Copies current contents of RAM to EEPROM for permanent storage. Changes to RAM are lost during reset.
Copy from EEPROM to RAM	Copies current contents of EEPROM to RAM.

For address locations of flags used in system program see Appendix A. For address locations of process variables, see version of file HAR*b_bb*.LOC, where *b_bb* is the version number of the software installed in the drive.

When reading or writing data to/from RAM addresses, a "4" prefix must be used, i.e., 4*bbbb* (where *bbbb* is a valid RAM address in hexadecimal format). Similarly, when reading or writing data to/from EEPROM addresses, a "6" prefix must be used, i.e., 6*bbbb* (where *bbbb* is a valid RAM address in hexadecimal format). (Note that hexadecimal digits include 0-9 and A-F.) Refer to Appendix A for more information.

Table 9-28. Diagnostic Log Menu (31)

Parameter	Range (Min)	Range (Max)	Description
Log var*n* (*n* = 1-4)	*List* (see Table 9-29)		Specifies each of 4 log variables (Log var1-4) which are selected from the list in Table 9-29. The values of these variables are captured in the diagnostic log.
Diag Log Time	0.0 sec	310.0 sec	Specifies the time interval (in seconds) over which 1280 samples of each variable (specified by Log var1 through Log var4, above) are captured. Minimum sample period is 2.78 msec (at 60 Hz) so it would take 3.56 sec (0.00278 * 1280) to produce the highest resolution available. This parameter defaults to 3.6 seconds.
Select Diagnostic Log	*function*		This function is initiated by pressing the [Enter] key on the keypad before using the diagnostic log.
Start Diagnostic Log	*function*		Starts recording log variables.
Diagnostic Log Upload	*function*		Uploads diagnostic log (in 2's complement hex format) in a 4 x 1,280 word block. Var1<sp>Var2<sp>Var3<sp> Var4<CR> This information is translated into ASCII format when it is displayed.

Table 9-29. Pick List Variables for Diagnostic Log, Analog Meters and Digital Meters

Raw Speed Input Signal	Direct Current Fb	Analog Aux1 Input
Speed Reg Command	Torque Command	Analog Aux2 Input
Speed Command Abs	Torque Curr Fb	Analog Aux3 Input
Spd fbk Abs Val	Torq Regulator Feedback	Gnd Fault Offset Lev
Speed Regulator fdbk	Available Line Voltage	Analog Module Input 1
Encoder Speed fdbk	Peak Line Voltage	Analog Module Input 2
Frequency Demand	Total current feedback	Analog Module Input 3
Mtr voltage command	Slip Speed	Analog Module Input 4
Mtr voltage feedback	MMF output speed	Analog Module Input 5
Quad Current Command	VCO Analog Value	Analog Module Input 6
Quad Current Output	VCO Delta Count	Analog Module Input 7
Quadrature Curr Fb	Phase Lock Loop Error	Analog Module Input 8
Direct Current Command	Output power in kW	Enter Address Manually
Direct Current Output	Analog Ref Input	

Also see Appendix 2 for a complete cross reference of variable names and variable descriptions.

> The "Enter Address Manually" function can be used to select a variable not listed in the previous table. Hexadecimal addresses can be found using the locator file HAR*b*_*bb*.LOC (the *b*_*bb* corresponds to the software version installed in the drive). For example, version 1.15 software has the locator file HAR1_15.LOC.

Table 9-30. Historic Log Menu (32)

Parameter	Type	Description
Select Historic Log	*function*	This function is initiated by pressing the "Enter" key on the keypad before using the historic log.
Hist var*n* (*n* = 1-7)	*list*	Historic log variables can be selected from Table 9-39 on page 9-355. The seven selected variables are logged 144 times before and 100 times after the occurrence of a fault. Each record is recorded at 2.78 msec intervals. The format of the record is: Rec No <Variables 1-7> Drive State <sp> Flt1 <sp> Flt2 <cr> "Rec (record) No" designates sample number, - before fault, + after fault. Drive state designates state of drive at the time of the sample. Flt1 and Flt2 form a 32-bit bitmap which can be decoded through .DAT file to inspect VFD fault status for each sample. Default values for variables 1-7 are: M % Speed, Mtr Freq, Trq cmd, Trq I Fb, Mtr V fb, I sum fb and V avail.
Historic Log Upload	*function*	Uploads the historic log in ASCII formatted text through the RS-232 port.

A state control diagram of the Perfect Harmony is available on sheet 6 of drawing 479333 in Appendix 2.

Table 9-31. Fault Log Menu (33)

Parameter	Type	Description
Fault Log Display	function	Lists the 64 most recent fault conditions along with the date and time of occurrence.
Fault Log Upload	function	Uploads the fault log in ASCII formatted text through the RS-232 port.

9.8. Drive Protect Menu (7) Options

The Drive Protect Menu (7) consists of the following menu options:

- Overload Menu (34)
- Limit Menu (35) [H/V].

These menus are explained in tables that follow.

Note that the Limit Menu (35) is a high performance/vector control menu which is visible from the Drive Protect Menu (7) only if the *std_cntrl_f* flag in the system program is set to "false".

Table 9-32. Overload Menu (34)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Overload Select	0	2	1	0-Constant, 1-Inverse 1, and 2-Inverse 2. Selecting "Constant" causes an Overload Fault condition when input current exceeds I overload (as a percentage of "full load current") for time period "I time-out". Selecting "Inverse 1" causes overload conditions to mimic a "classical" time inverse TOL motor relay (speed independent) when "I overload" setting is exceeded. "Inverse 2" is same as Inverse 1 except it linearly de-rates the I overload setting when actual speed falls below 50% of the "full load speed" setting to protect TEFC blowerless motors.
I overload	20%	210%	150%	For "Inverse 1 and 2", "I time-out" can be used to shorten (<1 sec) or extend (>1 sec) standard class 20 TOL trip times.
I time-out	0.01 s	300.00 s	60.00 s	For "Constant", I time-out sets trip time.
Motor Trip	5 v	9999 v	4800 v	Sets the absolute trip point for an output

Parameter	Range (Min)	Range (Max)	Typical Values	Description
volts				overvoltage fault.
OverSpeed	0%	250%	120%	Sets the threshold at which an overspeed fault will occur. Value is entered as a percent of "full ld spd" (the value of the full load speed parameter).
Encoder Loss Threshold	0%	75%	0%	Sets the threshold of error between the encoder feedback and the motor frequency at which the drive will trip with a Loss of Encoder fault. A value of 0 disables this function.
Drive IOC Setpoint	50%	200%	150%	Sets the threshold at which an Output Overcurrent Fault will occur. Value is entered as percent of "full load curr".
I Overload 2	20%	210%	150%	Multiple parameter set 2 for "I overload" settings (see above). These parameters are used when *tol_set_2* = true (in the system program).
I Time-out 2	0.01 s	300.00 s	60.00 s	See system programming and control drawings for more information.
I Overload 3	20%	210%	150%	Multiple parameter set 3 for I Overload settings (see above). These parameters are used when *tol_set_3* = true (in the system program).
I Time-out 3	0.01s	300.00 s	60.00 s	See system programming and control drawings for more information.
Enter for Fault Reset	*function*			Sets the flag *drv_flt_rst_f* in the system software to "true". This flag could be used to reset drive faults if the system program is configured to do so.
Clear Fault Message	*function*			Clears the fault message from the display without having to reset the fault.

Table 9-33. Limit Menu (35) (Vector Control Only)

Parameter	Range (Min)	Range (Max)	Typ. Vals.	Description
Motor Torque limit	0.0%	300%	100%	Positive torque limit invoked on the reference of the torque regulator in Vector Control Mode to limit maximum torque during accel and decel conditions. Values are entered as a percentage of the "full load current". For more information, refer to Appendix 2, sheet 4, zone (5D).

Parameter	Range (Min)	Range (Max)	Typ. Vals.	Description
Reg Torque limit	0.0%	30.0%	2.0%	Negative torque limit invoked on the reference of the torque regulator in Vector Control Mode to limit maximum torque during accel and decel conditions. Values are entered as a percentage of the "full load current".
Motor Analog limit	0.0%	300%	100%	Scales inputs from Power Interface Board inputs if selected for use as "forward torque limit" and "reverse torque limit".
Reg Analog limit	0.0%	10.0%	3.0%	For more information, refer to Appendix 2, sheet 4, zone (5D).
Motor Torque limit 2	0.0%	300%	100%	Multiple parameter set number two. Used for controlling "fwd torque limit" and "rev torque limit".
Reg Torque limit 2	0.0%	10.0%	3.0%	Selected for limits by setting flags *ai_swi7* = true and *al_swi8* = true in the system program. See also system programming and control drawings.
Motor Torque limit 3	0.0%	300%	100%	Multiple parameter set number three. Used for controlling "fwd torque limit" and "rev torque limit". Selected for limits by setting flags *ai_swi9* = true and *al_swi20* = true in the system program.
Reg Torque limit 3	0.0%	10.0%	3.0%	Also see system programming and control drawings.

See Table 9-16: Standard Control Setup Menu (24) on page 9-16 for standard performance information.

9.9. Meter Menu (8) Options

The Meter Menu (8) consists of the following menu options:

- Analog Setup I/O Menu (36)
- Display Variable Menu (37)
- Trim Analog Meters Menu (38)
- Local Analog Meters Menu (39)
- Local Digital Meters Menu (40).

Table 9-34. Analog I/O Setup Menu (36)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Alg var1	*list*		empty	Analog variables can be selected from the list in Table 9-29 on page 9-28.
Alg var2	*list*		empty	These outputs are on test points **TP1** and **TP2** on the Microprocessor Board.
Analog TP 1	-20.000 v	20.000 v	10.000 v	Scales "alg var1" and "alg var2". 10.000v = 100%.
Analog TP 2	-20.000 v	20.000 v	10.000 v	
Analog In	0%	250%	100%	Scalar for "ref in" and "aux 1,2 and 3" such that full range (10V) represents

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Scalar				this percentage of internal units (PU). This is used for comparators and other pick lists only. A separate scalar is used for scaling to the speed or torque command.
Anlg Out *n* (*N*) (*n*=1-8, *N*=111-118)	submenu (See Table 9-35)			Provides access to the individual analog output module submenus. Refer to Table 9-23 (page 9-223) for pick list names and variable descriptions for Analog Output submenus. See Table 9-35 for switch settings. Note that there is only one analog output reference per AO Module.
Anlg In *n* (*N*) (*n*=1-8, *N*=181-188)	submenu (See Table 9-37)			Provides access to the individual analog input configuration submenus. Inputs from the Analog Input Modules are available as velocity, aux velocity, PID and torque references. See Appendix 2, sheets 1 and 2, and also system programming. See Table 9-37 for switch settings. Note that there is only one analog input reference per AI Module.
Vel Ref	*list*		empty	These parameters are used to define input variables for the corresponding references. Any one of the eight analog inputs (Analog Module Input 1-Analog Module Input 8) or "empty" can be assigned to each of these parameters.
PID Ref	*list*		empty	Refer to Appendix 2 for more information.
Aux Vel Ref	*list*		empty	
Torque Ref	*list*		empty	

Table 9-35. Analog Output 1 (111) through Analog Output 8 (118)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Analog var*x* (*x*=1-8)	*list*		empty	Select for each module *x*, a variable from any listed in Table 9-23 (page 9-223).
Full range	0.0%	300.0%	0.0%	Scales the output range of the variable selected.
Module Address	0	15	0	Selects the address number set on the binary address switch found on the output module. Note: The module addresses must be unique from other installed analog input or analog output modules.
Var*x* type (*x* =1-8)	*list*		empty	Selects an output type for each module *x* (display text is shown in boldface): **Disabled** - Analog output disabled (off). **Bipolar** - Selects all module outputs so that "0" value of selected variable is: 2.5 v for 0-5 v output 0 v for -10 v to +10 v output 10 mA for 4-20 mA output. **Unipolar** - Selects all module outputs so that "0" value of selected variable is: 0 v for 0-5 v output -10 v for -10 v to +10 v output 0 mA for 4-20 mA output. **4-20 mA** - Selects all module outputs so that "0" value of selected variable is: +1 v for 0-5 v output -8 v for -10 v to +10 v output 4 mA for 0 to 20 mA output.

Table 9-36. Trim Analog Meters Menu (38)

Parameter	Type	Description
Trim Local Analog Meter *n* (*n* = 1-8)	function	This function trims the analog meter selected in Local Analog Meter Menu (39). The up ⇧ and down ⇩ arrow keys on the keypad can be used to trim the meter to a desired level.

Table 9-37. Local Analog Meter Menu (39)

Submenu	Description
Analog Meter *n* (*N*) (*n*=1-8, *N*=51-58)	Provides access to submenus Analog Meter 1 (51) through Analog Meter 8 (58). The contents of these menus are identical and are explained in the following table.

Table 9-37. Analog Input 1 (181) through Analog Input 8 (188)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Full range	0.0%	300.0%	0.0%	Scales the input range of the variable selected.
Module Address	0	15	0	Selects the address number set on the binary address switch located on the input module. Note: Module addresses must be unique from other installed analog input or output modules.
Var*x* type (*x* = 1-8)	*list*		empty	Selects an input type for each module *x* (display text is shown in boldface): **Disabled**- Analog input disabled (off). **Bipolar** - Selects all module inputs so that "0" value of selected variable is: 2.5 v for 0-5 v input 0 v for -10 v to +10 v input 10 mA for 4-20 mA input. **Unipolar** - Selects all module inputs so that "0" value of selected variable is: 0 v for 0-5 v input -10 v for -10 v to +10 v input 0 mA for 4-20 mA input. **4-20 mA** - Selects all module inputs so that "0" value of selected variable is: +1 v for 0-5 v input -8 v for -10 v to +10 v input 4 mA for 0 to 20 mA input.

Table 9-38. Display Variable Menu (37)

Parameter	Type	Typical Values	Description
Disp var 0	*list*	Speed Input	The LCD display variables can be selected from Table 9-39.
Disp var 1	*list*	Motor Freq	
Disp var 2	*list*	Motor RPM	
Disp var 3	*list*	Torque I Fb	

Table 9-39 contains name, abbreviation, display and variable columns of standard pick list variables (used in the Historic Log Menu, the Display Variable Menu, etc.). The name column contains the name of the display variable. This is what is displayed as the user scrolls through the list of available display variables. The abbreviation column contains an abbreviation that is displayed after a variable is selected from the list. The display column contains an even more abbreviated form of the variable name. This final abbreviation (between 2 and 5 characters in length) is what the Perfect Harmony displays on the front panel of the drive. The variable column shows the associated system program variable for reference.

Table 9-39. Pick List Variables for the Historic Log and the Front Display

Selection Text	Abbreviation	Display Text	Variable
Motor operating freq	Mtr Freq	Freq	*mmf_spd*
Motor speed in RPM	Mtr rpm	RPM	*vel_fb*
Motor speed in percent	M % spd	%Spd	*vel_fb*
Speed Regulator Command	Spd Reg Cmd	RPM	*vel_cmd*
Raw Speed Input Signal	Spd Input	Demd	*raw_vel_dmd1*
Encoder Speed Feedback	Encoder fb	Erpm	*vel_xdr_fb*
Torque Command	Trq cmd	%Trq	*trq3_cmd*
Torque Curr Fb	Trq I Fb	Itrq	*trq_i_fb*
Magnetizing Curr Fb	Mag I Fb	Imag	*mag_i_fb*
Total current feedback	I sum fb	Itot	*sum_i_fb*
Mtr voltage feedback	Mtr V fb	Vlts	*av_fb*
Input Line Frequency	Line Freq	LFrq	*line_freq*
Output Phase wrt line	Output Phase	PhFb	*phase_fb*
Available Line Voltage	V Avail	LVlt	*v_avail*
Peak Line Voltage	V Avail Pk	Pk-V	*vin_pk_fb*
Output power in kW	KW output	KW	*power*
Gnd Fault Offset Lev	Gnd Flt Lev	VNGa	*ground_fault_level*
Flux Position	Flux Pos	Fpos	*vco_cnt*
Flux Delta Position	Delta Pos	Dpos	*del_cnt_vco*
Ref Analog Input	Ref Input	Ref %	*ref_in_analog*
Aux1 Analog Input	Aux1 Input	Aux1	*aux_in1_analog*
Aux2 Analog Input	Aux2 Input	Aux2	*aux_in2_analog*
Aux3 Analog Input	Aux3 Input	Aux3	*aux_in3_analog*
Ramp Input	Ramp Input	RmpI	*raw_vel_dmd2*
Ramp Output	Ramp Output	RmpO	*vel_ref*
Analog Module Input 1	Alg In 1	Alg1	*analog_in_modules[0].value*
Analog Module Input 2	Alg In 2	Alg2	*analog_in_modules[1].value*
Analog Module Input 3	Alg In 3	Alg3	*analog_in_modules[2].value*
Analog Module Input 4	Alg In 4	Alg4	*analog_in_modules[3].value*
Analog Module Input 5	Alg In 5	Alg5	*analog_in_modules[4].value*
Analog Module Input 6	Alg In 6	Alg6	*analog_in_modules[5].value*
Analog Module Input 7	Alg In 7	Alg7	*analog_in_modules[6].value*
Analog Module Input 8	Alg In 8	Alg8	*analog_in_modules[7].value*
Enter address manually	n/a	(1234)	(hex address shown)

Table 9-41. Analog Meter *n* Menu (51-58)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Meter *n* variable (*n*=1-8)	*list*		empty	Each analog meter variable can be selected from the list in Table 9-29 on page 9-28.
Full Scale	000000	400000	000000	Scale each selected analog meter variable as required (32,000 = 100%).
Zero Position	0	1	1	Choose the location of the zero position on the meter: 0 = Left 1 = Center.

Table 9-42. Local Digital Meter Menu (40)

Submenu	Description
Digital Meter *n* (*N*) (*n*=1-7, *N*=61-67)	Provides access to submenus Digital Meter 1 (61) through Digital Meter 7 (67). The contents of these menus are identical and are explained in the following table.

Table 9-43. Digital Meter *n* Menu (61-67)

Parameter	Range (Min)	Range (Max)	Typical Values	Description
Meter *n* variable (*n*=1-7)	*list*		empty	Each digital meter variable can be selected from the list in Table 9-29 on page 9-28.
Rated Value	000000	400000	000000	Scale each selected digital meter variable as required (400,000 = 100%).
Decimal Places	0	6	0	Specifies the number of decimal places to be used (i.e., the number of significant digits to the right of decimal point).

9.10. Communications Menu (9) Options

The Communications Menu (9) consists of the following menu options:

- RS232 Functions Menu (41)
- Remote I/O Menu (42)
- XCL Send Setup Menu (43)
- XCL Receive Setup Menu (44)
- RS232 Input list
- RS232 Output list.

Table 9-44. Communications Menu (9)

Function	Type	Description
RS232 Functions (41)	submenu	Provides access to the RS232 Functions Menu.
Remote I/O Menu (42)	submenu	Provides access to the Remote I/O Menu.
XCL Send Setup (43)	submenu	Provides access to the XCL Send Setup Menu.
XCL Receive Setup (44)	submenu	Provides access to the XCL Receive Setup Menu.
RS232 input	*list*	Redirects an input from the drive's RS232 port to either the local keypad/display or to an external communication network (XCL). Log files listed under Log Control Menu (6) may be redirected. Options are Local keypad/display (LCL kbd) and XCL network. (XCL net).
RS232 out	*list*	Redirects an output from the drive's RS232 port to either the local keypad/display or to an external communication network (XCL). Log files listed under Log Control Menu (6) may be redirected. Options are Local keypad/display (LCL kbd) and XCL network. (XCL net).

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Table 9-45. RS232 Functions Menu (41)

Parameter	Type	Description
System Program Download	function	Downloads the drive's System Program to the EEPROM on the system module via the RS232 port. The program must be compiled with CMP.EXE.
System Program Upload	function	Uploads the drive's system program to a printer or computer in hex format via the RS232 port. The program can be reverse compiled with REVCMP.EXE.
Display Sys Prog Name	function	Displays the system program version, revision date and time.
Download entire EEPROM	function	Downloads to the EEPROM located on the System Module (via the RS232 port), a hex data file which contains the drive system program and parameter settings.
Upload entire EEPROM	function	Uploads from the EEPROM located on the System Module (via the RS232 port), a hex data file which contains the drive's system program and parameter settings.

Parameter	Type	Description
Parameter Data Download	Function	Downloads to the EEPROM located on the System Module (via the RS232 port), a hex data file which contains the drive's parameter settings.
Parameter Data Upload	Function	Uploads from the EEPROM located on the System Module (via the RS232 port), a hex data file which contains the drive's parameter settings.
RS232 Echo-back test	Function	Tests the drive's RS232 communication interface. Receives external data from a computer and echoes it back. Data may be an ASCII text or hex file. No processing of data is performed.
Parameter Log Upload	Function	Uploads the parameter settings of the drive in formatted ASCII text to a computer or printer via the RS232 port.
Onboard RS232	0 or 1	0 = Enables RS232 port on keypad 1 = Enables RS232 port on Microprocessor Board (default).

RS232 upload functions are used to transmit data from the drive to a printer or computer. RS232 download functions are used to transmit data to the drive. A terminal emulator such as Smart Term's "ST220.EXE" or Procomm's "PCPLUS" is required to upload, download, and echo files. Windows "Terminal" protocol settings for the RS232 port are 9600 baud, no parity, and one stop bit.

These functions listed in Table 9-46 are used to test if the microprocessor is receiving inputs and transmitting outputs as indicated by the User Module's LEDs. The drive must be off when reading or writing to the user modules.

Table 9-46. Remote I/O Menu (42) Functions

Function	Description
Read User Module (0-15)	Reads the state of the inputs of a digital input module. Enter the address set on the module switch. The state of the 6 inputs is displayed. For example, "111000" indicates inputs "a" through "f" from right to left. Inputs "a", "b", and "c" are false (0), and inputs "d", "e", and "f" are true (1).
Write User Module (0-15)	Writes to a digital output module. Enter the address set on the module switch and the desired state of the 4 relay outputs. Press [Enter] to write to the module. For example, "1110" sets relays "a" through "d" from right to left. Relay "a" is off (0); relays "b", "c", and "d" are on (1).

For drives equipped with an eXternal Communications Link (XCL), and Communications Adapter Board (CAB), the data item for each of the drive's output registers is selected. The PLC protocol determines whether data items are broadcast as global data onto the network bus, or as register based data transfers. Up to 16, 32-bit global data items can be broadcast by the drive. Up to 32 drive output data registers are available. PLC networks which support global data transfers are Modbus-Plus and Reliance's RE-Net. PLC networks which require register-to-register (point-to-point) data transfers include Allen Bradley's Data Highway, and Reliance's R-Net.

Table 9-47. XCL Send Setup Menu (43)

Parameter	Range (Min)	Range (Max)	Description
XCL Global Send Menu (145)	Submenu		Submenu that contains parameters XCL send01 through XCL send 16 which specify 32-bit global data items.
XCL Send Reg 1-31 (147)	Submenu		Submenu that contains parameters which specify variables whose values (register data, i.e., 1, 3, 5, 7, ..., 29, 31) are to be sent from the drive in applications where the PLC protocol dictates the use of register based data transfers. A value of "empty" means that no information is to be sent. Refer to Table 9-49 on page 9-41.
XCL Send Reg 33-63 (148)	Submenu		Submenu that is a continuation of submenu 147.
XCL Node Address	0	128	This parameter specifies a network or node address for networks that have software settable node addresses. The value corresponds to the node address of the Perfect Harmony drive. This parameter defaults to a value of 10.
CAB Configuration	0000	FFFF	This parameter is used to configure the CAB board for special network handling. This parameter specifies a CAB configuration word that is used for global data and/or special functions. Refer to respective CAB manual for more information.

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Table 9-48. XCL Global Send Menu (145)

Parameter	Type	Description
XLC send*nn* (where *nn* = 01-16)	*list*	These parameters (XCL send01 through XCL send 16) specify the 32-bit global data items (variables) whose values are to be globally broadcast from the drive over the network via the CAB. Each XCL Send*nn* parameter can be selected from a pick list as a drive variable (see Table 9- on page 9-42), a serial flag, or a drive memory address. Serial flags are defined in the drive system program as "SERIAL_F*xx*", where *xx* is the bit number 00 - 16. A memory address is entered as a 4-digit hexadecimal number that is obtained from the drive's locator file. This directs a 16-bit word, data type hex. A value of "empty" means that no information is to be sent. "Erase entry" will define XCL send*nn* as empty. "Heartbeat" is incremented every 2.7 ms to indicate that the drive Microprocessor Board is "healthy".

Table 9-49. XCL Send Reg 1-31 Menu (147)

Parameter	Type	Default	Description
XCL reg 001	list	Speed Input %	Parameters which specify variables whose values (register data, i.e., 1, 3, 5, 7, ..., 29, 31) are to be sent from the drive in applications where the PLC protocol dictates the use of register based data transfers.
XCL reg 003	list	Ramp Output %	A value of "empty" means that no information is to be sent.
XCL reg 005	list	Frequency Demand %	Table 9- on page 9-42 gives a complete list of the available variables from which to choose.
XCL reg 007	list	Total I Fb %	
XCL reg 009	list	Mtr voltage feedback %	
XCL reg 011	list	kW Output %	
XCL reg 013	list	Serial 1 Bit Flags	
XCL reg 015	list	Heartbeat	
XCL reg 017 through XCL reg 031 (odd numbers)	list	<empty>	

Table 9-50. XCL Send Reg 33-63 Menu (148)

Parameter	Type	Default	Description
XCL reg 033 through XCL reg 063 (odd numbers)	list	<empty>	Parameters which specify variables whose values (register data, i.e., 33, 35, 37, 39, ..., 61, 63) are to be sent from the drive in applications where the PLC protocol dictates the use of register based data transfers. A value of "empty" means that no information is to be sent. Table 9- on page 9-42 gives a complete list of the available variables from which to choose.

Table 9-51. XCL Send Setup Pick List

Selection Text	Display Text	Variable
Speed Reg Command RPM	Spd Cmd RPM	*vel_cmd*
Speed Command %	Spd Cmd %	*vel_cmd*
Speed Feedback RPM	Spd fb RPM	*vel_fb*
Speed Feedback %	Spd fb %	*vel_fb*
Frequency Demand	Freq Dmd	*mmf_spd*

Selection Text	Display Text	Variable
Frequency Demand %	Freq Dmd %	*Mmf_spd*
Raw Speed Input %	Spd Input %	*Raw_vel_dmd1*
Ramp Output %	Ramp Out %	*Vel_ref*
Encoder Fb RPM	Encoder Fb	*Vel_xdr_fb*
Encoder Fb %	Encoder Fb %	*Vel_xdr_fb*
Torque Command AMPS	Trq Cmd AMP	*Trq3_cmd*
Torque Command %	Trq cmd %	*Trq3_cmd*
Mtr voltage feedback	Mtr V fb	*Av_fb*
Mtr voltage feedback %	Mtr V fb %	*Av_fb*
Available Line Voltage	V Avail	*v_avail_ser*
Line Frequency	Line Freq	*Line_freq*
Torque Curr Fb	Trq I Fb	*Trq_i_fb*
Torque Curr Fb %	Trq I Fb %	*Trq_i_fb*
Magnetizing Curr Fb	Mag I Fb	*Mag_i_fb*
Magnetizing Curr Fb %	Mag I Fb %	*Mag_i_fb*
Total Curr Fb	Tot I Fb	*Sum_i_fb*
Total Curr Fb %	Tot I Fb %	*Sum_i_fb*
Serial 1 Bit Flags	Serial flg1	*Serial_f1*
Serial 2 Bit Flags	Serial flg2	*Serial_f2*
Serial 3 Bit Flags	Serial flg3	*Serial_f3*
Serial 4 Bit Flags	Serial flg4	*Serial_f4*
Fault Word 1	Flt wrd1	*flt_word1*
Fault Word 2	Flt wrd2	*flt_word2*
Drive State	Drv State	*Drv_state*
Heartbeat	Heartbt	*Lcl_watchdog*
Analog Ref Input	Ref input %	*Ref_in_analog*
Analog Aux1 Input	Aux1 input %	*Aux_in1_analog*
Analog Aux2 Input	Aux2 input %	*Aux_in2_analog*
Analog Aux3 Input	Aux3 input %	*Aux_in3_analog*
Gnd Fault Offset Lev	Gnd Flt Lev	*Ground_fault_level*
Output power in KW	KW output	*Power*
Output power in %	KW output %	*Power*
Analog Module Input 1	Alg In 1	*Analog_in_modules[0].value*
Analog Module Input 2	Alg In 2	*Analog_in_modules[1].value*
Analog Module Input 3	Alg In 3	*Analog_in_modules[2].value*
Analog Module Input 4	Alg In 4	*Analog_in_modules[3].value*

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Selection Text	Display Text	Variable
Analog Module Input 5	Alg In 5	*analog_in_modules[4].value*
Analog Module Input 6	Alg In 6	*analog_in_modules[5].value*
Analog Module Input 7	Alg In 7	*analog_in_modules[6].value*
Analog Module Input 8	Alg In 8	*analog_in_modules[7].value*
Enter address manually	(1234)	(hex address)
Erase Entry	(empty)	(clears entry)

Table 9-52. XCL Data Types for "Address Entered Manually" Option

Selection Text	Display Text (Not Displayed)	Selection Text	Display Text (Not Displayed)
Velocity type	0	Percent (%) Q13	10
Current type	1	Percent (%) Q14	11
Ratio type	3	Raw 16 Bit type	13
Acceleration type	4	Voltage type	14
System Flag type	9		

For drives equipped with an eXternal Communications Link (XCL), and Communications Adapter Board (CAB), the data item for each of the drive's input registers is selected within the submenus which follow. The PLC protocol determines whether data items are broadcast as global data onto the network bus, or as register-based data transfers.

For global data, the XCL pointers and communication flags define the PLC node and item as "AA:XXX", where "AA" is the PLC node, and "XXX" is the item, as determined by user protocol.

For networks with register-to-register data transfer, enter "99" for the PLC node, and "XXX" as the desired 16-bit register.

Table 9-53. XCL Receive Setup Menu (44)

Menu/Parameter	Type	Description
XCL Vel Ref (141)	submenu	Submenu containing XCL pointers 01-12.
XCL Vel Ctrl (142)	submenu	Submenu containing XCL pointers 13-36.
XCL Trq Ctrl (143)	submenu	Submenu containing XCL pointers 37-52.
XCL Comm Flags (144)	submenu	Submenu containing communications flags F01-F16.
Serial Input Scalars (146)	submenu	Submenu containing serial input scalars.

Table 9-54. XCL Velocity Reference Menu (141)

Parameter	Default Value	Description
XCLPTR_*bb* (*bb* = 01-04 and 06-12)	00:000	*Xclptr_01* through *xclptr_04* direct a ratio control reference to the drive. *Xclptr_05* through *xclptr_08* direct a velocity command to the drive. *Xclptr_09* through *xclptr_12* direct an auxiliary velocity input to the drive. The drive's system program will have a corresponding software switch *xcl_swxx* (where *xx*=1-12) set true to read an input. Values for these parameters take the form *AA*:*XXX*, where: *AA* = the PLC node number (0-64, and 99) *XXX* = the item number (000 and 069-127).
XCLPTR_*05*	99:065	Same as above for *xclptr_05* (which has a different default value). The default item number (i.e., 065) corresponds to the raw velocity demand from the PLC.

Table 9-55. XCL Velocity Control Menu (142)

Parameter	Default Value	Description
XCLPTR_*bb* (*bb* = 13-36)	00:000	*Xclptr_13* through *20* direct forward and reverse velocity limits to the drive. *Xclptr_21* through *36* direct forward and reverse acceleration and deceleration rates to the drive. The drive's system program will have a corresponding software switch *scl_swxx* (where *xx*=13-36) set true to read an input. Values for these parameters take the form *AA*:*XXX*, where: *AA* = the PLC node number (0-64, and 99) *XXX* = the item number (000 and 069-127).

Table 9-56. XCL Torque Control Menu (143)

Parameter	Default Value	Description
XCLPTR_*bb* (*bb* = 37-52)	00:000	*Xclptr_37* through *40* direct a torque command to the drive in torque follower applications. *Xclptr_41* through *44* direct a torque auxiliary command to be added to the internal torque command. *Xclptr_45* through *52* direct positive and regenerative torque limits to the drive. The drive's system program will have a corresponding software switch *scl_swxx* (where *xx*=37-52) set true to read an input. Values for these parameters take the form *AA*:*XXX*, where: *AA* = the PLC node number (0-64, and 99) *XXX* = the item number (000 and 069-127).

Table 9-57. XCL Communication Flags Menu (144)

Parameter	Default Value	Description
COMM_F01	99:067	Up to 16 communications flags may be received by the drive. Each flag consists of 16 bits. The individual bits are used as the drive's system program inputs. Syntax is COMM_Fbb_xx, where "bb" is the communication flag number, and "xx" is the bit. This permits up to 256 general purpose control functions from the PLC. Values for these parameters take the form *AA*:*XXX*, where: *AA* = the PLC node number (0-64, and 99) *XXX* = the item number (000 and 069-127). The default item number (i.e., 067) corresponds to serial bit data from the PLC.
COMM_F02	99:069	Same as above for *comm_f02* (which has a different default value). The default item number (i.e., 069) corresponds to serial bit data from the PLC.
COMM_F*bb* (*bb*=03-16)	00:000	Same as above for *comm_f03* through *comm_f16* (which have different default values).

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Table 9-58. Serial Input Scalars Menu (146)

Parameter	Range (Min)	Range (Max)	Default Value	Description
Vel Ref Serial	-125.000	125.000	1.000	Scalars for XCL serial inputs: Velocity reference
V Aux Ref Serial	-125.000	125.000	1.000	Velocity aux reference
V Ref Pos Limit Serial	-125.000	125.000	1.000	Velocity ref positive limit
V Ref Neg Limit Serial	-125.000	125.000	1.000	Velocity ref negative limit
Torque Cmd Serial	-125.000	125.000	1.000	Torque command
Aux Torque Serial	-125.000	125.000	1.000	Auxiliary torque command
Torque Pos Limit Serial	-125.000	125.000	1.000	Torque positive limit
Torque Neg Limit Serial	-125.000	125.000	1.000	Torque negative limit

Table 9-59. Hour Meter Setup (50)

Parameter	Type	Description
Display Hour Meter	function	Used to display the amount of time that the drive has been operational since it was commissioned.
kW Hours Consumed	function	Displays the total kW hours that have been accumulated since the drive was commissioned.

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CHAPTER 10: ISOLATION & RESTORATION PROCEDURES

Consult Brisbane Water Isolation and Restoration Procedures.

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CHAPTER 11:

The sub-contractor and proprietary equipment supplier is:

Robicon
500 Hunt Valley Rd
New Kensington
PA. USA 15068.

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Pulse Generator Instructions M485 SMARTach™

DESCRIPTION

The Avtron Model M485 SMARTach™ Rotary Pulse Generator (patent pending) is a **severe duty** speed and position transducer. When coupled to a motor or machine, its output is directly proportional to shaft position (pulse count) or speed (pulse rate). The M485 can be used for both control and instrumentation applications.

Mechanically, the M485 mounts on a NEMA 56C adapter flange or it can be foot mounted by using an optional foot mounting bracket kit.

The enclosure on Model M485 is rated IP66 to protect the internal components from contamination. This rating, along with several other important factors, makes the M485 ideal for demanding industries like paper, metals, and chemical processing.

The M485 utilizes magnetoresistive sensors. This proven technology is ideal for rugged environments since it is immune to contaminants that could affect the performance of optically-based pulse generators.

An Avtron SMARTach™ can be equipped with one or two sensor modules. Each module has a two-phase output (A, B) 90° out of phase, with complements ($\bar{A}$, $\bar{B}$). A marker pulse with complement (Z, $\bar{Z}$) is available as an option.

Output resolution is partly determined by the rotor's base PPR (pulses per revolution). Additionally, the sensor module can provide any one of three different resolutions from the same rotor: the base PPR, 1/2 the base PPR, or double the base PPR. With two sensor modules, the same pulse generator can provide two different PPRs at the same time. Groupings of 240, 480, or 960; 256, 512, or 1024; and 300, 600, or 1200 are available for maximum RPM values of 4500, 4200 and 3600, respectively.

Example: an M485 could use a 1024 PPR sensor output on one side for feedback to a drive system, and simultaneously use a 256 PPR sensor on the other side for a process computer.

The circuitry has a new diagnostic package that includes Adaptive Electronics and a Fault-Check output. With this package, the SMARTach™ can maintain itself, and provide a signal if there is a problem before the problem causes unscheduled downtime.

ADAPTIVE ELECTRONICS

The M485 continuously monitors duty cycle and makes corrections when necessary.

A perfect duty cycle consists of a waveform whose "high" and "low" conditions are of the same duration (50% / 50%). This is especially important in two phase (A,B) applications where direction of rotation is determined by the precise sequencing of the two phases.

Normally, over time, duty cycle will change due to component drift, temperature changes, and mechanical wear. The M485 SMARTach™ extends the life of the M485 by constantly monitoring and correcting duty cycle over time to maintain this critical performance specification. Not only does the pulse generator last longer, but the signal quality is more reliable over the life of the unit.

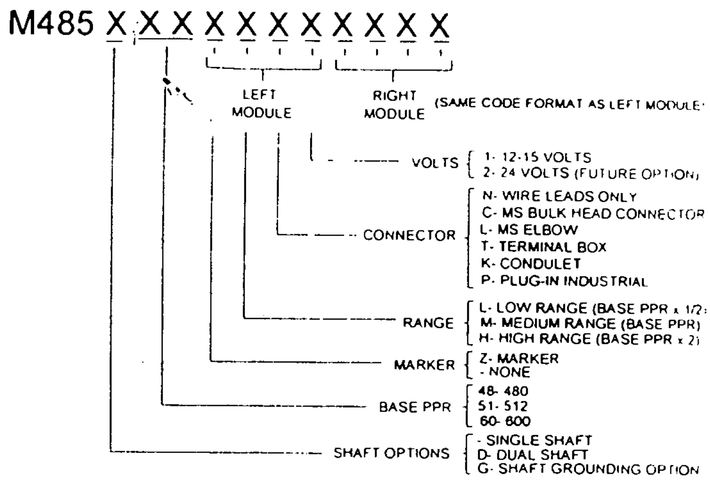
FAULT-CHECK

If the Adaptive Electronics reaches its adjustment limit, the Fault-Check output will notify the drive or controller of an impending failure. This contact closure output occurs **before** an actual failure, allowing steps to be taken to replace the unit before it causes unscheduled downtime.

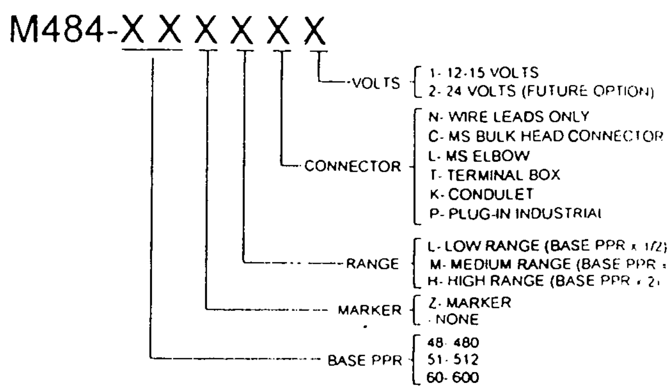
BUILT-IN SPARE

The design of the M485 SMARTach™ uses a special sensor module. In applications where 600 PPR or below is used, the SMARTach™ can automatically switch to a second set of sensor elements. The drive or controller is again notified by the Fault-Check system in this situation.

The available options for the M485 and how they are indicated in the M485 part number are shown below.



The removable sensor assemblies included with Model M485 Pulse Generators are identified by model number M484 as follows:



Refer to separate instructions for additional information on the shaft grounding option.

SPECIFICATIONS

ELECTRICAL:
- Input Operating Power:
  - Volts (+V): 11.5 VDC to 15.5 VDC
  - Current: 120 mA no load, per output. As loads are added, required current increases. See following examples for added loads:
    - Cable capacitance switching examples:
      - 320 mA @ 0.05 uF, 15 VDC, 72 kHz, Differential
      - 15 mA @ 0.05 uF, 12 VDC, 12 kHz, Single ended
    - Output example:
      - 28 mA for Quadrature output into 1 KΩ, 15 VDC in.
    - Alarm example:
      - +V (OUT) for Alarm: 50 mA max.
- Outputs: Square wave from 4428 differential line driver with transient protection
  - Volts, High: (+V) - 1.8, min. (0.05 uF, 15 VDC, 72 kHz, differential, +V (OUT) @ 50 mA);
    (+V) - 0.6, max. (0.0 uF, no load)
    Note: Does not include cable IR drop
  - Volts, Low: 0.12 typical, 0.5 max.
  - Current: 1.5 amps peak, 30 mA average typical.
  - Incremental channel:
    - Quadrature square wave, phase A leads phase B for CW shaft rotation as viewed from anti drive end of the motor (tach mounting end)
    - Duty cycle: 50% +/- 5%
    - Transition separation: 25% +/- 5%
    - Resolution: 240, 256, 300, 480, 512, 600, 960, 1024, 1200 PPR
  - Marker channel: Once per revolution. Pulse width approximately 1/3 of base PPR period.

ELECTRICAL (continued):
- Alarm Output:
  - +V (OUT): 50 mA max. This is a convenience output, internall jumpered to +V operating voltage. It is intended f arm circuits like solid state relays that can be referenc +V.
  - Alarm: Open collector, sink 100 mA max, withstand max referenced to common. Output goes low on alarm.

MECHANICAL:
- Speed range: 0-4500 RPM for base PPR of 480
- Speed range: 0-4200 RPM for base PPR of 512
- Speed range: 0-3600 RPM for base PPR of 600
- Weight: 11 lbs.
- Coupling Recommended: Zero Backlash; Thomas Miniature Flexible or Equivalent. Where axial endplay exceeds +/-0.020 inch, use Thomas CCX or equivalent.

ENVIRONMENTAL:
- Operating temperature: -20 deg C to 80 deg C
- Dust & Water: A standard M485 pulse generator is shipped with a universal breather/drain to equalize pressure if the tach is exposed to temperature cycles and provide a drain for condensate. The labyrinth design limits the entry of dust to normally satisfactory levels, and water spray in any direction has no harmful effect. In environments with stable temperatures the breather may be replaced with a 1/4" pipe plug making the pulse generator water-tight and dust-tight.

Features and specifications subject to change without notice.

INSTALLATION

Refer to the back page of these instructions for outline and mounting dimensions.

DRIVE INSTALLATION INSTRUCTIONS

The pulse generator must be driven by a positive drive rather than a friction drive. The following means of coupling are acceptable when properly installed: Direct Coupling, Timing Belt/Pulleys, Chain/Sprockets.

With a direct drive, use a flexible coupling and align the shafts as accurately as possible. The pulse generator should not be subjected to any axial thrust. Overhung loads should also be minimized. Installations using timing belts/pulleys should have just enough belt tension to eliminate belt sag. Excessive tension will shorten belt and bearing service life. If a rubber slinger disc is used, position it on the shaft so it will rotate freely.

CAUTION

Do not force or drive the coupling onto the shaft, or damage to the bearings may result. The coupling should slide easily on the shaft. Remove nicks and burrs if necessary. Consider driving shaft endplay when positioning coupling.

For more details on alignment specifications, measurement techniques, and special considerations in specifying and installing drive components, refer to separate installation instructions in the Avtron *PULSE GENERATOR HANDBOOK*.

FOOT MOUNTING INSTRUCTIONS

The NEMA 56C face is the preferred mounting metho the M485. In certain cases, however, it may be necessary to foot-mount this unit. The optional foot mounting bracket kit, Avtron part number A22232, will be required. Read all of the following instructions and the Avtron *PULSE GENERATOR HANDBOOK* prior to beginning any work.

The tach performance and life will be directly affected by the installation. Following this sequence of steps is recommended.

1) Clean and inspect motor / driver shaft. Do not use force to assemble coupling onto motor / driver shaft. The foot mounting bracket must be secured to a flat, rigid, vibration free steel or aluminum base which can be machined to accept 5/16-18 mounting hardware.
2) Temporarily mount the tach to the foot bracket, install the coupling to tach and driver, and verify that the location is suitable for installation.
3) If the M485 tach, bracket and coupling are suited to the area, check for parallel and angular alignment.
4) While maintaining alignment, precisely mark the position of the foot bracket on its mounting base.
5) Remove the M485. Transfer punch or layout the mounting hole pattern as indicated on outline drawing.
6) Machine four, 3/8" dia through holes or tap four, 5/16-18 holes in center of base slots to give some degree of freedom in final alignment.
7) Reinstall the M485 and tighten down all mounting hardware. Check alignment to verify that it meets specifications.
8) Recheck alignment and tighten all hardware after first several hours of operation.

MINIMIZE DOWN-TIME : Should tach replacement be r ed, leave the foot mounting bracket installed on its base and mount the new tach to the bracket. This maintains the original alignment.

WIRING INSTRUCTIONS

For bidirectional operation of the 2-phase SMARTach™, proper phasing of the two output channels is important. Phase A channel leads phase B channel for clockwise shaft rotation as viewed from the anti-drive or accessory end of the motor (tach mounting end).

Interconnecting cables specified in the wire selection chart below are based on typical applications. Refer to the system drawing for specific cable requirements where applicable.

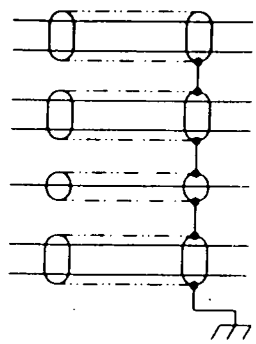
Physical properties of cable such as abrasion, temperature, te strength, solvents, etc., are dictated by the specific applica General electrical requirements are: stranded copper, 22 thr gauge (P options can use 14 AWG), each wire pair individ shielded with braid or foil with drain wire, 0.05 uF maximum mutual or direct capacitance, outer sheath insulator, 1,000 ft See Wire Selection Chart below for some suggested cables

WIRING DIAGRAMS

FOR SINGLE ENDED APPLICATIONS

M485

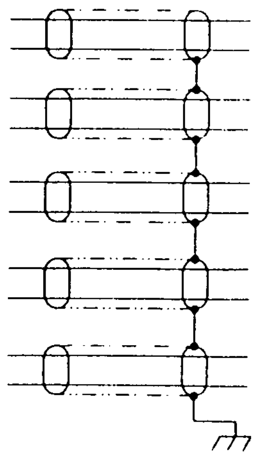
N&K	C&L	P	T	FUNCTION
RED	B	6	+V	OPERATING VOLTAGE
BLUE	E	3	B	ØB
GREEN	D	2	A	ØA
BLACK	A	1	COM	COMMON
ORANGE	C	4	Z	MARKER
BROWN	F	5	+V(OUT)	RELAY +V REF
VIOLET	J	10	ALM	ALARM
				GROUND



FOR DIFFERENTIAL APPLICATIONS

M485

N&K	C&L	P	T	FUNCTION
BLACK	A	1	COM	COMMON
RED	B	6	+V	OPERATING VOLTAGE
GREEN	D	2	A	ØA
YELLOW	G	7	$\bar{A}$	Ø$\bar{A}$
BLUE	E	3	B	ØB
GRAY	H	8	$\bar{B}$	Ø$\bar{B}$
ORANGE	C	4	Z	MARKER
WHITE	I	9	$\bar{Z}$	MARKER COMPLEMENT
BROWN	F	5	+V(OUT)	RELAY +V REF
VIOLET	J	10	ALM	ALARM
				GROUND



TYPICAL WIRE SELECTION CHART

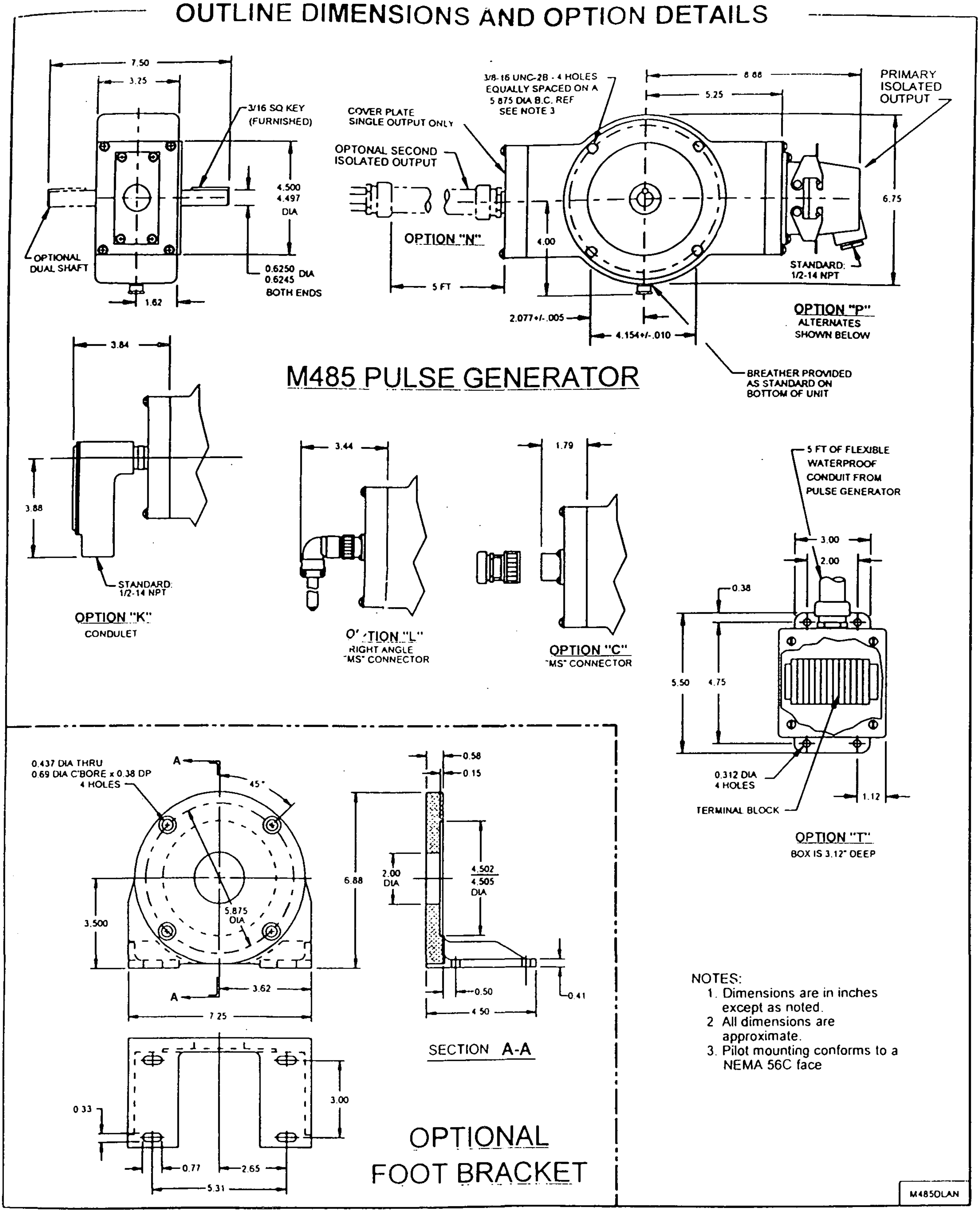
for 18 AWG, multiple pair, individually shielded

	BELDEN	ALPHA
2 PAIR	9368	6062
3 PAIR	9369	6063
4 PAIR	9388	6064
6 PAIR	9389	6066

NOTE: When using the plug-in industrial connector ("P" option), the wire ends must be tinned with solder before connection at the screw terminals.

M485CLAN

OUTLINE DIMENSIONS AND OPTION DETAILS



NOTES:
1. Dimensions are in inches except as noted.
2. All dimensions are approximate.
3. Pilot mounting conforms to a NEMA 56C face

Features and specifications subject to change without notice Avtron standard warranty applies. All dimensions are in inches REV C

3C428/30

Dayton

INSTALLATION INSTRUCTIONS & PARTS LIST

HIGH-VOLUME INDUSTRIAL BLOWERS

MODELS 3C428, 3C429 & 3C430

FORM
5S2433
05540

DAYTON ELECTRIC MANUFACTURING CO. CHICAGO 60648

0382/139/2M

**READ INSTRUCTIONS CAREFULLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THE DAYTON HIGH-VOLUME INDUSTRIAL BLOWER.
RETAIN INSTRUCTIONS FOR FUTURE REFERENCE.**

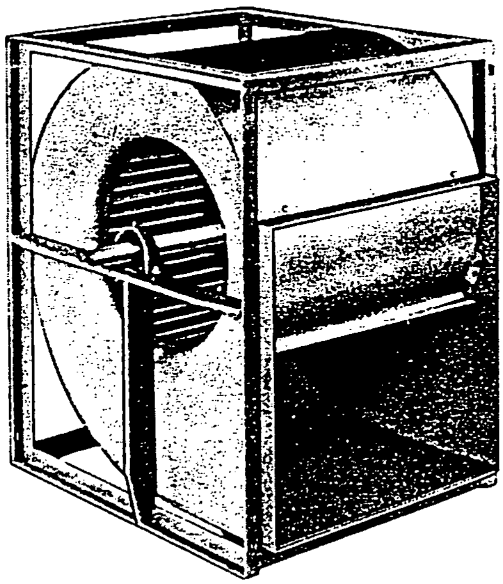


Figure 1

Description

Dayton high-volume industrial blowers are built to meet class 1 design performance and provide efficient air movement for heating, ventilation, cooling, and similar industrial applications up to 2" static pressure. Steel housing and corner braces provide a rigid support for mounting the blower in any one of four standard discharge positions. Dynamically balanced galvanized steel wheel. Cast iron ball bearings. Maximum operating temperature is 200°F (93.9°C).

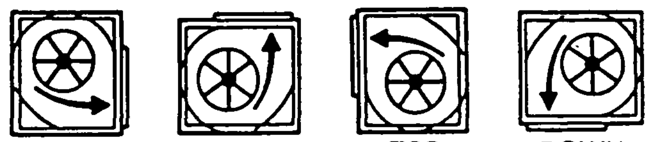
The maximum blower RPM per wheel diameter is listed in the performance table. Air deliveries listed are based on standard test codes of the Air Moving and Control Association.

Unpacking

After unpacking the blower, inspect carefully for any damage that may have occurred during transit. Rotate wheel by hand to be sure it turns freely.

NOTE: Never lift a blower assembly by the shaft. Use a sling or platform structure to lift the blower.

USE BLOWER FOR ANY OF THESE DISCHARGES

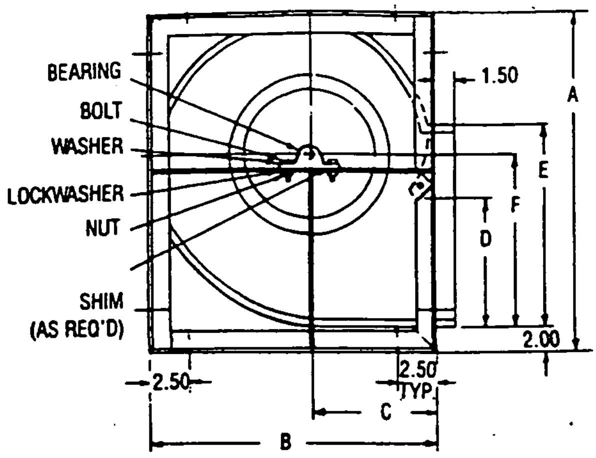


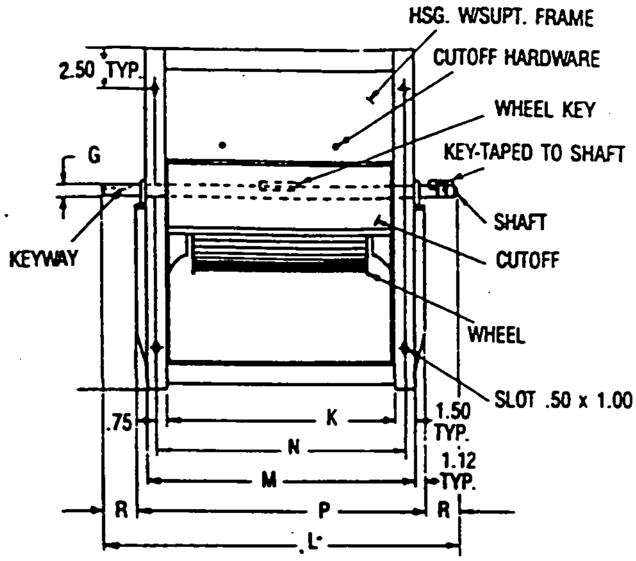
General Safety Information

1. Follow all local electrical and safety codes, as well as the National Electrical Code (NEC) and the Occupational Safety and Health Act (OSHA).
2. Blower must be securely and adequately grounded. This can be accomplished by wiring with a grounded, metal-clad raceway system, by using a separate ground wire connected to the bare metal of blower frame, or other suitable means.
3. Always disconnect power source before working on or near a motor or its connected load. If the power disconnect point is out-of-sight, lock it in the open position and tag to prevent unexpected application of power.
4. Be careful when touching the exterior of an operating motor — it may be hot enough to be painful or cause injury. With modern motors this condition is normal if operated at rated load and voltage — modern motors are built to operate at higher temperatures.
5. Protect the power cable from coming in contact with sharp objects.
6. Do not kink power cable and never allow the cable to come in contact with oil, grease, hot surfaces, or chemicals.
7. Make certain that the power source conforms to the requirements of your equipment.
8. When cleaning electrical or electronic equipment, always use an approved cleaning agent such as dry cleaning solvent.
9. Do not put hands near or allow loose and hanging clothing to be near belts, pulleys, or blower wheel while the unit is running.

WARNING: NOT RECOMMENDED AS AN EXPLOSION PROOF BLOWER. DO NOT USE WHERE EXPLOSIVE FUMES OR GASES ARE PRESENT.

Specifications





Model No.	Wheel Dia.	Wheel Width	A	B	C	D	E	F	G	K	L	M	N	P	R
3C428	20	20	38.00	31.25	12.94	14.00	24.75	20.53	1.44	24.75	36.75	27.75	26.25	30.00	3.38
3C429	22	22	41.50	34.25	14.19	14.75	27.25	22.59	1.44	27.25	39.25	30.25	28.75	32.50	3.38
3C430	25	25	46.75	38.38	15.75	17.50	31.25	25.66	1.44	31.25	43.25	34.25	32.76	36.50	3.38

CFM AIR DELIVERIES AT RPM SHOWN

Model	Blower RPM	H.P.	SP 1/4"	SP 3/8"	SP 1/2"	SP 3/4"	SP 1"	SP 1 1/4"	SP 1 1/2"	SP 2"
3C428	310	1	6,350	3,770						
	400	2	8,940	8,420	7,570					
	450	3		9,860	9,360	6,970				
	525	5		11,870	11,540	10,600	8,490			
	610	7½				13,200	12,370	10,920		
	760	15					15,900	14,500	13,850	10,000
	800	20					17,200	16,300	15,400	12,700
	850	25					18,700	17,900	17,000	14,850
3C429	310	1½	8,760	6,980						
	400	3	12,560	11,640	10,530					
	450	5		13,770	12,920	10,640				
	540	7½				15,310	13,500	10,410		
	585	10				17,310	15,860	13,990		
	730	15				19,000	18,000	16,900	15,700	11,900
	760	20				20,050	19,100	18,100	16,950	13,650
	800	20				21,300	20,450	19,500	18,550	16,000
	860	25				23,300	22,500	21,700	20,800	18,750
3C430	270	2	12,700	10,460						
	310	3	15,590	13,960	11,900					
	380	5		19,110	17,830	14,600				
	435	10		22,300	21,800	19,470	16,480			
	470	10				22,180	19,790	16,560		
	535	15					24,350	21,920	18,000	
	560	20				28,000	26,250	24,300	21,300	
	600	25				30,700	29,100	27,400	25,400	16,700
	635	25						29,900	28,300	23,000

DRIVE DATA

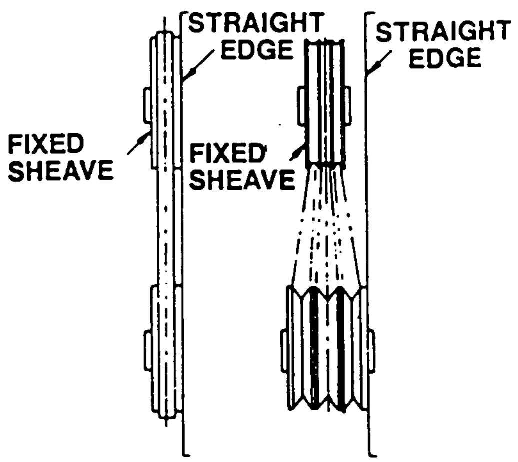
Model No.	Blower RPM	Motor H.P.	Motor Sheave Pitch Dia.	Motor Sheave Stock No.	Belt	Blower Sheave Pitch Dia.	Blower Sheave Stock No.	No. Grooves
3C428	310	1	3.2A	3X553	3X352	18.0A	1W963	2
	400	2	4.2A	3X557	3X352	18.0A	1W963	2
	450	3	3.7A	3X535	3X352	15.0A	1W962	2
	525	5	4.7A	3X559	3X351	15.0A	1W962	2
	610	7½	5.4B	3X560	3X353	15.4B	1W962	2
	760	15	5.4B	3X491	5X482	12.4B	3X616	3
	800	20	7.0B	3X458	3X354	15.4B	3X616	3
	850	25	9.0B	1A071	3X372	18.4B	1W963	2
3C429	310	1½	3.2A	3X553	3X352	18.0A	1W963	2
	400	3	4.2A	3X541	3X352	18.0A	1W963	2
	450	5	4.5A	3X558	3X371	18.0A	1W963	2
	540	7½	5.2A	3X561	3X351	18.0A	1W963	2
	585	10	6.4B	3X564	3X354	20.0B	3X271	2
	730	15	5.2B	3X490	3X353	12.4B	3X616	3
	760	20	6.6B	3X457	3X354	15.4B	3W618	3
	800	20	7.0B	3X458	3X354	15.4B	3X618	3
	860	25	9.0B	1A071	3X372	18.4B	1W963	2
3C430	270	2	2.8A	3X357	3X352	18.0A	1W963	2
	310	3	3.2A	3X530	3X352	18.0A	1W963	2
	380	5	4.4B	3X538	3X354	20.0B	3X271	2
	435	10	5.1B	3X559	3X372	20.0B	3X271	2
	470	10	5.6B	3X561	3X372	20.0B	3X271	2
	535	15	4.2B	3X479	3X354	13.6B	3X617	3
	560	20	5.8B	3X453	3X372	18.4B	3X619	3
	600	25	8.6B	1A070	3X651	25.0B	3W249	2
	635	25	9.0B	1A071	3X651	25.0B	3W249	2

Installation

NOTE: Check the interior of the blower housing. It should be clean and free of debris.

1. Rotate the blower wheel by hand. It should not rub against the inlet cones. If rubbing exists, loosen the set screws on the wheel hub and shift the wheel to obtain clearance. Retighten all set screws.
2. Mount the blower on a rigid, level foundation. Bolt the blower securely into position. Shim all gaps between blower frame and foundation. If the blower is to be mounted above ground, such as inside a building or on a roof, it should be located near or above a rigid wall or column.

   NOTE: Do not mount blower on a cantilevered or overhung steelwork.
3. Mount the fan sheave on the fan shaft and tighten its set screw securely on the key of the shaft.
4. Mount the motor sheave on the motor shaft. Leave some clearance between the pulley and the motor end bell. Tighten the set screws on the key of the motor shaft.
5. Attach the motor to the recommended motor mounting rails. (See Exploded View). Position motor at mid point on the rails and finger tighten the nuts to the square head bolts.



NOTE: Drive tension should be rechecked after the first 24 hours of operation and again after 50 to 100 hours of operation.

Figure 2 — Correct Sheave Alignment

6. Install matched belts in sheave grooves and align both sheaves by moving the motor mounting rail assembly on the foundation. See Figure 4 for correct sheave alignment.
7. After the belts are pulled snugly in the sheave grooves, and the motor at the mid position on the rails, secure the motor rails to the foundation.
8. Check belt tension by turning the adjustment screw provided with the mounting rails. Tighten the belt until the slack side can be depressed about ¾" for each foot of span between the pulleys. Tighten the motor to the motor mounting rails.
9. Before connecting the motor to the electrical supply, check the electrical characteristics and wiring instructions as indicated on the motor nameplate or inside the conduit box cover to insure proper voltage and phase. Make your electrical connections.

WARNING: A GROUND WIRE MUST BE CONNECTED FROM THE MOTOR HOUSING TO A SUITABLE ELECTRTICAL GROUND.

Operation

1. After electrical connections are completed, apply just enough power to start the unit. Be sure that the rotation of the wheel is correct. If proper rotation, apply full electrical power.
2. With the air system in full operation and all ducts attached, measure current input to the motor and compare with the nameplate rating to determine if the motor is operating under safe load conditions.
3. Motor will be overloaded if blower RPM exceeds that recommended in Performance Table or if operated below static pressure shown.

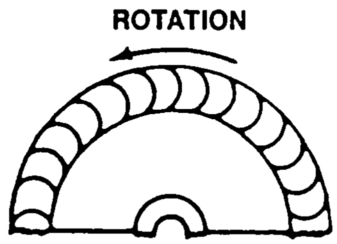


Figure 3

Maintenance

WARNING: DISCONNECT POWER SUPPLY BEFORE SERVICING THE BLOWER.

1. Bearings
   a. Inspect and tighten all bearing collar set screws after the first 50 to 100 hours of operation and periodically thereafter.

Maintenance (Continued)

b. Lubricate the bearings while the shaft is rotating. Disconnect power supply and rotate wheel by hand while slowly applying a good grade of Lithium base general purpose ball bearing grease conforming to NLGI # 2 consistency. Apply slowly with a hand gun until a slight bead of grease is noticeable around the bearing seal. Stop lubricating when the bead is formed.

NOTE: The maximum grease capacity of a 1-7/16" bearing chamber is about 5/8 ounce.

c. Relubrication intervals depend upon blower application. When lubricating the bearings observe the following. If the bearing grease is clean you could extend the lubrication interval but if the bearing grease is black and dirty the interval should be shortened. Refer to lubrication chart for a general guide to lubrication:

General Guide For Lubrication			
Max. Speed	Bearing Temp.	Condition	Greasing Interval
500 RPM	To 150°F	Clean	2 To 6 Mo.
850 RPM	To 200°F	Clean	2 Wks. To 2 Mo.

2. Inspect V-Belts for wear and proper tension. If it is necessary to replace one belt on a multiple belt drive, replace all the belts with a matched set.
3. Clean the blower wheel periodically. Material build up on the blades can cause wheel unbalance that may damage the bearings or cause self-destruction of the blower wheel.
4. Should further service to the blower be necessary, refer to the exploded view illustration (Fig. 4).

Trouble Shooting Chart

SYMPTOM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
Noise.	1. Foreign objects. 2. Loose set screw on wheel. 3. Incorrect wheel rotation.	1. Remove. 2. Tighten set screw. 3. Reverse rotation.
Bearing noise.	1. Misalignment. 2. Lack of bearing lubrication.	1. Realign. 2. Lubricate. See "Maintenance."
Drive noise.	1. Sheave misalignment. 2. Loose set screws. 3. Loose belts.	1. Realign. 2. Tighten. 3. Tighten.
Excessive vibration.	1. Bearing and drive alignment. 2. Mismatched belts. 3. Loose wheel on sheaves or shaft. 4. Loose or worn bearings. 5. Loose mounting bolts. 6. Motor out of balance. 7. Wheel out of balance. 8. Sheaves eccentric or out of balance. 9. Accumulation of material on wheel.	1. Realign. 2. Replace. 3. Tighten. 4. Replace. 5. Tighten. 6. Replace. 7. Replace or rebalance. 8. Replace. 9. Clean.
Motor overloaded.	1. Insufficient static pressure.	1. Connect all ducts, and install filters.

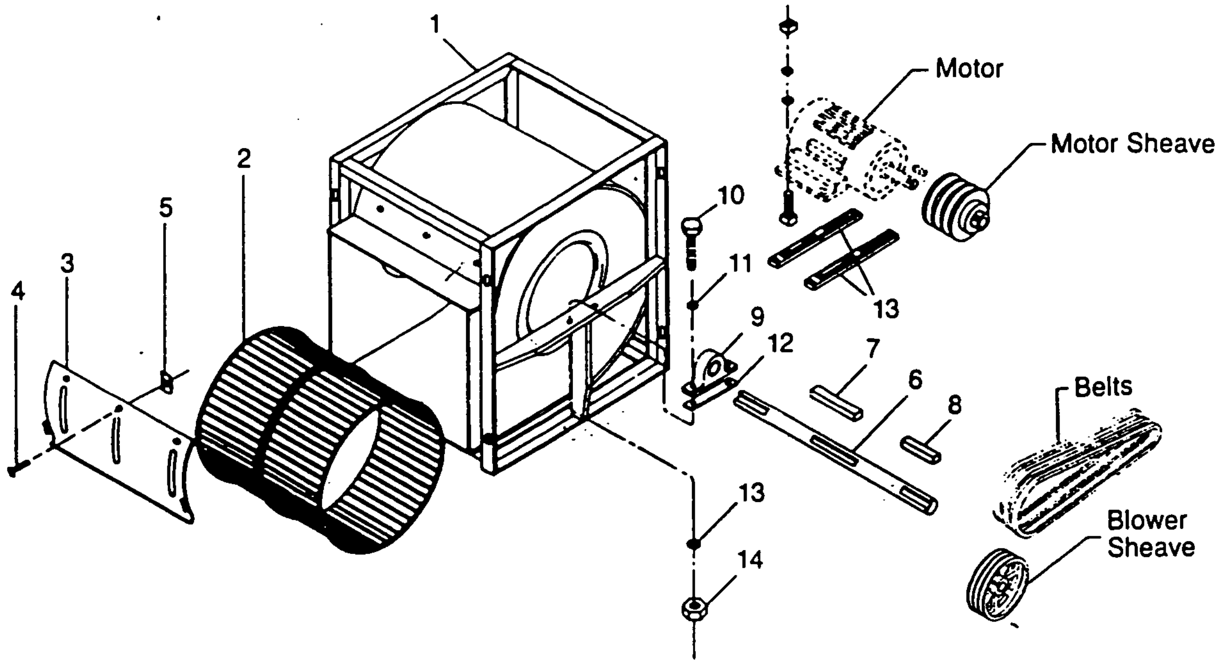


Figure 4

ORDER REPLACEMENT PARTS THROUGH DEALER FROM WHOM PRODUCT WAS PURCHASED

Please provide following information:
- Model Number
- Serial Number (if any)
- Part Description and Number as shown in parts list.

If dealer cannot supply, order from:
Dayton Electric Mfg. Co.
Customer Service Dept.
5959 W. Howard St.
Chicago, Illinois 60648

Replacement Parts List

Ref No.	Description	Part Numbers For Models			Qty
		3C428	3C429	3C430	
1	Blower housing	025795-02	025795-04	025795-09	1
2	Wheel	014302-35	013961-52	013962-37	1
3	Cutoff	017650-02	017650-05	017650-09	1
4	Screw 1/4-20 x 3/8 truss hd	*	*	*	5
5	Speed nut 1/4-20	*	*	*	5
6	Shaft	025780-28	025780-29	025780-30	1
7	Key, wheel	017240-56	017240-57	017240-57	1
8	Key, pulley	017240-75	017240-75	017240-75	1
9	Bearing, 1 7/16" bore	017391-09	017391-09	017391-09	2
10	Bearing bolt, 1/2"-13 x 2"	*	*	*	4
11	Washer, 1/2"	*	*	*	4
12	Shim	025770-01	025770-01	025770-01	2
13	Lock washer, 1/2"	*	*	*	4
14	Nut 1/2"-13	*	*	*	4

*Standard hardware item available locally.
NOTE: Motors, belts and sheaves available from W. W. Grainger Motorbook.

LIMITED WARRANTY

Dayton high-volume industrial blowers, Models 3C428, 3C429 & 3C430, are warranted by Dayton Electric Mfg. Co. (Dayton) to the original user against defects in workmanship or materials under normal use (rental use excluded) for one year after date of purchase. Any part which is determined to be defective in material or workmanship and returned to an authorized service location, as Dayton designates, shipping costs prepaid, will be repaired or replaced at Dayton's option. For warranty claim procedures, see "Prompt Disposition" below. This warranty gives purchasers specific legal rights, and purchasers may also have other rights which vary from state to state.

WARRANTY DISCLAIMER. Dayton has made a diligent effort to illustrate and describe the products in this literature accurately; however, such illustrations and descriptions are for the sole purpose of identification, and do not express or imply a warranty that the products are merchantable, or fit for a particular purpose, or that the products will necessarily conform to the illustrations or descriptions.

Except as provided below, no warranty or affirmation of fact, express or implied, other than as stated in "LIMITED WARRANTY" above is made or authorized by Dayton, and Dayton's liability in all events is limited to the purchase price paid.

Certain aspects of disclaimers are not applicable to consumer products; e.g., (a) some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you; (b) also, some states do not allow limitations on how long an implied warranty lasts, consequently the above limtiation may not apply to you; and (c) by law, during the period of this Limited Warranty, any implied warranties of merchantability or fitness for a particular purpose applicable to consumer products purchased by consumers, may not be excluded or otherwise disclaimed.

PROMPT DISPOSITION. Dayton will make a good faith effort for prompt correction or other adjustment with respect to any product which proves to be defective within warranty. For any product believed to be defective within warranty, first write or call dealer from whom product was purchased. Dealer will give additional directions. If unable to resolve satisfactorily, write to Dayton at address below, giving dealer's name, address, date and number of dealer's invoice, and describing the nature of the defect. If product was damaged in transit to you, file claim with carrier.

**DAYTON ELECTRIC MFG. CO., 5959 W. HOWARD STREET,
CHICAGO, ILLINOIS 60648**

GE Motors

Motor Installation and Maintenance

All Enclosures - Frames 143 - 449 - Single and Polyphase - Ball Bearing

Warning

Safe Motor Operation

High voltage and rotating parts of electrical machinery can cause serious or fatal injury. Its installation, operation and maintenance should be performed by qualified personnel only. Familiarization with NEMA MG2 Safety Standard for Construction and Guide for Selection, Installation and Use of Fractional and Integral Motors, the National Electrical Code and sound local practices is recommended. For equipment covered by these instructions, it is important to observe safety precautions to protect personnel from possible injury. Personnel should be instructed to:

Avoid contact with energized circuits. Disconnect all power sources before attempting maintenance or repair.

Avoid contact with rotating parts and be sure that shaft key is fully captive before motor is energized.

Avoid contact with the start or run capacitors in single-phase motors until a safe discharge procedure has been followed.

Act with care and in accordance with prescribed procedures in handling, fitting, installing, operating and maintaining the equipment.

Do not lift motor and driven equipment with motor lifting means. If eyebolts are used for lifting motors, they must be securely tightened and the direction of the lift must not exceed a 15 degree angle with the shank of the eyebolt.

Do not use motors with automatic thermal protection where unexpected starting of equipment might be hazardous to personnel. Provide proper safeguards for personnel against possible failure of motor mounted brake, particularly on applications involving overhauling loads.

Safe maintenance practices and qualified personnel are imperative. Before initiating maintenance procedures, be sure that all power sources are disconnected from the machine and accessories to avoid electrical shock and personal injury from rotating parts. If a high potential insulation test is required, procedures and precautions outlined in NEMA Standards MG1 should be followed.

Failure to properly ground motor may cause serious injury to personnel. Grounding should be in accordance with the National Electrical Code and consistent with sound local practice.

Installation

1. *Location*

a) **Dripproof motors** are used in a well ventilated place reasonably free of dirt and moisture.
b) **Standard enclosed motors** are used where they are exposed to dirt, moisture and most outdoor conditions.
c) **Severe-duty enclosed motors** are used in highly corrosive or excessively moist areas.
d) **Explosion-proof motors** bearing the Underwriters' Laboratories label designating the motor U/L Class and Group as defined in the National Electrical Code are designed for operation in areas classified by local authorities as hazardous in accordance with standards set forth in that Code.

. *Mounting*

(a) Mount motors securely on a firm, flat base. Grout-in larger motors, if necessary. Ball bearing motors can be sidewall or ceiling mounted. Ball bearing motors in 143 - 326 frame ratings can be vertically mounted. The standard transition and/or sliding bases are suitable for floor mounting. For other locations, check the factory for base recommendations. For motors having bolt-on bases shipped not assembled, refer to paragraph 'c' for assembly instructions before motors are put in service.

CAUTION: Remove drain plugs from the frame or endshields of enclosed motors used outdoors or in other high moisture areas.

b) Align motors accurately. For direct drive, use flexible couplings if possible. For drive recommendations, consult drive or equipment manufacturers or GE.

c) For base assembly and motor mounting, the bolts must be carefully tightened to prevent changes in alignment and possible damage to the equipment. It is recommended that a washer be used under each nut or bolt head to get a secure hold on the motor feet; or, as an alternative, flanged nuts or bolts may be used. The recommended tightening torques for medium carbon steel bolts, identified by three radial lines at 120 degrees on the head are:

Bolt Size		Recommended Torque in Ft.-lb. (N-M)			
Inch	(Metric)	Minimum		Maximum	
1/4	(M6)	7	(9)	11	(15)
5/16	(M8)	14	(19)	21	(28)
3/8	(M10)	25	(34)	37	(50)
1/2	(M12)	60	(81)	90	(122)
5/8	(M16)	120	(163)	180	(244)
3/4	(M20)	210	(285)	320	(433)

NOTE: For low carbon steel bolts, use 50% of the above recommended tightening torques. There are no ID marks on low carbon steel bolts.

d) When bases are removed on enclosed motors, the enclosure must be maintained by plugging the bolt holes with plastic plugs from Kit No. 1821BPK1. **Warning: Do not replace the bolts in the frame with the base removed.**

e) Tighten belts only enough to prevent slippage. Belt speed should not exceed 5000 feet per minute.

f) The application of pulleys, sheaves, sprockets and gears on motor shaft is shown in NEMA Standard MG1-14.07. The application of the V-belts dimensions to alternating current motors is shown in MG1-14.24A. V-belt sheave pitch diameters should not be less than the values shown in Table 1 on page 3.
Sheave ratios greater than 5:1 and center-to-center distances less than the diameter of the large sheave should be referred to the Company.

g) **On motors with dual mounting** holes, use **the holes** indicated **per the** drawing at right.

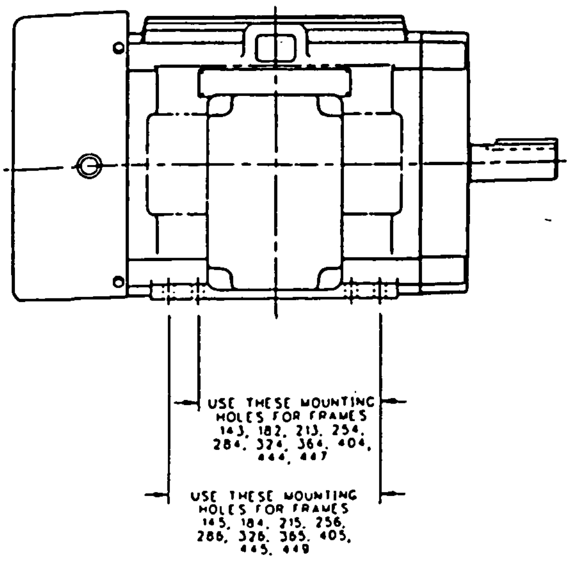


Table 1. V-belt Sheave Diameters (Minimum in Inches)

Horsepower				Conventional	Narrow
Synchronous Speed (RPM)				A, B, C, D, E* Pitch Dia.	3V, 5V, 8VΔ Outside Dia.
3600	1800	1200	900		
1.5	1	.75	.50	2.2	2.2
2-3	1.5-2	1	.75	2.4	2.4
—	3	1.5	1	2.4	2.4
—	—	2	1.5	2.4	2.4
5	—	—	—	2.6	2.4
7.5-10.0	5-7.5	3-5	2-3	3.0	3.0
15	10	7.5	5	3.8	3.8
20-25	15	10	7.5	4.4	4.4
—	20	15	10	4.6	4.4
—	25	—	—	5.0	4.4
—	30	20	15	5.4	5.2
—	40	25	20	6.0	6.0
—	50	30-40	25-30	6.8	6.8
—	60	—	—	7.4	7.4
—	—	50	40	8.2	8.2
—	75	—	—	9.0	8.6
—	—	60	—	9.0	8.0
—	—	—	50	9.0	8.4
—	100	—	—	10.0	8.6
—	—	75	60	10.0	10.0
—	125	—	—	11.5	10.5
—	—	100	—	11.0	10.0
—	—	—	75	10.5	9.5
—	150	—	—	—	9.5
—	—	125	100	12.5	12.0
—	200	—	—	—	13.2

* Maximum sheave width = 2(N-W) - 1/4 inch where N-W is the approximate usable shaft length.
Δ Maximum sheave width = N-W.

Power Supply and Connections

a) Nameplate voltage and frequency should agree with power supply. Motors will operate satisfactorily on line voltage within ± 10% of the nameplate value or frequency within ± 5%, combined variation not to exceed ± 10%.

b) Dual voltage motors can be connected for the desired voltage using instructions on nameplate or connection diagram.

c) Wiring of motor, control, overload protection and grounding should meet the National Electrical Code and local building codes.

Select wire size from the following table to help avoid voltage drop in the branch circuit of single-phase motors.

Individual Branch Circuits for Single-phase Motors

Motor Hp	Volts	Max. * Fuse Amps	Minimum Size Wire Gauge for Branch Circuit Lengths in Feet			
			0-5	100	200	500
.75	230	25	14	12	10	6
	115	45	12	8	6	2
1	230	25	14	14	12	8
	115	50	12	8	6	—
1.5	230	30	14	12	10	6
	115	60	10	6	4	—
2	230	40	14	12	8	4
	115	80	10	6	—	—
3	230	60	12	10	8	4
	115	110	8	8	—	—
5	230	90	10	8	6	2
7.5	230	125	8	6	—	—

* Value based on National Electrical Code.

IV. *Thermal Protectors*

a) Thermally-protected motors have those words on the nameplate and have built-in protection against dangerous overheating.
b) Manual-reset protectors are reset (after motor cools) by pressing external reset button.
c) Automatic-reset protectors (no external button) reset automatically after motor cools.

Warning: Where unexpected starting would be dangerous to personnel, do not use automatic reset protection.

Operation

a) Dry out motors thoroughly which have been stored in a damp location before operating. Do not exceed a temperature of 85°C (185F) in drying.
b) Operate at no load to check rotation and for free running. To reverse rotation:
   Three phase - interchange leads T1 and T3.
   One phase - follow the motor connection nameplate or label.
c) Operate under load for an initial period of at least one hour to observe whether any unusual noise or hot spots develop.
d) Check operating current against the nameplate current. Do not exceed the value of the nameplate amperes multiplied by the service factor (if any) under continuous load.
e) 208 Volt system. When a 230/460 Volt motor with a nameplate which states "usable at 200V, __Hp, __Amps, 1.0 SF" is operated on a 208 Volt system, the motor slip will increase approximately 30% and the motor locked-rotor, pull-up and breakdown torque values will be reduced by approximately 20 to 30%.
   Therefore, it should be determined by the user that the motor will start and accelerate the connected load without injurious heating and that the breakdown torque is adequate for the application.

Maintenance

I. *Inspection*

a) Inspect motor at regular intervals. Keep motor clean and ventilating openings clear.

II. *Lubrication*

a) Ball bearing motors are adequately lubricated at the factory. Motors with regreasing facilities should be relubricated at intervals consistent with type of service (see Table 2 on page 5) to provide maximum bearing life. Excessive or too frequent lubrication may damage motor.
b) Relubricate motors with GE grease D6A2C14 or any Polyurea thickened grease unless a special grease is specified on the nameplate.
   Relubricate while the motor is warm with the shaft stationary for safety and best purging of old grease.
   Warning: If lubrication is performed with the motor running, stay clear of rotating parts.
c) **Dripproof Motors.** On the drive end and opposite drive end of motors with pipe plugs, insert a lubrication fitting. Remove the other plug for grease relief of all motors. Clean grease relief opening of any hardened grease. Be sure fittings are clean and free of dirt. Insert a pipe cleaner down the relief hole. Using a low-pressure, hand-operated grease gun, pump in clean recommended grease until new grease appears on the pipe cleaner. After lubricating, allow the motor to run for ten minutes before replacing relief plug.
d) **Totally Enclosed Fan Cooled Motors.** Remove the caps on the fan cover for access to the grease plugs. Follow the greasing instructions described above for dripproof motors.
e) **Motors not having pipe plugs or grease fittings** in bearing housing can be relubricated by removing endshields from motor, cleaning grease cavity and refilling with recommended grease.
   Caution: Bearings and grease must be kept free of dirt.

Table 2. Motor Lubrication Guide

Type of Service	Typical Examples	Hp Range	Lubrication Interval (Yrs.) Horizontal	Vertical
Easy	Valves; door openers; portable floor sanders; motor operating infrequently (one hour per day)	1.0 -7.5 10 - 40 50 - 150 200 - 350 400 - 800	10 7 4 3 1	9 3 1.5 9 mo. -
Standard	Machine tools; air-conditioning apparatus; conveyors, one or two shifts; garage compressors; refrigeration machinery; laundry machinery; oil well pumps; water pumps; wood working machinery	1.0 - 7.5 10 - 40 50 - 150 200 - 350 400 - 800	7 4 1.5 1 6 mo.	3 1 6 mo. 3 mo. -
Severe	Motor for fans, M-G sets, etc., that run 24 hours per day, 365 days per year; coal and mining machinery; motors subject to severe vibration; steel mill machinery	1.0 - 7.5 10 - 40 50 - 150 200 - 350 400 - 800	4 1.5 9 mo. 6 mo. 3 mo.	1.5 6 mo. 3 mo. 1.5 mo. -
Very Severe	Dirty, vibrating applications; where end of shaft is hot (pumps and fans); high ambient temperature	1.0 - 7.5 10 - 40 50 - 150 200 - 350 400 - 800	9 mo. 4 mo. 4 mo. 3 mo. 2 mo.	6 mo. 3 mo. 2 mo. 1 mo. -

III. *Explosion-Proof Motors*

a) Explosion-proof motors have special features and are manufactured in accordance with U/L and carry its label. Therefore, it is recommended that repairs be made at a GE Service Shop which has been authorized to make such repairs.

IV. *Motor Windings*

a) To clean motors use a soft brush and, if necessary, a slow acting solvent in a well ventilated room.

Service

Your GE motor should be serviced only by qualified persons who have the proper tools and equipment. Fast, dependable in-warranty service for your motor can be obtained from any of the worldwide network of GE Authorized Electric Motor Servicenters. Consult the Yellow Pages of your telephone directory for the Servicenter nearest you.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Co.

CHAPTER 12: SPARE PARTS LISTS

In This Section:

This section contains sample spare parts lists for Perfect Harmony drives. Within each section, the lists are arranged based on horsepower and part number. A base part number is given for each table. The part number for each associated spare parts kit is the base part number with the .SPK extension.

The spare parts listed in this appendix are for standard drives only. Parts lists for customized drives may vary

A6. Spare Parts list for 6600V drives

Table -1. Spare Parts List for 2700 Hp Drive without Cell Bypass Option (P/N: 459133.00)

Cabinet	Qty	Description	P/N
Cell	1	VFD Power Cell Without Bypass	460F60.04H
	1	Cell Control Board (CCB)	460J45.00
	1	KV Gate Drive Board (GDB)	460H85.00
	4	Fuse, 250A, 660V	086704
	4	Fuse, 5A, 700V	086701
	2	Power Module (DDA-DDE)	085725
	4	IGBT Module (Q1-Q4)	085726
	2	Capacitor 450V, 4700UF (C1A-C2G)	261369.00
Control and Blower	1	Interface Board (IB)	469564.04VT
	1	Micro Processor Board (MB)	469718.00VT
	1	System Module Board (SMB)	362877.01VT
	1	Fiber Optic Hub Board (FOHB)	460B80.00VT
	1	Master Link Board (MLB)	469147.04VT
	1	Keypad (KPD)	460A68.00T
	1	Digital Output Module	362871.00VT
	1	Analog Input Module	362153.03
	1	Analog Output Module	369174.00
	1	Digital Input Module	362872.02VT
	3	Fuse 3A, 500V	003878
	2	Fuse 7A, 250V	045651
	2	Fuse 1.6A, 250V	029707

12

12

Table -2. Spare Parts List for 3200 Hp Drive without Cell Bypass Option (P/N: 459137.00)

Cabinet	Qty	Description	P/N
Cell	1	VFD Power Cell Without Bypass	460F60.04H
	1	Cell Control Board (CCB)	460J45.00
	1	KV Gate Drive Board (GDB)	460H85.00
	4	Fuse, 250A, 660V	086704
	4	Fuse, 5A, 700V	086701
	2	Power Module (DDA-DDE)	085725
	4	IGBT Module (Q1-Q4)	085726
	2	Capacitor 450V, 4700UF (C1A-C2G)	261369.00
Control and Blower	1	Interface Board (IB)	469564.04VT
	1	Micro Processor Board (MB)	469718.00VT
	1	System Module Board (SMB)	362877.01VT
	1	Fiber Optic Hub Board (FOHB)	460B80.00VT
	1	Master Link Board (MLB)	469147.04VT
	1	Keypad (KPD)	460A68.00T
	1	Digital Output Module	362871.00VT
	1	Analog Output Module	369174.00
	1	Digital Input Module	362872.02VT
	2	Fuse 7A, 250V	045651
	2	Fuse 1.6A, 250V	029707

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CHAPTER 13: ENGINEERING DRAWINGS

459133 sht 1 SYSTEM OUTLINE
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 2 TRANSFORMER CABINET
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 3 CELL CABINET
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 4 CONTROL CABINET
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 5 SYSTEM POWER SCHEMATIC
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 6 POWER SCHEMATIC
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 7 CONTROL SCHEMATIC
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 8 POWER SCHEMATIC
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 9 CONTROL SCHEMATIC
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 10 CONTROL SCHEMATIC
2000KW SR11 DRIVE
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 11 SYSTEM OUTLINE
2000KW SR11,SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

459133 sht 12 CONTROL SCHEMATIC
2000KW SR12, SR13 DRIVES
6.6KV/6.6KV, 50Hz, SIZE4H

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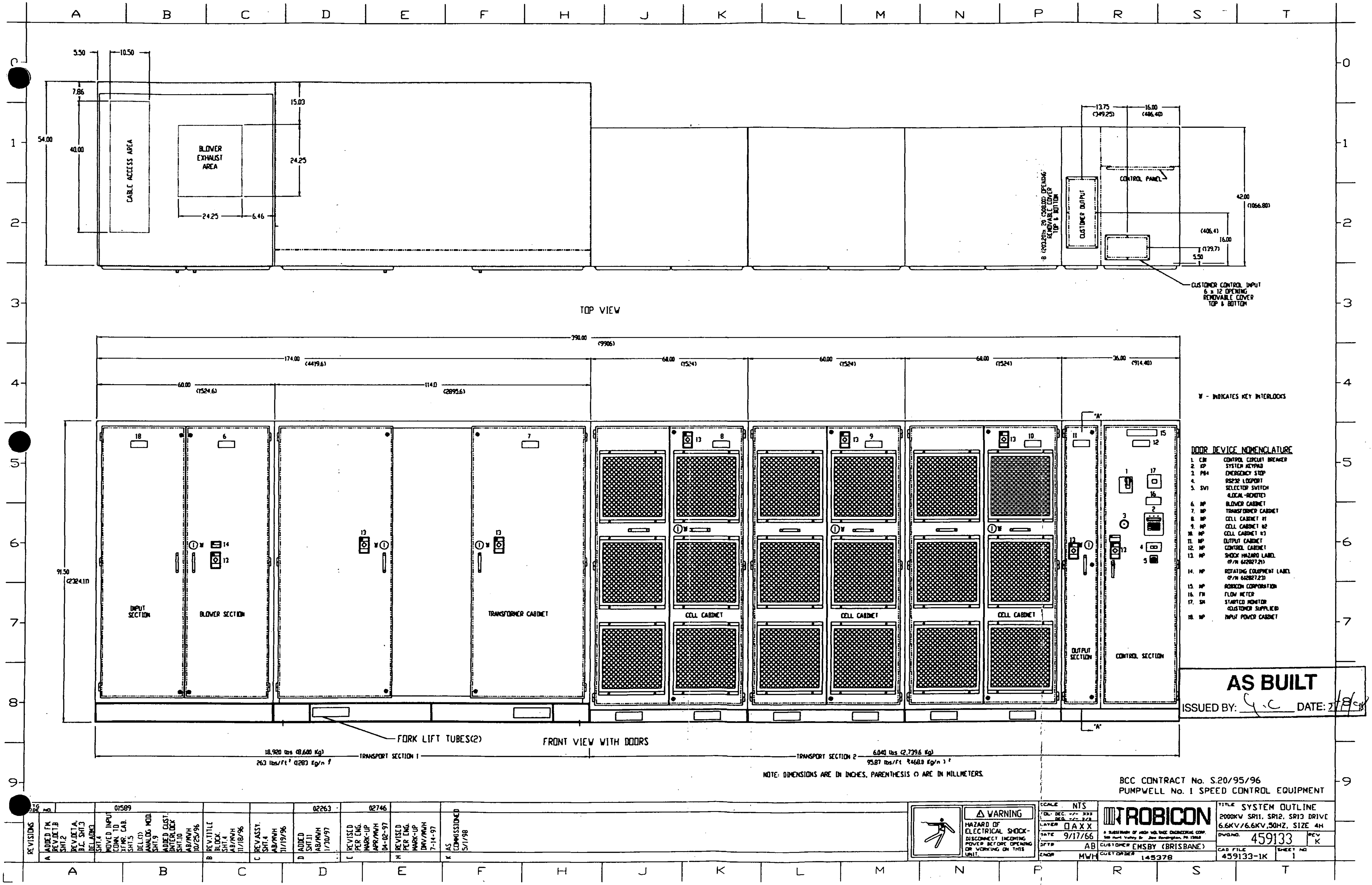
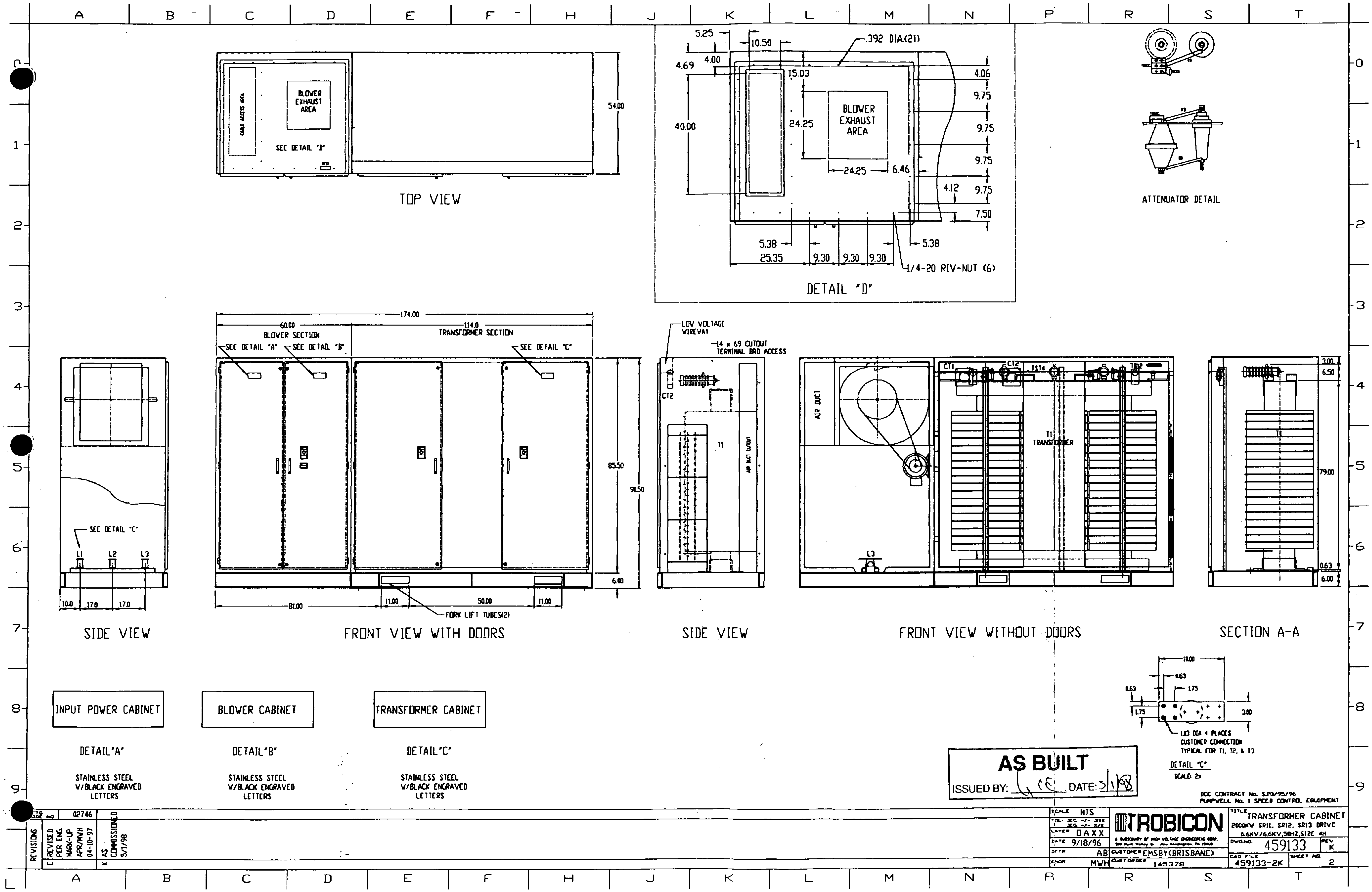
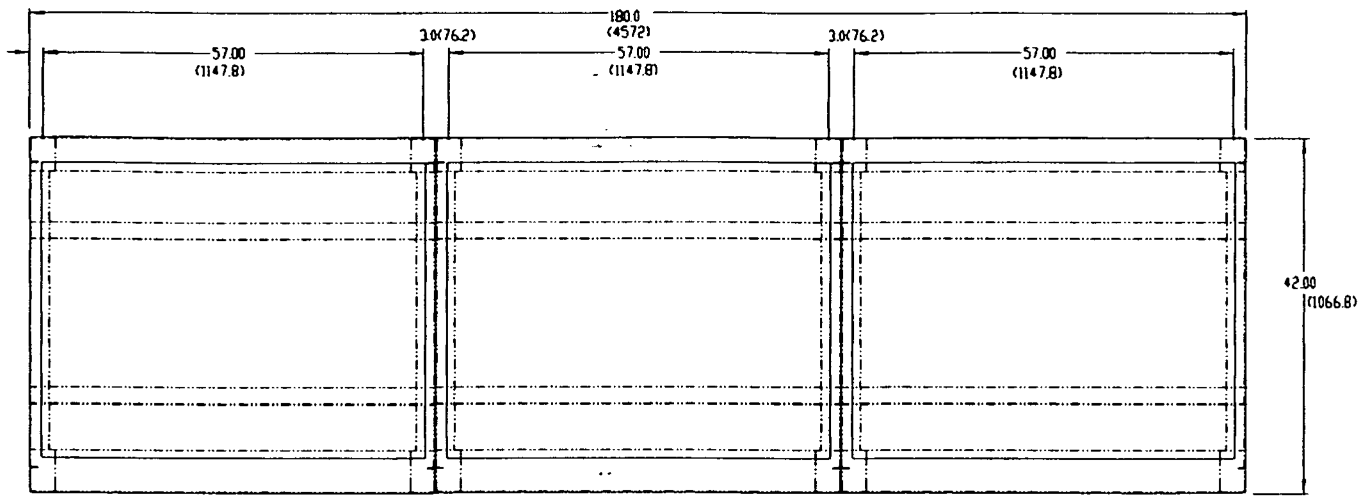
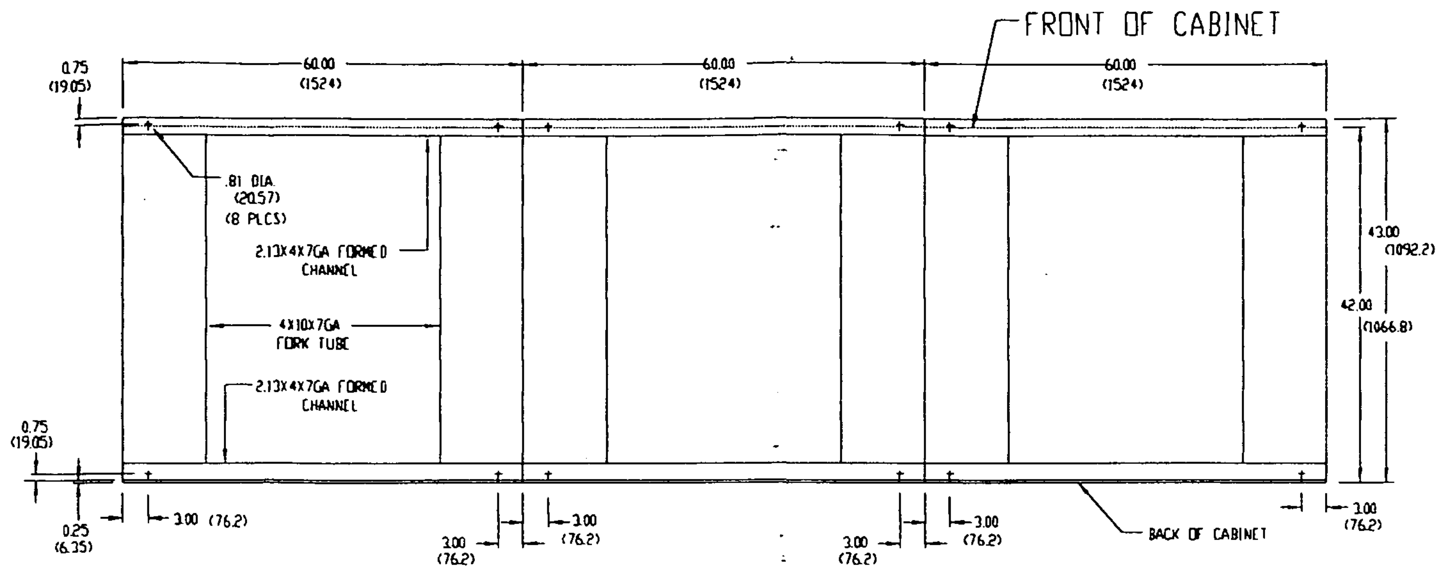


TOP VIEW
CABLE ACCESS AREA
BLOWER EXHAUST AREA
CUSTOMER OUTPUT
CONTROL PANEL
CUSTOMER CONTROL INPUT 6 x 12 OPENING REMOVABLE COVER TOP & BOTTOM
FRONT VIEW WITH DOORS
INPUT SECTION
BLOWER SECTION
TRANSFORMER CABINET
CELL CABINET
OUTPUT SECTION
CONTROL SECTION
FORK LIFT TUBES(2)
TRANSPORT SECTION 1
TRANSPORT SECTION 2
NOTE: DIMENSIONS ARE IN INCHES, PARENTHESIS () ARE IN MILLIMETERS.
- INDICATES KEY INTERLOCKS
DOOR DEVICE NOMENCLATURE
1. CB CONTROL CIRCUIT BREAKER
2. KP SYSTEM KEYPAD
3. PB4 EMERGENCY STOP
4. RS232 LOGPORT
5. SW1 SELECTOR SWITCH (LOCAL-REMOTE)
6. NP BLOWER CABINET
7. NP TRANSFORMER CABINET
8. NP CELL CABINET #1
9. NP CELL CABINET #2
10. NP CELL CABINET #3
11. NP OUTPUT CABINET
12. NP CONTROL CABINET
13. NP SHOCK HAZARD LABEL (P/N 612827.21)
14. NP ROTATING EQUIPMENT LABEL (P/N 612827.23)
15. NP ROBICON CORPORATION
16. FM FLOW METER
17. SM STARTCO MONITOR (CUSTOMER SUPPLIED)
18. NP INPUT POWER CABINET
AS BUILT
ISSUED BY:
DATE:
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
WARNING
HAZARD OF ELECTRICAL SHOCK-
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE NTS
LAYER DAXX
DATE 9/17/66
DFTR AB
ENGR MWH
ROBICON
CUSTOMER EMSBY (BRISBANE)
CUST ORDER 145378
TITLE SYSTEM OUTLINE
2000KV SR11, SR12, SR13 DRIVE
6.6KV/6.6KV,50HZ, SIZE 4H
DWG NO. 459133
REV K
CAD FILE 459133-1K
SHEET NO 1

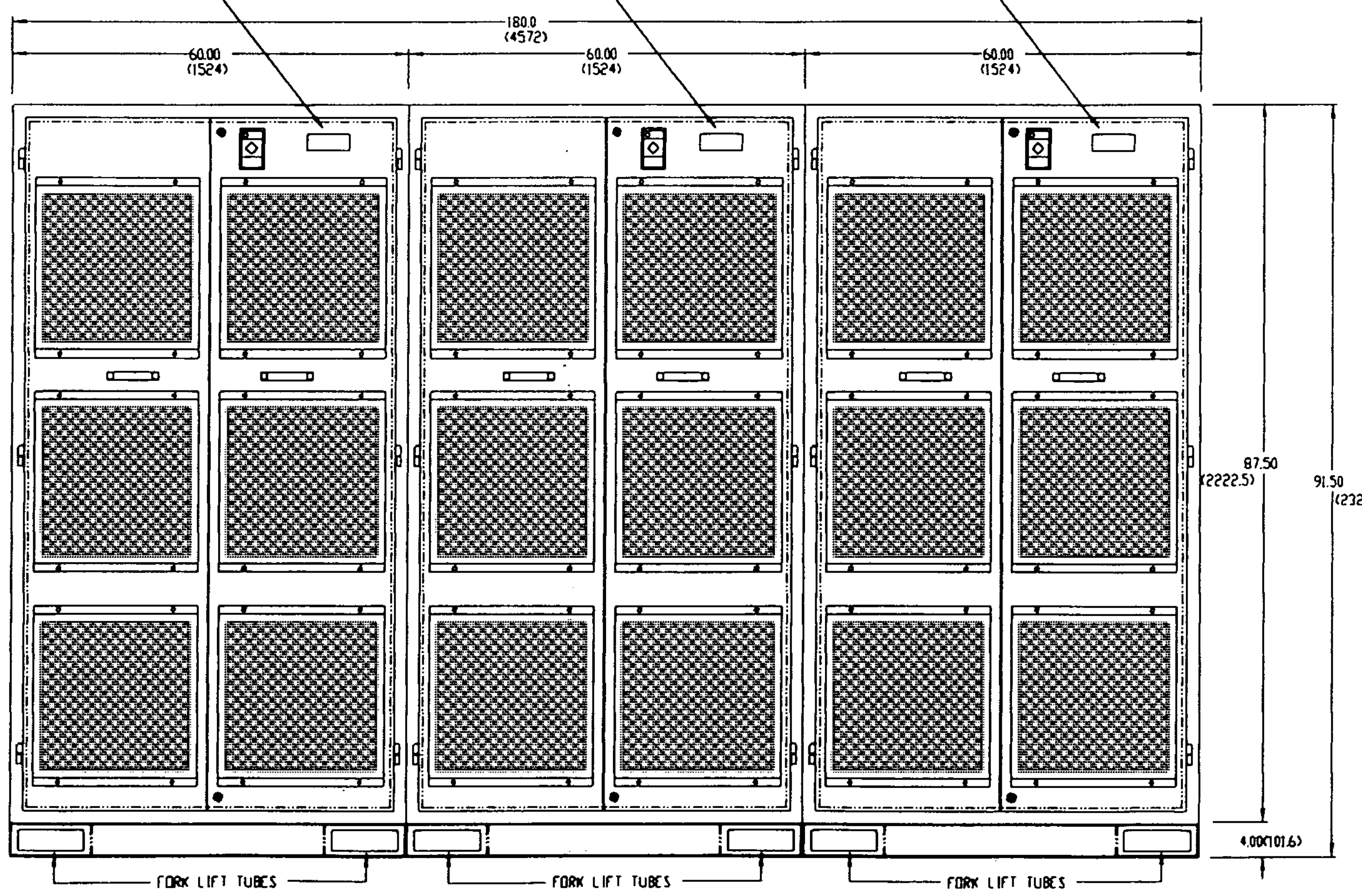

TOP VIEW
BLOWER EXHAUST AREA
SEE DETAIL "D"
54.00
DETAIL "D"
5.25
10.50
.392 DIA(21)
4.69
4.00
15.03
40.00
24.25
24.25
6.46
4.06
9.75
9.75
9.75
4.12
9.75
7.50
5.38
25.35
9.30
9.30
9.30
5.38
1/4-20 RIV-NUT (6)
ATTENUATOR DETAIL
174.00
60.00
BLOWER SECTION
114.0
TRANSFORMER SECTION
SEE DETAIL "A"
SEE DETAIL "B"
SEE DETAIL "C"
85.50
91.50
6.00
81.00
11.00
50.00
11.00
FORK LIFT TUBES(2)
SIDE VIEW
SEE DETAIL "C"
L1
L2
L3
10.0
17.0
17.0
FRONT VIEW WITH DOORS
LOW VOLTAGE WIREWAY
14 x 69 CUTOUT TERMINAL BRD ACCESS
CT2
T1
SIDE VIEW
AIR DUCT
CT1
CT2
TST4
T1 TRANSFORMER
L3
FRONT VIEW WITHOUT DOORS
6.50
79.00
0.63
6.00
SECTION A-A
INPUT POWER CABINET
DETAIL "A"
STAINLESS STEEL W/BLACK ENGRAVED LETTERS
BLOWER CABINET
DETAIL "B"
STAINLESS STEEL W/BLACK ENGRAVED LETTERS
TRANSFORMER CABINET
DETAIL "C"
STAINLESS STEEL W/BLACK ENGRAVED LETTERS
18.00
0.63
1.75
0.63
1.75
3.00
1.13 DIA 4 PLACES CUSTOMER CONNECTION TYPICAL FOR T1, T2, & T3
DETAIL "C"
SCALE: 2x
AS BUILT
ISSUED BY:
DATE: 5/1/98
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
J REVISED PER ENG. MARK-UP APR/MWH 04-10-97
K AS COMMISSIONED 5/1/98
SCALE NTS
LAYER DAXX
DATE 9/18/96
DFTR AB
ENGR MWH
ROBICON
CUSTOMER EMSBY(BRISBANE)
CUST ORDER 145378
TITLE TRANSFORMER CABINET
2000KV SR11, SR12, SR13 DRIVE
6.6KV/6.6KV,50HZ,SIZE 4H
DWG.NO. 459133
REV K
CAD FILE 459133-2K
SHEET NO. 2



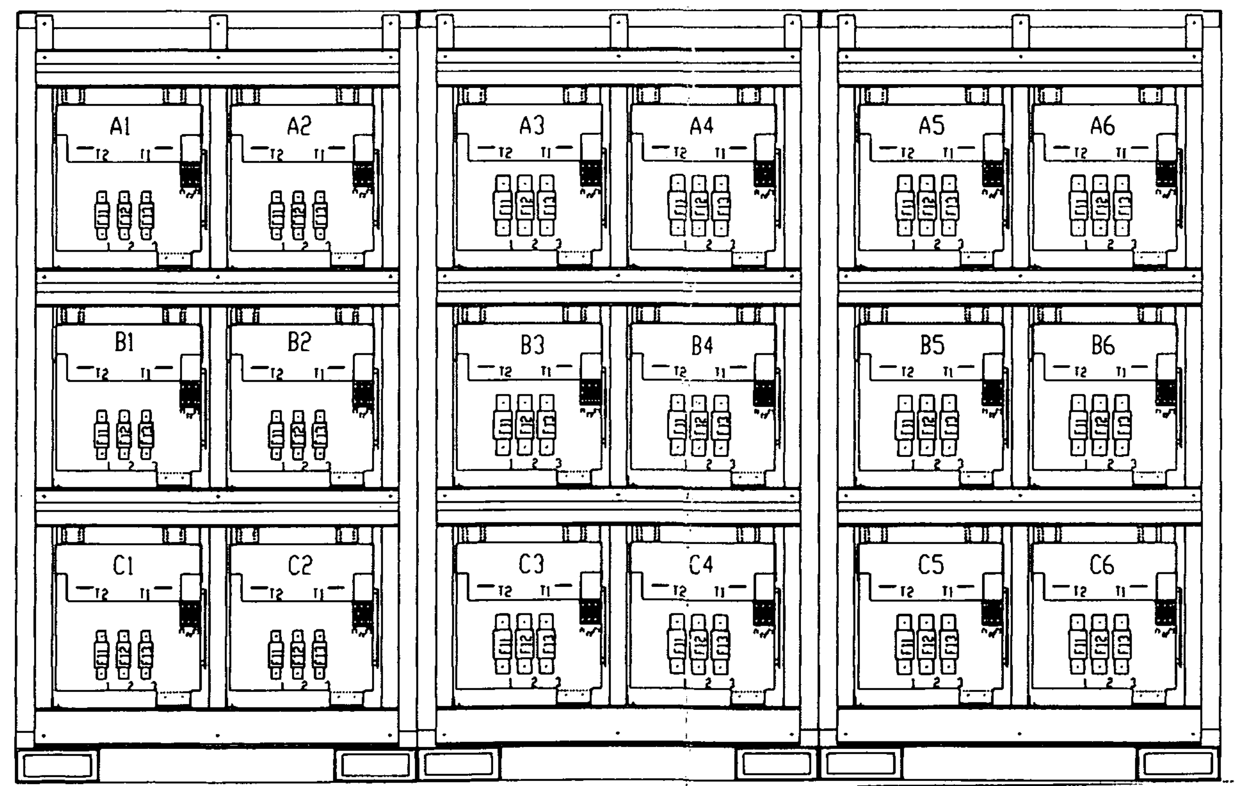
TOP VIEW



BOTTOM VIEW



FRONT VIEW



FRONT VIEW
(WITH DOORS REMOVED)

STAINLESS STEEL W/BLACK ENGRAVED LETTERS

CELL CABINET #1	CELL CABINET #2	CELL CABINET #3
DETAIL "A"	DETAIL "B"	DETAIL "C"

NOTE: DIMENSIONS ARE IN INCHES. PARENTHESES ( ) ARE IN MILLIMETERS.

AS BUILT
ISSUED BY: C.C. DATE: 5/1/98

BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS		
ECO NO	02746	
L	REVISED PER ENG. MARK-UP APR/MWH 04-03-97	
K	AS COMMISSIONED 5/1/98	

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK - DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

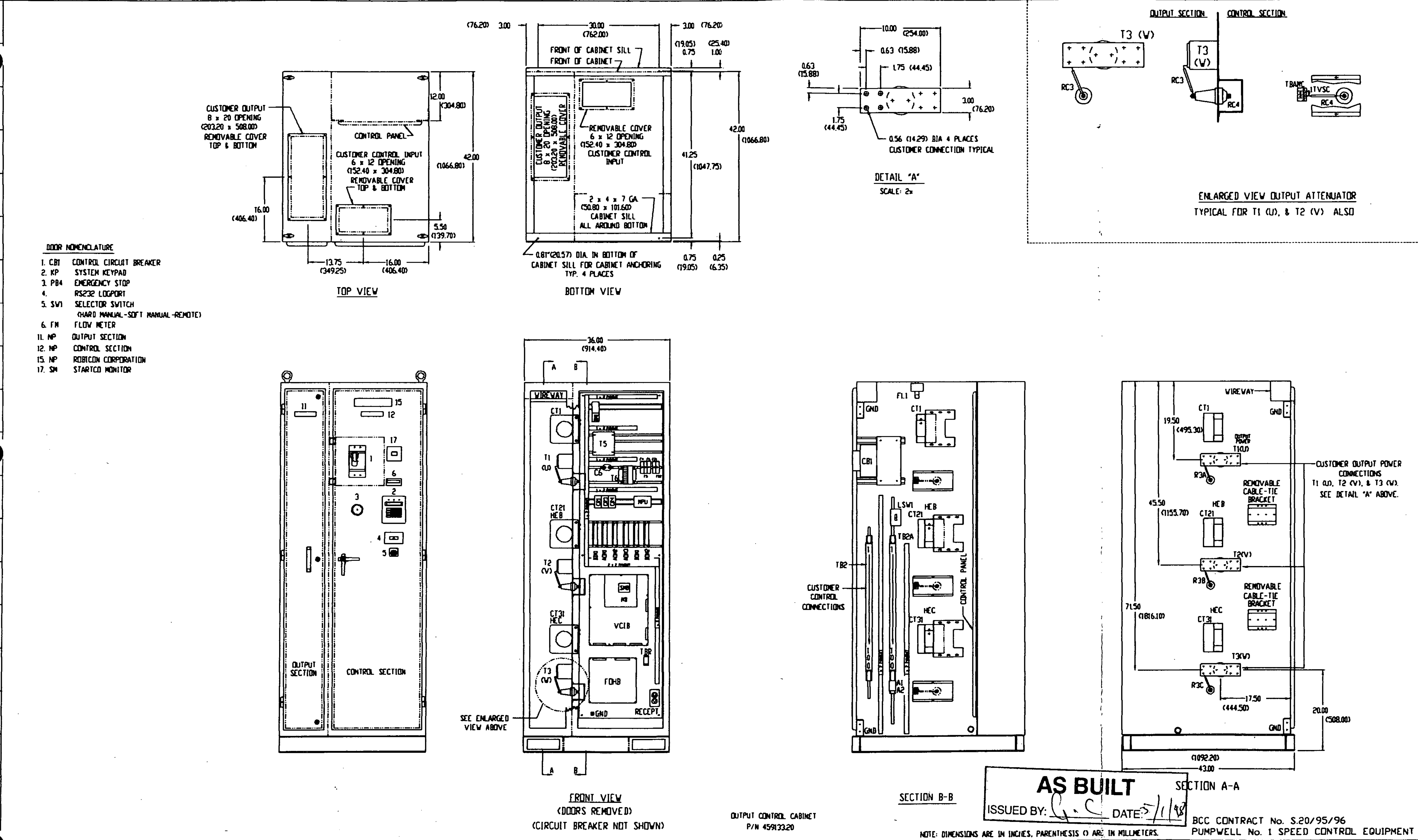
SCALE	3/32"=1"
TOL	
LAYER	0XXX
DATE	9/18/96
DFTR	AB
ENGR	MWH

ROBICON
A SUBSIDIARY OF HIGH VOLTAGE ENGINEERING CORP.

CUSTOMER: EMSBY (BRISBANE)
CUST ORDER: 145378

TITLE: CELL CABINET
2000KW SR11, SR12, SR13 DRIVE
6.6KV/6.6KV, 50HZ, SIZE 4H

DWG NO. 459133 REV K
CAD FILE 459133-3K SHEET NO 3



AS BUILT
ISSUED BY: G.C DATE: 5/1/98

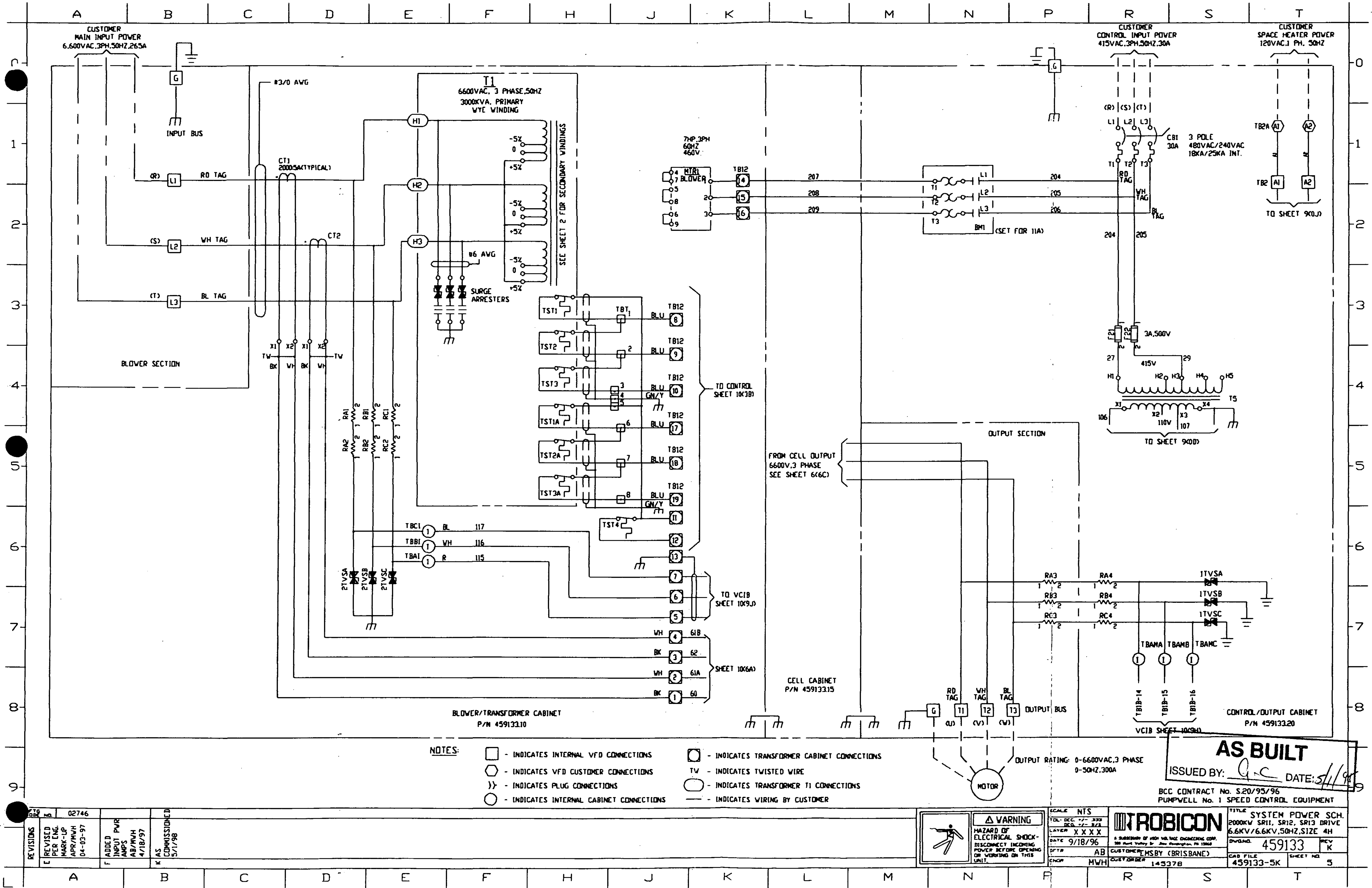
OUTPUT CONTROL CABINET
P/N 459133.20

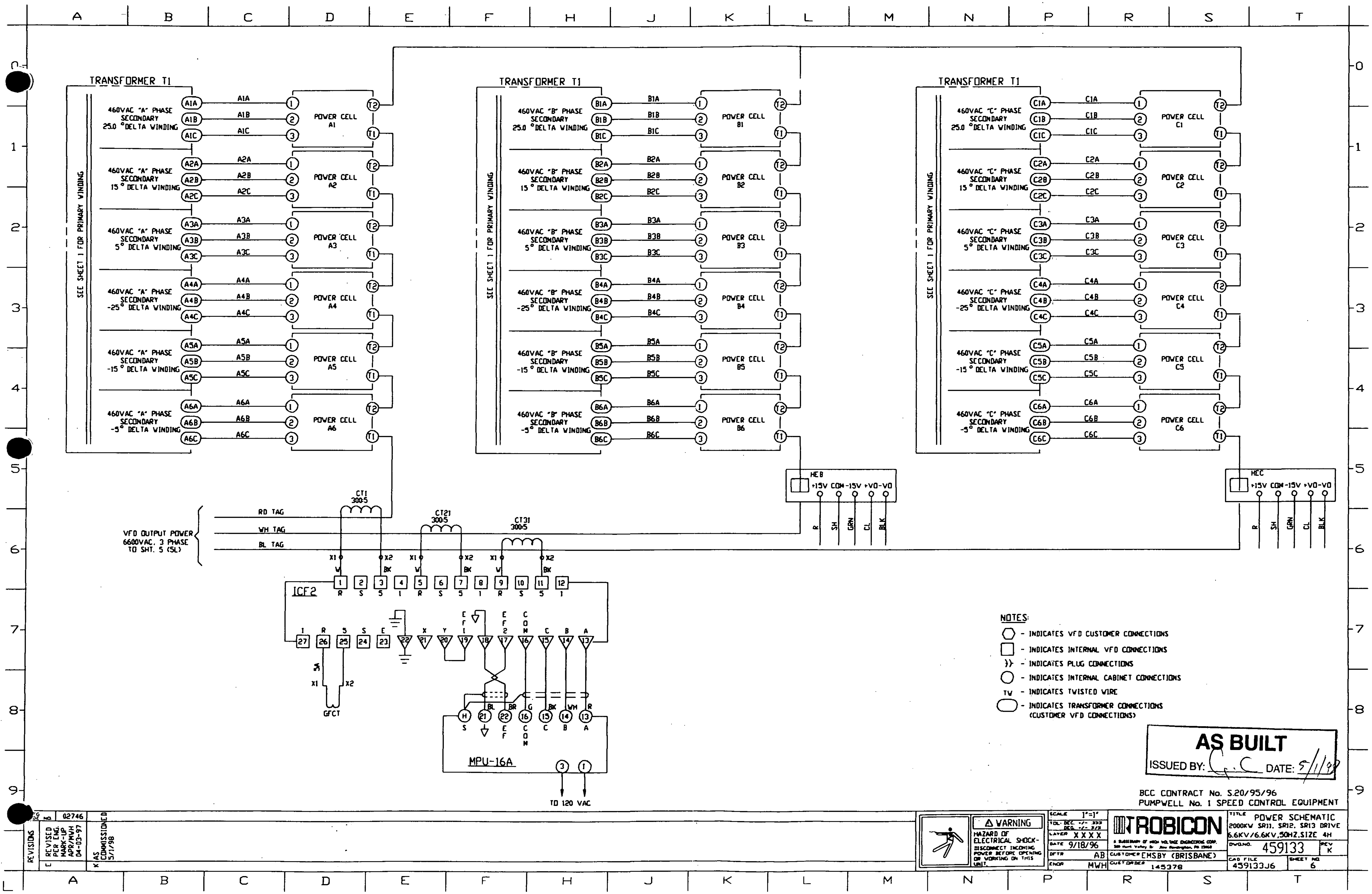
NOTE: DIMENSIONS ARE IN INCHES, PARENTHESIS () ARE IN MILLIMETERS.

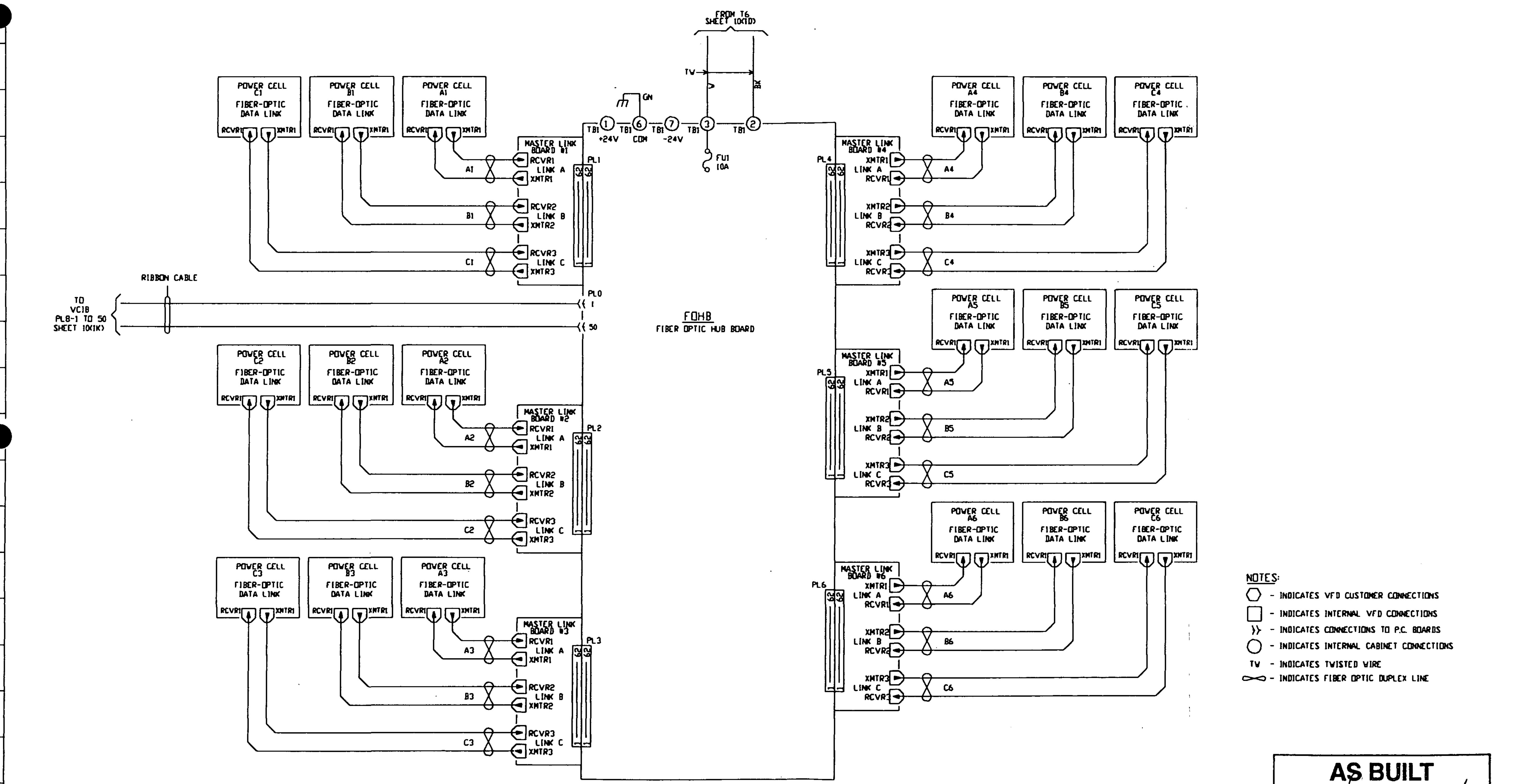
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS	J: REVISED PER ENG. MARK-UP APR/MWH 04-03-97; K: AS COMMISSIONED 5/1/98
⚠ WARNING	HAZARD OF ELECTRICAL SHOCK - DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE	3/32"=1'
LAYER	0AXX
DATE	9/18/96
DFTR	AB
ENGR	MWH
CUSTOMER	EMSBY (BRISBANE)
CUST ORDER	145378
TITLE	CONTROL CABINET 2000KW SR11, SR12, SR13 DRIVE 6.6KV/6.6KV,50HZ,SIZE 4H
DWG NO.	459133
REV	K
CAD FILE	459133-4K
SHEET NO	4

ROBICON


CUSTOMER MAIN INPUT POWER 6,600VAC,3PH,50HZ,265A
INPUT BUS
#3/0 AWG
T1
6600VAC, 3 PHASE,50HZ
3000KVA, PRIMARY
WYE WINDING
SEE SHEET 2 FOR SECONDARY WINDINGS
CT1 2000:5A(TYPICAL)
CT2
RD TAG
WH TAG
BL TAG
#6 AWG
SURGE ARRESTERS
BLOWER SECTION
7HP,3PH 60HZ 460V
MTR1 BLOWER
TO CONTROL SHEET 10(3B)
TO VCIB SHEET 10(9J)
SHEET 10(6A)
BLOWER/TRANSFORMER CABINET
P/N 459133.10
CELL CABINET
P/N 459133.15
FROM CELL OUTPUT 6600V,3 PHASE SEE SHEET 6(6C)
OUTPUT SECTION
(SET FOR 11A)
CUSTOMER CONTROL INPUT POWER 415VAC,3PH,50HZ,30A
CB1 30A 3 POLE 480VAC/240VAC 18KA/25KA INT.
3A,500V
415V
110V
TO SHEET 9(0D)
CUSTOMER SPACE HEATER POWER 120VAC,1 PH, 50HZ
TO SHEET 9(0J)
OUTPUT BUS
MOTOR
OUTPUT RATING: 0-6600VAC,3 PHASE 0-50HZ,300A
VCIB SHEET 10(9H)
CONTROL/OUTPUT CABINET
P/N 459133.20
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES PLUG CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
- INDICATES TRANSFORMER CABINET CONNECTIONS
TV - INDICATES TWISTED WIRE
- INDICATES TRANSFORMER T1 CONNECTIONS
- INDICATES WIRING BY CUSTOMER
AS BUILT
ISSUED BY:
DATE:
BCC CONTRACT No. S20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
E REVISED PER ENG. MARK-UP APR/MWH 04-03-97
F ADDED INPUT PWR AMPS AB/MWH 4/18/97
K AS COMMISSIONED 5/1/98
WARNING
HAZARD OF ELECTRICAL SHOCK- DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE NTS
DATE 9/18/96
DFTR AB
ENGR MWH
ROBICON
CUSTOMER EMSBY (BRISBANE)
CUST ORDER 145378
TITLE SYSTEM POWER SCH. 2000KW SR11, SR12, SR13 DRIVE 6.6KV/6.6KV,50HZ,SIZE 4H
DWG NO. 459133
REV K
CAD FILE 459133-5K
SHEET NO. 5


TRANSFORMER T1
460VAC "A" PHASE SECONDARY 25.0 °DELTA WINDING
POWER CELL A1
POWER CELL A2
POWER CELL A3
POWER CELL A4
POWER CELL A5
POWER CELL A6
POWER CELL B1
POWER CELL C1
SEE SHEET 1 FOR PRIMARY WINDING
VFD OUTPUT POWER 6600VAC, 3 PHASE TO SHT. 5 (5L)
RD TAG
WH TAG
BL TAG
CT1 300:5
CT21 300:5
CT31 300:5
ICF2
GFCT
MPU-16A
TO 120 VAC
HEB
HEC
+15V COM -15V +VO -VO
NOTES:
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES PLUG CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES TRANSFORMER CONNECTIONS (CUSTOMER VFD CONNECTIONS)
AS BUILT
ISSUED BY:
DATE:
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
REVISED PER ENG. MARK-UP APR/MWH 04-03-97
AS COMMISSIONED 5/1/98
02746
WARNING
HAZARD OF ELECTRICAL SHOCK-DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
ROBICON
POWER SCHEMATIC
2000KW SR11, SR12, SR13 DRIVE 6.6KV/6.6KV,50HZ,SIZE 4H
DWG NO. 459133
REV K
DATE 9/18/96
DFTR AB
ENGR MWH
CUSTOMER EMSBY (BRISBANE)
CUST ORDER 145378
CAD FILE 459133J6
SHEET NO 6



AS BUILT

ISSUED BY: DATE: 5/1/98

BCC CONTRACT No. S.20/95/96

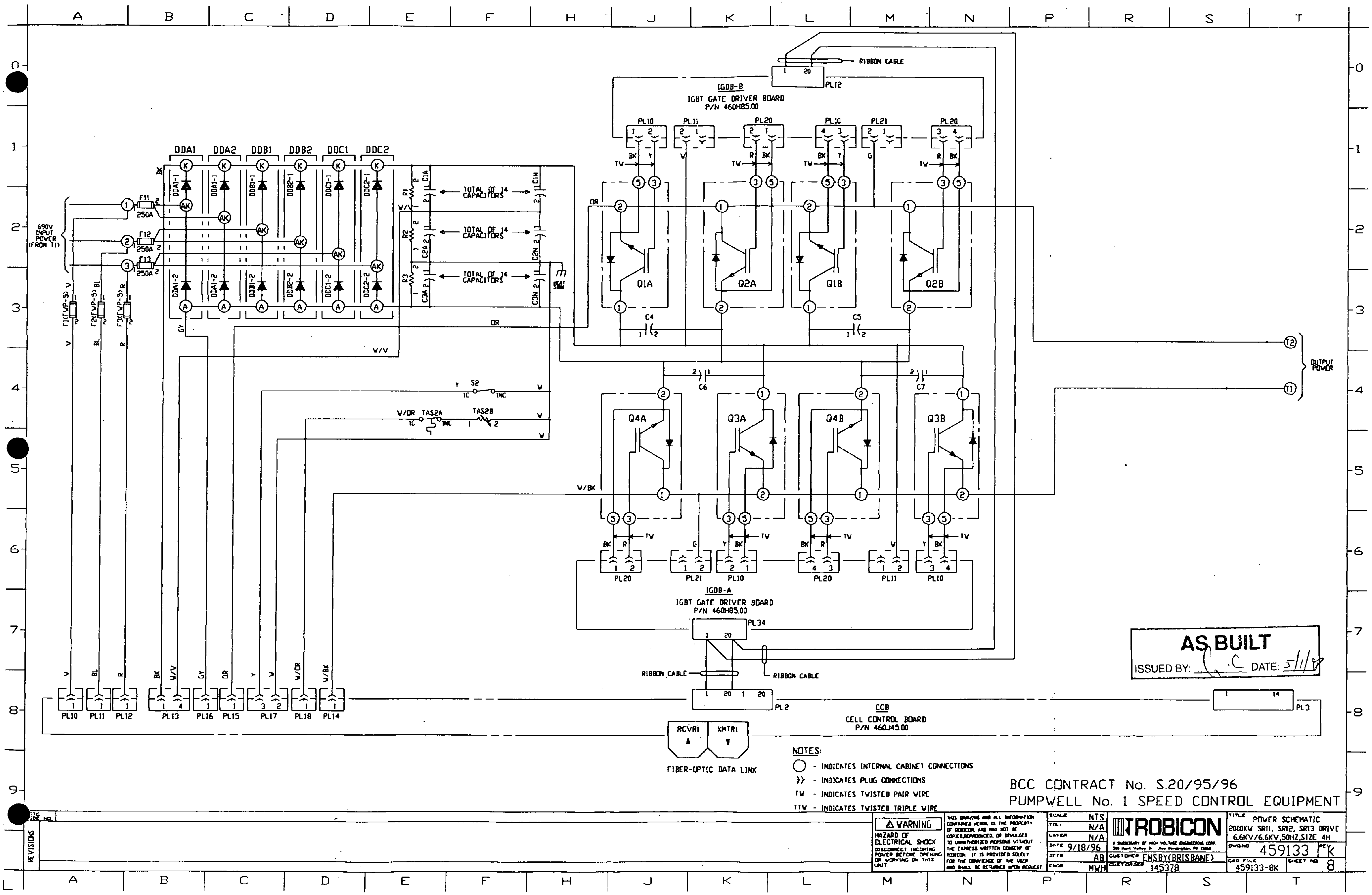
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS	02746
L	REVISED PER ENG. MARK-UP APR/MWH 04-04-97
K	AS COMMISSIONED 5/1/98

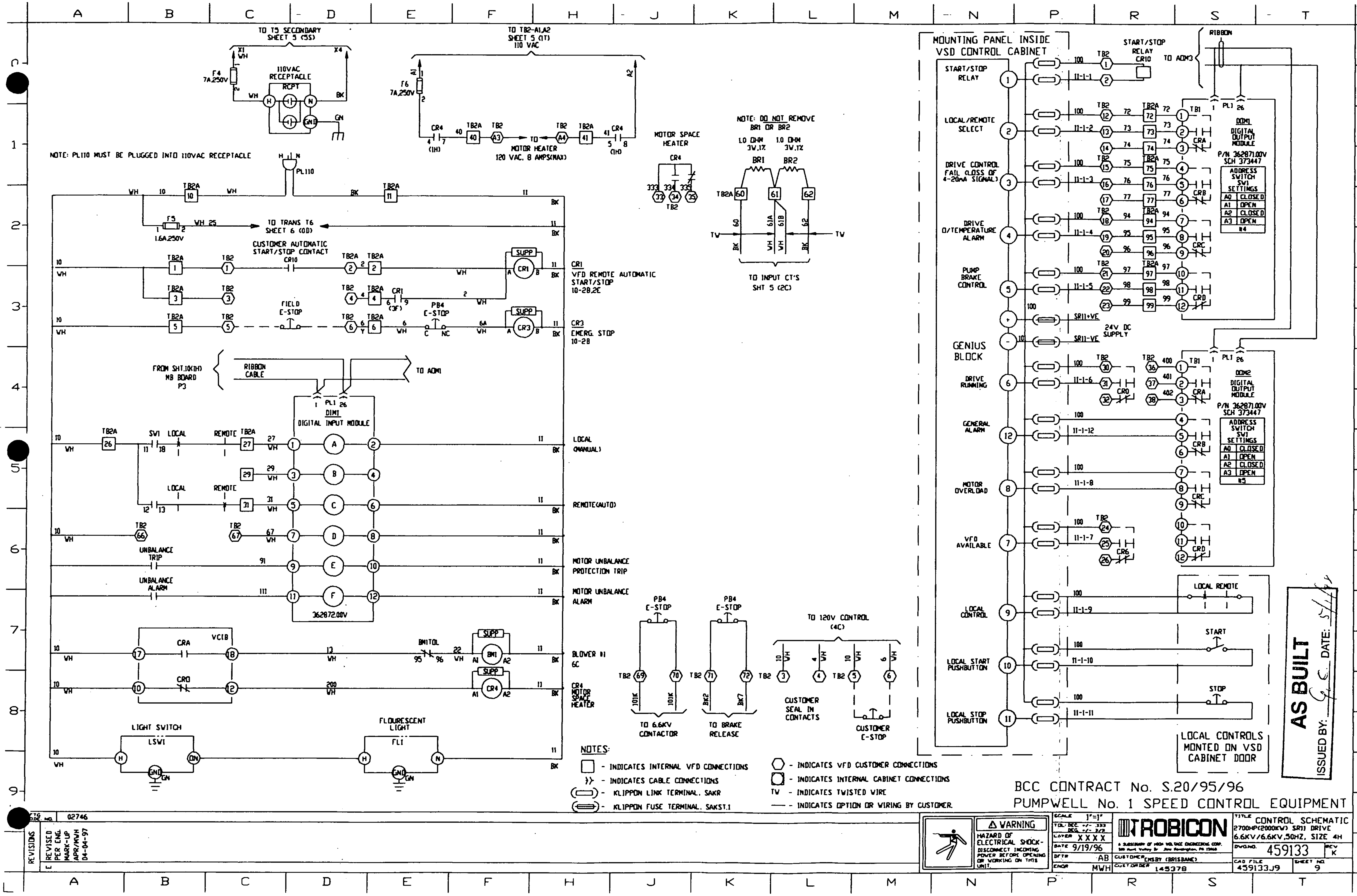
⚠ WARNING
HAZARD OF ELECTRICAL SHOCK - DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

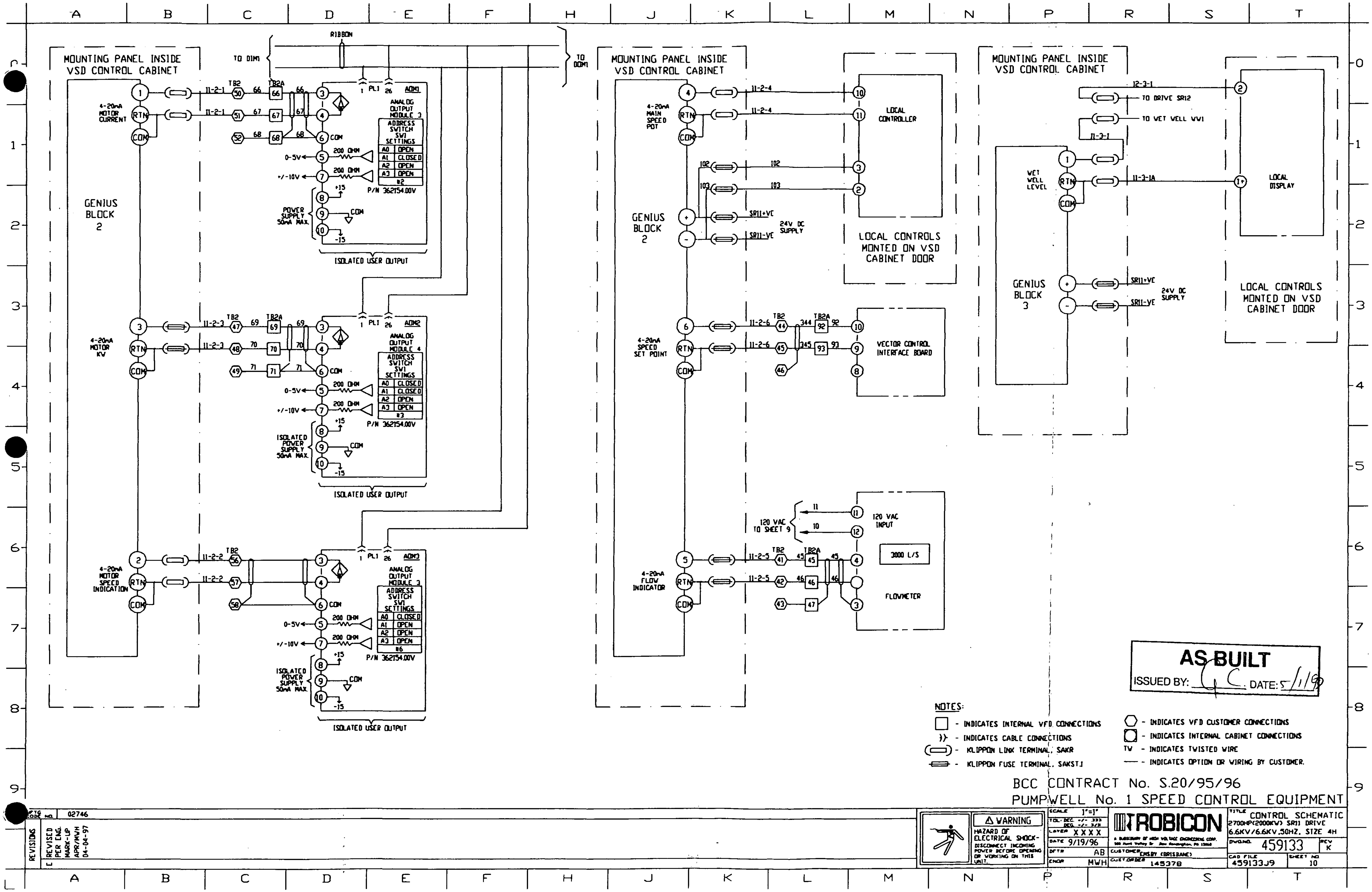
SCALE	1"=1"
LAYER	XXXX
DATE	9/18/96
DFTR	AB
ENGR	MWH
CUSTOMER	CNSBT (BRISBANE)
CUST ORDER	145378
TITLE	CONTROL SCHEMATIC 2000KW SR11, SR12, SR13 DRIVE 6.6KV/6.6KV, 50HZ, SIZE 4H
DWG NO.	459133
REV	K
CAD FILE	45913-7K
SHEET NO	7

ROBICON

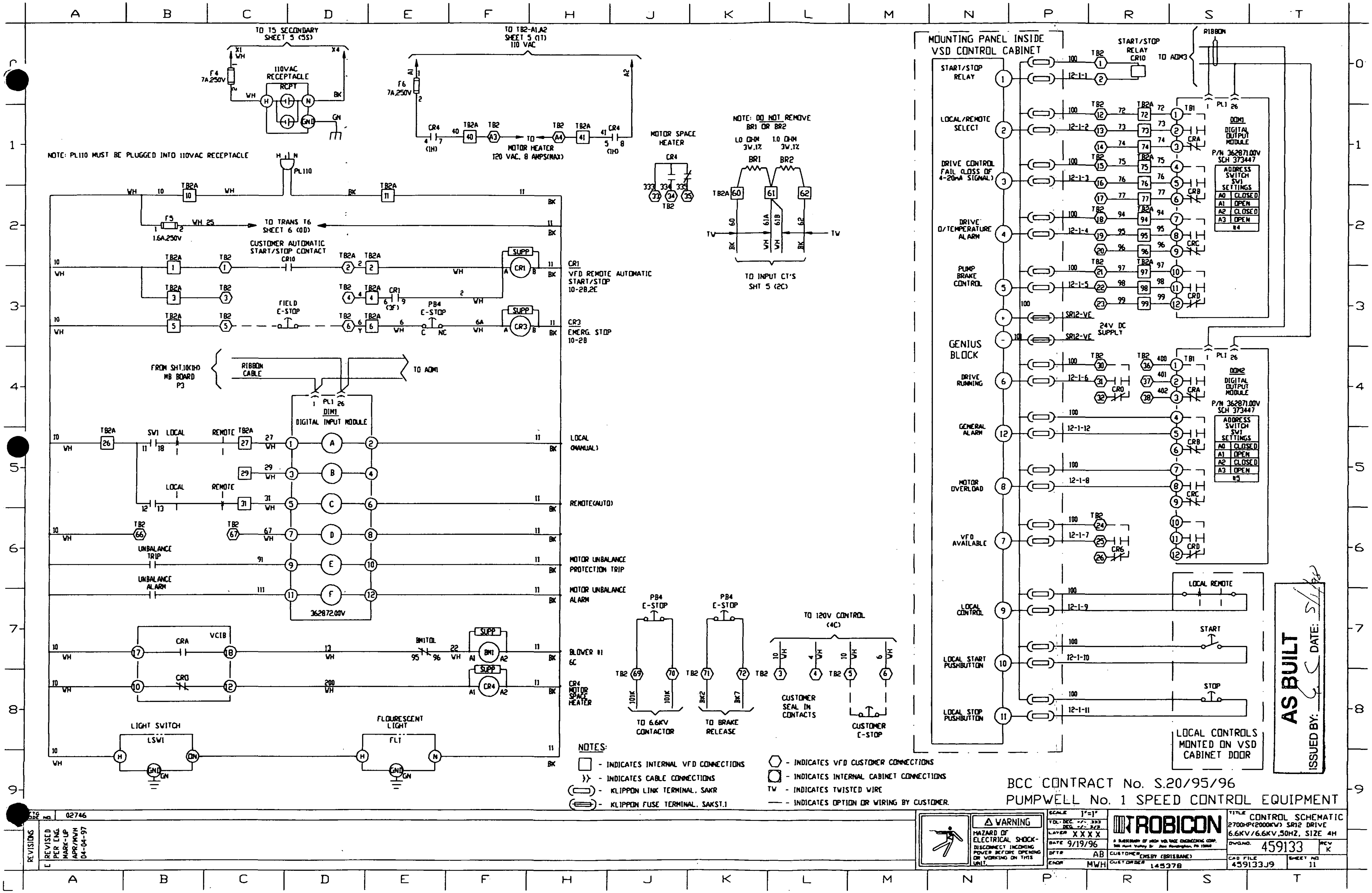


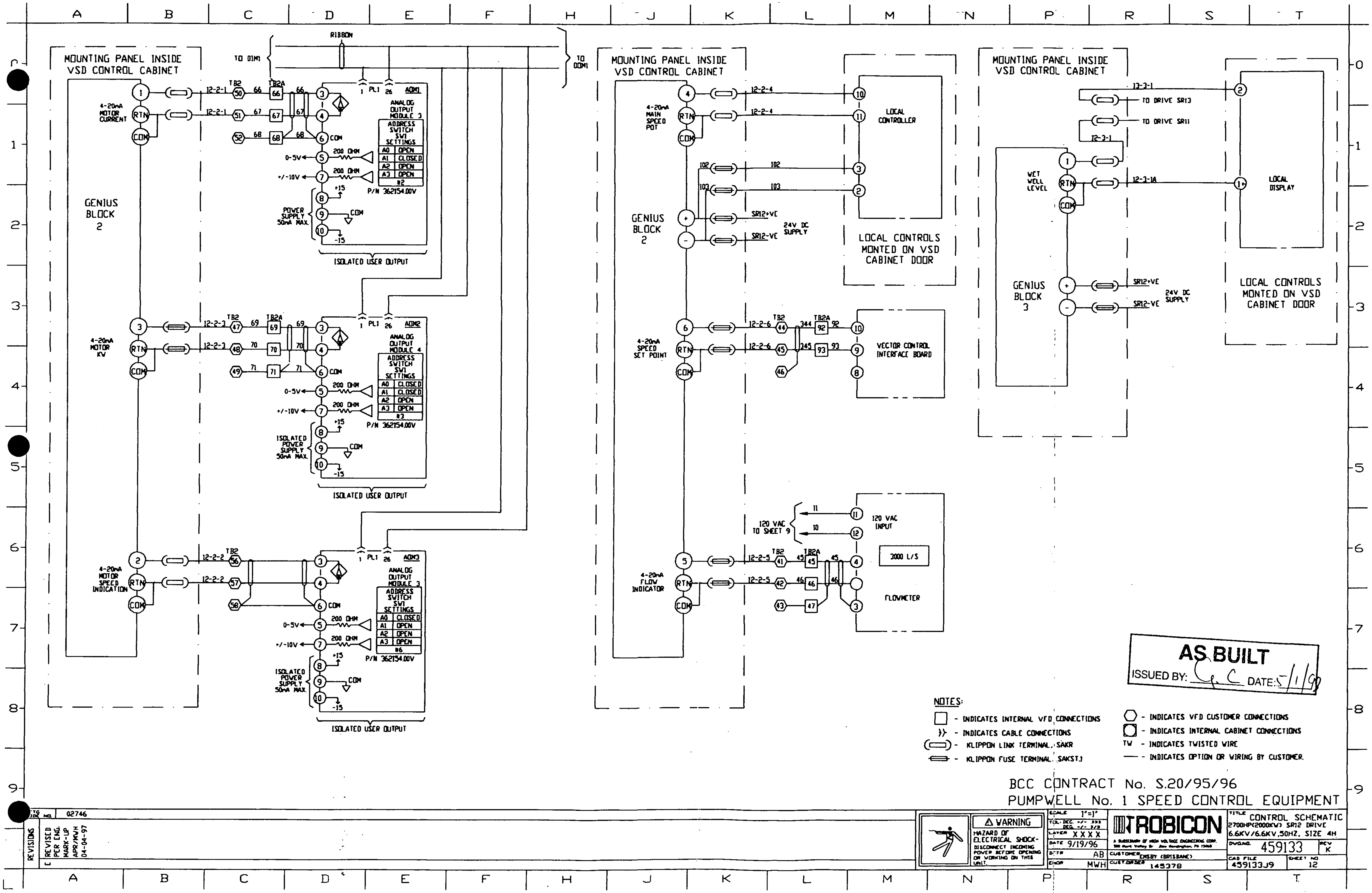
IGDB-B
IGBT GATE DRIVER BOARD
P/N 460H85.00
RIBBON CABLE
PL12
DDA1 DDA2 DDB1 DDB2 DDC1 DDC2
690V INPUT POWER (FROM T1)
F11 250A
F12 250A
F13 250A
TOTAL OF 14 CAPACITORS
Q1A Q2A Q1B Q2B
Q4A Q3A Q4B Q3B
C4 C5 C6 C7
OUTPUT POWER
T1 T2
S2
TAS2A TAS2B
IGDB-A
IGBT GATE DRIVER BOARD
P/N 460H85.00
PL34
RIBBON CABLE
PL10 PL11 PL12 PL13 PL16 PL15 PL17 PL18 PL14
PL2 PL3
CCB
CELL CONTROL BOARD
P/N 460J45.00
RCVR1 XMTR1
FIBER-OPTIC DATA LINK
NOTES:
◯ - INDICATES INTERNAL CABINET CONNECTIONS
>> - INDICATES PLUG CONNECTIONS
TW - INDICATES TWISTED PAIR WIRE
TTW - INDICATES TWISTED TRIPLE WIRE
AS BUILT
ISSUED BY: DATE:
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE NTS
TOL N/A
LAYER N/A
DATE 9/18/96
DFTR AB
ENGR MWH
ROBICON
CUSTOMER EMSBY(BRISBANE)
CUST ORDER 145378
TITLE POWER SCHEMATIC
2000KW SR11, SR12, SR13 DRIVE
6.6KV/6.6KV,50HZ,SIZE 4H
DWG NO. 459133
REV K
CAD FILE 459133-8K
SHEET NO. 8

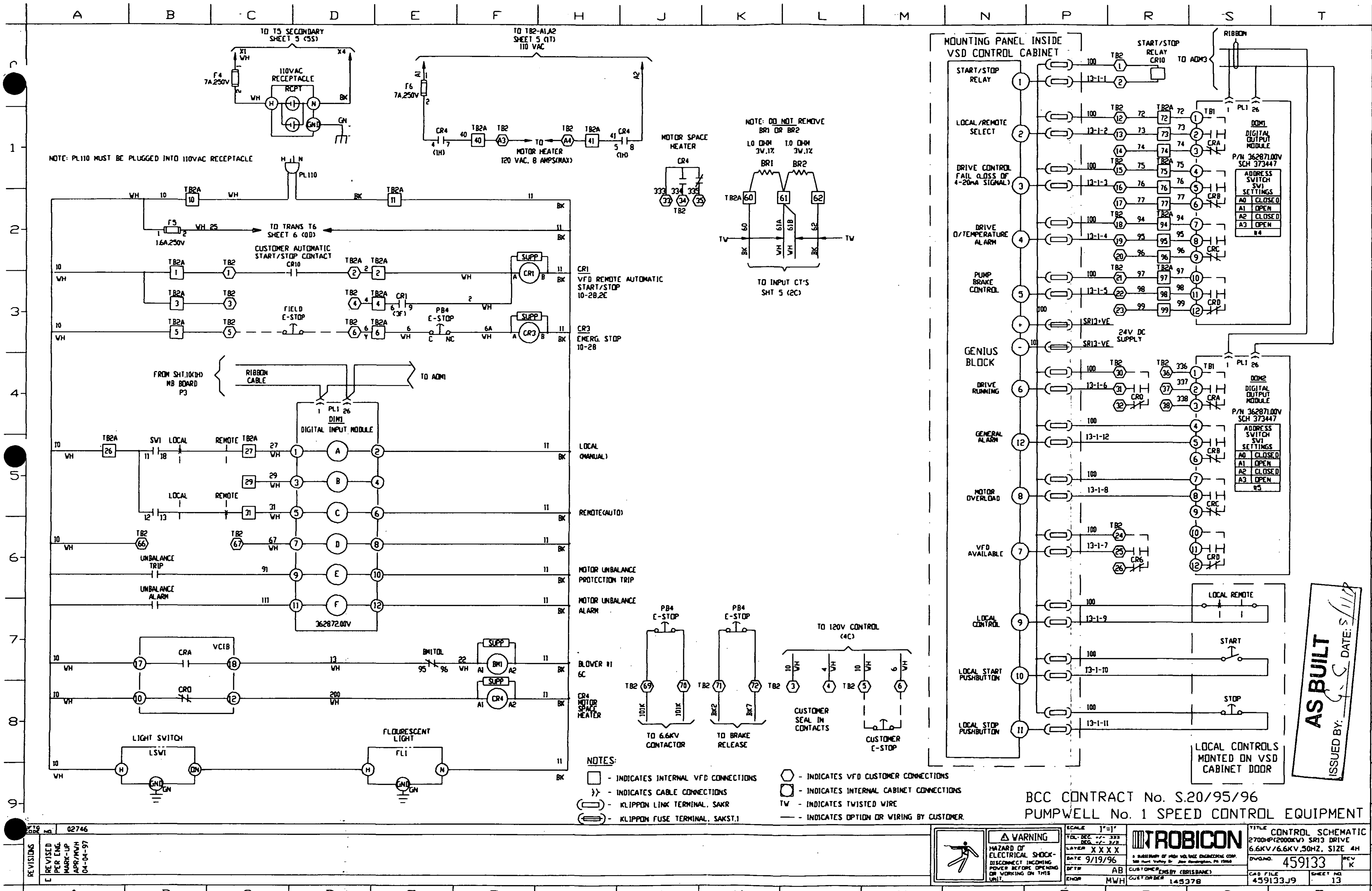

MOUNTING PANEL INSIDE VSD CONTROL CABINET
GENIUS BLOCK
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL. SAKR
- KLIPPON FUSE TERMINAL. SAKST.1
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
AS BUILT
ROBICON
CONTROL SCHEMATIC
2700HP(2000KW) SRII DRIVE
6.6KV/6.6KV,50HZ, SIZE 4H
459133
9/19/96
CUSTOMER EMSBY (BRISBANE)
WARNING
HAZARD OF ELECTRICAL SHOCK-



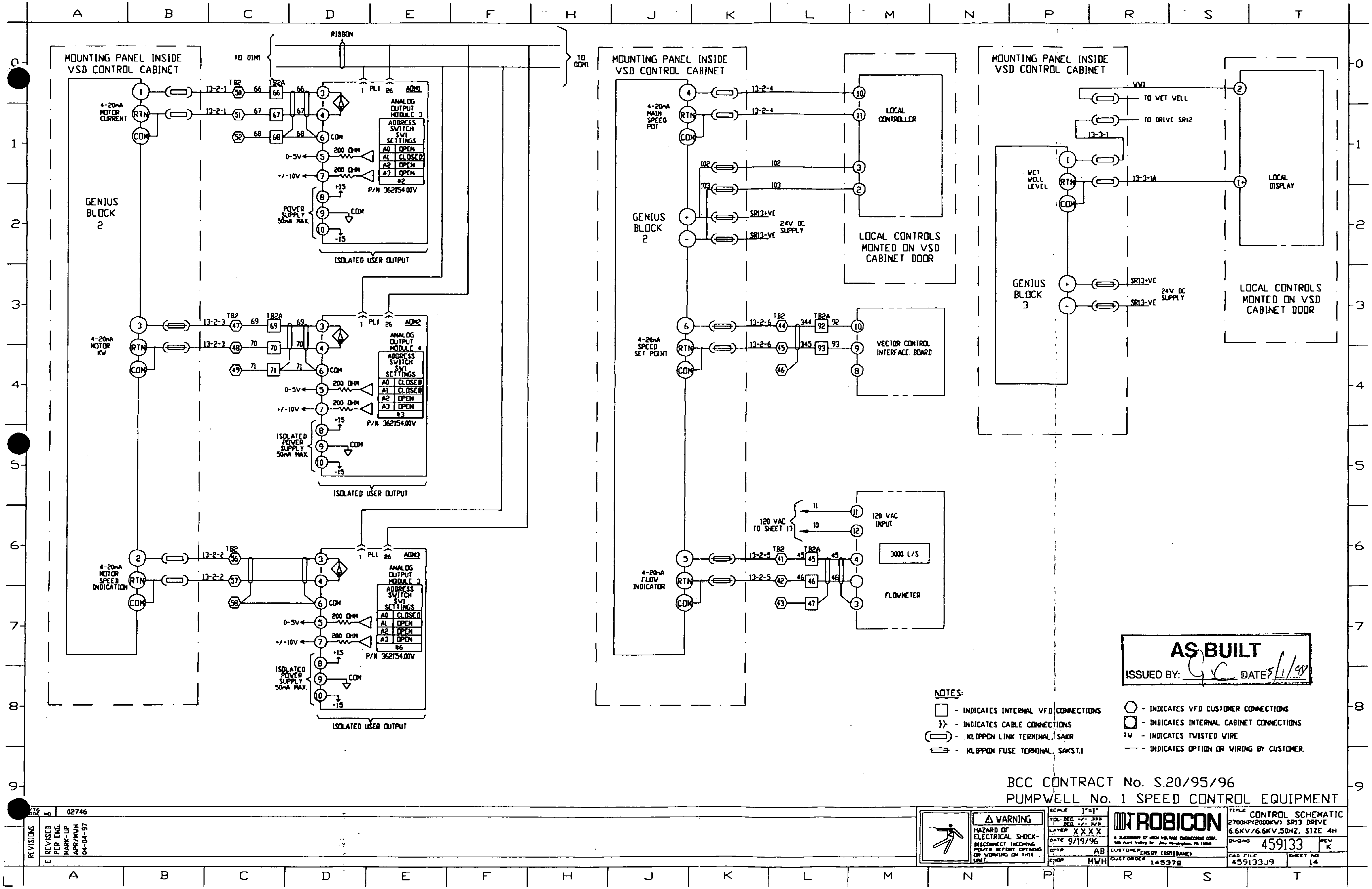
MOUNTING PANEL INSIDE VSD CONTROL CABINET
GENIUS BLOCK 2
GENIUS BLOCK 3
RIBBON
TO DIM
TO DOM
4-20mA MOTOR CURRENT
4-20mA MOTOR KV
4-20mA MOTOR SPEED INDICATION
ANALOG OUTPUT MODULE 3
ANALOG OUTPUT MODULE 4
ADDRESS SWITCH SW1 SETTINGS
P/N 362154.00V
POWER SUPPLY 50mA MAX
ISOLATED POWER SUPPLY 50mA MAX
ISOLATED USER OUTPUT
4-20mA MAIN SPEED POT
LOCAL CONTROLLER
24V DC SUPPLY
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
4-20mA SPEED SET POINT
VECTOR CONTROL INTERFACE BOARD
120 VAC TO SHEET 9
120 VAC INPUT
3000 L/S
4-20mA FLOW INDICATOR
FLOWMETER
TO DRIVE SR12
TO WET WELL WW1
WET WELL LEVEL
LOCAL DISPLAY
AS BUILT
ISSUED BY:
DATE:
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL, SAKR
- KLIPPON FUSE TERMINAL, SAKSTI
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER.
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
WARNING
HAZARD OF ELECTRICAL SHOCK- DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
ROBICON
CONTROL SCHEMATIC
2700HP(2000KW) SR11 DRIVE
6.6KV/6.6KV,50HZ, SIZE 4H
459133
K
459133J9
10
145378
ENSBY (BRISBANE)
9/19/96
AB
MWH
REVISIONS
REVISED PER ENG. MARK-UP APR/MVH 04-04-97
02746

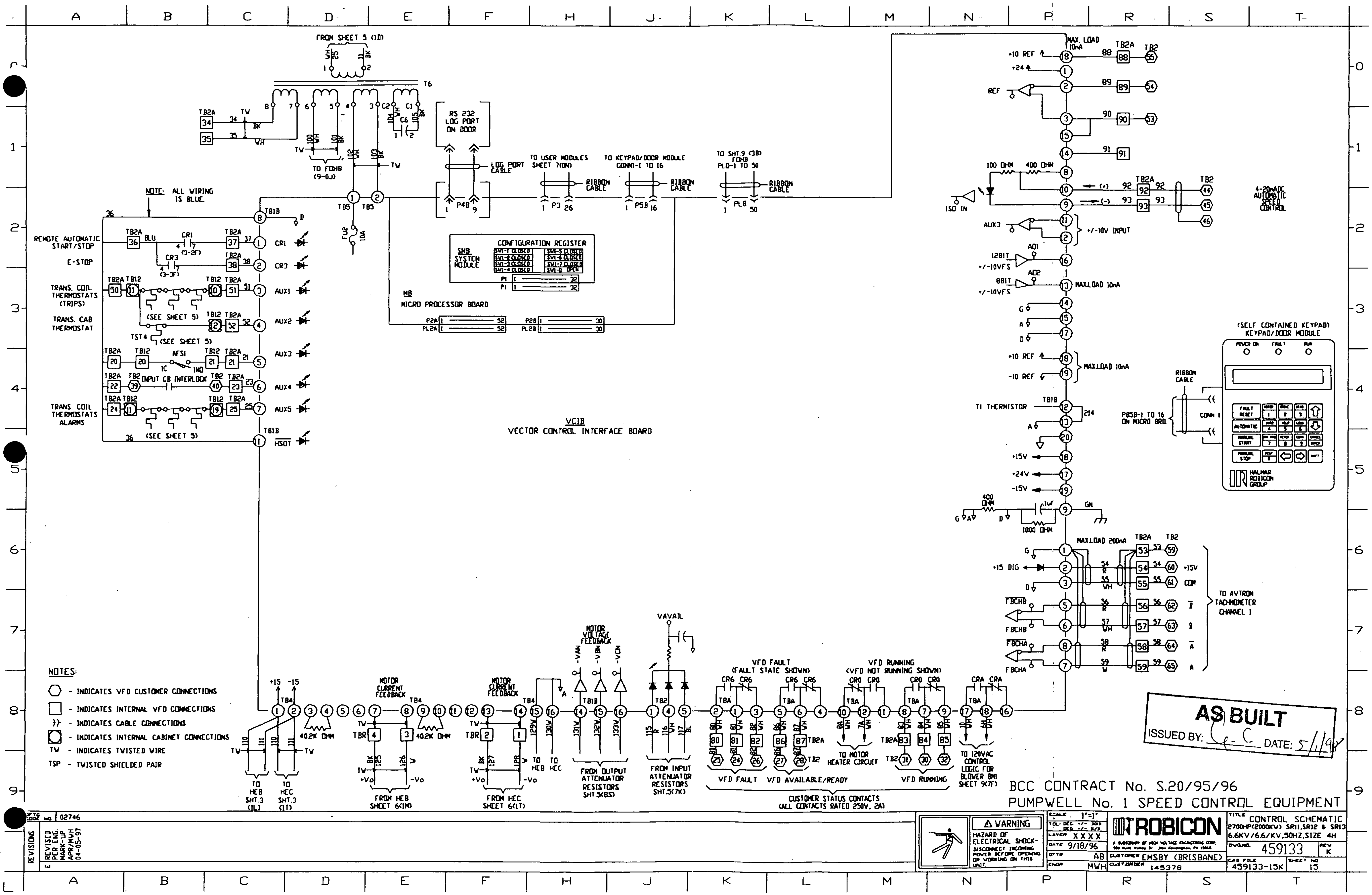

TO T5 SECONDARY SHEET 5 (5S)
110VAC RECEPTACLE
F4 7A,250V
TO TB2-A1,A2 SHEET 5 (1T) 110 VAC
F6 7A,250V
MOTOR HEATER 120 VAC, 8 AMPS(MAX)
MOTOR SPACE HEATER
NOTE: DO NOT REMOVE BR1 OR BR2
LO OHM 3W,1% BR1 BR2 1.0 OHM 3W,1%
TO INPUT CT'S SHT 5 (2C)
NOTE: PL110 MUST BE PLUGGED INTO 110VAC RECEPTACLE
F5 1.6A,250V
TO TRANS T6 SHEET 6 (0D)
CUSTOMER AUTOMATIC START/STOP CONTACT
CR1 VFD REMOTE AUTOMATIC START/STOP 10-2B,2E
FIELD E-STOP
PB4 E-STOP
CR3 EMERG. STOP 10-2B
FROM SHT.10(8H) MB BOARD P3
RIBBON CABLE
TO ADM1
DIM1 DIGITAL INPUT MODULE
LOCAL (MANUAL)
REMOTE(AUTO)
UNBALANCE TRIP
MOTOR UNBALANCE PROTECTION TRIP
UNBALANCE ALARM
MOTOR UNBALANCE ALARM
362872.00V
BLOWER #1 6C
CR4 MOTOR SPACE HEATER
LIGHT SWITCH LSW1
FLOURESCENT LIGHT FL1
TO 6.6KV CONTACTOR
TO BRAKE RELEASE
TO 120V CONTROL (4C)
CUSTOMER SEAL IN CONTACTS
CUSTOMER E-STOP
MOUNTING PANEL INSIDE VSD CONTROL CABINET
START/STOP RELAY
LOCAL/REMOTE SELECT
DRIVE CONTROL FAIL (LOSS OF 4-20mA SIGNAL)
DRIVE O/TEMPERATURE ALARM
PUMP BRAKE CONTROL
GENIUS BLOCK
24V DC SUPPLY
DRIVE RUNNING
GENERAL ALARM
MOTOR OVERLOAD
VFD AVAILABLE
LOCAL CONTROL
LOCAL START PUSHBUTTON
LOCAL STOP PUSHBUTTON
START/STOP RELAY CR10
TO ADM3
DOM1 DIGITAL OUTPUT MODULE P/N 362871.00V SCH 373447
DOM2 DIGITAL OUTPUT MODULE P/N 362871.00V SCH 373447
ADDRESS SWITCH SW1 SETTINGS
LOCAL REMOTE
START
STOP
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
AS BUILT
ISSUED BY:
DATE:
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL, SAKR
- KLIPPON FUSE TERMINAL, SAKST.1
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
02746
REVISED PER ENG. MARK-UP APR/MWH 04-04-97
REVISIONS
WARNING HAZARD OF ELECTRICAL SHOCK- DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE 1"=1"
DATE 9/19/96
DFTR AB
ENGR MWH
CUSTOMER CMSBY (BRISBANE)
CUST ORDER 145378
ROBICON
CONTROL SCHEMATIC 2700HP(2000KW) SR12 DRIVE 6.6KV/6.6KV,50HZ, SIZE 4H
DWG NO. 459133 REV K
CAD FILE 459133J9
SHEET NO 11

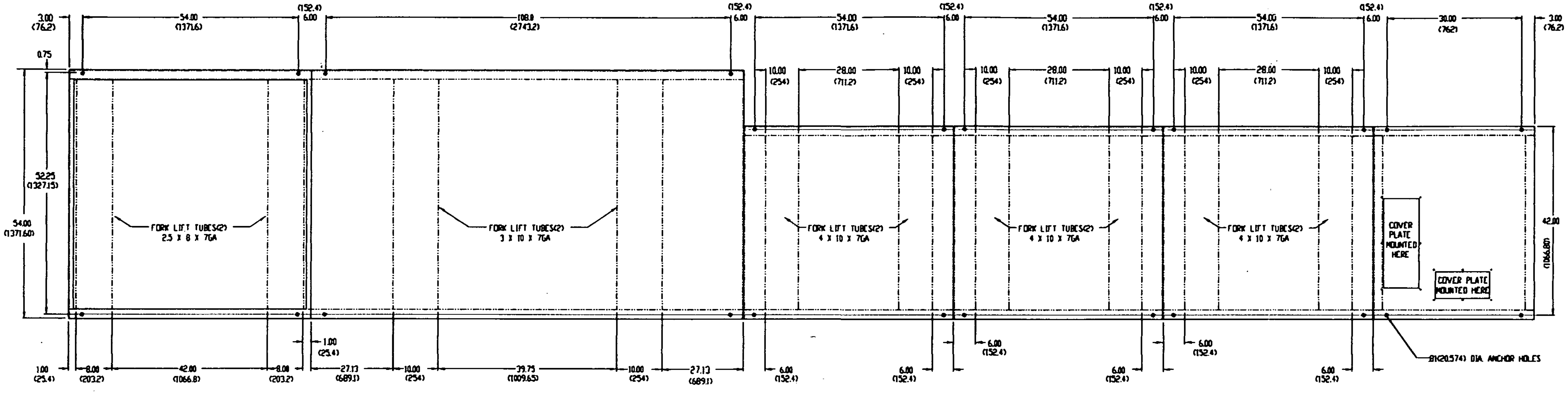

MOUNTING PANEL INSIDE VSD CONTROL CABINET
GENIUS BLOCK 2
4-20mA MOTOR CURRENT
4-20mA MOTOR KV
4-20mA MOTOR SPEED INDICATION
RIBBON
TO DIM1
TO DDM1
ANALOG OUTPUT MODULE 3
ANALOG OUTPUT MODULE 4
ADDRESS SWITCH SW1 SETTINGS
P/N 362T54.00V
POWER SUPPLY 50mA MAX.
ISOLATED POWER SUPPLY 50mA MAX.
ISOLATED USER OUTPUT
4-20mA MAIN SPEED POT
4-20mA SPEED SET POINT
4-20mA FLOW INDICATOR
LOCAL CONTROLLER
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
24V DC SUPPLY
VECTOR CONTROL INTERFACE BOARD
120 VAC TO SHEET 9
120 VAC INPUT
3000 L/S
FLOWMETER
GENIUS BLOCK 3
WET WELL LEVEL
TO DRIVE SR13
TO DRIVE SR11
LOCAL DISPLAY
AS BUILT
ISSUED BY:
DATE:
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL, SAKR
- KLIPPON FUSE TERMINAL, SAKSTJ
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER.
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
REVISED PER ENG. MARK-UP APR/MWH 04-04-97
02746
WARNING
HAZARD OF ELECTRICAL SHOCK-DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
ROBICON
CONTROL SCHEMATIC
2700HP(2000KW) SR12 DRIVE
6.6KV/6.6KV,50HZ, SIZE 4H
459133
K
9/19/96
AB
MWH
145378
459133J9
12



TO T5 SECONDARY SHEET 5 (5S)
110VAC RECEPTACLE
TO TB2-A1,A2 SHEET 5 (1T) 110 VAC
MOTOR HEATER 120 VAC, 8 AMPS(MAX)
MOTOR SPACE HEATER
NOTE: DO NOT REMOVE BR1 OR BR2
TO INPUT CT'S SHT 5 (2C)
NOTE: PL110 MUST BE PLUGGED INTO 110VAC RECEPTACLE
TO TRANS T6 SHEET 6 (0D)
CUSTOMER AUTOMATIC START/STOP CONTACT
CR1 VFD REMOTE AUTOMATIC START/STOP 10-2B,2E
FIELD E-STOP
PB4 E-STOP
CR3 EMERG. STOP 10-2B
FROM SHT.10(1D) MB BOARD P3
RIBBON CABLE
TO ADM1
DIM1 DIGITAL INPUT MODULE
LOCAL (MANUAL)
REMOTE(AUTO)
UNBALANCE TRIP
MOTOR UNBALANCE PROTECTION TRIP
UNBALANCE ALARM
MOTOR UNBALANCE ALARM
362872.00V
BLOWER #1 6C
CR4 MOTOR SPACE HEATER
LIGHT SWITCH
FLOURESCENT LIGHT
TO 6.6KV CONTACTOR
TO BRAKE RELEASE
TO 120V CONTROL (4C)
CUSTOMER SEAL IN CONTACTS
CUSTOMER E-STOP
MOUNTING PANEL INSIDE VSD CONTROL CABINET
START/STOP RELAY
LOCAL/REMOTE SELECT
DRIVE CONTROL FAIL (LOSS OF 4-20mA SIGNAL)
DRIVE O/TEMPERATURE ALARM
PUMP BRAKE CONTROL
24V DC SUPPLY
GENIUS BLOCK
DRIVE RUNNING
GENERAL ALARM
MOTOR OVERLOAD
VFD AVAILABLE
LOCAL CONTROL
LOCAL START PUSHBUTTON
LOCAL STOP PUSHBUTTON
DOM1 DIGITAL OUTPUT MODULE P/N 362871.00V SCH 373447
DOM2 DIGITAL OUTPUT MODULE P/N 362871.00V SCH 373447
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
AS BUILT
ISSUED BY:
DATE:
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL, SAKR
- KLIPPON FUSE TERMINAL, SAKST.1
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISED PER ENG. MARK-UP APR/MWH 04-04-97
02746
WARNING HAZARD OF ELECTRICAL SHOCK-
ROBICON
CONTROL SCHEMATIC 2700HP(2000KW) SR13 DRIVE 6.6KV/6.6KV,50HZ, SIZE 4H
459133
K
459133J9
13
9/19/96
MWH
ENSBY (BRISBANE)
145378


MOUNTING PANEL INSIDE VSD CONTROL CABINET
RIBBON
TO OIM1
TO OOM1
GENIUS BLOCK 2
4-20mA MOTOR CURRENT
4-20mA MOTOR KV
4-20mA MOTOR SPEED INDICATION
ANALOG OUTPUT MODULE 3
ANALOG OUTPUT MODULE 4
ADDRESS SWITCH SW1 SETTINGS
P/N 362154.00V
ISOLATED USER OUTPUT
ISOLATED POWER SUPPLY 50mA MAX.
4-20mA MAIN SPEED POT
LOCAL CONTROLLER
24V DC SUPPLY
LOCAL CONTROLS MONTED ON VSD CABINET DOOR
4-20mA SPEED SET POINT
VECTOR CONTROL INTERFACE BOARD
120 VAC TO SHEET 13
120 VAC INPUT
3000 L/S
4-20mA FLOW INDICATOR
FLOWMETER
TO WET WELL
TO DRIVE SR12
WET WELL LEVEL
LOCAL DISPLAY
GENIUS BLOCK 3
AS BUILT
ISSUED BY:
DATE
NOTES:
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- KLIPPON LINK TERMINAL, SAKR
- KLIPPON FUSE TERMINAL, SAKST.1
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
- INDICATES OPTION OR WIRING BY CUSTOMER
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
REVISED PER ENG. MARK-UP APR/MVH 04-04-97
WARNING
HAZARD OF ELECTRICAL SHOCK
ROBICON
CONTROL SCHEMATIC
2700HP(2000KW) SR13 DRIVE
6.6KV/6.6KV,50HZ, SIZE 4H
459133
DATE 9/19/96
CUSTOMER EMSBY (BRISBANE)
CUST.ORDER 145378
CAD FILE 459133J9
SHEET NO. 14
REV K


FROM SHEET 5 (1D)
T6
RS 232 LOG PORT ON DOOR
LOG PORT CABLE
TO USER MODULES SHEET 7(0N)
TO KEYPAD/DOOR MODULE CONN1-1 TO 16
RIBBON CABLE
NOTE: ALL WIRING IS BLUE.
REMOTE AUTOMATIC START/STOP
E-STOP
TRANS. COIL THERMOSTATS (TRIPS)
TRANS. CAB THERMOSTAT
TRANS. COIL THERMOSTATS ALARMS
(SEE SHEET 5)
INPUT CB INTERLOCK
CONFIGURATION REGISTER
SMB SYSTEM MODULE
MB MICRO PROCESSOR BOARD
VCIB VECTOR CONTROL INTERFACE BOARD
4-20mADC AUTOMATIC SPEED CONTROL
+/-10V INPUT
MAXLOAD 10mA
T1 THERMISTOR
(SELF CONTAINED KEYPAD) KEYPAD/DOOR MODULE
HALMAR ROBICON GROUP
P858-1 TO 16 ON MICRO BRD.
TO AVTRON TACHOMETER CHANNEL 1
MAXLOAD 200mA
NOTES:
- INDICATES VFD CUSTOMER CONNECTIONS
- INDICATES INTERNAL VFD CONNECTIONS
- INDICATES CABLE CONNECTIONS
- INDICATES INTERNAL CABINET CONNECTIONS
TW - INDICATES TWISTED WIRE
TSP - TWISTED SHIELDED PAIR
MOTOR CURRENT FEEDBACK
MOTOR VOLTAGE FEEDBACK
VAVAIL
TO HEB SHT.3 (1L)
TO HCC SHT.3 (1T)
FROM HEB SHEET 6(1M)
FROM HCC SHEET 6(1T)
FROM OUTPUT ATTENUATOR RESISTORS SHT.5(8S)
FROM INPUT ATTENUATOR RESISTORS SHT.5(7K)
VFD FAULT (FAULT STATE SHOWN)
VFD RUNNING (VFD NOT RUNNING SHOWN)
TO MOTOR HEATER CIRCUIT
TO 120VAC CONTROL LOGIC FOR BLOWER BM1 SHEET 9(7F)
VFD FAULT
VFD AVAILABLE/READY
VFD RUNNING
CUSTOMER STATUS CONTACTS (ALL CONTACTS RATED 250V, 2A)
AS BUILT
ISSUED BY:
DATE:
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
REVISED PER ENG. MARK-UP
⚠ WARNING
HAZARD OF ELECTRICAL SHOCK-DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
SCALE 1"=1"
DATE 9/18/96
ROBICON
CUSTOMER ENSBY (BRISBANE)
TITLE CONTROL SCHEMATIC
2700HP(2000KV) SR11,SR12 & SR13
6.6KV/6.6/KV,50HZ,SIZE 4H
DWG.NO. 459133
REV K
CAD FILE 459133-15K
SHEET NO 15
145378



NOTE: DIMENSIONS ARE IN INCHES, PARENTHESIS () ARE IN MILLIMETERS.

TOP VIEW

AS BUILT
ISSUED BY: ______ DATE: 5/1/98

BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS		
G	REVISE PER ENG MARK UP DMV/JBS 7-3-97	
H	REVISE DIMENSIONS DMV/JBS 7-14-97	
J	REVISE CELL CAB. SCALE APR/MWH 08/22/97	
K	AS COMMISSIONED 5/1/98	

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK- DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

SCALE	NTS
LAYER	0XXX
DATE	1/30/97
DFTR	AB
ENGR	MWH
CUSTOMER	EMSBY (BRISBANE)
CUST ORDER	145378
TITLE	SYSTEM BASE DETAIL 6.6KV/6.6KV,50HZ, SIZE 4H
DWG.NO.	459133
REV	K
CAD FILE	459133-16K
SHEET NO	16

ROBICON

CHAPTER 14: TRAINING

Please consult Emsby for operator and maintenance staff training on 3274 2566.

∇ ∇ ∇

CHAPTER 15: MODIFICATIONS

Brisbane Water requested modifications

VVVF drive earthing to suit Energex requirements

VVVF drive primary cables to drive transformer have been supported.

VVVF drive blower motor drive belt guards installed.

VVVF drive Standard Operating programme (SOP) has been modified to suit Brisbane Water requirements. Refer to SOP in section 16 of this manual.
This SOP reflects the operating procedure at the time of commissioning.

VVVF drive control interfacing has been modified to suit Brisbane water requirements.

∇ ∇ ∇

CHAPTER 16: COMMISSIONING & TEST REPORTS

The following pages lists the site test reports, Standard Operating program (SOP) and the parameter dump for the three Perfect Harmony drives.

THIS DOCUMENTATION WILL BE INCLUDED IN THE FINAL ISSUE OF MANUALS

∇ ∇ ∇

16

CHAPTER 16: COMMISSIONING & TEST REPORTS

The following pages lists the site test reports, Standard Operating program (SOP) and the parameter dump for the three Perfect Harmony drives.

∇ ∇ ∇

16

22/10/98

```
#harmony;
;-----------------------------------------------------------------------------
; SYSTEM PROGRAM FOR MEDIUM VOLTAGE PWM DRIVE (STANDARD PERFORMANCE)
;
; CUSTOMER: EMSBY (Brisbane City Council)     3R11
; CO:       145378
; P/N:      459133.00
; DATE:     November 2, 1997
; REV.DATE: November 14, 1997
; FILE:     CO1453789.SOP
; ENGINEER: B.Crisp
;-----------------------------------------------------------------------------
; SYMBOL DEFINITION
;
;    = equals          * logical and    + logical or
;    / logical not     ; comment line
;-----------------------------------------------------------------------------
--
; INTERFACE TERMINAL REFERENCE
;
; Cr1_f is the customer remote start/stop.
;
; Cr3_f is the Cr3 E-STOP (coast stop) pushbutton.
;   - Cr3 must be closed to run drive.
;
; pib_aux1_f is used to monitor Transformer coil thermal switches (trips).
;
; pib_aux2_f is used to monitor Transformer cabinet thermal switch.
;
; pib_aux3_f is used to monitor blower motor #1 air flow switch.
;
; pib_aux4_f is used to monitor the Input circuit breaker to verify
;            that input power is applied. This contact must be closed
;            for the VFD to accept a run command.
;
; pib_aux5_f is used to display an alarm indication if the transformer thermal
;            switches are opened due to high temperature.
;-----------------------------------------------------------------------------
;DIGITAL USER MODULE TERMINAL REFERENCE
;
;mc_pickup_f Blower #1 Starter contact
;umdo04_a    Local/Remote status (energized when in remote).
;umdo04_b    Drive Control Loss (de-energized when in remote and 4-20mA is 0).
;umdo04_c    Cell overtemperature/trax alarm fault(opens on fault).
;umdo04_d    Pump Brake control.
;umdo05_a    Transformer Overtemperature (opens on fault).
;umdo05_b    General non-fatal Fault     (opens on fault).
;umdo05_c    Motor Overload/unbalance.
;umdo05_d    Spare.
;umdi01_a    Local mode(system starts with keypad start).
;umdi01_b    Spare.
;umdi01_c    Remote mode.
;umdi01_d    Manual PLC input (this input must be true for manual)Not used.
;umdi01_e    Trip from MPU indicating motor current imbalance.
;umdi01_f    Alarm from MPU indicating motor current unbalance.
```

```
;
;---------------------------------------------------------------------------
; INITIALIZED FLAGS
;
std_cntrl_f = false;     set standard torque control
;
;std_cntrl_f must be set FALSE when vector control is being used.
; vector control is a keypad menu controlled function.
;
;acc_sw1         = TRUE;          menu accel and decel settings
as_sw1          = TRUE;          no auxiliary speed reference
vl_sw3          = TRUE;          forward speed limit from keypad setpoint
vl_sw5          = TRUE;          reverse speed limit from keypad setpoint
csa_sw          = TRUE;          critical speed avoidance enabled
al_sw4          = TRUE;          pos torque limit from keypad setpt
al_sw8          = TRUE;          neg torque limit from keypadsetpt
;rc_sw1         = TRUE;          ratio cntrl from keypad setpt
ai_sw1          = TRUE;          enable torque reference
;aa_sw1         = TRUE;          set aux torque reference to zero
pc_sw1          = FALSE;         reverse direction disabled
vel_dl_cntrl_f  = TRUE;          enable velocity double loop control
spin_load_en_f  = TRUE;          spinning load off
;---------------------------------------------------------------------------
;MANUAL MODE START/STOP LOGIC
;The keypad is used to start and stop the drive in manual mode. The Cr1
;contact has no effect in this mode.
;
; temp01 and Counter05 are used for Manual start.
temp01_f = kbd_man_start * umdi01_a ;
counter05(01) = temp01_f * pib_aux4_f;
cntr_reset05 = /cr3_f + kbd_man_stop + temp02_f + drv_flt_f + umdi01_c ;
;
;---------------------------------------------------------------------------
;AUTOMATIC MODE START/STOP LOGIC
;The Cr1 contact is used to start and stop the drive in automatic mode. In
;addition, the keypad manual stop button may be used to stop the drive.
;
temp02_f = kbd_auto * umdi01_c + temp17_f * umdi01_c;
;
counter06(01) = temp02_f * pib_aux4_f;
cntr_reset06 =  temp01_f + /umdi01_c +kbd_man_stop;
;
;---------------------------------------------------------------------------
-----
;DRIVE RUN REQUEST FLAG
;
run_req_f = counter05 + counter06 * cr1_f*cr3_f;
;
;---------------------------------------------------------------------------
-
;BLOWER CONTROL LOGIC
;Code to cycle blowers from cell heat sink thermistor.
;
counter01(01) = mv_ot_warning_f + mv_ot_trip_f + /pib_aux2_f ;
;
```

```
timer03(90) = counter01 * /mv_ot_warning_f ;
;
cntr_reset01 = timer03;
;
;---------------------------------------------------------------------------
;Code to cycle blower on for 3 minutes every two hours if medium
;voltage is applied to the cells.
;
timer10(90) = /trq_cntr_en_f * compar_1_f * /temp15_f ;
;
;Compar_1_f   A-Vavail, B-fixed percent (80%), C-Magnitude Compar.
;
counter03(1) = timer10;
temp15_f = counter03;
counter02(80)  = counter03;
timer01(90)    = counter02;
timer02(90) =  timer01 * counter02;
cntr_reset03 = temp15_f;
cntr_reset02 = timer02;
;
;---------------------------------------------------------------------------
;Main blower control loop;
;
temp03_f = trq_cntr_en_f + counter01 + counter02 + temp03_f * /temp05_f
           + compar_1_f;
;
;The following 3 lines of code is used to keep the blower running for 3
;minutes after the drive shuts down.
;
timer04(90) = /trq_cntr_en_f * temp03_f ;
timer05(90) = timer04 * temp03_f ;
;
temp05_f = timer05 ;
;
mc_pickup_f = temp03_f ; start blower #1
;
;---------------------------------------------------------------------------
; Code for blower failure user fault
;
timer07(03) = temp03_f * /pib_aux3_f ;
;If we attempt to start blower and no air flow is sensed,
;timer07 will time out after 3 seconds.
;
;
;---------------------------------------------------------------------------
-
;MPU trip function / Motor Overload
;
;MPU alarm function
;
temp07_f = umdi01_f;   Current unbalance alarm from MPU
;
temp06_f = umdi01_e;  Current unbalance Trip input from MPU relay.
;
umdo05_c = temp12_f * /temp13_f; Output to Genuis Box
```

```
;                                                   indicating Overload and current
;                                                   unbalance.
;
timer09(3) = temp06_f;
;
timer08(10) = temp07_f;
;
;
temp12_f = /overload_pending;
temp13_f = timer08;
;
;--------------------------------------------------------------------------------
;User Fault Designation
;
;
;
user_fault1 = timer07 ;
user_fault2 = /pib_aux1_f;
user_text_1 = "Blower Failed" ;
user_text_2 = "Transformer Overtemp";
user_fault3 = signal_loss_f * auto_f;
user_text_3 = "Loss of 4-20ma signal";
user_fault4 = timer09;
user_text_4 = "Motor Current Unbalance";
user_fault5 = temp16_f;
user_text_5 = "Drive Hot";
;user_fault6 = /cr3_f;
;user_text_6 = "Brake-Emerg Stop";
;
;--------------------------------------------------------------------------------
;STOP LOGIC
;
estop_f = drv_flt_f  ;
;
cstop_f = /estop_f ;
;--------------------------------------------------------------------------------
;LOSS OF 4-20ma LOGIC
;
; The system will continue to  run at the last speed ref
; if the 4-20mA signal drops below a set level
; when operating in the remote mode.
;
vd_sw27 = signal_loss_f * counter06;
hold_speed_f = /signal_loss_f;
;
;--------------------------------------------------------------------------------
;
;DRIVE FAULT LOGIC
;
;
drv_flt_f =  ground_flt_f + loc_pcl_flt + mot_ov_fault + user_fault1
             + user_fault2 + user_fault4 + drv_flt_f * /drv_flt_rst_f ;
;
drv_flt_rst_f = kbd_flt_reset +temp17_f;
;
```

```
;estop_rst_f=kbd_flt_reset ;
;
;--------------------------------------------------------------------------
;RAMP LOGIC
;
;The Drive will ramp up to 280 rpm in "ramp1" menu 17.
;At 280 rpm the ramp will change to parameters set
;in "ramp2" menu17.  (system dependant)
;
;The Drive will decelerate as quickly as is practical
;for the drive and the system.
;
acc_sw1 = compar_3_f;   Rapid accel/decel to 46.6%
;
acc_sw4 = /compar_3_f;  Else slower system determined accel/decel
;
;   Comp 3 A in = Enter fixed % of 46.6%
;   Comp 3 B in = Encoder speed fdbk
;   Comp 3 = Magnitude
;
acc_sw5 = /compar_3_f * /cr1_f * counter06; fast decel when the drive is
;                                 running above 280rpm and cr1
;                                 is removed "ramp 3" menu 17.
;
;--------------------------------------------------------------------------
;SPEED REFERENCE
;
vd_sw28 = /vd_sw24 ;              Pressing "Manual Start" on 454 GT keypad,
;                                 speed adjusted by up and down arrow buttons.
;
vd_sw24 = counter06 ;             Enable 4-20 mA input in auto if we lose XCL.
;                                 Pressing "Automatic" on 454 GT keypad, speed
;                                 setting from 4-20mA input and Auto menu (4).
;
sp_sw =  vd_sw24 ;                Enable speed profile.
auto_f = vd_sw24 ;                Keypad display.
;
;--------------------------------------------------------------------------
; PUMP BRAKE RELEASE LOGIC
;
; When a run command is received, the pump brake release signal on
; Digital Output module 04 d is de-energaized. It remains de-energized until
; the run command is removed and the speed is less than 15 rpm which
; is approximately  2.5% speed. A comparator is used to detect this condition.
;
; Compar_2_f A = "encoder feedback"
; Compar_2_f B = "15rpm (2.5% of maximum speed 600 rpm)"
; Compar_2_f C = Magnitude compare
;
temp18_f = /run_req_f * /compar_2_f;
counter04(1) = temp18_f;
umdo04_d     = counter04;
cntr_reset04 = run_req_f;
;
;--------------------------------------------------------------------------
```

```
;KEYPAD INDICATOR LAMPS AND VECTOR CONTROL INTERFACE BOARD RELAYS
;
; Cr0 is energized when the VFD is running.
; Cr6 is energized when no VFD fault exists.
;
cr0_f = trq_cntr_en_f * /drv_flt_f ;
cr6_f = drv_flt_f ;
umdo04_a = counter06;    Auto selected.
umdo04_b = /signal_loss_f; 4-20mA signal loss
umdo04_c = pib_aux5_f * /mv_ot_warning_f ; Cell Overtemperature/trax
overtemperature warning
umdo05_a = temp10_f * temp11_f;    Transformer Overtemperature/blower fail trip
;
temp16_f = mv_ot_warning_f + /pib_aux5_f;
;
temp10_f = pib_aux1_f;
temp11_f = /timer07;
;
kbd_flt_led = drv_flt_f ;      Fault light.
kbd_run_led = trq_cntr_en_f ;  Run light.
;
;-------------------------------------------------------------------------------
-
;               Powerup reset
;
timer12(03)     = compar_1_f;
timer13(04)     = compar_1_f;
counter08(01)   = timer13;
temp17_f        = timer12 * /counter08;
cntr_reset08    = /compar_1_f;
;
;
;
;-------------------------------------------------------------------------------
;END PROGRAM
;-------------------------------------------------------------------------------
-------
```

ISSUED BY: DATE:
AS BUILT

```
#harmony;
;-----------------------------------------------------------------------
; SYSTEM PROGRAM FOR MEDIUM VOLTAGE PWM DRIVE (STANDARD PERFORMANCE)
;
; CUSTOMER: EMSBY (Brisbane City Council) SR12 AND SR13
; CO:        145378
; P/N:       459133.00
; DATE:      November 2, 1997
; REV.DATE:  November 14, 1997
; FILE:      C01453789.SOP
; ENGINEER:  B.Crisp
;-----------------------------------------------------------------------
; SYMBOL DEFINITION
;
;    = equals          * logical and     + logical or
;    / logical not     ; comment line
;-----------------------------------------------------------------------
--
; INTERFACE TERMINAL REFERENCE
;
; Cr1_f is the customer remote start/stop.
;
; Cr3_f is the Cr3 E-STOP (coast stop) pushbutton.
;   - Cr3 must be closed to run drive.
;
; pib_aux1_f is used to monitor Transformer coil thermal switches (trips).
;
; pib_aux2_f is used to monitor Transformer cabinet thermal switch.
;
; pib_aux3_f is used to monitor blower motor #1 air flow switch.
;
; pib_aux4_f is used to monitor the Input circuit breaker to verify
;            that input power is applied. This contact must be closed
;            for the VFD to accept a run command.
;
; pib_aux5_f is used to display an alarm indication if the transformer thermal
;            switches are opened due to high temperature.
;-----------------------------------------------------------------------
;DIGITAL USER MODULE TERMINAL REFERENCE
;
;mc_pickup_f Blower #1 Starter contact
;umdo04_a    Local/Remote status (energized when in remote).
;umdo04_b    Drive Control Loss (de-energized when in remote and 4-20mA is 0).
;umdo04_c    Cell overtemperature/trax alarm fault(opens on fault).
;umdo04_d    Pump Brake control.
;umdo05_a    Transformer Overtemperature (opens on fault).
;umdo05_b    General non-fatal Fault      (opens on fault).
;umdo05_c    Motor Overload/unbalance.
;umdo05_d    Spare.
;umdi01_a    Local mode(system starts with keypad start).
;umdi01_b    Spare.
;umdi01_c    Remote mode.
;umdi01_d    Manual PLC input (this input must be true for manual)Not used.
;umdi01_e    Trip from MPU indicating motor current imbalance.
;umdi01_f    Alarm from MPU indicating motor current unbalance.
```

```
;
;-----------------------------------------------------------------------
; INITIALIZED FLAGS
;
std_cntrl_f = false;     set standard torque control
;
;std_cntrl_f must be set FALSE when vector control is being used.
; vector control is a keypad menu controlled function.
;
;acc_sw1          = TRUE;         menu accel and decel settings
as_sw1           = TRUE;         no auxiliary speed reference
vl_sw3           = TRUE;         forward speed limit from keypad setpoint
vl_sw5           = TRUE;         reverse speed limit from keypad setpoint
csa_sw           = TRUE;         critical speed avoidance enabled
al_sw4           = TRUE;         pos torque limit from keypad setpt
al_sw8           = TRUE;         neg torque limit from keypadsetpt
;rc_sw1          = TRUE;         ratio cntrl from keypad setpt
ai_sw1           = TRUE;         enable torque reference
;aa_sw1          = TRUE;         set aux torque reference to zero
pc_sw1           = FALSE;        reverse direction disabled
vel_dl_cntrl_f = TRUE;           enable velocity double loop control
spin_load_en_f = TRUE;           spinning load off
;-----------------------------------------------------------------------
;MANUAL MODE START/STOP LOGIC
;The keypad is used to start and stop the drive in manual mode. The Cr1
;contact has no effect in this mode.
;
; temp01 and Counter05 are used for Manual start.
temp01_f = kbd_man_start * umdi01_a ;
counter05(01) = temp01_f * pib_aux4_f;
cntr_reset05 = /cr3_f + kbd_man_stop + temp02_f + drv_flt_f + umdi01_c ;
;
;-----------------------------------------------------------------------
;AUTOMATIC MODE START/STOP LOGIC
;The Cr1 contact is used to start and stop the drive in automatic mode. In
;addition, the keypad manual stop button may be used to stop the drive.
;
temp02_f = kbd_auto * umdi01_c + temp17_f * umdi01_c;
;
counter06(01) = temp02_f * pib_aux4_f;
cntr_reset06 =  temp01_f + /umdi01_c +kbd_man_stop;
;
;-----------------------------------------------------------------------
-----
;DRIVE RUN REQUEST FLAG
;
run_req_f = counter05 + counter06 * cr1_f*cr3_f;
;
;-----------------------------------------------------------------------
-
;BLOWER CONTROL LOGIC
;Code to cycle blowers from cell heat sink thermistor.
;
counter01(01) = mv_ot_warning_f + mv_ot_trip_f + /pib_aux2_f ;
;
```

```
timer03(90) = counter01 * /mv_ot_warning_f ;
;
cntr_reset01 = timer03;
;
;----------------------------------------------------------------------------
;Code to cycle blower on for 3 minutes every two hours if medium
;voltage is applied to the cells.
;
timer10(90) = /trq_cntr_en_f * compar_1_f * /temp15_f ;
;
;Compar_1_f   A-Vavail, B-fixed percent (80%), C-Magnitude Compar.
;
counter03(1) = timer10;
temp15_f = counter03;
counter02(80) = counter03;
timer01(90)   = counter02;
timer02(90) =  timer01 * counter02;
cntr_reset03 = temp15_f;
cntr_reset02 = timer02;
;
;----------------------------------------------------------------------------
;Main blower control loop;
;
temp03_f = trq_cntr_en_f + counter01 + counter02 + temp03_f * /temp05_f
           + compar_1_f;
;
;The following 3 lines of code is used to keep the blower running for 3
;minutes after the drive shuts down.
;
timer04(90) = /trq_cntr_en_f * temp03_f ;
timer05(90) = timer04 * temp03_f ;
;
temp05_f = timer05 ;
;
mc_pickup_f = temp03_f ; start blower #1
;
;----------------------------------------------------------------------------
; Code for blower failure user fault
;
timer07(03) = temp03_f * /pib_aux3_f ;
;If we attempt to start blower and no air flow is sensed,
;timer07 will time out after 3 seconds.
;
;
;----------------------------------------------------------------------------
-
;MPU trip function / Motor Overload
;
;MPU alarm function
;
temp07_f = umdi01_f;   Current unbalance alarm from MPU
;
temp06_f = umdi01_e;  Current unbalance Trip input from MPU relay.
;
umdo05_c = temp12_f * /temp13_f; Output to Genuis Box
```

```
;                                                indicating Overload and current
;                                                unbalance.
;
timer09(3) = temp06_f;
;
timer08(10) = temp07_f;
;
;
temp12_f = /overload_pending;
temp13_f = timer08;
;
;-----------------------------------------------------------------------------
;User Fault Designation
;
;
;
user_fault1 = timer07 ;
user_fault2 = /pib_aux1_f;
user_text_1 = "Blower Failed" ;
user_text_2 = "Transformer Overtemp";
user_fault3 = signal_loss_f * auto_f;
user_text_3 = "Loss of 4-20ma signal";
user_fault4 = timer09;
user_text_4 = "Motor Current Unbalance";
user_fault5 = temp16_f;
user_text_5 = "Drive Hot";
;user_fault6 = /cr3_f;
;user_text_6 = "Brake-Emerg Stop";
;
;-----------------------------------------------------------------------------
;STOP LOGIC
;
estop_f = drv_flt_f  ;
;
cstop_f = /estop_f ;
;-----------------------------------------------------------------------------
;LOSS OF 4-20ma LOGIC
;
; The system will continue to  run at the last speed ref
; if the 4-20mA signal drops below a set level
; when operating in the remote mode.
;
vd_sw27 = signal_loss_f * counter06;
hold_speed_f = /signal_loss_f;
;
;-----------------------------------------------------------------------------
;
;DRIVE FAULT LOGIC
;
;
drv_flt_f =  ground_flt_f + loc_pcl_flt + mot_ov_fault + user_fault1
             + user_fault2 + user_fault4 + drv_flt_f * /drv_flt_rst_f ;
;
drv_flt_rst_f = kbd_flt_reset +temp17_f;
;
```

```
;estop_rst_f=kbd_flt_reset ;
;
;---------------------------------------------------------------------
;RAMP LOGIC
;
;The Drive will ramp up to 280 rpm in "ramp1" menu 17.
;At 280 rpm the ramp will change to parameters set
;in "ramp2" menu17.  (system dependant)
;
;The Drive will decelerate as quickly as is practical
;for the drive and the system.
;
acc_sw1 = compar_3_f;   Rapid accel/decel to 46.6%
;
acc_sw4 = /compar_3_f;  Else slower system determined accel/decel
;
;   Comp 3 A in = Enter fixed % of 46.6%
;   Comp 3 B in = Encoder speed fdbk
;   Comp 3 = Magnitude
;
acc_sw5 = /compar_3_f * /cr1_f * counter06; fast decel when the drive is
;                                 running above 280rpm and cr1
;                                 is removed "ramp 3" menu 17.
;
;---------------------------------------------------------------------
;SPEED REFERENCE
;
vd_sw28 = /vd_sw24 ;              Pressing "Manual Start" on 454 GT keypad,
;                                 speed adjusted by up and down arrow buttons.
;
vd_sw24 = counter06 ;             Enable 4-20 mA input in auto if we lose XCL.
;                                 Pressing "Automatic" on 454 GT keypad, speed
;                                 setting from 4-20mA input and Auto menu (4).
;
sp_sw =  vd_sw24 ;                Enable speed profile.
auto_f = vd_sw24 ;                Keypad display.
;
;---------------------------------------------------------------------
; PUMP BRAKE RELEASE LOGIC
;
; When a run command is received, the pump brake release signal on
; Digital Output module 04 d is de-energaized. It remains de-energized until
; the run command is removed and the speed is less than 15 rpm which
; is approximately  2.5% speed. A comparator is used to detect this condition.
;
; Compar_2_f A = "encoder feedback"
; Compar_2_f B = "15rpm (2.5% of maximum speed 600 rpm)"
; Compar_2_f C = Magnitude compare
;
umdo04_d = /run_req_f * /compar_2_f
;
;---------------------------------------------------------------------
;KEYPAD INDICATOR LAMPS AND VECTOR CONTROL INTERFACE BOARD RELAYS
;
; Cr0 is energized when the VFD is running.
```

```
; Cr6 is energized when no VFD fault exists.
;
cr0_f = trq_cntr_en_f * /drv_flt_f ;
cr6_f = drv_flt_f ;
umdo04_a = counter06;    Auto selected.
umdo04_b = /signal_loss_f; 4-20mA signal loss
umdo04_c = pib_aux5_f * /mv_ot_warning_f ; Cell Overtemperature/trax
overtemperature warning
umdo05_a = temp10_f * temp11_f;    Transformer Overtemperature/blower fail trip
;
temp16_f = mv_ot_warning_f + /pib_aux5_f;
;
temp10_f = pib_aux1_f;
temp11_f = /timer07;
;
kbd_flt_led = drv_flt_f ;      Fault light.
kbd_run_led = trq_cntr_en_f ;  Run light.
;
;-------------------------------------------------------------------------------
-
;               Powerup reset
;
timer12(03)     = compar_1_f;
timer13(04)     = compar_1_f;
counter08(01)   = timer13;
temp17_f        = timer12 * /counter08;
cntr_reset08    = /compar_1_f;
;
;
;
;-------------------------------------------------------------------------------
;END PROGRAM
;-------------------------------------------------------------------------------
-------
```

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CO #145378 Drive # 11

description		change	range	xcl#	lev	hmpd
Main menu	(5)					
Motor Menu	(1)		(submenu)		0	0000
Drive Menu	(2)		(submenu)		0	0000
Stability Menu	(3)		(submenu)		0	0000
Auto Menu	(4)		(submenu)		0	0000
Log Control	(6)		(submenu)		0	0000
Drive Protect Menu	(7)		(submenu)		0	0000
Meter Menu	(8)		(submenu)		0	0000
Communications Menu	(9)		(submenu)		0	0000
Enter Security Code			(function)		0	0000
Change Security Codes			(function)		2	1000
Security Edit	(0)		(submenu)		7	1000
Motor Menu	(1)					
Motor Param Menu	(11)		(submenu)		0	0000
Encoder Menu	(12)		(submenu)		0	0000
Motor Flux Menu	(13)		(submenu)		0	0000
Drive Menu	(2)					
Drive Param Menu	(14)		(submenu)		0	0000
Speed Setup	(15)		(submenu)		0	0000
Torq Ref Menu	(16)		(submenu)		0	0000
Ramp Setup Menu	(17)		(submenu)		0	0000
Pot Setup Menu	(18)		(submenu)		0	0000
Timebase Setup	(19)		(submenu)		0	0000
Hardware Scale Menu	(20)		(submenu)		0	0000
Cell Menu	(21)		(submenu)		0	0000
Transfer Menu	(200)		(submenu)		7	1000
Stability Menu	(3)					
Current Loop Setup	(22)		(submenu)		0	0000
Vector Control Tune	(23)		(submenu)		0	0000
Std Control Setup	(24)		(submenu)		0	0000
Control Loop Test	(25)		(submenu)		0	0000
Auto Menu	(4)					
Speed Profile Menu	(26)		(submenu)		0	0000
Speed Setpoint Menu	(27)		(submenu)		0	0000
Critical Speed Menu	(28)		(submenu)		0	0000
Comparator Setup	(29)		(submenu)		7	1000
PID Select Menu	(48)		(submenu)		0	0000

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description		change	range		xcl#	lev	hmpd
Log Control (6)							
Memory Functions (30)			(submenu)			0	0000
Diagnostic Log Menu(31)			(submenu)			0	0000
Historic Log Menu (32)			(submenu)			0	0000
Fault Log Menu (33)			(submenu)			0	0000
Drive Protect Menu(7)							
Overload Menu (34)			(submenu)			0	0000
Limit Menu (35)			(submenu)			0	0000
Meter Menu (8)							
Analog I/O Setup (36)			(submenu)			0	0000
Display Var. Menu (37)			(submenu)			0	0000
Trim Analog Meters (38)			(submenu)			7	0000
Loc. Alg. Meters (39)			(submenu)			0	0000
Loc. Dig. Meters (40)			(submenu)			0	0000
Communications Menu(9)							
RS232 Functions (41)			(submenu)			0	0000
Remote I/O Menu (42)			(submenu)			0	0000
XCL Send Setup (43)			(submenu)			7	1000
XCL Recv Setup (44)			(submenu)			7	1000
RS232 input- (empty)			(list)			0	0000
RS232 out - (empty)			(list)			0	0000
Motor Param Menu(11)							
Motor Freq	50 Hz	______	15	120	1101	7	0000
Number of poles	10	______	2	36	1102	7	0000
Motor eff	0.96	______	0.60	0.99	1103	7	0000
Full Ld Spd	593 rpm	______	1	7200	1104	7	0000
Motor voltage	6600 V	______	380	9000	1105	7	0000
Full load curr	227 A	______	12	1500	1106	7	0000
Motor KW	2000 KW	______	10	10000	1107	7	0000
Encoder Menu (12)							
Encoder1 PPR	1024	______	1	4000	1201	7	0000
Encoder2 PPR	1024	______	1	4000	1202	7	0000

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description		change	range		xcl#	lev	hmpd
Motor Flux Menu (13)							
Motor V Trim	1.000	_______	0.050	2.000	1301	7	0000
Volts/Hz gain	1.00	_______	0.00	10.00	1302	7	0000
Mag Current	70.0 A	_______	0.1	1500.0	1303	7	0000
Extended Enable	0	_______	0	1	1304	7	0000
Flux Pause Level	40 %	_______	0	100		7	0000
Flux pause	2.00 sec	_______	0.01	8.00		7	0000
Drive Param Menu(14)							
Drive current	300 A	_______	12	1500	1401	7	0000
Drive Rated Out	6600 V	_______	200	15000	1402	7	0000
Drive Input Vlt	6600 V	_______	200	15000	1403	7	0000
Auto reset enable	0	_______	0	1	1404	7	0000
Aut rst time	1.00 sec	_______	1.00	120.00	1405	7	0000
Spinning Load Select	0	_______	0	1	1407	7	0000
Vector Control Select	1	_______	0	1	1408	7	1001
Ramp Stop Select	1	_______	0	1	1409	7	0000
Hall Effect Select	1	_______	0	1		7	1001
Reduced Voltage Oper.	0	_______	0	1		7	0000
Display Version Number			(function)			7	0000
Customer Order	145378	_______	0	999999		7	0000
Customer Drive	11	_______	0	20		7	0000
Speed Setup (15)							
Ratio Control	1.000	_______	-125.000	125.000	1501	7	0000
Spd Fwd Lim	100 %	_______	0	200	1502	7	0000
Spd Rev Lim	0 %	_______	-200	0	1503	7	0000
Zero Speed	1 %	_______	0	100	1504	7	0000
Alg Spd Scaler	100 %	_______	0	250	1505	7	0000
Aux Spd Scaler	100 %	_______	0	250	1506	7	0000
Spd Fwd Lim 2	100 %	_______	0	200	1507	7	1000
Spd Rev Lim 2	-100 %	_______	-200	0	1508	7	1000
Spd Fwd Lim 3	100 %	_______	0	200	1509	7	1000
Spd Rev Lim 3	-100 %	_______	-200	0	1510	7	1000
Encoder filter adj	4	_______	0	6	1511	7	1000
Torq Ref Menu (16)							
Alg Trq Scaler	100 %	_______	0	250	1601	7	0000
Aux Trq Scaler	100 %	_______	0	250	1602	7	0000
Trq Setpoint	50 %	_______	0	250	1603	7	0000
Holding Torque	0 %	_______	-250	250	1604	7	1000
Alg hold Trq Scl	0 %	_______	0	250	1605	7	1000
Trq Ramp incr	0.18 sec	_______	0.00	999.99	1606	7	0000
Trq Ramp decr	0.18 sec	_______	0.00	999.99	1607	7	0000

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description		change	range		xcl#	lev	hmpd
Ramp Setup Menu (17)							
Fwd Accel	90.0 sec	_______	0.0	3200.0	1701	7	0000
Fwd Decel	90.0 sec	_______	0.0	3200.0	1702	7	0000
Rev Accel	0.0 sec	_______	0.0	3200.0	1703	7	0000
Rev Decel	0.0 sec	_______	0.0	3200.0	1704	7	0000
Jerk Rate	0.10 sec	_______	0.00	78.12	1705	7	0000
2 Stage Ramp Enable	0	_______	0	1	1706	7	0000
Fwd Accel 2	180.0 sec	_______	0.0	3200.0	1707	7	1000
Fwd Decel 2	180.0 sec	_______	0.0	3200.0	1708	7	1000
Rev Accel 2	5.0 sec	_______	0.0	3200.0	1709	7	1000
Rev Decel 2	5.0 sec	_______	0.0	3200.0	1710	7	1000
Fwd Accel 3	90 sec	_______	0	32000	1711	7	1000
Fwd Decel 3	90 sec	_______	0	32000	1712	7	1000
Rev Accel 3	0 sec	_______	0	32000	1713	7	1000
Rev Decel 3	0 sec	_______	0	32000	1714	7	1000
Pot Setup Menu (18)							
Set max pos	100 %	_______	0	200	1801	7	0000
Set max neg	0 %	_______	-200	0	1802	7	0000
4-20ma Max	104.0 %	_______	1.0	150.0	1803	7	0000
4-20ma Dropout	3.5 ma	_______	0.0	10.0	1804	7	0000
Timebase Setup (19)							
Cond Stop Tmr	0.8 sec	_______	0.0	999.9	1901	7	0000
Cond Run Tmr	0.8 sec	_______	0.0	999.9	1902	7	0000
Cycle Timer	0 Hrs	_______	0	10000	1903	7	0000
Hour Meter Setup	(50)		(submenu)			7	0000
Set the Clock time			(function)			7	0000
Hardware Scale Menu(20)							
Mot V fb	1600 v/v	_______	1	3000	2001	7	0000
Line V fb	1650 v/v	_______	1	9000	2002	7	0000
Ib Offset Adjust	9F	_______	00	FF	2003	7	0000
Ic Offset Adjust	76	_______	00	FF	2004	7	0000
Std Mot V Trim	9.100 V	_______	0.000	10.000	2006	7	0000
Cell Menu (21)							
Installed Stages	6	_______	3	7	2101	7	0000
Minimum Stage Count	3	_______	1	6	2102	7	0000
Auto Bypass Enable	0	_______	0	1	2103	7	0000
Print Cell Status			(function)			0	0000
Display Cell Fault(s)			(function)			0	0000
Print Cell Fault(s)			(function)			0	0000

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description		change		range	xcl#	lev	hmpd
Cell Menu	(21)	continued					
RS232 Diag Bypass	0	______	0	1		7	1000
Current Loop Setup(22)							
I quad I gain	0.625	______	0.000	0.996	2201	7	0000
I quad P gain	0.500	______	0.000	0.996	2202	7	0000
I direct I gain	0.300	______	0.000	0.996	2203	7	0000
I direct P gain	0.699	______	0.000	0.996	2204	7	0000
Vector Control Tune(23)							
Vel P gain	4.300	______	0.000	127.996	2301	7	0000
Vel I gain	4.300	______	0.000	255.996	2302	7	0000
Imag P gain	0.058	______	0.000	127.996	2303	7	0000
Imag I gain	0.121	______	0.000	127.996	2304	7	0000
Slip P gain	0.058	______	0.000	127.996	2305	7	0000
Slip I gain	0.101	______	0.000	127.996	2306	7	0000
Vel P gain 2	5.000	______	0.000	127.996	2307	7	1000
Vel I gain 2	4.000	______	0.000	255.996	2308	7	1000
Vel P gain 3	5.000	______	0.000	127.996	2309	7	1000
Vel I gain 3	4.000	______	0.000	255.996	2310	7	1000
Std Control Setup(24)							
Std Volts/Hz	1.000	______	-127.996	127.996	2401	0	0000
Volt P gain	0.500	______	-127.996	127.996	2402	0	0000
Volt I gain	0.500	______	-127.996	127.996	2403	0	0000
Vel P gain	5.000	______	0.000	127.996	2404	0	0000
Vel I gain	5.000	______	0.000	255.996	2405	0	0000
Trq P gain	0.011	______	0.000	127.996	2406	0	0000
Trq I gain	0.300	______	0.000	255.996	2407	0	0000
Full Load boost	0.0 %	______	0.0	100.0	2408	0	0000
Slow Ramp Time	3.00 sec	______	0.00	9.99	2409	0	0000
Mot trq limit	50 %	______	0	300	2410	0	0000
Regen trq limit	3.0 %	______	0.2	10.0	2411	0	0000
Energy Saver	0 %	______	0	100	2412	0	0000
K1	0.8	______	0.1	1.0		0	0000
Spin Load Thresh	4.3 %	______	0.0	50.0	2413	0	0000
Spin Flux Scale	6.25 %	______	1.00	15.00		0	0000
Flux Ramp	7.0 sec	______	0.1	15.0	2414	0	0000
Freq Scan Rate	5.0 sec	______	1.5	9.0	2415	0	0000
Freq Drop Level	5.0 %	______	0.0	12.0	2416	0	0000
Vel P gain 2	5.000	______	0.000	127.996	2417	7	1000
Vel I gain 2	4.000	______	0.000	255.996	2418	7	1000
Vel P gain 3	5.000	______	0.000	127.996	2419	7	1000
Vel I gain 3	4.000	______	0.000	255.996	2420	7	1000
Trq P gain 2	0.011	______	0.000	127.996	2421	7	1000

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description		change	range		xcl#	lev	hmpd
Std Control Setup(24) continued							
Trq I gain 2	0.300	______	0.000	255.996	2422	7	1000
Trq P gain 3	0.011	______	0.000	127.996	2423	7	1000
Trq I gain 3	0.300	______	0.000	255.996	2424	7	1000
Mot trq limit 2	100 %	______	0	300	2425	7	1000
Regen trq limit 2	3.0 %	______	0.2	10.0	2426	7	1000
Mot trq limit 3	100 %	______	0	300	2427	7	1000
Regen trq limit 3	3.0 %	______	0.2	10.0	2428	7	1000
Control Loop Test(25)							
Spd Test Pos	3 %	______	-200	200		7	0000
Spd Test Neg	0 %	______	-200	200		7	0000
Spd Test Time	3.1 sec	______	0.0	500.0		7	0000
Begin Speed Loop test			(function)			7	0000
Stop Speed Loop test			(function)			7	0000
Trq Test Pos	50 %	______	-200	200		7	0000
Trq Test Neg	0 %	______	-200	200		7	0000
Trq Test Time	0.75 sec	______	0.00	91.00		7	0000
Begin Torque Loop test			(function)			7	0000
Stop Torque Loop test			(function)			7	0000
Start Diagnostic Log			(function)			0	0000
Select Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Speed Profile Menu(26)							
Entry Pt.	0.0 %	______	0.0	150.0	2601	7	0000
Exit Pt.	100.0 %	______	0.0	150.0	2602	7	0000
Entry Spd	48.3 %	______	0.0	150.0	2603	7	0000
Exit Spd	98.2 %	______	0.0	150.0	2604	7	0000
Auto off	0.0 %	______	0.0	100.0	2605	7	0000
Delay off	0.5 sec	______	0.5	100.0	2606	7	0000
Auto on	0.0 %	______	0.0	100.0	2607	7	0000
Delay on	0.5 sec	______	0.5	100.0	2608	7	0000
Speed Setpoint Menu(27)							
Spd Setpt 1	0 rpm	______	-9999	9999	2701	7	0000
Spd Setpt 2	0 rpm	______	-9999	9999	2702	7	0000
Spd Setpt 3	0 rpm	______	-9999	9999	2703	7	0000
Spd Setpt 4	0 rpm	______	-9999	9999	2704	7	0000
Spd Setpt 5	0 rpm	______	-9999	9999	2705	7	0000
Spd Setpt 6	0 rpm	______	-9999	9999	2706	7	0000
Spd Setpt 7	0 rpm	______	-9999	9999	2707	7	0000

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description		change	range		xcl#	lev	hmpd
Critical Speed Menu(28)							
Skip Freq 1	15.0 Hz	______	0.0	120.0	2801	7	0000
Skip Freq 2	30.0 Hz	______	0.0	120.0	2802	7	0000
Skip Freq 3	45.0 Hz	______	0.0	120.0	2803	7	0000
Skip band 1	0.0 Hz	______	0.0	6.0	2804	7	0000
Skip band 2	0.0 Hz	______	0.0	6.0	2805	7	0000
Skip band 3	0.0 Hz	______	0.0	6.0	2806	7	0000
Comparator Setup(29)							
Compare 1 Setup	(121)		(submenu)			7	1000
Compare 2 Setup	(122)		(submenu)			7	1000
Compare 3 Setup	(123)		(submenu)			7	1000
Compare 4 Setup	(124)		(submenu)			7	1000
Compare 5 Setup	(125)		(submenu)			7	1000
Compare 6 Setup	(126)		(submenu)			7	1000
Compare 7 Setup	(127)		(submenu)			7	1000
Compare 8 Setup	(128)		(submenu)			7	1000
Compare 9 Setup	(129)		(submenu)			7	1000
Compare 10 Setup	(130)		(submenu)			7	1000
Compare 11 Setup	(131)		(submenu)			7	1000
Compare 12 Setup	(132)		(submenu)			7	1000
Compare 13 Setup	(133)		(submenu)			7	1000
Compare 14 Setup	(134)		(submenu)			7	1000
Compare 15 Setup	(135)		(submenu)			7	1000
Compare 16 Setup	(136)		(submenu)			7	1000
PID Select Menu (48)							
PID scaler 1	0.390	______	-127.996	127.996	4801	7	0000
PID scaler 2	-0.390	______	-127.996	127.996	4802	7	0000
PID P Gain	0.390	______	0.000	98.996	4803	7	0000
PID I Gain	0.390	______	0.000	98.996	4804	7	0000
PID D Gain	0.000	______	0.000	98.996	4805	7	0000
PID Min Clamp	0 %	______	-200	200	4806	7	0000
PID Max Clamp	100 %	______	-200	200	4807	7	0000
PID Setpoint	0 %	______	-200	200	4808	7	1000
Memory Functions(30)							
Read Memory Byte			(function)			0	0000
Read Memory Word			(function)			0	0000
Write Memory Byte			(function)			7	0000
Write Memory Word			(function)				
Copy from RAM to EEPROM			(function)			7	0000
Copy from EEPROM to RAM			(function)			7	0000

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description		change	range		xcl#	lev	hmpd
Diagnostic Log Menu(31)							
Log var1	-Encoder fb		(list)			0	0000
Log var2	-Trq Cmd		(list)			0	0000
Log var3	-Slip Spd		(list)			0	0000
Log var4	-Mmf Spd		(list)			0	0000
Diag Log Time	3.6 sec	______	0.0	310.0		0	0000
Select Diagnostic Log			(function)			0	0000
Start Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Historic Log Menu(32)							
Select Historic Log			(function)			0	0000
Hist var1	-M % spd		(list)			0	0000
Hist var2	-Mtr Freq		(list)			0	0000
Hist var3	-Trq cmd		(list)			0	0000
Hist var4	-Trq I Fb		(list)			0	0000
Hist var5	-Mtr V fb		(list)			0	0000
Hist var6	-I sum fb		(list)			0	0000
Hist var7	-V Avail		(list)			0	0000
Historic Log Upload			(function)			0	0000
Fault Log Menu (33)							
Fault Log Display			(function)			0	0000
Fault Log Upload			(function)			0	0000
Overload Menu (34)							
Overld Select	1	______	0	2	3401	7	0000
I overload	120 %	______	20	210	3402	7	0000
I timeout	30.00 sec	______	0.01	300.00	3403	7	0000
Motor Trip volts	8500 V	______	5	9999	3404	7	0000
OverSpeed	120 %	______	0	250	3405	7	0000
Encoder Loss Thsh	0 %	______	0	75	3406	7	0000
Drive IOC Setpt	150 %	______	50	200	3407	7	0000
I overload 2	150 %	______	20	210	3408	7	1000
I timeout 2	60.00 sec	______	0.01	300.00	3409	7	1000
I overload 3	150 %	______	20	210	3410	7	1000
I timeout 3	60.00 sec	______	0.01	300.00	3411	7	1000
Enter for Fault Reset			(function)			0	0000
Clear Fault Message			(function)			7	1000

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description		change		range	xcl#	lev	hmpd
Limit Menu (35)							
Mot trq limit	100 %	_______	0	300	3501	7	0000
Reg trq limit	2.0 %	_______	0.0	30.0	3502	7	0000
Mot Alg limit	100 %	_______	0	300	3503	7	0000
Regen Alg limit	2.0 %	_______	0.0	30.0	3504	7	0000
Mot trq limit 2	100 %	_______	0	300	3505	7	1000
Reg trq limit 2	3.6 %	_______	0.0	30.0	3506	7	1000
Mot trq limit 3	100 %	_______	0	300	3507	7	1000
Reg trq limit 3	3.6 %	_______	0.0	30.0	3508	7	1000
Analog I/O Setup(36)							
Alg var1	-Speed fb			(list)		7	0000
Alg var2	-Spd Reg Cmd			(list)		7	0000
Analog TP 1	10.000 V	_______	-20.000	20.000		7	0000
Analog TP 2	10.000 V	_______	-20.000	20.000		7	0000
Alg In Scaler	100 %	_______	0	250		7	0000
Analog Output 1	(111)			(submenu)		7	1000
Analog Output 2	(112)			(submenu)		7	1000
Analog Output 3	(113)			(submenu)		7	1000
Analog Output 4	(114)			(submenu)		7	1000
Analog Output 5	(115)			(submenu)		7	1000
Analog Output 6	(116)			(submenu)		7	1000
Analog Output 7	(117)			(submenu)		7	1000
Analog Output 8	(118)			(submenu)		7	1000
Analog Input 1	(181)			(submenu)		7	1000
Analog Input 2	(182)			(submenu)		7	1000
Analog Input 3	(183)			(submenu)		7	1000
Analog Input 4	(184)			(submenu)		7	1000
Analog Input 5	(185)			(submenu)		7	1000
Analog Input 6	(186)			(submenu)		7	1000
Analog Input 7	(187)			(submenu)		7	1000
Analog Input 8	(188)			(submenu)		7	1000
Vel Ref	- (empty)			(list)		7	1000
PID Ref	- (empty)			(list)		7	1000
Aux Vel Ref	- (empty)			(list)		7	1000
Trq Ref	- (empty)			(list)		7	1000
Display Var. Menu(37)							
Disp var0	-Mtr rpm			(list)		0	0000
Disp var1	-Encoder fb			(list)		0	0000
Disp var2	-Mag I Fb			(list)		0	0000
Disp var3	-Spd Input			(list)		0	0000

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description		change		range	xcl#	lev	hmpd
Trim Analog Meters(38)							
Trim local meter 1				(function)		7	0000
Trim local meter 2				(function)		7	0000
Trim local meter 3				(function)		7	0000
Trim local meter 4				(function)		7	0000
Trim local meter 5				(function)		7	0000
Trim local meter 6				(function)		7	0000
Trim local meter 7				(function)		7	0000
Trim local meter 8				(function)		7	0000
Loc. Alg. Meters(39)							
Analog Meter 1	(51)			(submenu)		0	0000
Analog Meter 2	(52)			(submenu)		0	0000
Analog Meter 3	(53)			(submenu)		0	0000
Analog Meter 4	(54)			(submenu)		0	0000
Analog Meter 5	(55)			(submenu)		0	0000
Analog Meter 6	(56)			(submenu)		0	0000
Analog Meter 7	(57)			(submenu)		0	0000
Analog Meter 8	(58)			(submenu)		0	0000
Loc. Dig. Meters(40)							
Digital Meter 1	(61)			(submenu)		0	0000
Digital Meter 2	(62)			(submenu)		0	0000
Digital Meter 3	(63)			(submenu)		0	0000
Digital Meter 4	(64)			(submenu)		0	0000
Digital Meter 5	(65)			(submenu)		0	0000
Digital Meter 6	(66)			(submenu)		0	0000
Digital Meter 7	(67)			(submenu)		0	0000
RS232 Functions (41)							
System Program Download				(function)		7	0000
System Program Upload				(function)		0	0000
Display Sys Prog Name				(function)		0	0000
Download entire EEPROM				(function)		7	0000
Upload entire EEPROM				(function)		0	0000
Parameter Data Download				(function)		7	0000
Parameter Data Upload				(function)		0	0000
RS232 Echo-back test				(function)		0	0000
Parameter Log Upload				(function)		0	0000
Onboard RS232	1	______	0	1		7	1000

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description		change	range		xcl#	lev	hmpd
Remote I/O Menu (42)							
Read user module			(function)			0	0000
Write user module			(function)			7	0000
XCL Send Setup (43)							
XCL Global Send (145)			(submenu)			7	1001
XCL Send Reg 1-31 (147)			(submenu)			7	1000
XCL Send Reg 33-63(148)			(submenu)			7	1000
XCL Node Address	10	______	0	128		7	1001
CAB Configuration	0000	______	0000	FFFF		7	1001
XCL Global Send(145)							
XCL send01 - (empty)			(list)			0	0000
XCL send02 - (empty)			(list)			0	0000
XCL send03 - (empty)			(list)			0	0000
XCL send04 - (empty)			(list)			0	0000
XCL send05 - (empty)			(list)			0	0000
XCL send06 - (empty)			(list)			0	0000
XCL send07 - (empty)			(list)			0	0000
XCL send08 - (empty)			(list)			0	0000
XCL send09 - (empty)			(list)			0	0000
XCL send10 - (empty)			(list)			0	0000
XCL send11 - (empty)			(list)			0	0000
XCL send12 - (empty)			(list)			0	0000
XCL send13 - (empty)			(list)			0	0000
XCL send14 - (empty)			(list)			0	0000
XCL send15 - (empty)			(list)			0	0000
XCL send16 - (empty)			(list)			0	0000
XCL Send Reg 1-31(147)							
XCLreg001 -Spd Input %			(list)			0	0000
XCLreg003 -Ramp Out %			(list)			0	0000
XCLreg005 -Freq Dmd %			(list)			0	0000
XCLreg007 -Tot I Fb %			(list)			0	0000
XCLreg009 -Mtr V fb %			(list)			0	0000
XCLreg011 -KW output %			(list)			0	0000
XCLreg013 -Serial flg1			(list)			0	0000
XCLreg015 -Heartbt			(list)			0	0000
XCLreg017 - (empty)			(list)			0	0000
XCLreg019 - (empty)			(list)			0	0000
XCLreg021 - (empty)			(list)			0	0000
XCLreg023 - (empty)			(list)			0	0000
XCLreg025 - (empty)			(list)			0	0000
XCLreg027 - (empty)			(list)			0	0000
XCLreg029 - (empty)			(list)			0	0000

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description		change		range	xcl#	lev	hmpd
XCL Send Reg 1-31(147)		continued					
XCLreg031	- (empty)			(list)		0	0000
XCL Send Reg 33-63(148)							
XCLreg033	- (empty)			(list)		0	0000
XCLreg035	- (empty)			(list)		0	0000
XCLreg037	- (empty)			(list)		0	0000
XCLreg039	- (empty)			(list)		0	0000
XCLreg041	- (empty)			(list)		0	0000
XCLreg043	- (empty)			(list)		0	0000
XCLreg045	- (empty)			(list)		0	0000
XCLreg047	- (empty)			(list)		0	0000
XCLreg049	- (empty)			(list)		0	0000
XCLreg051	- (empty)			(list)		0	0000
XCLreg053	- (empty)			(list)		0	0000
XCLreg055	- (empty)			(list)		0	0000
XCLreg057	- (empty)			(list)		0	0000
XCLreg059	- (empty)			(list)		0	0000
XCLreg061	- (empty)			(list)		0	0000
XCLreg063	- (empty)			(list)		0	0000
XCL Recv Setup (44)							
XCL Vel Ref	(141)			(submenu)		7	1000
XCL Vel Ctrl	(142)			(submenu)		7	1000
XCL Trq Ctrl	(143)			(submenu)		7	1000
XCL Com Flags	(144)			(submenu)		7	1000
Ser Input Scalers	(146)			(submenu)		7	1001
XCL Vel Ref (141)							
XCLPTR_01	00:000	______	000	099		0	0001
XCLPTR_02	00:000	______	000	099		0	0001
XCLPTR_03	00:000	______	000	099		0	0001
XCLPTR_04	00:000	______	000	099		0	0001
XCLPTR_05	99:065	______	000	099		0	0001
XCLPTR_06	00:000	______	000	099		0	0001
XCLPTR_07	00:000	______	000	099		0	0001
XCLPTR_08	00:000	______	000	099		0	0001
XCLPTR_09	00:000	______	000	099		0	0001
XCLPTR_10	00:000	______	000	099		0	0001
XCLPTR_11	00:000	______	000	099		0	0001
XCLPTR_12	00:000	______	000	099		0	0001

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description		change	range		xcl#	lev	hmpd
XCL Vel Ctrl (142)							
XCLPTR_13	00:000	______	000	099		0	0001
XCLPTR_14	00:000	______	000	099		0	0001
XCLPTR_15	00:000	______	000	099		0	0001
XCLPTR_16	00:000	______	000	099		0	0001
XCLPTR_17	00:000	______	000	099		0	0001
XCLPTR_18	00:000	______	000	099		0	0001
XCLPTR_19	00:000	______	000	099		0	0001
XCLPTR_20	00:000	______	000	099		0	0001
XCLPTR_21	00:000	______	000	099		0	0001
XCLPTR_22	00:000	______	000	099		0	0001
XCLPTR_23	00:000	______	000	099		0	0001
XCLPTR_24	00:000	______	000	099		0	0001
XCLPTR_25	00:000	______	000	099		0	0001
XCLPTR_26	00:000	______	000	099		0	0001
XCLPTR_27	00:000	______	000	099		0	0001
XCLPTR_28	00:000	______	000	099		0	0001
XCLPTR_29	00:000	______	000	099		0	0001
XCLPTR_30	00:000	______	000	099		0	0001
XCLPTR_31	00:000	______	000	099		0	0001
XCLPTR_32	00:000	______	000	099		0	0001
XCLPTR_33	00:000	______	000	099		0	0001
XCLPTR_34	00:000	______	000	099		0	0001
XCLPTR_35	00:000	______	000	099		0	0001
XCLPTR_36	00:000	______	000	099		0	0001
XCL Trq Ctrl (143)							
XCLPTR_37	00:000	______	000	099		0	0001
XCLPTR_38	00:000	______	000	099		0	0001
XCLPTR_39	00:000	______	000	099		0	0001
XCLPTR_40	00:000	______	000	099		0	0001
XCLPTR_41	00:000	______	000	099		0	0001
XCLPTR_42	00:000	______	000	099		0	0001
XCLPTR_43	00:000	______	000	099		0	0001
XCLPTR_44	00:000	______	000	099		0	0001
XCLPTR_45	00:000	______	000	099		0	0001
XCLPTR_46	00:000	______	000	099		0	0001
XCLPTR_47	00:000	______	000	099		0	0001
XCLPTR_48	00:000	______	000	099		0	0001
XCLPTR_49	00:000	______	000	099		0	0001
XCLPTR_50	00:000	______	000	099		0	0001
XCLPTR_51	00:000	______	000	099		0	0001
XCLPTR_52	00:000	______	000	099		0	0001

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description		change	range		xcl#	lev	hmpd
XCL Com Flags (144)							
COMM_F01	99:067	______	000	099		0	0001
COMM_F02	99:069	______	000	099		0	0001
COMM_F03	00:000	______	000	099		0	0001
COMM_F04	00:000	______	000	099		0	0001
COMM_F05	00:000	______	000	099		0	0001
COMM_F06	00:000	______	000	099		0	0001
COMM_F07	00:000	______	000	099		0	0001
COMM_F08	00:000	______	000	099		0	0001
COMM_F09	00:000	______	000	099		0	0001
COMM_F10	00:000	______	000	099		0	0001
COMM_F11	00:000	______	000	099		0	0001
COMM_F12	00:000	______	000	099		0	0001
COMM_F13	00:000	______	000	099		0	0001
COMM_F14	00:000	______	000	099		0	0001
COMM_F15	00:000	______	000	099		0	0001
COMM_F16	00:000	______	000	099		0	0001
Ser Input Scalers(146)							
Vel Ref Ser	1.000	______	-125.000	125.000	4601	7	1000
V Aux Ref Ser	1.000	______	-125.000	125.000	4602	7	1000
V Ref P Lm Ser	1.000	______	-125.000	125.000	4603	7	1000
V Ref N Lm Ser	1.000	______	-125.000	125.000	4604	7	1000
Trq Cmd Ser	1.000	______	-125.000	125.000	4605	7	1000
Aux Trq Ser	1.000	______	-125.000	125.000	4606	7	1000
Trq P Lim Ser	1.000	______	-125.000	125.000	4607	7	1000
Trq N Lim Ser	1.000	______	-125.000	125.000	4608	7	1000
Hour Meter Setup(50)							
Display Hour Meter				(function)		0	0000
KW Hours Consumed				(function)		0	0000
Analog Meter 1 (51)							
Meter 1 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 2 (52)							
Meter 2 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000

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description		change		range	xcl#	lev	hmpd
Analog Meter 3 (53)							
Meter 3 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 4 (54)							
Meter 4 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 5 (55)							
Meter 5 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 6 (56)							
Meter 6 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 7 (57)							
Meter 7 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 8 (58)							
Meter 8 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Digital Meter 1 (61)							
Meter 1 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000

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description		change		range	xcl#	lev	hmpd
Digital Meter 2 (62)							
Meter 2 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 3 (63)							
Meter 3 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 4 (64)							
Meter 4 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 5 (65)							
Meter 5 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 6 (66)							
Meter 6 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 7 (67)							
Meter 7 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Analog Output 1(111)							
Analog var1-I sum fb				(list)		7	1000
Full Range	125.0 %	______	0.0	300.0		7	1000
Module Address	2	______	0	15		7	1000
Var1 type	-4-20ma			(list)		7	1000

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description		change		range	xcl#	lev	hmpd
Analog Output 2(112)							
Analog var2-KW output				(list)		7	1000
Full Range	85.0 %	_______	0.0	300.0		7	1000
Module Address	3	_______	0	15		7	1000
Var2 type -4-20ma				(list)		7	1000
Analog Output 3(113)							
Analog var3-Spd fb Abs				(list)		7	1000
Full Range	98.0 %	_______	0.0	300.0		7	1000
Module Address	6	_______	0	15		7	1000
Var3 type -4-20ma				(list)		7	1000
Analog Output 4(114)							
Analog var4- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var4 type - (empty)				(list)		7	1000
Analog Output 5(115)							
Analog var5- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var5 type - (empty)				(list)		7	1000
Analog Output 6(116)							
Analog var6- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var6 type - (empty)				(list)		7	1000
Analog Output 7(117)							
Analog var7- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var7 type - (empty)				(list)		7	1000

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description	change	range		xcl#	lev	hmpd
Analog Output 8(118)						
Analog var8- (empty)			(list)		7	1000
Full Range 0.0 %	_______	0.0	300.0		7	1000
Module Address 0	_______	0	15		7	1000
Var8 type - (empty)			(list)		7	1000
Compare 1 Setup(121)						
Comp 1 A in-V Avail			(list)		7	0000
Comp 1 B in- + 80.0 %			(list)		7	0000
Compare 1 -Magnitude			(list)		7	0000
Compare 2 Setup(122)						
Comp 2 A in-Encoder fb			(list)		7	0000
Comp 2 B in- + 2.5 %			(list)		7	0000
Compare 2 -Magnitude			(list)		7	0000
Compare 3 Setup(123)						
Comp 3 A in- + 48.3 %			(list)		7	0000
Comp 3 B in-Encoder fb			(list)		7	0000
Compare 3 -Magnitude			(list)		7	0000
Compare 4 Setup(124)						
Comp 4 A in- (empty)			(list)		0	0000
Comp 4 B in- (empty)			(list)		0	0000
Compare 4 - (empty)			(list)		0	0000
Compare 5 Setup(125)						
Comp 5 A in- (empty)			(list)		0	0000
Comp 5 B in- (empty)			(list)		0	0000
Compare 5 - (empty)			(list)		0	0000
Compare 6 Setup(126)						
Comp 6 A in- (empty)			(list)		0	0000
Comp 6 B in- (empty)			(list)		0	0000
Compare 6 - (empty)			(list)		0	0000

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description	change	range	xcl#	lev	hmpd
Compare 7 Setup(127)					
Comp 7 A in-	(empty)	(list)		0	0000
Comp 7 B in-	(empty)	(list)		0	0000
Compare 7 -	(empty)	(list)		0	0000
Compare 8 Setup(128)					
Comp 8 A in-	(empty)	(list)		0	0000
Comp 8 B in-	(empty)	(list)		0	0000
Compare 8 -	(empty)	(list)		0	0000
Compare 9 Setup(129)					
Comp 9 A in-	(empty)	(list)		0	0000
Comp 9 B in-	(empty)	(list)		0	0000
Compare 9 -	(empty)	(list)		0	0000
Compare 10 Setup(130)					
Comp 10 A i-	(empty)	(list)		0	0000
Comp 10 B i-	(empty)	(list)		0	0000
Compare 10 -	(empty)	(list)		0	0000
Compare 11 Setup(131)					
Comp 11 A i-	(empty)	(list)		0	0000
Comp 11 B i-	(empty)	(list)		0	0000
Compare 11 -	(empty)	(list)		0	0000
Compare 12 Setup(132)					
Comp 12 A i-	(empty)	(list)		0	0000
Comp 12 B i-	(empty)	(list)		0	0000
Compare 12 -	(empty)	(list)		0	0000
Compare 13 Setup(133)					
Comp 13 A i-	(empty)	(list)		0	0000
Comp 13 B i-	(empty)	(list)		0	0000
Compare 13 -	(empty)	(list)		0	0000

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             CO #145378   Drive # 11

        description         change              range      xcl# lev hmpd

      Compare 14 Setup(134)

    Comp 14 A i- (empty)                       (list)            0  0000
    Comp 14 B i- (empty)                       (list)            0  0000
    Compare 14 - (empty)                       (list)            0  0000

      Compare 15 Setup(135)

    Comp 15 A i- (empty)                       (list)            0  0000
    Comp 15 B i- (empty)                       (list)            0  0000
    Compare 15 - (empty)                       (list)            0  0000

      Compare 16 Setup(136)

    Comp 16 A i- (empty)                       (list)            0  0000
    Comp 16 B i- (empty)                       (list)            0  0000
    Compare 16 - (empty)                       (list)            0  0000

        Analog Input 1(181)

    Full Range        0.0 %  ______      0.0       300.0         7  1000
    Module Address      0    ______        0          15         7  1000
    Var1 type   - (empty)                      (list)            7  1000

        Analog Input 2(182)

    Full Range        0.0 %  ______      0.0       300.0         7  1000
    Module Address      0    ______        0          15         7  1000
    Var2 type   - (empty)                      (list)            7  1000

        Analog Input 3(183)

    Full Range        0.0 %  ______      0.0       300.0         7  1000
    Module Address      0    ______        0          15         7  1000
    Var3 type   - (empty)                      (list)            7  1000

        Analog Input 4(184)

    Full Range        0.0 %  ______      0.0       300.0         7  1000
    Module Address      0    ______        0          15         7  1000
    Var4 type   - (empty)                      (list)            7  1000
```

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description		change	range		xcl# lev	hmpd
Analog Input 5(185)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var5 type	- (empty)			(list)	7	1000
Analog Input 6(186)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var6 type	- (empty)			(list)	7	1000
Analog Input 7(187)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var7 type	- (empty)			(list)	7	1000
Analog Input 8(188)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var8 type	- (empty)			(list)	7	1000
Transfer Menu (200)						
Phase I gain	8	______	0	15	7	1000
Phase P shft	6	______	1	12	7	1000
Phase offset	0.0 deg	______	0.0	180.0	7	1000
Hardwr offst	-121.0 deg	______	-180.0	180.0	7	1000
Phase err thrsh	1.5 deg	______	0.0	5.0	7	0000
Line sync source	0	______	0	2	7	1001

End of Harmony PWM Parameter Dump

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CO #145378 Drive # 12

description		change	range	xcl#	lev	hmpd
Main menu	**(5)**					
Motor Menu	(1)		(submenu)		0	0000
Drive Menu	(2)		(submenu)		0	0000
Stability Menu	(3)		(submenu)		0	0000
Auto Menu	(4)		(submenu)		0	0000
Log Control	(6)		(submenu)		0	0000
Drive Protect Menu	(7)		(submenu)		0	0000
Meter Menu	(8)		(submenu)		0	0000
Communications Menu	(9)		(submenu)		0	0000
Enter Security Code			(function)		0	0000
Change Security Codes			(function)		2	1000
Security Edit	(0)		(submenu)		7	1000
Motor Menu	**(1)**					
Motor Param Menu	(11)		(submenu)		0	0000
Encoder Menu	(12)		(submenu)		0	0000
Motor Flux Menu	(13)		(submenu)		0	0000
Drive Menu	**(2)**					
Drive Param Menu	(14)		(submenu)		0	0000
Speed Setup	(15)		(submenu)		0	0000
Torq Ref Menu	(16)		(submenu)		0	0000
Ramp Setup Menu	(17)		(submenu)		0	0000
Pot Setup Menu	(18)		(submenu)		0	0000
Timebase Setup	(19)		(submenu)		0	0000
Hardware Scale Menu	(20)		(submenu)		0	0000
Cell Menu	(21)		(submenu)		0	0000
Transfer Menu	(200)		(submenu)		7	1000
Stability Menu	**(3)**					
Current Loop Setup	(22)		(submenu)		0	0000
Vector Control Tune	(23)		(submenu)		0	0000
Std Control Setup	(24)		(submenu)		0	0000
Control Loop Test	(25)		(submenu)		0	0000
Auto Menu	**(4)**					
Speed Profile Menu	(26)		(submenu)		0	0000
Speed Setpoint Menu	(27)		(submenu)		0	0000
Critical Speed Menu	(28)		(submenu)		0	0000
Comparator Setup	(29)		(submenu)		7	1000
PID Select Menu	(48)		(submenu)		0	0000

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description		change		range	xcl#	lev	hmpd
Log Control (6)							
Memory Functions (30)				(submenu)		0	0000
Diagnostic Log Menu(31)				(submenu)		0	0000
Historic Log Menu (32)				(submenu)		0	0000
Fault Log Menu (33)				(submenu)		0	0000
Drive Protect Menu(7)							
Overload Menu (34)				(submenu)		0	0000
Limit Menu (35)				(submenu)		0	0000
Meter Menu (8)							
Analog I/O Setup (36)				(submenu)		0	0000
Display Var. Menu (37)				(submenu)		0	0000
Trim Analog Meters (38)				(submenu)		7	0000
Loc. Alg. Meters (39)				(submenu)		0	0000
Loc. Dig. Meters (40)				(submenu)		0	0000
Communications Menu(9)							
RS232 Functions (41)				(submenu)		0	0000
Remote I/O Menu (42)				(submenu)		0	0000
XCL Send Setup (43)				(submenu)		7	1000
XCL Recv Setup (44)				(submenu)		7	1000
RS232 input- (empty)				(list)		0	0000
RS232 out - (empty)				(list)		0	0000
Motor Param Menu(11)							
Motor Freq	50 Hz	______	15	120	1101	7	0000
Number of poles	10	______	2	36	1102	7	0000
Motor eff	0.96	______	0.60	0.99	1103	7	0000
Full Ld Spd	593 rpm	______	1	7200	1104	7	0000
Motor voltage	6600 V	______	380	9000	1105	7	0000
Full load curr	227 A	______	12	1500	1106	7	0000
Motor KW	2000 KW	______	10	10000	1107	7	0000
Encoder Menu (12)							
Encoder1 PPR	1024	______	1	4000	1201	7	0000
Encoder2 PPR	1024	______	1	4000	1202	7	0000

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description		change	range		xcl#	lev	hmpd
Motor Flux Menu (13)							
Motor V Trim	1.000		0.050	2.000	1301	7	0000
Volts/Hz gain	1.00		0.00	10.00	1302	7	0000
Mag Current	72.0A		0.1	1500.0	1303	7	0000
Extended Enable	0		0	1	1304	7	0000
Flux Pause Level	40 %		0	100		7	0000
Flux pause	1.00 sec		0.01	8.00		7	0000
Drive Param Menu(14)							
Drive current	300 A		12	1500	1401	7	0000
Drive Rated Out	6600 V		200	15000	1402	7	0000
Drive Input Vlt	6600 V		200	15000	1403	7	0000
Auto reset enable	0		0	1	1404	7	0000
Aut rst time	1.00 sec		1.00	120.00	1405	7	0000
Spinning Load Select	0		0	1	1407	7	0000
Vector Control Select	1		0	1	1408	7	1001
Ramp Stop Select	1		0	1	1409	7	0000
Hall Effect Select	1		0	1		7	1001
Reduced Voltage Oper.	0		0	1		7	0000
Display Version Number			(function)			7	0000
Customer Order	145378		0	999999		7	0000
Customer Drive	12		0	20		7	0000
Speed Setup (15)							
Ratio Control	1.000		-125.000	125.000	1501	7	0000
Spd Fwd Lim	100 %		0	200	1502	7	0000
Spd Rev Lim	0 %		-200	0	1503	7	0000
Zero Speed	1 %		0	100	1504	7	0000
Alg Spd Scaler	100 %		0	250	1505	7	0000
Aux Spd Scaler	100 %		0	250	1506	7	0000
Spd Fwd Lim 2	100 %		0	200	1507	7	1000
Spd Rev Lim 2	-100 %		-200	0	1508	7	1000
Spd Fwd Lim 3	100 %		0	200	1509	7	1000
Spd Rev Lim 3	-100 %		-200	0	1510	7	1000
Encoder filter adj	2		0	6	1511	7	1000
Torq Ref Menu (16)							
Alg Trq Scaler	100 %		0	250	1601	7	0000
Aux Trq Scaler	100 %		0	250	1602	7	0000
Trq Setpoint	50 %		0	250	1603	7	0000
Holding Torque	0 %		-250	250	1604	7	1000
Alg hold Trq Scl	0 %		0	250	1605	7	1000
Trq Ramp incr	0.06 sec		0.00	999.99	1606	7	0000
Trq Ramp decr	0.06 sec		0.00	999.99	1607	7	0000

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description		change	range		xcl#	lev	hmpd
Ramp Setup Menu (17)							
Fwd Accel	90.0 sec	______	0.0	3200.0	1701	7	0000
Fwd Decel	90.0 sec	______	0.0	3200.0	1702	7	0000
Rev Accel	5.0 sec	______	0.0	3200.0	1703	7	0000
Rev Decel	5.0 sec	______	0.0	3200.0	1704	7	0000
Jerk Rate	0.10 sec	______	0.00	78.12	1705	7	0000
2 Stage Ramp Enable	0	______	0	1	1706	7	0000
Fwd Accel 2	180.0 sec	______	0.0	3200.0	1707	7	1000
Fwd Decel 2	180.0 sec	______	0.0	3200.0	1708	7	1000
Rev Accel 2	5.0 sec	______	0.0	3200.0	1709	7	1000
Rev Decel 2	5.0 sec	______	0.0	3200.0	1710	7	1000
Fwd Accel 3	90 sec	______	0	32000	1711	7	1000
Fwd Decel 3	90 sec	______	0	32000	1712	7	1000
Rev Accel 3	50 sec	______	0	32000	1713	7	1000
Rev Decel 3	50 sec	______	0	32000	1714	7	1000
Pot Setup Menu (18)							
Set max pos	100 %	______	0	200	1801	7	0000
Set max neg	0 %	______	-200	0	1802	7	0000
4-20ma Max	101.8 %	______	1.0	150.0	1803	7	0000
4-20ma Dropout	3.5 ma	______	0.0	10.0	1804	7	0000
Timebase Setup (19)							
Cond Stop Tmr	0.8 sec	______	0.0	999.9	1901	7	0000
Cond Run Tmr	0.8 sec	______	0.0	999.9	1902	7	0000
Cycle Timer	0 Hrs	______	0	10000	1903	7	0000
Hour Meter Setup	(50)		(submenu)			7	0000
Set the Clock time			(function)			7	0000
Hardware Scale Menu(20)							
Mot V fb	1600 v/v	______	1	3000	2001	7	0000
Line V fb	1650 v/v	______	1	9000	2002	7	0000
Ib Offset Adjust	7A	______	00	FF	2003	7	0000
Ic Offset Adjust	76	______	00	FF	2004	7	0000
Std Mot V Trim	9.100 V	______	0.000	10.000	2006	7	0000
Cell Menu (21)							
Installed Stages	6	______	3	7	2101	7	0000
Minimum Stage Count	3	______	1	6	2102	7	0000
Auto Bypass Enable	0	______	0	1	2103	7	0000
Print Cell Status			(function)			0	0000
Display Cell Fault(s)			(function)			0	0000
Print Cell Fault(s)			(function)			0	0000

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description		change	range		xcl#	lev	hmpd
Cell Menu (21) continued							
RS232 Diag Bypass	0		0	1		7	1000
Current Loop Setup(22)							
I quad I gain	0.625		0.000	0.996	2201	7	0000
I quad P gain	0.500		0.000	0.996	2202	7	0000
I direct I gain	0.300		0.000	0.996	2203	7	0000
I direct P gain	0.699		0.000	0.996	2204	7	0000
Vector Control Tune(23)							
Vel P gain	4.000		0.000	127.996	2301	7	0000
Vel I gain	4.000		0.000	255.996	2302	7	0000
Imag P gain	0.039		0.000	127.996	2303	7	0000
Imag I gain	0.300		0.000	127.996	2304	7	0000
Slip P gain	0.019		0.000	127.996	2305	7	0000
Slip I gain	0.199		0.000	127.996	2306	7	0000
Vel P gain 2	5.000		0.000	127.996	2307	7	1000
Vel I gain 2	4.000		0.000	255.996	2308	7	1000
Vel P gain 3	5.000		0.000	127.996	2309	7	1000
Vel I gain 3	4.000		0.000	255.996	2310	7	1000
Std Control Setup(24)							
Std Volts/Hz	1.000		-127.996	127.996	2401	0	0000
Volt P gain	0.500		-127.996	127.996	2402	0	0000
Volt I gain	0.500		-127.996	127.996	2403	0	0000
Vel P gain	5.000		0.000	127.996	2404	0	0000
Vel I gain	5.000		0.000	255.996	2405	0	0000
Trq P gain	0.007		0.000	127.996	2406	0	0000
Trq I gain	0.300		0.000	255.996	2407	0	0000
Full Load boost	0.0 %		0.0	100.0	2408	0	0000
Slow Ramp Time	3.00 sec		0.00	9.99	2409	0	0000
Mot trq limit	100 %		0	300	2410	0	0000
Regen trq limit	3.0 %		0.2	10.0	2411	0	0000
Energy Saver	0 %		0	100	2412	0	0000
K1	1.0		0.1	1.0		0	0000
Spin Load Thresh	4.3 %		0.0	50.0	2413	0	0000
Spin Flux Scale	6.25 %		1.00	15.00		0	0000
Flux Ramp	7.0 sec		0.1	15.0	2414	0	0000
Freq Scan Rate	5.0 sec		1.5	9.0	2415	0	0000
Freq Drop Level	5.0 %		0.0	12.0	2416	0	0000
Vel P gain 2	5.000		0.000	127.996	2417	7	1000
Vel I gain 2	4.000		0.000	255.996	2418	7	1000
Vel P gain 3	5.000		0.000	127.996	2419	7	1000
Vel I gain 3	4.000		0.000	255.996	2420	7	1000
Trq P gain 2	0.011		0.000	127.996	2421	7	1000

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description		change	range		xcl#	lev	hmpd
Std Control Setup(24) continued							
Trq I gain 2	0.300	______	0.000	255.996	2422	7	1000
Trq P gain 3	0.011	______	0.000	127.996	2423	7	1000
Trq I gain 3	0.300	______	0.000	255.996	2424	7	1000
Mot trq limit 2	100 %	______	0	300	2425	7	1000
Regen trq limit 2	3.0 %	______	0.2	10.0	2426	7	1000
Mot trq limit 3	100 %	______	0	300	2427	7	1000
Regen trq limit 3	3.0 %	______	0.2	10.0	2428	7	1000
Control Loop Test(25)							
Spd Test Pos	3 %	______	-200	200		7	0000
Spd Test Neg	0 %	______	-200	200		7	0000
Spd Test Time	3.1 sec	______	0.0	500.0		7	0000
Begin Speed Loop test			(function)			7	0000
Stop Speed Loop test			(function)			7	0000
Trq Test Pos	50 %	______	-200	200		7	0000
Trq Test Neg	0 %	______	-200	200		7	0000
Trq Test Time	0.75 sec	______	0.00	91.00		7	0000
Begin Torque Loop test			(function)			7	0000
Stop Torque Loop test			(function)			7	0000
Start Diagnostic Log			(function)			0	0000
Select Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Speed Profile Menu(26)							
Entry Pt.	0.0 %	______	0.0	150.0	2601	7	0000
Exit Pt.	100.0 %	______	0.0	150.0	2602	7	0000
Entry Spd	48.3 %	______	0.0	150.0	2603	7	0000
Exit Spd	98.3 %	______	0.0	150.0	2604	7	0000
Auto off	0.0 %	______	0.0	100.0	2605	7	0000
Delay off	0.5 sec	______	0.5	100.0	2606	7	0000
Auto on	0.0 %	______	0.0	100.0	2607	7	0000
Delay on	0.5 sec	______	0.5	100.0	2608	7	0000
Speed Setpoint Menu(27)							
Spd Setpt 1	0 rpm	______	-9999	9999	2701	7	0000
Spd Setpt 2	0 rpm	______	-9999	9999	2702	7	0000
Spd Setpt 3	0 rpm	______	-9999	9999	2703	7	0000
Spd Setpt 4	0 rpm	______	-9999	9999	2704	7	0000
Spd Setpt 5	0 rpm	______	-9999	9999	2705	7	0000
Spd Setpt 6	0 rpm	______	-9999	9999	2706	7	0000
Spd Setpt 7	0 rpm	______	-9999	9999	2707	7	0000

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description		change	range		xcl#	lev	hmpd
Critical Speed Menu(28)							
Skip Freq 1	15.0 Hz	______	0.0	120.0	2801	7	0000
Skip Freq 2	30.0 Hz	______	0.0	120.0	2802	7	0000
Skip Freq 3	45.0 Hz	______	0.0	120.0	2803	7	0000
Skip band 1	0.0 Hz	______	0.0	6.0	2804	7	0000
Skip band 2	0.0 Hz	______	0.0	6.0	2805	7	0000
Skip band 3	0.0 Hz	______	0.0	6.0	2806	7	0000
Comparator Setup(29)							
Compare 1 Setup	(121)		(submenu)			7	1000
Compare 2 Setup	(122)		(submenu)			7	1000
Compare 3 Setup	(123)		(submenu)			7	1000
Compare 4 Setup	(124)		(submenu)			7	1000
Compare 5 Setup	(125)		(submenu)			7	1000
Compare 6 Setup	(126)		(submenu)			7	1000
Compare 7 Setup	(127)		(submenu)			7	1000
Compare 8 Setup	(128)		(submenu)			7	1000
Compare 9 Setup	(129)		(submenu)			7	1000
Compare 10 Setup	(130)		(submenu)			7	1000
Compare 11 Setup	(131)		(submenu)			7	1000
Compare 12 Setup	(132)		(submenu)			7	1000
Compare 13 Setup	(133)		(submenu)			7	1000
Compare 14 Setup	(134)		(submenu)			7	1000
Compare 15 Setup	(135)		(submenu)			7	1000
Compare 16 Setup	(136)		(submenu)			7	1000
PID Select Menu (48)							
PID scaler 1	0.390	______	-127.996	127.996	4801	7	0000
PID scaler 2	-0.390	______	-127.996	127.996	4802	7	0000
PID P Gain	0.390	______	0.000	98.996	4803	7	0000
PID I Gain	0.390	______	0.000	98.996	4804	7	0000
PID D Gain	0.000	______	0.000	98.996	4805	7	0000
PID Min Clamp	0 %	______	-200	200	4806	7	0000
PID Max Clamp	100 %	______	-200	200	4807	7	0000
PID Setpoint	0 %	______	-200	200	4808	7	1000
Memory Functions(30)							
Read Memory Byte			(function)			0	0000
Read Memory Word			(function)			0	0000
Write Memory Byte			(function)			7	0000
Write Memory Word			(function)			7	0000
Copy from RAM to EEPROM			(function)			7	0000
Copy from EEPROM to RAM			(function)			7	0000

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description		change	range		xcl#	lev	hmpd
Diagnostic Log Menu(31)							
Log var1 -Encoder fb			(list)			0	0000
Log var2 -Trq Cmd			(list)			0	0000
Log var3 -Slip Spd			(list)			0	0000
Log var4 -Mmf Spd			(list)			0	0000
Diag Log Time	3.6 sec	______	0.0	310.0		0	0000
Select Diagnostic Log			(function)			0	0000
Start Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Historic Log Menu(32)							
Select Historic Log			(function)			0	0000
Hist var1 -M % spd			(list)			0	0000
Hist var2 -Mtr Freq			(list)			0	0000
Hist var3 -Trq cmd			(list)			0	0000
Hist var4 -Trq I Fb			(list)			0	0000
Hist var5 -Mtr V fb			(list)			0	0000
Hist var6 -I sum fb			(list)			0	0000
Hist var7 -V Avail			(list)			0	0000
Historic Log Upload			(function)			0	0000
Fault Log Menu (33)							
Fault Log Display			(function)			0	0000
Fault Log Upload			(function)			0	0000
Overload Menu (34)							
Overld Select	1	______	0	2	3401	7	0000
I overload	120 %	______	20	210	3402	7	0000
I timeout	30.00 sec	______	0.01	300.00	3403	7	0000
Motor Trip volts	8500 V	______	5	9999	3404	7	0000
OverSpeed	120 %	______	0	250	3405	7	0000
Encoder Loss Thsh	0 %	______	0	75	3406	7	0000
Drive IOC Setpt	150 %	______	50	200	3407	7	0000
I overload 2	150 %	______	20	210	3408	7	1000
I timeout 2	60.00 sec	______	0.01	300.00	3409	7	1000
I overload 3	150 %	______	20	210	3410	7	1000
I timeout 3	60.00 sec	______	0.01	300.00	3411	7	1000
Enter for Fault Reset			(function)			0	0000
Clear Fault Message			(function)			7	1000

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description		change	range		xcl#	lev	hmpd
Limit Menu (35)							
Mot trq limit	100 %	_______	0	300	3501	7	0000
Reg trq limit	3.0 %	_______	0.0	30.0	3502	7	0000
Mot Alg limit	100 %	_______	0	300	3503	7	00
Regen Alg limit	3.6 %	_______	0.0	30.0	3504	7	0000
Mot trq limit 2	100 %	_______	0	300	3505	7	1000
Reg trq limit 2	3.6 %	_______	0.0	30.0	3506	7	1000
Mot trq limit 3	100 %	_______	0	300	3507	7	1000
Reg trq limit 3	3.6 %	_______	0.0	30.0	3508	7	1000
Analog I/O Setup(36)							
Alg var1	-Speed fb			(list)		7	0000
Alg var2	-Spd Reg Cmd			(list)		7	0000
Analog TP 1	10.000 V	_______	-20.000	20.000		7	0000
Analog TP 2	10.000 V	_______	-20.000	20.000		7	0000
Alg In Scaler	100 %	_______	0	250		7	0000
Analog Output 1	(111)			(submenu)		7	1000
Analog Output 2	(112)			(submenu)		7	1000
Analog Output 3	(113)			(submenu)		7	1000
Analog Output 4	(114)			(submenu)		7	1000
Analog Output 5	(115)			(submenu)		7	1000
Analog Output 6	(116)			(submenu)		7	1000
Analog Output 7	(117)			(submenu)		7	1000
Analog Output 8	(			(submenu)		7	1000
Analog Input 1	(181)			(submenu)		7	1000
Analog Input 2	(182)			(submenu)		7	1000
Analog Input 3	(183)			(submenu)		7	1000
Analog Input 4	(184)			(submenu)		7	1000
Analog Input 5	(185)			(submenu)		7	1000
Analog Input 6	(186)			(submenu)		7	1000
Analog Input 7	(187)			(submenu)		7	1000
Analog Input 8	(188)			(submenu)		7	1000
Vel Ref	- (empty)			(list)		7	1000
PID Ref	- (empty)			(list)		7	1000
Aux Vel Ref-	(empty)			(list)		7	1000
Trq Ref	- (empty)			(list)		7	1000
Display Var. Menu(37)							
Disp var0	-Mtr rpm			(list)		0	0000
Disp var1	-Encoder fb			(list)		0	0000
Disp var2	-Mag I Fb			(list)		0	0000
Disp var3	-I sum fb			(list)		0	0000

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description	change	range	xcl#	lev	hmpd
Trim Analog Meters(38)					
Trim local meter 1		(function)		7	0000
Trim local meter 2		(function)		7	0000
Trim local meter 3		(function)		7	0000
Trim local meter 4		(function)		7	0000
Trim local meter 5		(function)		7	0000
Trim local meter 6		(function)		7	0000
Trim local meter 7		(function)		7	0000
Trim local meter 8		(function)		7	0000
Loc. Alg. Meters(39)					
Analog Meter 1 (51)		(submenu)		0	0000
Analog Meter 2 (52)		(submenu)		0	0000
Analog Meter 3 (53)		(submenu)		0	0000
Analog Meter 4 (54)		(submenu)		0	0000
Analog Meter 5 (55)		(submenu)		0	0000
Analog Meter 6 (56)		(submenu)		0	0000
Analog Meter 7 (57)		(submenu)		0	0000
Analog Meter 8 (58)		(submenu)		0	0000
Loc. Dig. Meters(40)					
Digital Meter 1 (61)		(submenu)		0	0000
Digital Meter 2 (62)		(submenu)		0	0000
Digital Meter 3 (63)		(submenu)		0	0000
Digital Meter 4 (64)		(submenu)		0	0000
Digital Meter 5 (65)		(submenu)		0	0000
Digital Meter 6 (66)		(submenu)		0	0000
Digital Meter 7 (67)		(submenu)		0	0000
RS232 Functions (41)					
System Program Download		(function)		7	0000
System Program Upload		(function)		0	0000
Display Sys Prog Name		(function)		0	0000
Download entire EEPROM		(function)		7	0000
Upload entire EEPROM		(function)		0	0000
Parameter Data Download		(function)		7	0000
Parameter Data Upload		(function)		0	0000
RS232 Echo-back test		(function)		0	0000
Parameter Log Upload		(function)		0	0000
Onboard RS232 1	_______	0 1		7	1000

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description		change	range		xcl#	lev	hmpd
Remote I/O Menu (42)							
Read user module			(function)			0	0000
Write user module			(function)			7	0000
XCL Send Setup (43)							
XCL Global Send (145)			(submenu)			7	1001
XCL Send Reg 1-31 (147)			(submenu)			7	1000
XCL Send Reg 33-63(148)			(submenu)			7	1000
XCL Node Address	10	______	0	128		7	1001
CAB Configuration	0000	______	0000	FFFF		7	1001
XCL Global Send(145)							
XCL send01 - (empty)			(list)			0	0000
XCL send02 - (empty)			(list)			0	0000
XCL send03 - (empty)			(list)			0	0000
XCL send04 - (empty)			(list)			0	0000
XCL send05 - (empty)			(list)			0	0000
XCL send06 - (empty)			(list)			0	0000
XCL send07 - (empty)			(list)			0	0000
XCL send08 - (empty)			(list)			0	0000
XCL send09 - (empty)			(list)			0	0000
XCL send10 - (empty)			(list)			0	0000
XCL send11 - (empty)			(list)			0	0000
XCL send12 - (empty)			(list)			0	0000
XCL send13 - (empty)			(list)			0	0000
XCL send14 - (empty)			(list)			0	0000
XCL send15 - (empty)			(list)			0	0000
XCL send16 - (empty)			(list)			0	0000
XCL Send Reg 1-31(147)							
XCLreg001 -Spd Input %			(list)			0	0000
XCLreg003 -Ramp Out %			(list)			0	0000
XCLreg005 -Freq Dmd %			(list)			0	0000
XCLreg007 -Tot I Fb %			(list)			0	0000
XCLreg009 -Mtr V fb %			(list)			0	0000
XCLreg011 -KW output %			(list)			0	0000
XCLreg013 -Serial flg1			(list)			0	0000
XCLreg015 -Heartbt			(list)			0	0000
XCLreg017 - (empty)			(list)			0	0000
XCLreg019 - (empty)			(list)			0	0000
XCLreg021 - (empty)			(list)			0	0000
XCLreg023 - (empty)			(list)			0	0000
XCLreg025 - (empty)			(list)			0	0000
XCLreg027 - (empty)			(list)			0	0000
XCLreg029 - (empty)			(list)			0	0000

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description		change		range	xcl#	lev	hmpd
XCL Send Reg 1-31(147)		continued					
XCLreg031	- (empty)			(list)		0	0000
XCL Send Reg 33-63(148)							
XCLreg033	- (empty)			(list)		0	0000
XCLreg035	- (empty)			(list)		0	0000
XCLreg037	- (empty)			(list)		0	0000
XCLreg039	- (empty)			(list)		0	0000
XCLreg041	- (empty)			(list)		0	0000
XCLreg043	- (empty)			(list)		0	0000
XCLreg045	- (empty)			(list)		0	0000
XCLreg047	- (empty)			(list)		0	0000
XCLreg049	- (empty)			(list)		0	0000
XCLreg051	- (empty)			(list)		0	0000
XCLreg053	- (empty)			(list)		0	0000
XCLreg055	- (empty)			(list)		0	0000
XCLreg057	- (empty)			(list)		0	0000
XCLreg059	- (empty)			(list)		0	0000
XCLreg061	- (empty)			(list)		0	0000
XCLreg063	- (empty)			(list)		0	0000
XCL Recv Setup (44)							
XCL Vel Ref	(141)			(submenu)		7	1000
XCL Vel Ctrl	(142)			(submenu)		7	1000
XCL Trq Ctrl	(143)			(submenu)		7	1000
XCL Com Flags	(144)			(submenu)		7	1000
Ser Input Scalers	(146)			(submenu)		7	1001
XCL Vel Ref (141)							
XCLPTR_01	00:000	______	000	099		0	0001
XCLPTR_02	00:000	______	000	099		0	0001
XCLPTR_03	00:000	______	000	099		0	0001
XCLPTR_04	00:000	______	000	099		0	0001
XCLPTR_05	99:065	______	000	099		0	0001
XCLPTR_06	00:000	______	000	099		0	0001
XCLPTR_07	00:000	______	000	099		0	0001
XCLPTR_08	00:000	______	000	099		0	0001
XCLPTR_09	00:000	______	000	099		0	0001
XCLPTR_10	00:000	______	000	099		0	0001
XCLPTR_11	00:000	______	000	099		0	0001
XCLPTR_12	00:000	______	000	099		0	0001

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description		change		range	xcl#	lev	hmpd
XCL Vel Ctrl (142)							
XCLPTR_13	00:000	______	000	099	0	0001	
XCLPTR_14	00:000	______	000	099	0	0001	
XCLPTR_15	00:000	______	000	099	0	0001	
XCLPTR_16	00:000	______	000	099	0	0001	
XCLPTR_17	00:000	______	000	099	0	0001	
XCLPTR_18	00:000	______	000	099	0	0001	
XCLPTR_19	00:000	______	000	099	0	0001	
XCLPTR_20	00:000	______	000	099	0	0001	
XCLPTR_21	00:000	______	000	099	0	0001	
XCLPTR_22	00:000	______	000	099	0	0001	
XCLPTR_23	00:000	______	000	099	0	0001	
XCLPTR_24	00:000	______	000	099	0	0001	
XCLPTR_25	00:000	______	000	099	0	0001	
XCLPTR_26	00:000	______	000	099	0	0001	
XCLPTR_27	00:000	______	000	099	0	0001	
XCLPTR_28	00:000	______	000	099	0	0001	
XCLPTR_29	00:000	______	000	099	0	0001	
XCLPTR_30	00:000	______	000	099	0	0001	
XCLPTR_31	00:000	______	000	099	0	0001	
XCLPTR_32	00:000	______	000	099	0	0001	
XCLPTR_33	00:000	______	000	099	0	0001	
XCLPTR_34	00:000	______	000	099	0	0001	
XCLPTR_35	00:000	______	000	099	0	0001	
XCLPTR_36	00:000	______	000	099	0	0001	
XCL Trq Ctrl (143)							
XCLPTR_37	00:000	______	000	099	0	0001	
XCLPTR_38	00:000	______	000	099	0	0001	
XCLPTR_39	00:000	______	000	099	0	0001	
XCLPTR_40	00:000	______	000	099	0	0001	
XCLPTR_41	00:000	______	000	099	0	0001	
XCLPTR_42	00:000	______	000	099	0	0001	
XCLPTR_43	00:000	______	000	099	0	0001	
XCLPTR_44	00:000	______	000	099	0	0001	
XCLPTR_45	00:000	______	000	099	0	0001	
XCLPTR_46	00:000	______	000	099	0	0001	
XCLPTR_47	00:000	______	000	099	0	0001	
XCLPTR_48	00:000	______	000	099	0	0001	
XCLPTR_49	00:000	______	000	099	0	0001	
XCLPTR_50	00:000	______	000	099	0	0001	
XCLPTR_51	00:000	______	000	099	0	0001	
XCLPTR_52	00:000	______	000	099	0	0001	

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description		change	range		xcl#	lev	hmpd
XCL Com Flags (144)							
COMM_F01	99:067	______	000	099		0	0001
COMM_F02	99:069	______	000	099		0	0001
COMM_F03	00:000	______	000	099		0	0001
COMM_F04	00:000	______	000	099		0	0001
COMM_F05	00:000	______	000	099		0	0001
COMM_F06	00:000	______	000	099		0	0001
COMM_F07	00:000	______	000	099		0	0001
COMM_F08	00:000	______	000	099		0	0001
COMM_F09	00:000	______	000	099		0	0001
COMM_F10	00:000	______	000	099		0	0001
COMM_F11	00:000	______	000	099		0	0001
COMM_F12	00:000	______	000	099		0	0001
COMM_F13	00:000	______	000	099		0	0001
COMM_F14	00:000	______	000	099		0	0001
COMM_F15	00:000	______	000	099		0	0001
COMM_F16	00:000	______	000	099		0	0001
Ser Input Scalers(146)							
Vel Ref Ser	1.000	______	-125.000	125.000	4601	7	1000
V Aux Ref Ser	1.000	______	-125.000	125.000	4602	7	1000
V Ref P Lm Ser	1.000	______	-125.000	125.000	4603	7	1000
V Ref N Lm Ser	1.000	______	-125.000	125.000	4604	7	1000
Trq Cmd Ser	1.000	______	-125.000	125.000	4605	7	1000
Aux Trq Ser	1.000	______	-125.000	125.000	4606	7	1000
Trq P Lim Ser	1.000	______	-125.000	125.000	4607	7	1000
Trq N Lim Ser	1.000	______	-125.000	125.000	4608	7	1000
Hour Meter Setup(50)							
Display Hour Meter			(function)			0	0000
KW Hours Consumed			(function)			0	0000
Analog Meter 1 (51)							
Meter 1 var- (empty)			(list)			0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 2 (52)							
Meter 2 var- (empty)			(list)			0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000

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description		change		range	xcl#	lev	hmpd
Analog Meter 3 (53)							
Meter 3 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 4 (54)							
Meter 4 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 5 (55)							
Meter 5 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 6 (56)							
Meter 6 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 7 (57)							
Meter 7 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 8 (58)							
Meter 8 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Digital Meter 1 (61)							
Meter 1 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000

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description		change		range	xcl#	lev	hmpd
Digital Meter 2 (62)							
Meter 2 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 3 (63)							
Meter 3 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 4 (64)							
Meter 4 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 5 (65)							
Meter 5 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 6 (66)							
Meter 6 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 7 (67)							
Meter 7 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Analog Output 1(111)							
Analog var1-I sum fb				(list)		7	1000
Full Range	125.0 %	______	0.0	300.0		7	1000
Module Address	2	______	0	15		7	1000
Var1 type -4-20ma				(list)		7	1000

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description		change	range		xcl#	lev	hmpd
Analog Output 2(112)							
Analog var2-KW output				(list)		7	1000
Full Range	74.0 %	_______	0.0	300.0		7	1000
Module Address	3	_______	0	15		7	1000
Var2 type	-4-20ma			(list)		7	1000
Analog Output 3(113)							
Analog var3-Encoder fb				(list)		7	1000
Full Range	101.0 %	_______	0.0	300.0		7	1000
Module Address	6	_______	0	15		7	1000
Var3 type	-4-20ma			(list)		7	1000
Analog Output 4(114)							
Analog var4- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var4 type	- (empty)			(list)		7	1000
Analog Output 5(115)							
Analog var5- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var5 type	- (empty)			(list)		7	1000
Analog Output 6(116)							
Analog var6- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var6 type	- (empty)			(list)		7	1000
Analog Output 7(117)							
Analog var7- (empty)				(list)		7	1000
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var7 type	- (empty)			(list)		7	1000

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description	change		range	xcl#	lev	hmpd
Analog Output 8(118)						
Analog var8- (empty)			(list)		7	1000
Full Range 0.0 %	______	0.0	300.0		7	1000
Module Address 0	______	0	15		7	1000
Var8 type - (empty)			(list)		7	1000
Compare 1 Setup(121)						
Comp 1 A in-V Avail			(list)		7	0000
Comp 1 B in- + 80.0 %			(list)		7	0000
Compare 1 -Magnitude			(list)		7	0000
Compare 2 Setup(122)						
Comp 2 A in-Encoder fb			(list)		7	0000
Comp 2 B in- + 2.5 %			(list)		7	0000
Compare 2 -Magnitude			(list)		7	0000
Compare 3 Setup(123)						
Comp 3 A in- + 48.3 %			(list)		7	0000
Comp 3 B in-Encoder fb			(list)		7	0000
Compare 3 -Magnitude			(list)		7	0000
Compare 4 Setup(124)						
Comp 4 A in- (empty)			(list)		0	0000
Comp 4 B in- (empty)			(list)		0	0000
Compare 4 - (empty)			(list)		0	0000
Compare 5 Setup(125)						
Comp 5 A in- (empty)			(list)		0	0000
Comp 5 B in- (empty)			(list)		0	0000
Compare 5 - (empty)			(list)		0	0000
Compare 6 Setup(126)						
Comp 6 A in- (empty)			(list)		0	0000
Comp 6 B in- (empty)			(list)		0	0000
Compare 6 - (empty)			(list)		0	0000

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description	change	range	xcl#	lev	hmpd
Compare 7 Setup(127)					
Comp 7 A in-	(empty)	(list)		0	0000
Comp 7 B in-	(empty)	(list)		0	0000
Compare 7 -	(empty)	(list)		0	0000
Compare 8 Setup(128)					
Comp 8 A in-	(empty)	(list)		0	0000
Comp 8 B in-	(empty)	(list)		0	0000
Compare 8 -	(empty)	(list)		0	0000
Compare 9 Setup(129)					
Comp 9 A in-	(empty)	(list)		0	0000
Comp 9 B in-	(empty)	(list)		0	0000
Compare 9 -	(empty)	(list)		0	0000
Compare 10 Setup(130)					
Comp 10 A i-	(empty)	(list)		0	0000
Comp 10 B i-	(empty)	(list)		0	0000
Compare 10 -	(empty)	(list)		0	0000
Compare 11 Setup(131)					
Comp 11 A i-	(empty)	(list)		0	0000
Comp 11 B i-	(empty)	(list)		0	0000
Compare 11 -	(empty)	(list)		0	0000
Compare 12 Setup(132)					
Comp 12 A i-	(empty)	(list)		0	0000
Comp 12 B i-	(empty)	(list)		0	0000
Compare 12 -	(empty)	(list)		0	0000
Compare 13 Setup(133)					
Comp 13 A i-	(empty)	(list)		0	0000
Comp 13 B i-	(empty)	(list)		0	0000
Compare 13 -	(empty)	(list)		0	0000

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description		change	range		xcl#	lev	hmpd
Compare 14 Setup(134)							
Comp 14 A i-	(empty)			(list)		0	0000
Comp 14 B i-	(empty)			(list)		0	0000
Compare 14 -	(empty)			(list)		0	0000
Compare 15 Setup(135)							
Comp 15 A i-	(empty)			(list)		0	0000
Comp 15 B i-	(empty)			(list)		0	0000
Compare 15 -	(empty)			(list)		0	0000
Compare 16 Setup(136)							
Comp 16 A i-	(empty)			(list)		0	0000
Comp 16 B i-	(empty)			(list)		0	0000
Compare 16 -	(empty)			(list)		0	0000
Analog Input 1(181)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var1 type -	(empty)			(list)		7	1000
Analog Input 2(182)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var2 type -	(empty)			(list)		7	1000
Analog Input 3(183)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var3 type -	(empty)			(list)		7	1000
Analog Input 4(184)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var4 type -	(empty)			(list)		7	1000

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description		change	range		xcl#	lev	hmpd
Analog Input 5(185)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var5 type	- (empty)			(list)		7	1000
Analog Input 6(186)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var6 type	- (empty)			(list)		7	1000
Analog Input 7(187)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var7 type	- (empty)			(list)		7	1000
Analog Input 8(188)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var8 type	- (empty)			(list)		7	1000
Transfer Menu (200)							
Phase I gain	8	_______	0	15		7	1000
Phase P shft	6	_______	1	12		7	1000
Phase offset	0.0 deg	_______	0.0	180.0		7	1000
Hardwr offst	-121.0 deg	_______	-180.0	180.0		7	1000
Phase err thrsh	1.5 deg	_______	0.0	5.0		7	0000
Line sync source	0	_______	0	2		7	1001

End of Harmony PWM Parameter Dump

ISSUED BY: G.C DATE: 22/10/98
AS BUILT

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CO #145378 Drive # 13

description		change	range	xcl#	lev	hmpd
Main menu	(5)					
Motor Menu	(1)		(submenu)		0	0000
Drive Menu	(2)		(submenu)		0	0000
Stability Menu	(3)		(submenu)		0	0000
Auto Menu	(4)		(submenu)		0	0000
Log Control	(6)		(submenu)		0	0000
Drive Protect Menu	(7)		(submenu)		0	0000
Meter Menu	(8)		(submenu)		0	0000
Communications Menu	(9)		(submenu)		0	0000
Enter Security Code			(function)		0	0000
Change Security Codes			(function)		2	1000
Security Edit	(0)		(submenu)		7	1000
Motor Menu	(1)					
Motor Param Menu	(11)		(submenu)		0	0000
Encoder Menu	(12)		(submenu)		0	0000
Motor Flux Menu	(13)		(submenu)		0	0000
Drive Menu	(2)					
Drive Param Menu	(14)		(submenu)		0	0000
Speed Setup	(15)		(submenu)		0	0000
Torq Ref Menu	(16)		(submenu)		0	0000
Ramp Setup Menu	(17)		(submenu)		0	0000
Pot Setup Menu	(18)		(submenu)		0	0000
Timebase Setup	(19)		(submenu)		0	0000
Hardware Scale Menu	(20)		(submenu)		0	0000
Cell Menu	(21)		(submenu)		0	0000
Transfer Menu	(200)		(submenu)		7	1000
Stability Menu	(3)					
Current Loop Setup	(22)		(submenu)		0	0000
Vector Control Tune	(23)		(submenu)		0	0000
Std Control Setup	(24)		(submenu)		0	0000
Control Loop Test	(25)		(submenu)		0	0000
Auto Menu	(4)					
Speed Profile Menu	(26)		(submenu)		0	0000
Speed Setpoint Menu	(27)		(submenu)		0	0000
Critical Speed Menu	(28)		(submenu)		0	0000
Comparator Setup	(29)		(submenu)		7	1000
PID Select Menu	(48)		(submenu)		0	0000

description		change		range	xcl#	lev	hmpd
Log Control (6)							
Memory Functions (30)				(submenu)		0	0000
Diagnostic Log Menu (31)				(submenu)		0	0000
Historic Log Menu (32)				(submenu)		0	0000
Fault Log Menu (33)				(submenu)		0	0000
Drive Protect Menu (7)							
Overload Menu (34)				(submenu)		0	0000
Limit Menu (35)				(submenu)		0	0000
Meter Menu (8)							
Analog I/O Setup (36)				(submenu)		0	0000
Display Var. Menu (37)				(submenu)		0	0000
Trim Analog Meters (38)				(submenu)		7	0000
Loc. Alg. Meters (39)				(submenu)		0	0000
Loc. Dig. Meters (40)				(submenu)		0	0000
Communications Menu (9)							
RS232 Functions (41)				(submenu)		0	0000
Remote I/O Menu (42)				(submenu)		0	0000
XCL Send Setup (43)				(submenu)		7	1000
XCL Recv Setup (44)				(submenu)		7	1000
RS232 input- (empty)				(list)		0	0000
RS232 out - (empty)				(list)		0	0000
Motor Param Menu (11)							
Motor Freq	50 Hz	______	15	120	1101	7	0000
Number of poles	10	______	2	36	1102	7	0000
Motor eff	0.96	______	0.60	0.99	1103	7	0000
Full Ld Spd	593 rpm	______	1	7200	1104	7	0000
Motor voltage	6600 V	______	380	9000	1105	7	0000
Full load curr	227 A	______	12	1500	1106	7	0000
Motor KW	2000 KW	______	10	10000	1107	7	0000
Encoder Menu (12)							
Encoder1 PPR	1024	______	1	4000	1201	7	0000
Encoder2 PPR	1024	______	1	4000	1202	7	0000

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description		change	range		xcl#	lev	hmpd
Motor Flux Menu (13)							
Motor V Trim	1.000	______	0.050	2.000	1301	7	0000
Volts/Hz gain	1.00	______	0.00	10.00	1302	7	0000
Mag Current	73.0 A	______	0.1	1500.0	1303	7	0000
Extended Enable	0	______	0	1	1304	7	0000
Flux Pause Level	40 %	______	0	100		7	0000
Flux pause	2.00 sec	______	0.01	8.00		7	0000
Drive Param Menu(14)							
Drive current	300 A	______	12	1500	1401	7	0000
Drive Rated Out	6600 V	______	200	15000	1402	7	0000
Drive Input Vlt	6600 V	______	200	15000	1403	7	0000
Auto reset enable	0	______	0	1	1404	7	0000
Aut rst time	1.00 sec	______	1.00	120.00	1405	7	0000
Spinning Load Select	0	______	0	1	1407	7	0000
Vector Control Select	1	______	0	1	1408	7	1001
Ramp Stop Select	1	______	0	1	1409	7	0000
Hall Effect Select	1	______	0	1		7	1001
Reduced Voltage Oper.	0	______	0	1		7	0000
Display Version Number			(function)			7	0000
Customer Order	145378	______	0	999999		7	0000
Customer Drive	13	______	0	20		7	0000
Speed Setup (15)							
Ratio Control	1.000	______	-125.000	125.000	1501	7	0000
Spd Fwd Lim	100 %	______	0	200	1502	7	0000
Spd Rev Lim	0 %	______	-200	0	1503	7	0000
Zero Speed	1 %	______	0	100	1504	7	0000
Alg Spd Scaler	100 %	______	0	250	1505	7	0000
Aux Spd Scaler	100 %	______	0	250	1506	7	0000
Spd Fwd Lim 2	100 %	______	0	200	1507	7	1000
Spd Rev Lim 2	-100 %	______	-200	0	1508	7	1000
Spd Fwd Lim 3	100 %	______	0	200	1509	7	1000
Spd Rev Lim 3	-100 %	______	-200	0	1510	7	1000
Encoder filter adj	4	______	0	6	1511	7	1000
Torq Ref Menu (16)							
Alg Trq Scaler	100 %	______	0	250	1601	7	0000
Aux Trq Scaler	100 %	______	0	250	1602	7	0000
Trq Setpoint	50 %	______	0	250	1603	7	0000
Holding Torque	0 %	______	-250	250	1604	7	1000
Alg hold Trq Scl	0 %	______	0	250	1605	7	1000
Trq Ramp incr	0.18 sec	______	0.00	999.99	1606	7	0000
Trq Ramp decr	0.18 sec	______	0.00	999.99	1607	7	0000

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description		change	range		xcl#	lev	hmpd
Ramp Setup Menu (17)							
Fwd Accel	90.0 sec	______	0.0	3200.0	1701	7	0000
Fwd Decel	90.0 sec	______	0.0	3200.0	1702	7	0000
Rev Accel	5.0 sec	______	0.0	3200.0	1703	7	0000
Rev Decel	5.0 sec	______	0.0	3200.0	1704	7	0000
Jerk Rate	0.10 sec	______	0.00	78.12	1705	7	0000
2 Stage Ramp Enable	0	______	0	1	1706	7	0000
Fwd Accel 2	180.0 sec	______	0.0	3200.0	1707	7	1000
Fwd Decel 2	180.0 sec	______	0.0	3200.0	1708	7	1000
Rev Accel 2	5.0 sec	______	0.0	3200.0	1709	7	1000
Rev Decel 2	5.0 sec	______	0.0	3200.0	1710	7	1000
Fwd Accel 3	90 sec	______	0	32000	1711	7	1000
Fwd Decel 3	90 sec	______	0	32000	1712	7	1000
Rev Accel 3	50 sec	______	0	32000	1713	7	1000
Rev Decel 3	50 sec	______	0	32000	1714	7	1000
Pot Setup Menu (18)							
Set max pos	100 %	______	0	200	1801	7	0000
Set max neg	0 %	______	-200	0	1802	7	0000
4-20ma Max	104.0 %	______	1.0	150.0	1803	7	0000
4-20ma Dropout	3.5 ma	______	0.0	10.0	1804	7	0000
Timebase Setup (19)							
Cond Stop Tmr	0.8 sec	______	0.0	999.9	1901	7	0000
Cond Run Tmr	0.8 sec	______	0.0	999.9	1902	7	0000
Cycle Timer	0 Hrs	______	0	10000	1903	7	0000
Hour Meter Setup	(50)		(submenu)			7	0000
Set the Clock time			(function)			7	0000
Hardware Scale Menu(20)							
Mot V fb	1600 v/v	______	1	3000	2001	7	0000
Line V fb	1650 v/v	______	1	9000	2002	7	0000
Ib Offset Adjust	7C	______	00	FF	2003	7	0000
Ic Offset Adjust	77	______	00	FF	2004	7	0000
Std Mot V Trim	9.100 V	______	0.000	10.000	2006	7	0000
Cell Menu (21)							
Installed Stages	6	______	3	7	2101	7	0000
Minimum Stage Count	3	______	1	6	2102	7	0000
Auto Bypass Enable	0	______	0	1	2103	7	0000
Print Cell Status			(function)			0	0000
Display Cell Fault(s)			(function)			0	0000
Print Cell Fault(s)			(function)			0	0000

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description		change	range		xcl#	lev	hmpd
Cell Menu (21)		continued					
RS232 Diag Bypass	0	______	0	1		7	1000
Current Loop Setup(22)							
I quad I gain	0.625	______	0.000	0.996	2201	7	0000
I quad P gain	0.500	______	0.000	0.996	2202	7	0000
I direct I gain	0.300	______	0.000	0.996	2203	7	0000
I direct P gain	0.699	______	0.000	0.996	2204	7	0000
Vector Control Tune(23)							
Vel P gain	4.300	______	0.000	127.996	2301	7	0000
Vel I gain	4.300	______	0.000	255.996	2302	7	0000
Imag P gain	0.058	______	0.000	127.996	2303	7	0000
Imag I gain	0.101	______	0.000	127.996	2304	7	0000
Slip P gain	0.050	______	0.000	127.996	2305	7	0000
Slip I gain	0.101	______	0.000	127.996	2306	7	0000
Vel P gain 2	5.000	______	0.000	127.996	2307	7	1000
Vel I gain 2	4.000	______	0.000	255.996	2308	7	1000
Vel P gain 3	5.000	______	0.000	127.996	2309	7	1000
Vel I gain 3	4.000	______	0.000	255.996	2310	7	1000
Std Control Setup(24)							
Std Volts/Hz	1.000	______	-127.996	127.996	2401	0	0000
Volt P gain	0.500	______	-127.996	127.996	2402	0	0000
Volt I gain	0.500	______	-127.996	127.996	2403	0	0000
Vel P gain	5.000	______	0.000	127.996	2404	0	0000
Vel I gain	5.000	______	0.000	255.996	2405	0	0000
Trq P gain	0.011	______	0.000	127.996	2406	0	0000
Trq I gain	0.300	______	0.000	255.996	2407	0	0000
Full Load boost	0.0 %	______	0.0	100.0	2408	0	0000
Slow Ramp Time	3.00 sec	______	0.00	9.99	2409	0	0000
Mot trq limit	100 %	______	0	300	2410	0	0000
Regen trq limit	2.0 %	______	0.2	10.0	2411	0	0000
Energy Saver	0 %	______	0	100	2412	0	0000
K1	1.0	______	0.1	1.0		0	0000
Spin Load Thresh	2.3 %	______	0.0	50.0	2413	0	0000
Spin Flux Scale	6.25 %	______	1.00	15.00		0	0000
Flux Ramp	5.0 sec	______	0.1	15.0	2414	0	0000
Freq Scan Rate	5.0 sec	______	1.5	9.0	2415	0	0000
Freq Drop Level	5.0 %	______	0.0	12.0	2416	0	0000
Vel P gain 2	5.000	______	0.000	127.996	2417	7	1000
Vel I gain 2	4.000	______	0.000	255.996	2418	7	1000
Vel P gain 3	5.000	______	0.000	127.996	2419	7	1000
Vel I gain 3	4.000	______	0.000	255.996	2420	7	1000
Trq P gain 2	0.011	______	0.000	127.996	2421	7	1000

description		change	range		xcl#	lev	hmpd
Std Control Setup(24)		continued					
Trq I gain 2	0.300	______	0.000	255.996	2422	7	1000
Trq P gain 3	0.011	______	0.000	127.996	2423	7	1000
Trq I gain 3	0.300	______	0.000	255.996	2424	7	1000
Mot trq limit 2	100 %	______	0	300	2425	7	1000
Regen trq limit 2	3.0 %	______	0.2	10.0	2426	7	1000
Mot trq limit 3	100 %	______	0	300	2427	7	1000
Regen trq limit 3	3.0 %	______	0.2	10.0	2428	7	1000
Control Loop Test(25)							
Spd Test Pos	3 %	______	-200	200		7	0000
Spd Test Neg	0 %	______	-200	200		7	0000
Spd Test Time	3.1 sec	______	0.0	500.0		7	0000
Begin Speed Loop test			(function)			7	0000
Stop Speed Loop test			(function)			7	0000
Trq Test Pos	50 %	______	-200	200		7	0000
Trq Test Neg	0 %	______	-200	200		7	0000
Trq Test Time	0.75 sec	______	0.00	91.00		7	0000
Begin Torque Loop test			(function)			7	0000
Stop Torque Loop test			(function)			7	0000
Start Diagnostic Log			(function)			0	0000
Select Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Speed Profile Menu(26)							
Entry Pt.	0.0 %	______	0.0	150.0	2601	7	0000
Exit Pt.	100.0 %	______	0.0	150.0	2602	7	0000
Entry Spd	48.3 %	______	0.0	150.0	2603	7	0000
Exit Spd	98.3 %	______	0.0	150.0	2604	7	0000
Auto off	0.0 %	______	0.0	100.0	2605	7	0000
Delay off	0.5 sec	______	0.5	100.0	2606	7	0000
Auto on	0.0 %	______	0.0	100.0	2607	7	0000
Delay on	0.5 sec	______	0.5	100.0	2608	7	0000
Speed Setpoint Menu(27)							
Spd Setpt 1	0 rpm	______	-9999	9999	2701	7	0000
Spd Setpt 2	0 rpm	______	-9999	9999	2702	7	0000
Spd Setpt 3	0 rpm	______	-9999	9999	2703	7	0000
Spd Setpt 4	0 rpm	______	-9999	9999	2704	7	0000
Spd Setpt 5	0 rpm	______	-9999	9999	2705	7	0000
Spd Setpt 6	0 rpm	______	-9999	9999	2706	7	0000
Spd Setpt 7	0 rpm	______	-9999	9999	2707	7	0000

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description		change	range		xcl#	lev	hmpd
Critical Speed Menu(28)							
Skip Freq 1	15.0 Hz	______	0.0	120.0	2801	7	0000
Skip Freq 2	30.0 Hz	______	0.0	120.0	2802	7	0000
Skip Freq 3	45.0 Hz	______	0.0	120.0	2803	7	0000
Skip band 1	0.0 Hz	______	0.0	6.0	2804	7	0000
Skip band 2	0.0 Hz	______	0.0	6.0	2805	7	0000
Skip band 3	0.0 Hz	______	0.0	6.0	2806	7	0000
Comparator Setup(29)							
Compare 1 Setup	(121)		(submenu)			7	1000
Compare 2 Setup	(122)		(submenu)			7	1000
Compare 3 Setup	(123)		(submenu)			7	1000
Compare 4 Setup	(124)		(submenu)			7	1000
Compare 5 Setup	(125)		(submenu)			7	1000
Compare 6 Setup	(126)		(submenu)			7	1000
Compare 7 Setup	(127)		(submenu)			7	1000
Compare 8 Setup	(128)		(submenu)			7	1000
Compare 9 Setup	(129)		(submenu)			7	1000
Compare 10 Setup	(130)		(submenu)			7	1000
Compare 11 Setup	(131)		(submenu)			7	1000
Compare 12 Setup	(132)		(submenu)			7	1000
Compare 13 Setup	(133)		(submenu)			7	1000
Compare 14 Setup	(134)		(submenu)			7	1000
Compare 15 Setup	(135)		(submenu)			7	1000
Compare 16 Setup	(136)		(submenu)			7	1000
PID Select Menu (48)							
PID scaler 1	0.390	______	-127.996	127.996	4801	7	0000
PID scaler 2	-0.390	______	-127.996	127.996	4802	7	0000
PID P Gain	0.390	______	0.000	98.996	4803	7	0000
PID I Gain	0.390	______	0.000	98.996	4804	7	0000
PID D Gain	0.000	______	0.000	98.996	4805	7	0000
PID Min Clamp	0 %	______	-200	200	4806	7	0000
PID Max Clamp	100 %	______	-200	200	4807	7	0000
PID Setpoint	0 %	______	-200	200	4808	7	1000
Memory Functions(30)							
Read Memory Byte			(function)			0	0000
Read Memory Word			(function)			0	0000
Write Memory Byte			(function)			7	0000
Write Memory Word			(function)			7	0000
Copy from RAM to EEPROM			(function)			7	0000
Copy from EEPROM to RAM			(function)			7	0000

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CO #145378 Drive # 13

description		change	range		xcl#	lev	hmpd
Diagnostic Log Menu(31)							
Log var1	-Mtr V cmd		(list)			0	0000
Log var2	-Id out		(list)			0	0000
Log var3	-KW output		(list)			0	0000
Log var4	-Mmf Spd		(list)			0	0000
Diag Log Time	10.7 sec	______	0.0	310.0		0	0000
Select Diagnostic Log			(function)			0	0000
Start Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Historic Log Menu(32)							
Select Historic Log			(function)			0	0000
Hist var1	-M % spd		(list)			0	0000
Hist var2	-Mtr Freq		(list)			0	0000
Hist var3	-Trq cmd		(list)			0	0000
Hist var4	-Trq I Fb		(list)			0	0000
Hist var5	-Mtr V fb		(list)			0	0000
Hist var6	-I sum fb		(list)			0	0000
Hist var7	-V Avail		(list)			0	0000
Historic Log Upload			(function)			0	0000
Fault Log Menu (33)							
Fault Log Display			(function)			0	0000
Fault Log Upload			(function)			0	0000
Overload Menu (34)							
Overld Select	1	______	0	2	3401	7	0000
I overload	110 %	______	20	210	3402	7	0000
I timeout	30.00 sec	______	0.01	300.00	3403	7	0000
Motor Trip volts	8500 V	______	5	9999	3404	7	0000
OverSpeed	120 %	______	0	250	3405	7	0000
Encoder Loss Thsh	0 %	______	0	75	3406	7	0000
Drive IOC Setpt	150 %	______	50	200	3407	7	0000
I overload 2	150 %	______	20	210	3408	7	1000
I timeout 2	60.00 sec	______	0.01	300.00	3409	7	1000
I overload 3	150 %	______	20	210	3410	7	1000
I timeout 3	60.00 sec	______	0.01	300.00	3411	7	1000
Enter for Fault Reset			(function)			0	0000
Clear Fault Message			(function)			7	1000

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description		change	range		xcl#	lev	hmpd
Limit Menu (35)							
Mot trq limit	100 %	______	0	300	3501	7	0000
Reg trq limit	3.0 %	______	0.0	30.0	3502	7	0000
Mot Alg limit	100 %	______	0	300	3503	7	0000
Regen Alg limit	2.0 %	______	0.0	30.0	3504	7	0000
Mot trq limit 2	100 %	______	0	300	3505	7	1000
Reg trq limit 2	3.6 %	______	0.0	30.0	3506	7	1000
Mot trq limit 3	100 %	______	0	300	3507	7	1000
Reg trq limit 3	3.6 %	______	0.0	30.0	3508	7	1000
Analog I/O Setup(36)							
Alg var1	- (2960H)		(list)			0	0000
Alg var2	-Spd Reg Cmd		(list)			0	0000
Analog TP 1	10.000 V	______	-20.000	20.000		7	0000
Analog TP 2	10.000 V	______	-20.000	20.000		7	0000
Alg In Scaler	100 %	______	0	250		7	0000
Analog Output 1	(111)		(submenu)			7	1000
Analog Output 2	(112)		(submenu)			7	1000
Analog Output 3	(113)		(submenu)			7	1000
Analog Output 4	(114)		(submenu)			7	1000
Analog Output 5	(115)		(submenu)			7	1000
Analog Output 6	(116)		(submenu)			7	1000
Analog Output 7	(117)		(submenu)			7	1000
Analog Output 8	(118)		(submenu)			7	1000
Analog Input 1	(181)		(submenu)			7	1000
Analog Input 2	(182)		(submenu)			7	1000
Analog Input 3	(183)		(submenu)			7	1000
Analog Input 4	(184)		(submenu)			7	1000
Analog Input 5	(185)		(submenu)			7	1000
Analog Input 6	(186)		(submenu)			7	1000
Analog Input 7	(187)		(submenu)			7	1000
Analog Input 8	(188)		(submenu)			7	1000
Vel Ref	- (empty)		(list)			7	1000
PID Ref	- (empty)		(list)			7	1000
Aux Vel Ref	- (empty)		(list)			7	1000
Trq Ref	- (empty)		(list)			7	1000
Display Var. Menu(37)							
Disp var0	-Mtr rpm		(list)			0	0000
Disp var1	-Encoder fb		(list)			0	0000
Disp var2	-Mag I Fb		(list)			0	0000
Disp var3	-KW output		(list)			0	0000

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description		change	range		xcl#	lev	hmpd
Trim Analog Meters(38)							
Trim local meter 1			(function)			7	0000
Trim local meter 2			(function)			7	0000
Trim local meter 3			(function)			7	0000
Trim local meter 4			(function)			7	0000
Trim local meter 5			(function)			7	0000
Trim local meter 6			(function)			7	0000
Trim local meter 7			(function)			7	0000
Trim local meter 8			(function)			7	0000
Loc. Alg. Meters(39)							
Analog Meter 1	(51)		(submenu)			0	0000
Analog Meter 2	(52)		(submenu)			0	0000
Analog Meter 3	(53)		(submenu)			0	0000
Analog Meter 4	(54)		(submenu)			0	0000
Analog Meter 5	(55)		(submenu)			0	0000
Analog Meter 6	(56)		(submenu)			0	0000
Analog Meter 7	(57)		(submenu)			0	0000
Analog Meter 8	(58)		(submenu)			0	0000
Loc. Dig. Meters(40)							
Digital Meter 1	(61)		(submenu)			0	0000
Digital Meter 2	(62)		(submenu)			0	0000
Digital Meter 3	(63)		(submenu)			0	0000
Digital Meter 4	(64)		(submenu)			0	0000
Digital Meter 5	(65)		(submenu)			0	0000
Digital Meter 6	(66)		(submenu)			0	0000
Digital Meter 7	(67)		(submenu)			0	0000
RS232 Functions (41)							
System Program Download			(function)			7	0000
System Program Upload			(function)			0	0000
Display Sys Prog Name			(function)			0	0000
Download entire EEPROM			(function)			7	0000
Upload entire EEPROM			(function)			0	0000
Parameter Data Download			(function)			7	0000
Parameter Data Upload			(function)			0	0000
RS232 Echo-back test			(function)			0	0000
Parameter Log Upload			(function)			0	0000
Onboard RS232	1	______	0	1		7	1000

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description	change	range		xcl#	lev	hmpd
Remote I/O Menu (42)						
Read user module		(function)			0	0000
Write user module		(function)			7	0000
XCL Send Setup (43)						
XCL Global Send (145)		(submenu)			7	1001
XCL Send Reg 1-31 (147)		(submenu)			7	1000
XCL Send Reg 33-63 (148)		(submenu)			7	1000
XCL Node Address 10	_______	0	128		7	1001
CAB Configuration 0000	_______	0000	FFFF		7	1001
XCL Global Send(145)						
XCL send01 - (empty)		(list)			0	0000
XCL send02 - (empty)		(list)			0	0000
XCL send03 - (empty)		(list)			0	0000
XCL send04 - (empty)		(list)			0	0000
XCL send05 - (empty)		(list)			0	0000
XCL send06 - (empty)		(list)			0	0000
XCL send07 - (empty)		(list)			0	0000
XCL send08 - (empty)		(list)			0	0000
XCL send09 - (empty)		(list)			0	0000
XCL send10 - (empty)		(list)			0	0000
XCL send11 - (empty)		(list)			0	0000
XCL send12 - (empty)		(list)			0	0000
XCL send13 - (empty)		(list)			0	0000
XCL send14 - (empty)		(list)			0	0000
XCL send15 - (empty)		(list)			0	0000
XCL send16 - (empty)		(list)			0	0000
XCL Send Reg 1-31(147)						
XCLreg001 -Spd Input %		(list)			0	0000
XCLreg003 -Ramp Out %		(list)			0	0000
XCLreg005 -Freq Dmd %		(list)			0	0000
XCLreg007 -Tot I Fb %		(list)			0	0000
XCLreg009 -Mtr V fb %		(list)			0	0000
XCLreg011 -KW output %		(list)			0	0000
XCLreg013 -Serial flg1		(list)			0	0000
XCLreg015 -Heartbt		(list)			0	0000
XCLreg017 - (empty)		(list)			0	0000
XCLreg019 - (empty)		(list)			0	0000
XCLreg021 - (empty)		(list)			0	0000
XCLreg023 - (empty)		(list)			0	0000
XCLreg025 - (empty)		(list)			0	0000
XCLreg027 - (empty)		(list)			0	0000
XCLreg029 - (empty)		(list)			0	0000

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description		change		range	xcl#	lev	hmpd
XCL Send Reg 1-31(147)		continued					
XCLreg031	- (empty)			(list)		0	0000
XCL Send Reg 33-63(148)							
XCLreg033	- (empty)			(list)		0	0000
XCLreg035	- (empty)			(list)		0	0000
XCLreg037	- (empty)			(list)		0	0000
XCLreg039	- (empty)			(list)		0	0000
XCLreg041	- (empty)			(list)		0	0000
XCLreg043	- (empty)			(list)		0	0000
XCLreg045	- (empty)			(list)		0	0000
XCLreg047	- (empty)			(list)		0	0000
XCLreg049	- (empty)			(list)		0	0000
XCLreg051	- (empty)			(list)		0	0000
XCLreg053	- (empty)			(list)		0	0000
XCLreg055	- (empty)			(list)		0	0000
XCLreg057	- (empty)			(list)		0	0000
XCLreg059	- (empty)			(list)		0	0000
XCLreg061	- (empty)			(list)		0	0000
XCLreg063	- (empty)			(list)		0	0000
XCL Recv Setup (44)							
XCL Vel Ref	(141)			(submenu)		7	1000
XCL Vel Ctrl	(142)			(submenu)		7	1000
XCL Trq Ctrl	(143)			(submenu)		7	1000
XCL Com Flags	(144)			(submenu)		7	1000
Ser Input Scalers	(146)			(submenu)		7	1001
XCL Vel Ref (141)							
XCLPTR_01	00:000	______	000	099		0	0001
XCLPTR_02	00:000	______	000	099		0	0001
XCLPTR_03	00:000	______	000	099		0	0001
XCLPTR_04	00:000	______	000	099		0	0001
XCLPTR_05	99:065	______	000	099		0	0001
XCLPTR_06	00:000	______	000	099		0	0001
XCLPTR_07	00:000	______	000	099		0	0001
XCLPTR_08	00:000	______	000	099		0	0001
XCLPTR_09	00:000	______	000	099		0	0001
XCLPTR_10	00:000	______	000	099		0	0001
XCLPTR_11	00:000	______	000	099		0	0001
XCLPTR_12	00:000	______	000	099		0	0001

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description		change	range		xcl#	lev	hmpd
XCL Vel Ctrl (142)							
XCLPTR_13	00:000	_______	000	099	0	0001	
XCLPTR_14	00:000	_______	000	099	0	0001	
XCLPTR_15	00:000	_______	000	099	0	0001	
XCLPTR_16	00:000	_______	000	099	0	0001	
XCLPTR_17	00:000	_______	000	099	0	0001	
XCLPTR_18	00:000	_______	000	099	0	0001	
XCLPTR_19	00:000	_______	000	099	0	0001	
XCLPTR_20	00:000	_______	000	099	0	0001	
XCLPTR_21	00:000	_______	000	099	0	0001	
XCLPTR_22	00:000	_______	000	099	0	0001	
XCLPTR_23	00:000	_______	000	099	0	0001	
XCLPTR_24	00:000	_______	000	099	0	0001	
XCLPTR_25	00:000	_______	000	099	0	0001	
XCLPTR_26	00:000	_______	000	099	0	0001	
XCLPTR_27	00:000	_______	000	099	0	0001	
XCLPTR_28	00:000	_______	000	099	0	0001	
XCLPTR_29	00:000	_______	000	099	0	0001	
XCLPTR_30	00:000	_______	000	099	0	0001	
XCLPTR_31	00:000	_______	000	099	0	0001	
XCLPTR_32	00:000	_______	000	099	0	0001	
XCLPTR_33	00:000	_______	000	099	0	0001	
XCLPTR_34	00:000	_______	000	099	0	0001	
XCLPTR_35	00:000	_______	000	099	0	0001	
XCLPTR_36	00:000	_______	000	099	0	0001	
XCL Trq Ctrl (143)							
XCLPTR_37	00:000	_______	000	099	0	0001	
XCLPTR_38	00:000	_______	000	099	0	0001	
XCLPTR_39	00:000	_______	000	099	0	0001	
XCLPTR_40	00:000	_______	000	099	0	0001	
XCLPTR_41	00:000	_______	000	099	0	0001	
XCLPTR_42	00:000	_______	000	099	0	0001	
XCLPTR_43	00:000	_______	000	099	0	0001	
XCLPTR_44	00:000	_______	000	099	0	0001	
XCLPTR_45	00:000	_______	000	099	0	0001	
XCLPTR_46	00:000	_______	000	099	0	0001	
XCLPTR_47	00:000	_______	000	099	0	0001	
XCLPTR_48	00:000	_______	000	099	0	0001	
XCLPTR_49	00:000	_______	000	099	0	0001	
XCLPTR_50	00:000	_______	000	099	0	0001	
XCLPTR_51	00:000	_______	000	099	0	0001	
XCLPTR_52	00:000	_______	000	099	0	0001	

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description		change	range		xcl#	lev	hmpd
XCL Com Flags (144)							
COMM_F01	99:067	______	000	099		0	0001
COMM_F02	99:069	______	000	099		0	0001
COMM_F03	00:000	______	000	099		0	0001
COMM_F04	00:000	______	000	099		0	0001
COMM_F05	00:000	______	000	099		0	0001
COMM_F06	00:000	______	000	099		0	0001
COMM_F07	00:000	______	000	099		0	0001
COMM_F08	00:000	______	000	099		0	0001
COMM_F09	00:000	______	000	099		0	0001
COMM_F10	00:000	______	000	099		0	0001
COMM_F11	00:000	______	000	099		0	0001
COMM_F12	00:000	______	000	099		0	0001
COMM_F13	00:000	______	000	099		0	0001
COMM_F14	00:000	______	000	099		0	0001
COMM_F15	00:000	______	000	099		0	0001
COMM_F16	00:000	______	000	099		0	0001
Ser Input Scalers(146)							
Vel Ref Ser	1.000	______	-125.000	125.000	4601	7	1000
V Aux Ref Ser	1.000	______	-125.000	125.000	4602	7	1000
V Ref P Lm Ser	1.000	______	-125.000	125.000	4603	7	1000
V Ref N Lm Ser	1.000	______	-125.000	125.000	4604	7	1000
Trq Cmd Ser	1.000	______	-125.000	125.000	4605	7	1000
Aux 1.000 ______ -125.000 125.000 4605 7 1000							
Aux Trq Ser	1.000	______	-125.000	125.000	4606	7	1000
Trq P Lim Ser	1.000	______	-125.000	125.000	4607	7	1000
Trq N Lim Ser	1.000	______	-125.000	125.000	4608	7	1000
Hour Meter Setup(50)							
Display Hour Meter			(function)			0	0000
KW Hours Consumed			(function)			0	0000
Analog Meter 1 (51)							
Meter 1 var- (empty)			(list)			0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 2 (52)							
Meter 2 var- (empty)			(list)			0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000

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description		change		range	xcl#	lev	hmpd
Analog Meter 3 (53)							
Meter 3 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 4 (54)							
Meter 4 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 5 (55)							
Meter 5 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 6 (56)							
Meter 6 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 7 (57)							
Meter 7 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 8 (58)							
Meter 8 var-	(empty)			(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Digital Meter 1 (61)							
Meter 1 var-	(empty)			(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000

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description		change		range	xcl#	lev	hmpd
Digital Meter 2 (62)							
Meter 2 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 3 (63)							
Meter 3 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 4 (64)							
Meter 4 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 5 (65)							
Meter 5 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 6 (66)							
Meter 6 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 7 (67)							
Meter 7 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Analog Output 1(111)							
Analog var1-I sum fb				(list)		7	1000
Full Range	128.0 %	______	0.0	300.0		7	1000
Module Address	2	______	0	15		7	1000
Var1 type	-4-20ma			(list)		7	1000

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description		change		range	xcl#	lev	hmpd
Analog Output 2(112)							
Analog var2-KW output				(list)		7	1000
Full Range	73.0 %	______	0.0	300.0		7	1000
Module Address	3	______	0	15		7	1000
Var2 type	-4-20ma			(list)		7	1000
Analog Output 3(113)							
Analog var3-Encoder fb				(list)		7	1000
Full Range	100.0 %	______	0.0	300.0		7	1000
Module Address	6	______	0	15		7	1000
Var3 type	-4-20ma			(list)		7	1000
Analog Output 4(114)							
Analog var4- (empty)				(list)		7	1000
Full Range	0.0 %	______	0.0	300.0		7	1000
Module Address	0	______	0	15		7	1000
Var4 type	- (empty)			(list)		7	1000
Analog Output 5(115)							
Analog var5- (empty)				(list)		7	1000
Full Range	0.0 %	______	0.0	300.0		7	1000
Module Address	0	______	0	15		7	1000
Var5 type	- (empty)			(list)		7	1000
Analog Output 6(116)							
Analog var6- (empty)				(list)		7	1000
Full Range	0.0 %	______	0.0	300.0		7	1000
Module Address	0	______	0	15		7	1000
Var6 type	- (empty)			(list)		7	1000
Analog Output 7(117)							
Analog var7- (empty)				(list)		7	1000
Full Range	0.0 %	______	0.0	300.0		7	1000
Module Address	0	______	0	15		7	1000
Var7 type	- (empty)			(list)		7	1000

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description	change		range	xcl#	lev	hmpd
Analog Output 8(118)						
Analog var8- (empty)			(list)		7	1000
Full Range 0.0 %	_______	0.0	300.0		7	1000
Module Address 0	_______	0	15		7	1000
Var8 type - (empty)			(list)		7	1000
Compare 1 Setup(121)						
Comp 1 A in-V Avail			(list)		7	0000
Comp 1 B in- + 80.0 %			(list)		7	0000
Compare 1 -Magnitude			(list)		7	0000
Compare 2 Setup(122)						
Comp 2 A in-Encoder fb			(list)		7	0000
Comp 2 B in- + 2.5 %			(list)		7	0000
Compare 2 -Magnitude			(list)		7	0000
Compare 3 Setup(123)						
Comp 3 A in- + 48.3 %			(list)		7	0000
Comp 3 B in-Encoder fb			(list)		7	0000
Compare 3 -Magnitude			(list)		7	0000
Compare 4 Setup(124)						
Comp 4 A in- (empty)			(list)		0	0000
Comp 4 B in- (empty)			(list)		0	0000
Compare 4 - (empty)			(list)		0	0000
Compare 5 Setup(125)						
Comp 5 A in- (empty)			(list)		0	0000
Comp 5 B in- (empty)			(list)		0	0000
Compare 5 - (empty)			(list)		0	0000
Compare 6 Setup(126)						
Comp 6 A in- (empty)			(list)		0	0000
Comp 6 B in- (empty)			(list)		0	0000
Compare 6 - (empty)			(list)		0	0000

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description	change	range	xcl#	lev	hmpd
Compare 7 Setup(127)					
Comp 7 A in-	(empty)	(list)		0	0000
Comp 7 B in-	(empty)	(list)		0	0000
Compare 7 -	(empty)	(list)		0	0000
Compare 8 Setup(128)					
Comp 8 A in-	(empty)	(list)		0	0000
Comp 8 B in-	(empty)	(list)		0	0000
Compare 8 -	(empty)	(list)		0	0000
Compare 9 Setup(129)					
Comp 9 A in-	(empty)	(list)		0	0000
Comp 9 B in-	(empty)	(list)		0	0000
Compare 9 -	(empty)	(list)		0	0000
Compare 10 Setup(130)					
Comp 10 A i-	(empty)	(list)		0	0000
Comp 10 B i-	(empty)	(list)		0	0000
Compare 10 -	(empty)	(list)		0	0000
Compare 11 Setup(131)					
Comp 11 A i-	(empty)	(list)		0	0000
Comp 11 B i-	(empty)	(list)		0	0000
Compare 11 -	(empty)	(list)		0	0000
Compare 12 Setup(132)					
Comp 12 A i-	(empty)	(list)		0	0000
Comp 12 B i-	(empty)	(list)		0	0000
Compare 12 -	(empty)	(list)		0	0000
Compare 13 Setup(133)					
Comp 13 A i-	(empty)	(list)		0	0000
Comp 13 B i-	(empty)	(list)		0	0000
Compare 13 -	(empty)	(list)		0	0000

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description		change		range	xcl#	lev	hmpd
Compare 14 Setup(134)							
Comp 14 A i-	(empty)			(list)		0	0000
Comp 14 B i-	(empty)			(list)		0	0000
Compare 14 -	(empty)			(list)		0	0000
Compare 15 Setup(135)							
Comp 15 A i-	(empty)			(list)		0	0000
Comp 15 B i-	(empty)			(list)		0	0000
Compare 15 -	(empty)			(list)		0	0000
Compare 16 Setup(136)							
Comp 16 A i-	(empty)			(list)		0	0000
Comp 16 B i-	(empty)			(list)		0	0000
Compare 16 -	(empty)			(list)		0	0000
Analog Input 1(181)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var1 type -	(empty)			(list)		7	1000
Analog Input 2(182)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var2 type -	(empty)			(list)		7	1000
Analog Input 3(183)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var3 type -	(empty)			(list)		7	1000
Analog Input 4(184)							
Full Range	0.0 %	_______	0.0	300.0		7	1000
Module Address	0	_______	0	15		7	1000
Var4 type -	(empty)			(list)		7	1000

Harmony PWM Parameter Dump (Ver 1.10 b5 6-2-97) 3/05/98 14:32:10 21
CO #145378 Drive # 13

description		change	range		xcl# lev	hmpd
Analog Input 5(185)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var5 type	- (empty)			(list)	7	1000
Analog Input 6(186)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var6 type	- (empty)			(list)	7	1000
Analog Input 7(187)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var7 type	- (empty)			(list)	7	1000
Analog Input 8(188)						
Full Range	0.0 %	______	0.0	300.0	7	1000
Module Address	0	______	0	15	7	1000
Var8 type	- (empty)			(list)	7	1000
Transfer Menu (200)						
Phase I gain	8	______	0	15	7	1000
Phase P shft	6	______	1	12	7	1000
Phase offset	0.0 deg	______	0.0	180.0	7	1000
Hardwr offst	-121.0 deg	______	-180.0	180.0	7	1000
Phase err thrsh	1.5 deg	______	0.0	5.0	7	0000
Line sync source	0	______	0	2	7	1001

End of Harmony PWM Parameter Dump

APPENDIX A1: GLOSSARY OF TERMS

This appendix contains definitions of terms and abbreviations used throughout this manual.

automatic bypass operation - Automatic bypass operation is the same as bypass operation, but it occurs automatically if a drive fault occurs and a pre-defined time has elapsed after the fault.

automatic mode - Automatic mode is a control scheme in which the operator selects an input to be used as the desired velocity input. Speed profiling is used in automatic mode to allow the operator to scale the output based on a programmable input range.

bypass option - Bypass is an option that can be selected to customize a drive to provide optional line operation of the motor.

converter - The converter is the component of the drive that changes AC voltage to DC voltage.

critical speed avoidance - Critical speed avoidance is a feature that allows the operator to program up to 3 mechanical system frequencies that the drive will "skip over" during its operation.

DC link - The DC link is a large inductor between the converter and inverter section of the drive. The DC link, along with the converter, establish the current source for the inverter.

DCL - DCL is an acronym for Drive Communications Link - a ROBICON drive-to-drive communications scheme (non-industry standard) that is currently unsupported in Perfect Harmony drives.

drive - The term "drive" refers to the Perfect Harmony system.

ESD - ESD is an acronym for electrostatic discharge. ESD is an undesirable electrical side effect that occurs when static charges build up on a surface and are discharged to another. When printed circuit boards are involved, impaired operation and component damage are possible side effects due to the static sensitive nature of the PC board components. These side effects may manifest themselves as intermittent problems or total component failures. It is important to recognize that these effects are cumulative and may not be obvious.

faults - Faults are error conditions that have occurred in the Perfect Harmony system. The severity of faults vary. Likewise, the *treatment* or corrective action for faults may vary from changing a parameter value to replacing a hardware component such as a fuse.

GAL - GAL is an acronym for Generic Array Logic - a device similar to a PAL (programmable array logic) that is electrically erasable and programmable like an EEPROM.

harmonics - Harmonics are undesirable AC currents or voltages at integer multiples of the fundamental frequency. The fundamental frequency is the lowest frequency in the wave form (generally the repetition frequency). Harmonics are present in any non-sinusoidal wave form and they cannot transfer power on average.

Harmonics arise from non-linear loads in which current is not strictly proportional to voltage. Linear loads like resistors, capacitors and inductors do not produce harmonics. However, non-linear devices such as diodes and SCRs do generate harmonic currents. Harmonics are also found in uninterruptable power supplies (UPSs), rectifiers, transformers, ballasts, welders, arc furnaces and personal computers.

hmpd - The term "hmpd" refers to a set of four security fields associated with each parameter of the system. These fields allow the operator to individually customize specific security features for each menu option (submenu, parameter, pick list and function). These fields are shown in parameter dumps and have the following meanings. Setting H=1 hides the menu option from view until the appropriate access level has been activated. Setting M=1 blocks submenus from printing when a parameter dump is performed. Setting P=1 locks out the menu option during parameter dump printouts. Setting D=1 hides the menu option only when the drive is running.

I/O - I/O is an acronym for input/output. I/O refers to any and all inputs and outputs connected to a system. Both inputs and outputs can be classified as analog (e.g., input power, drive output, meter outputs, etc.) or digital (e.g., contact closures or switch inputs, relay outputs, etc.).

induction motor - An induction motor is an AC motor that produces torque by the reaction between a varying magnetic field (generated in the stator) and the current induced in the coils of the rotor.

inverter - The inverter is a portion of the drive that changes DC voltage into AC voltage. The term "inverter" is sometimes used mistakenly to refer to the entire drive (the converter, DC link and inverter sections).

jerk rate - Jerk rate is the time it takes for the drive to go from one acceleration rate to another. The jerk rate is a programmable parameter used to limit the rate of change of the acceleration. Jerk rate has no effect if acceleration is constant. Jerk rate helps to prevent small overshoots and provides the "S-curve" (time/speed plot) characteristic as the speed setpoint is reached.

jog mode - Jog mode is an operational mode that uses a pre-programmed jog speed when a digital input (programmed as the jog mode input) is closed.

jumpers - Jumper blocks are groups of pins that can control functions of the system based on the state of the jumpers. Jumpers (small, removable connectors) are either installed (on) or not installed (off) to provide a hardware switch.

LCD - liquid crystal display. On the Perfect Harmony, a 2-line by 24-character back-lit display interface located on the front panel of the system.

loss of signal feature - The loss of signal feature is a control scheme (in automatic mode) that gives the operator the ability to select one of 3 possible actions in the event that an external sensor is configured to specify the speed demand and the signal from that sensor is lost. Under this condition, the operator may program the drive (through the system program) to (1) revert to a fixed, pre-programmed speed, (2) maintain the current speed, or (3) perform a controlled (ramped) stop of the drive. By default, current speed is maintained.

microprocessor - A microprocessor is a central processing unit (CPU) that exists on a single silicon chip. The microprocessor board is the printed circuit board on which the microprocessor is mounted.

NEMA 1 and **NEMA 12** - NEMA 1 is an enclosure rating in which no openings allow penetration of a 0.25-inch diameter rod. NEMA 1 enclosures are intended for indoor use only. NEMA 12 is a more stringent NEMA rating in which the cabinet is said to be "dust tight" (although it is still not advisable to use NEMA 12 in conductive dust atmospheres).

PID - PID is an acronym for proportional + integral + derivative, a control scheme used to control modulating equipment in such a way that the control output is based on (1) a proportional amount of the error between the desired setpoint and the actual feedback value, (2) the summation of this error over time, and (3) the change in error over time. Output contributions from each of these three components are combined to create a single output response. The amount of contribution from each component is programmable through gain parameters. By optimizing these gain parameters, the operator can "tune" the PID control loop for maximum efficiency, minimal overshoot, quick response time and minimal cycling.

qualified user - A qualified user is an individual who is familiar with the construction and operation of the equipment and the hazards involved.

RS232 interface - RS232 interface is a DB25 serial port located on the front of the drive or on DB9 of the microprocessor board. This interface is used to connect the drive to a printer, dumb terminal or PC to allow parameter listing, system program downloading (after off-line editing), and uploading of historical and diagnostic log files.

setpoint - Setpoint is the desired or optimal speed of the VFD to maintain process levels. (Speed command).

slip - Slip is the difference between the stator speed of the motor and the rotor speed of the motor, normalized to the rotor speed as shown in the following equation.

$$Slip = \frac{\omega_S - \omega_R}{\omega_S}$$

Slip is the force that produces torque in the motor. Slip can also be defined as the shaft power of the motor divided by the rotor input power.

standard control - Standard control is one of two available application modes of the Perfect Harmony drive. Standard control mode means that the control algorithm of the drive consists of an *open loop* speed control component with *closed* loop voltage and current control. In standard control applications, the drive compensates for the load by using the current and voltage loops. Encoders and magnetic pickups are not needed in standard control applications. Typical standard control applications include centrifugal loads such as fans and pumps. Compare with *vector control.*

system program - The functions of the programmable inputs and outputs are determined by the default *system program.* These functions can be changed by modifying the appropriate setup menus from the front keypad and display. I/O assignments can also be changed by editing the system program (an ASCII text file with the extension .SOP), compiling it using the compiler program (CMP.EXE), and then downloading it to the controller through its serial port.

torque - The force that produces (or attempts to produce) rotation as in the case of a motor.

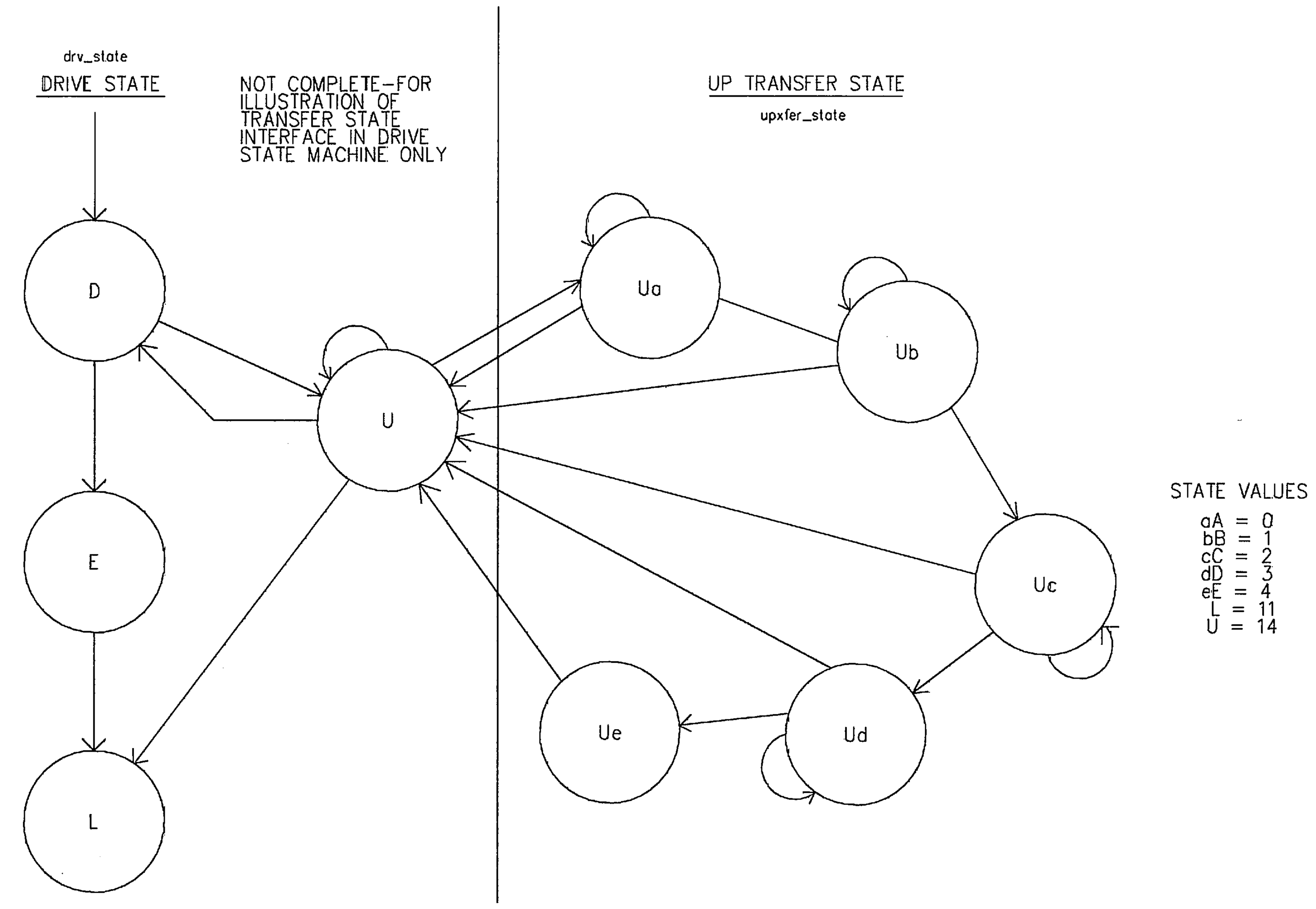
vector control - Vector control is one of two available application modes of the Perfect Harmony drive. Vector control mode means that the control algorithm of the drive consists of a *closed loop* speed control component and a *closed loop* torque control component. Since vector control applications require (a) precisely controlled starting torques (±0.1%), (b) precisely controlled speeds (±0.1%), and/or (c) fast response, such applications use either an encoder or a magnetic pickup for direct speed control feedback. Typical vector control applications include centrifuges, extruders and test stands. Compare with *standard control.*

∇ ∇ ∇

APPENDIX A2: SYSTEM CONTROL DIAGRAMS

This appendix contains the system control diagrams for the Perfect Harmony drive. The pages that follow are sheets 1 through 8 of ROBICON drawing number 479333.

UP TRANSFER STATE MACHINE TRANSITIONS



UP TRANSFER STATE MACHINE
DRIVE STATE "U"

STATE DESCRIPTIONS:

State Ua: Initial State

Point of entry into up transfer state machine
Any means that removes the drive from drive state "U"
initializes the up transfer state machine to state "a"
The drive is waiting until it is running at line frequency.
this is determined by the calculated error being less than 0.73%.
The frequency lock timer is initialized to zero.

State Ub:

The drive is waiting for frequency lock, determined by the velocity loop error "vel_err_z" (which is half of actual error) remaing below 0.18% for one second. Transfer phase lock loop is enabled ("phase_lock_enabled" ==True) on exit.

State Uc:

The drive is waiting for phase lock. This is determined by the phase error remaining below phase error threshold "Phase err thrsh" for three seconds. Once this occurs the "do_up_xfer_f" is set true. This should be used to enable the line contactor.

State Ud:

The drive is waiting for the line contactor to close.
this is detected by the state of the "line_con_ack_f" system flag which should be tied to the aux contact on the line contactor and debounced.
When the line contactor is closed, the "do_up_xfer_f" is set false on exit.

State Ue:

The vfd hardware and all software loops are disabled and the transfer complete flag "upxfer_complete_f" is set true.
The drive will stay in this state until an e-stop or fault occurs or there is a loss of CR3 or run request at which time the drive will reinitialize the up transfer state (to Ua) and the drive will enter the coast stop state (drive state "L")

The loss of run request or up transfer timeout in any state other than Ue will result in the drive returning to the run state (drive state "D")

State Transition Logic

D -> U

------

upxfer_req_f && ! dnxfer_req_f
&& ! upxfer_flt_f && ! line_con_ack_f

U -> L

------

sw_estop_f ‖ !cr3_picked	tripped
‖ !run_request && (upxfer_state>state_d)	stopped when synch'd

U -> D

!run_request && (upxfer_state <= state_d)	stopped before completion
‖ upxfer_timeout_f && (upxfer_state != state_e)	transfer timed out before complete
‖(line_freq==0)	no line freq to sync with
‖ !upxfer_req_f && (upxfer_state != state_e)	transfer cancelled before completion

Ua -> Ub

------

abs(line_freq-vel_fb) <= 60 (0.73%)	wait for vel error to be small

Ub -> Uc

(abs(vel_err_z) <= 15) && freq_ok_cnt >= 360) (0.37%) (0.18%)	small vel error, frequency matched for one second

Uc -> Ud

(abs(phase_err) <= phase_err_thrsh) && (synch_cnt >= 1080)	phase error is below minimum threshold for three seconds

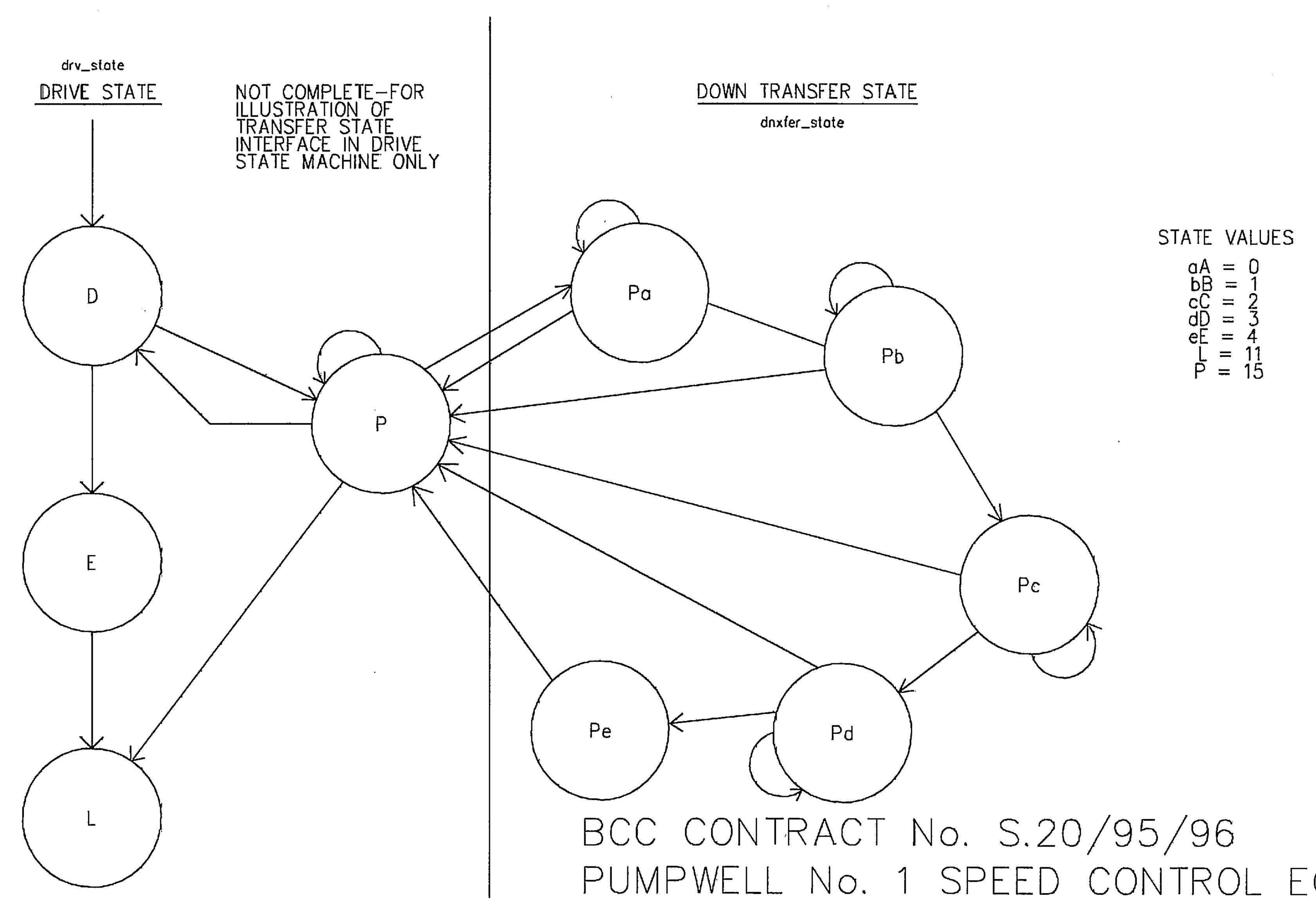
Ud -> Ue

------

line_con_ack_f	line contactor is in

&& - AND
‖ - OR
! - NOT

DOWN TRANSFER STATE MACHINE TRANSITIONS



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DOWN TRANSFER STATE MACHINE
DRIVE STATE "P"

STATE DESCRIPTIONS:

State Pa: Initial State

Point of entry into down transfer state machine
Any means that removes the drive from drive state "P"
initializes the down transfer state machine to state "a"
The drive is waiting until the output frequency reaches line frequency.
This is determined by the calculated error being less than 0.24%.
The frequency lock timer is initialized to zero.

State Pb:

The drive is waiting for frequency lock, determined by the velocity loop error "vel_err_z" (which is half of actual error) remaing below 0.18% for one second. Transfer phase lock loop is enabled ("phase_lock_enabled" ==True) on exit.

State Pc:

The drive is waiting for phase lock. This is determined by the phase error remaining below phase error threshold "Phase err thrsh" for three seconds. Once this occurs the "do_dn_xfer_f" is set true. This should be used to enable the VFD contactor.

State Pd:

The drive is waiting for the VFD contactor to close.
this is detected by the state of the "vfd_con_ack_f" system flag being set true by a debounced VFD contactor auxiliary contact.
This should be used to drop the line contactor.

State Pe:

The down transfer is complete with the exception of the removal of the line contactor. The "dnxfer_complete_f" is set true and the "do_dn_xfer_f" is set false. When the line contactor is removed, these system flags should be used to drop the "dnxfer_req_f" to put the drive back into the run state (drive state "D")

With the exception of the sw_estop_f and loss of CR3,which result in a drive "trip" placing the drive in the coast stop state,all other exits from the down transfer state machine place the drive back into the run state with only a successful transfer not setting the down transfer fault flag (dnxfer_flt_f). A successful transfer does not check for the line contactor to be open and must be addressed outside the state machine.

State Transition Logic

D -> P

------

dnxfer_req_f && ! upxfer_req_f
&& ! dnxfer_req_f && ! vfd_con_ack_f

P -> L

------

sw_estop_f ‖ !cr3_picked	tripped

P -> D

!run_request && (dnxfer_state<state_d)	stopped before synch
‖ dnxfer_timeout_f && (dnxfer_state != state_e)	timed out before complete
‖(line_freq==0)	no line sync signal
‖ !dnxfer_req_f	transfer cancelled
	(fault if transfer not complete)

Pa -> Pb

------

abs(line_freq-vel_fb) <= 20 (0.24%)	wait for velocity error to be small

Pb -> Pc

(abs(vel_err_z) <= 15) && (freq_ok_cnt >= 360) (0.18%)	small vel error, frequency matched for one second

Pc -> Pd

(abs(phase_err) <= phase_err_thrsh) && (synch_cnt >= 1080)	phase error is below minimum threshold for three seconds

Pd -> Pe

------

vfd_con_ack_f	VFD contactor is in

&& - AND
‖ - OR
! - NOT

REVISIONS		
DFTG CODE NO.		
A	REVISED STATE FLOW DIAGRAM. ELB 4/17/97	02877
B	THIS DRAWING WAS SHT. 8. ELB 7/01/97	03414
C	REVISED DIAGRAM JDR 2/4/98	04068

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

SCALE	NTS
TOL:	N/A
LAYER	N/A
DATE	11/25/94
DFTR	ELB
ENGR	MFA

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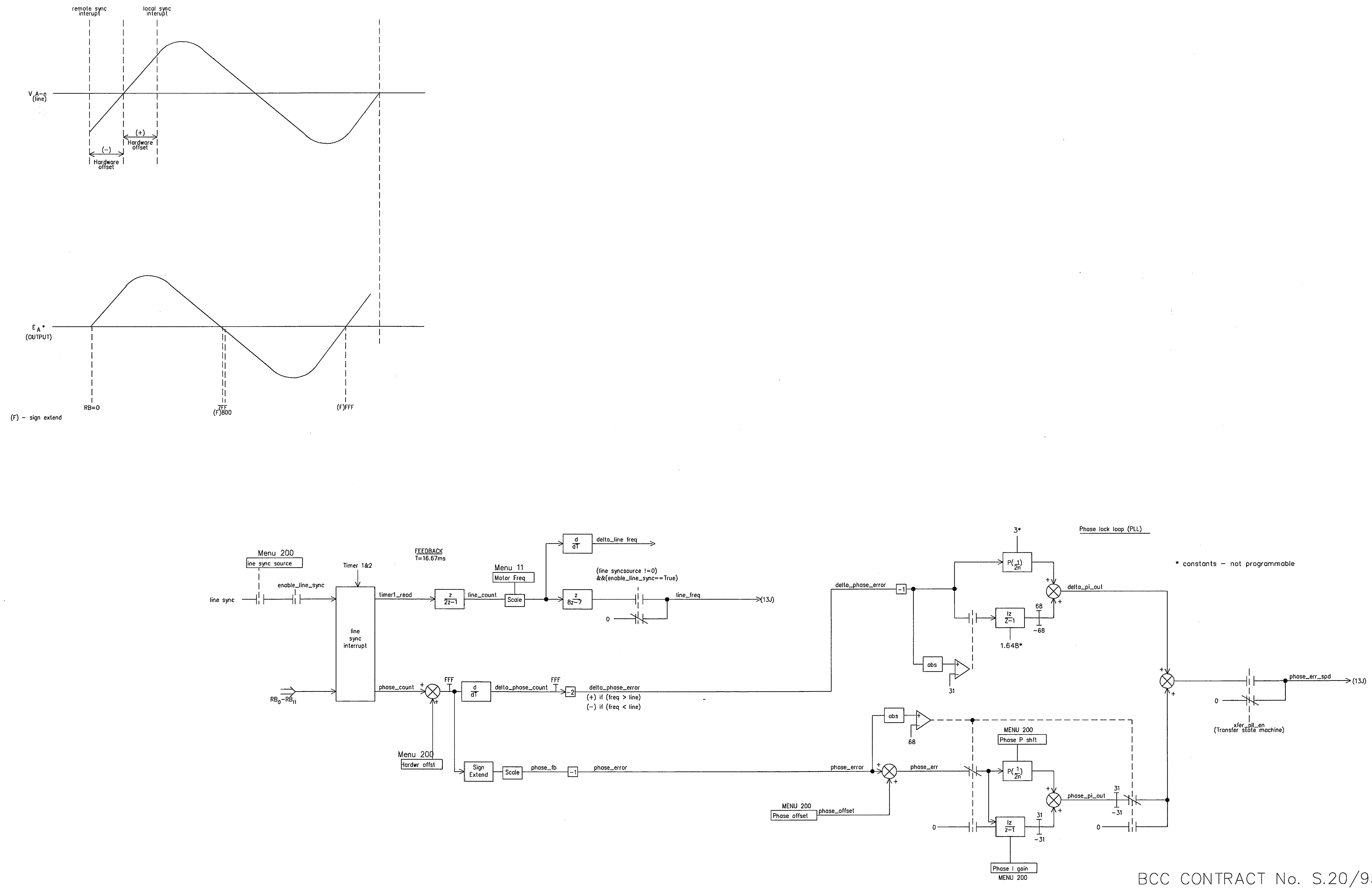
CUSTOMER ROBICON
WORK ORDER STD.

TITLE STATE FLOW DIAGRAM VECTOR CONTROL/HARMONY
DWG.NO 479333 REVISION G
CAD FILE 479333G.08 SHEET NO. 8



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REVISIONS		
DFTG CODE NO.	03414	04068
	B	G
	ADDED THIS SHEET. ELB 7/01/97	REVISED DIAGRAM JDR 2/4/98

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
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SCALE	NTS
TOL:	N/A
LAYER	N/A
DATE	07/01/97
DFTR	ELB
ENGR	MFA

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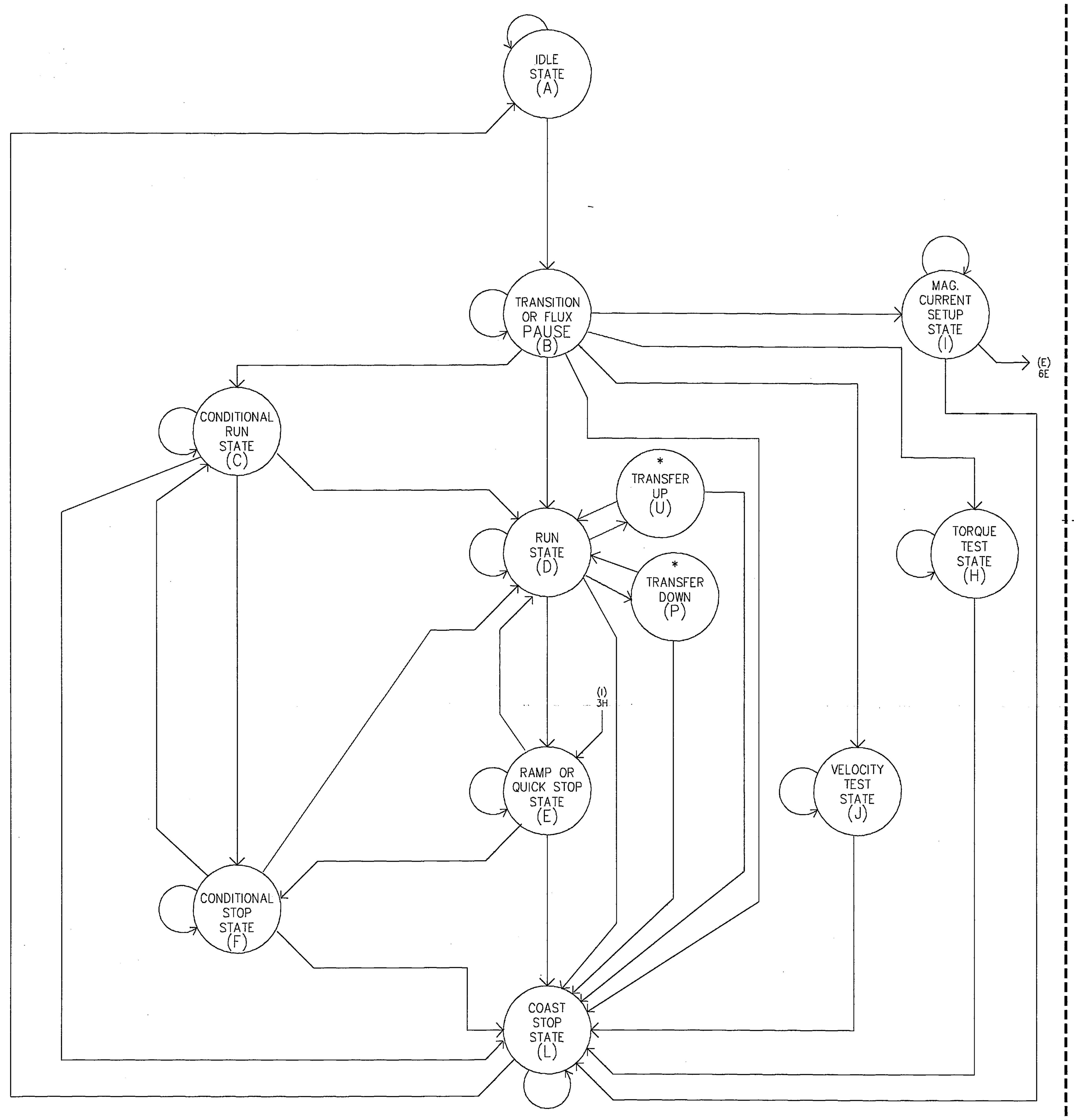
TITLE CONTROL DIAGRAM VECTOR CONTROL/HARMONY
DWG.NO 479333 | REVISION G
CAD FILE 479333G.07 | SHEET NO. 7



* - SEE NEXT SHEET FOR TRANSFER STATE MACHINES

THE PERFECT HARMONY CONTROLS OPERATE AS A STATE MACHINE, i.e. THE DRIVE IS EITHER IN ONE OF THE DEFINED STATES SHOWN, OR IN THE TRANSITION BETWEEN STATES.
THE STATES OF THE IDPWM VECTOR CONTROL ARE AS FOLLOWS:

State A: Idle State

The drive is idle.
All feedbacks are enabled.
All selected inputs are read.
The hardware current loops are disabled (Vector).
The hardware voltage loop is disabled (Standard control and Harmony).
The control is looking for a valid run request.

State B: Transition or Flux Pause State

The drive is in transition between idle and other states.
The current loops are enabled if in vector control else the hardware voltage loop is enabled.
The torque loop is enabled.
It will remain in this state for one pass through the state machine before continuing to the next state. In vector control the duration of this state is controlled by the time setting of the "Flux Pause" parameter.

State C: Conditional Run State

The drive is waiting for the timeout from conditional run.
The torque loop is enabled and the velocity loop is disabled.
The torque command comes strictly from the holding current switches which are disabled with no transfer (no preset) when going to the run state.

State D: Run State

The drive is fully operational with the torque loop enabled and the velocity loop enabled only if ai_sw1 is active.
All holding current switches are inactive.

State E: Ramp and Quick Stop State

Drive is enabled and waiting for zero speed.
This state is available for velocity mode only (ai_sw1 = true).
Quick stop uses an override to zero the speed loop command while the ramp stop zeroes the input to the ramp.

State F: Conditional Stop State

The drive is at zero speed waiting for conditional stop timeout.
The velocity loop is disabled and the torque loop enabled.
The torque reference comes from the holding current switches only (no transition from the existing torque command prior to entering this state).

State H: Torque Loop Test State

The torque loop is enabled and velocity loop disabled.
The torque reference comes from the torque loop setpoints and toggles between the two setpoints at the time period entered (Vector).
For the Standard control the torque command ramps from zero to the first setpoint and then between the setpoints with the ramp rate calculated from the time setting.

State I: Magnetizing Current Setup State

The velocity and torque loops are both enabled and the drive is in velocity mode.
The velocity command is generated by the background program to setup the extended speed flux profile.
This mode is entered automatically by first enabling extended speed and then changing the magnetizing current parameter value. Therefore extreme caution should be used to ensure safety to personnel and equipment.

State J: Velocity Loop Test State

The velocity and torque loops are both enabled and the drive is in velocity mode.
The velocity reference comes from the speed test setpoints and toggles between the two setting at the rate entered in the speed test time parameter. The reference becomes an input to the velocity ramp.

State L: Coast Stop State

This is the transition state between coast stop and idle states.
It disables the hardware (START = False) and delays a minimum of 28 msecs before disabling the velocity and torque loops and going to the idle state. This assures software control until the hardware is completely shut down.

State Transition Logic

```
A -> B
------
run_request || vel_tst_mode_f || trq_tst_mode_f || vel_tst_sw || trq_tst_sw
|| i_mag_tst_mode_f && !sw_estop_f && !drv_flt_f && cr3_picked
 (add these two statements for Harmony Only)
&& !one_sec_tmr && (av_fb < M_V_5_PERCENT)
&& cells_initialized
 (add this statement for 460 and Harmony)
&& !drv_flt_rst_f

B -> C
------
!sw_estop_f && cr3_picked
&& run_request && cndtnl_r_s_f && !leave_c_r_f
&& [std_cntrl_f ||(flux_pause_tmr>=flux_pause_thrshld)]

B -> D
------
!sw_estop_f && cr3_picked
&& run_request && (!cndtnl_r_s_f || leave_c_r_f)

B -> H
------
!sw_estop_f && cr3_picked &&(trq_tst_mode_f || trq_tst_sw)

B -> I
------
!sw_estop_f && cr3_picked && i_mag_tst_mode_f

B -> J
------
!sw_estop_f && cr3_picked &&(vel_tst_mode_f || vel_tst_sw)

B -> L
------
sw_estop_f || !cr3_picked
|| ![run_request || vel_tst_mode_f || trq_tst_mode_f
|| vel_tst_sw || trq_tst_sw || i_mag_tst_mode_f]

C -> D
------
!sw_estop_f && cr3_picked && run_request && leave_c_r_f

C -> F
------
!sw_estop_f && cr3_picked
&& !run_request && (cndtnl_r_s_f && !leave_c_r_f)

C -> L
------
sw_estop_f || !cr3_picked
|| [!run_request && !(cndtnl_r_s_f && !leave_c_r_f)]

D -> E
------
!sw_estop_f && cr3_picked
&& [(!run_request && ai_sw1 && rstop_f) ||
(!run_request && ai_sw1 && qstop_f)]

D -> L
------
sw_estop_f || !cr3_picked
|| (!run_request && !ai_sw1)
|| (!run_request && ai_sw1 && !rstop_f && !qstop_f && cstop_f)
|| (!run_request && ai_sw1 && !rstop_f && !qstop_f)

E -> D
------
!sw_estop_f && cr3_picked && run_request

E -> F
------
!sw_estop_f && cr3_picked
&& [!run_request && zero_spd_f && (cndtnl_r_s_f && !leave_c_s_f)]

E -> L
------
sw_estop_f || !cr3_picked
|| [!run_request && zero_spd_f && !(cndtnl_r_s_f && !leave_c_s_f)]

F -> C
------
!sw_estop_f && cr3_picked
&& [run_request && (cndtnl_r_s_f && !leave_c_r_f)]

F -> D
------
!sw_estop_f && cr3_picked
&& [run_request && !(cndtnl_r_s_f && !leave_c_r_f)]

F -> L
------
sw_estop_f || !cr3_picked
|| (!run_request && leave_c_s_f)

H -> L
------
sw_estop_f || !cr3_picked
|| [!trq_tst_mode_f && !trq_tst_sw]

I -> E
------
!sw_estop_f && cr3_picked
&& !i_mag_tst_mode_f

I -> L
------
sw_estop_f || !cr3_picked

J -> L
------
sw_estop_f || !cr3_picked
|| [!vel_tst_mode_f && !vel_tst_sw]

L -> A
------
stop_dwell_tmr >= stop_dwell_thrshld
```

&& - AND
|| - OR
! - NOT

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DFTG. CODE NO.		02813	02877	03414	04068
Revised state diagram and description MFA 1/10/95	Revised state diagram and description MSW 6-12-95	Revised state diagram and description ELB 4/3/97	Revised state diagram . ELB 4/17/97	ADDED STATE TRANS. LOGIC NOTES. ELB 6/30/97	Revised state diagram . JDR 2/4/98
A	B	C	D	E	G

REVISIONS

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

SCALE	NTS
TOL:	N/A
LAYER	N/A
DATE	11/25/94
DFTR	MFA
ENGR	MFA

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500 Hunt Valley Dr., New Kensington, PA 15068
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TITLE STATE FLOW DIAGRAM VECTOR CONTROL/HARMONY
DWG.NO 479333 REVISION G
CAD FILE 479333G.06 SHEET NO. 6

Encoder or Pulse Pick-up
Menu 12
Encoder 1 PPR
Menu 11
Motor Frequency
Number of Poles
Motor eff
Full Ld Spd
Motor Voltage
Full load Curr
Motor Kw
Menu 21
Auto Bypass Enable
Installed Stages
Minimum Stg. Count
PERFECT HARMONY ONLY
460VAC ONLY
Perfect Harmony VFD
460 VAC Clean Power VFD
Full load current
Motor Voltage
3 Phase Induction Motor
R=4.2Mohm for 7,200Vac
R=4.0Mohm for 6,900Vac
R=3.8Mohm for 6,600Vac
R=3.2Mohm for 6,000Vac
R=2.5Mohm for 4,800Vac
R=1.0Mohm for 460Vac
R=2.0Mohm for 4,160Vac
R=1.4Mohm for 3,300Vac
R=0.8Mohm for 2,300Vac
Menu 21
Drive Current
Drive Input Vlt
Drive Rated Out
Input 3 phase power
Hardware Voltage Regulator
Installed Stages
Installed Stages - #Bypassed
Menu 21
(Harmony Only)
Third Harmonic Inject.
See Sheet 8
Tri-wave Gen.
Menu 14
Car Frq Adj
(VECTOR ONLY)
460VAC ONLY
1.5KHz Max
Under/Overlap
Motor Voltage x Gain
Gain=:
5/1000 for 460 Vac
5/3000 for 5 cell Harmony
5/2400 for 4 cell Harmony
5/1800 for 3 cell Harmony
** Menu 22 not used in standard Performance
ID* scaled proportionally by 1/4 to produce Ud*
UQ* =0
Menu 22
I direct P gain
I direct I gain
I quad P gain
I quad I gain
Filter
see sheet 4
Direct current Fb
Quadrature curr. Fb
IDQ
DQ
Menu 20
Ic Offset Adjust
Ib Offset Adjust
Use Ic, Ib Offset to zero DC Offsets on IcFDBK and IbFDBK to <1mvdc.
SHTB
HGNDFLT To Fault Gal IC28
Flux Position Bus (12 bit)
Up/Down Counters/Latches
IC30,31,32,29,33
See Sheet 3
Select for VCO1=10Vdc for UPCLK1 = 500KHz
FLUX SPEED
Control GAL
IOC (To Fault GAL IC28)
Menu 34
Drive IOC Setpt
1.25v at 50%
3.75v at 150%
(38S) Standard Performance
(48S) Hyperformance
At Rated Output Voltage (no Phase loss):
(30L) Standard Performance
(31A) Standard Performance
Legend
bbbbbb Menu Parameter Item
bbbbbb Pick List Item
bb_bbbb Software or System Variable
See DRCTRY.PWM (Harmony and 460VAC)
vecx_xx.loc (460VAC Only)
hrmx_xx.loc (Harmony Only)
Where x_xx is the current version number
BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT
REVISIONS
WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.
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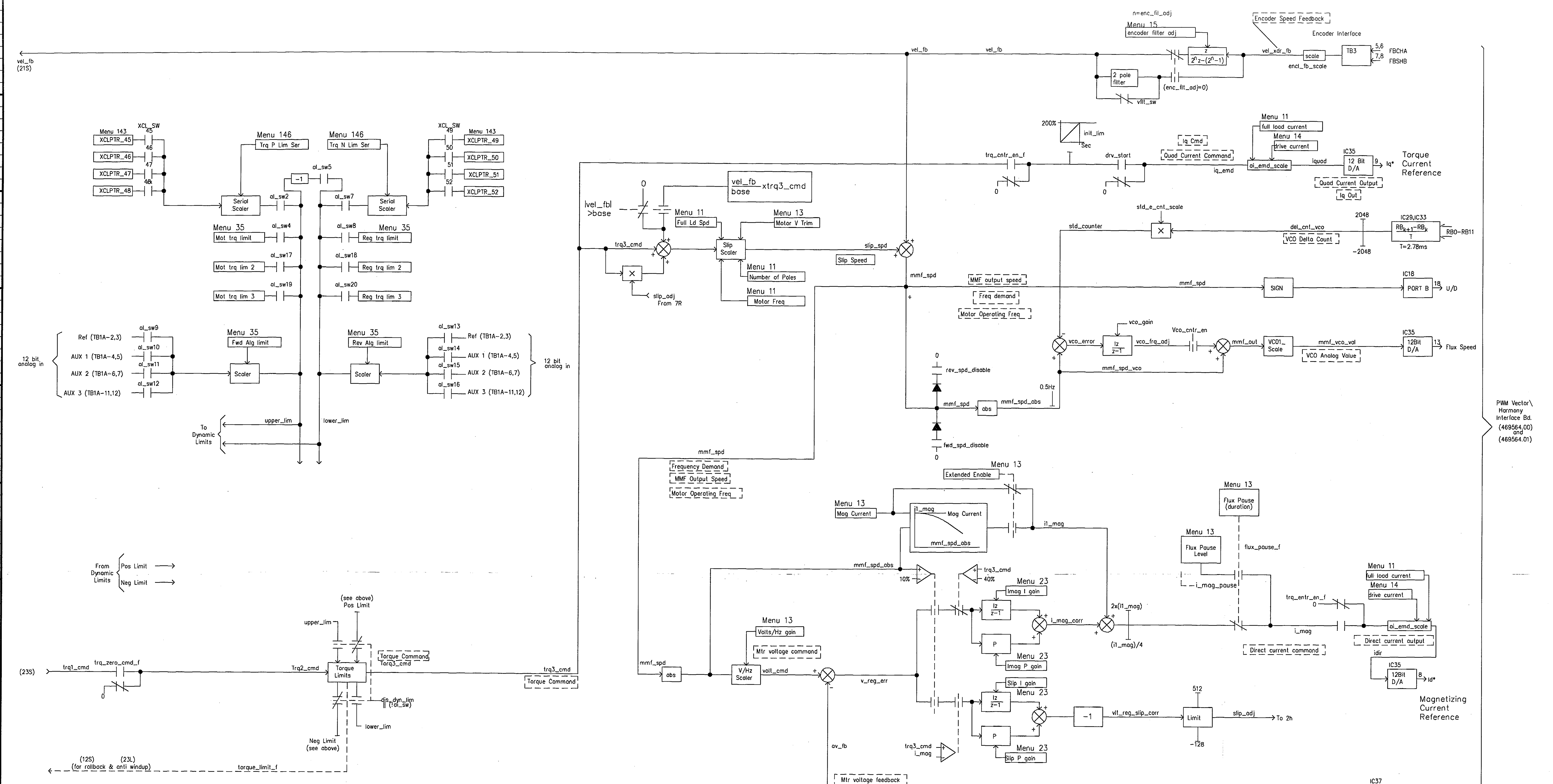
SCALE NTS
DATE 11/29/94
ROBICON
A SUBSIDIARY OF HIGH VOLTAGE ENGINEERING CORP.
CONTROL DIAGRAM
VECTOR CONTROL/HARMONY
DWG.NO 479333
REVISION G
CAD FILE 479333E.05
SHEET NO. 5



Legend

bbbbbb	Menu Parameter Item
bbbbbb (dashed)	Pick List Item
bb_bbbb	Software or System Variable

See DRCTRY.PWM (Harmony and 460VAC)
VECX_XX.LOC (460VAC Only)
HRMX_XX.LOC (Harmony Only)
Where x_xx is the version number

BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS

DFTG CODE NO.				02813	02877	03414	04068
Revise Cnt Diagram MFA 1/10/95	Revise Cnt Diagram MSW 6-13-95	Revise Cnt Diagram JTP 1/29/96	Revise Cnt Diagram ELB 4/3/97	Revise Cnt Diagram ELB 4/17/97	CLEAN UP OF SYMBOLS ELB 6/30/97	Revise Cnt Diagram JDRS 4/5/98	
A	B	C	D	E	F	G	

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

SCALE	NTS
TOL	N/A
LAYER	N/A
DATE	11/29/97
DFTR	MFA
ENGR	MFA

ROBICON
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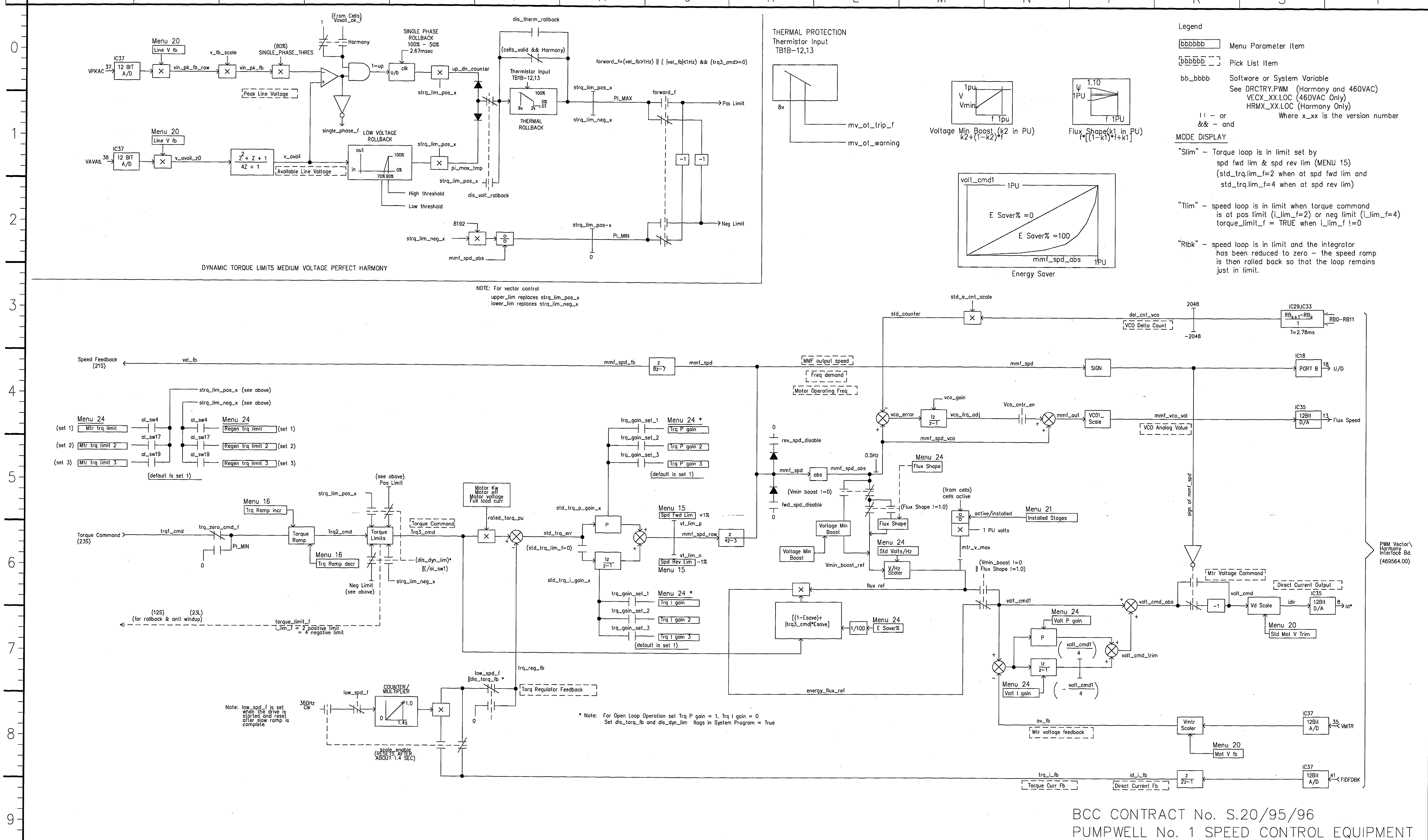
CUSTOMER ROBICON
WORK ORDER STD.

TITLE CONTROL DIAGRAM VECTOR CONTROL/HARMONY
DWG NO 479333 REVISION G
CAD FILE 479333G.04 SHEET NO. 4



BCC CONTRACT No. S.20/95/96

PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS		
A	Revised Cnt Diagram MFA 1/11/95	
B	Revised Cnt Diagram MSW 6-12-95	
C	Revised Cnt Diagram JTP 1/29/96	02813
D	Revised Cnt Diagram ELB 4/3/97	02877
E	Revised Cnt Diagram ELB 4/17/97	03414
F	ADDED VOLTAGE MIN BOOST ELB 7/02/97	04068
G	Revised Cnt Diagram JDR 4/5/98	

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

SCALE	NTS
TOL:	N/A
LAYER	N/A
DATE	11/29/94
DFTR	MFA
ENGR	MFA

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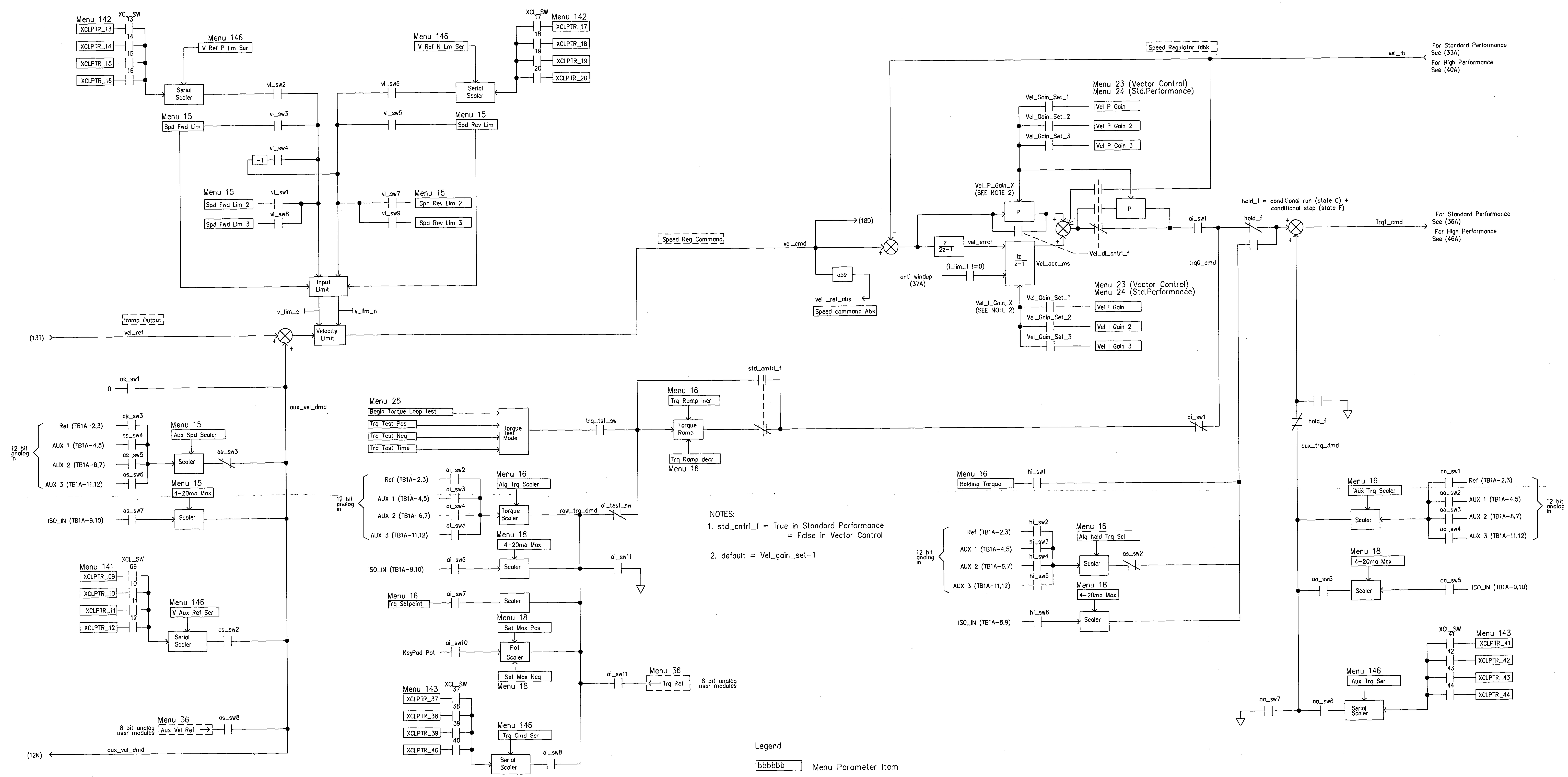
TITLE CONTROL DIAGRAM VECTOR CONTROL/HARMONY
DWG.NO 479333 REVISION G
CAD FILE 479333G.03 SHEET NO. 3



NOTES:

1. std_cntrl_f = True in Standard Performance
= False in Vector Control

2. default = Vel_gain_set-1

Legend

bbbbbb	Menu Parameter Item
bbbbbb (dashed)	Pick List Item
bb_bbbb	Software or System Variable See DRCTRY.PWM (Harmony and 460VAC) VECX_XX.LOC (460VAC Only) HRMX_XX.LOC (Harmony Only) Where x_xx is the version number

BCC CONTRACT No. S.20/95/96
PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS

DFTG CODE NO.			02813	03414	04068
Revised Cnt Diagram MFA 1/10/95	Revised Cnt Diagram MFA 1/10/95	Revised Cnt Diagram JTP 1/29/96	Revised Cnt Diagram ELB 4/3/97	REVISED TRQ REF AIRDF.ML ELB 7/01/97	Revised Cnt Diagram JDR 4/5/98
A	B	C	D	E	G

⚠ WARNING
HAZARD OF ELECTRICAL SHOCK
DISCONNECT INCOMING POWER BEFORE OPENING OR WORKING ON THIS UNIT.

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SCALE	NTS
TOL	N/A
LAYER	N/A
DATE	11/28/94
DFTR	MFA
ENGR	MFA

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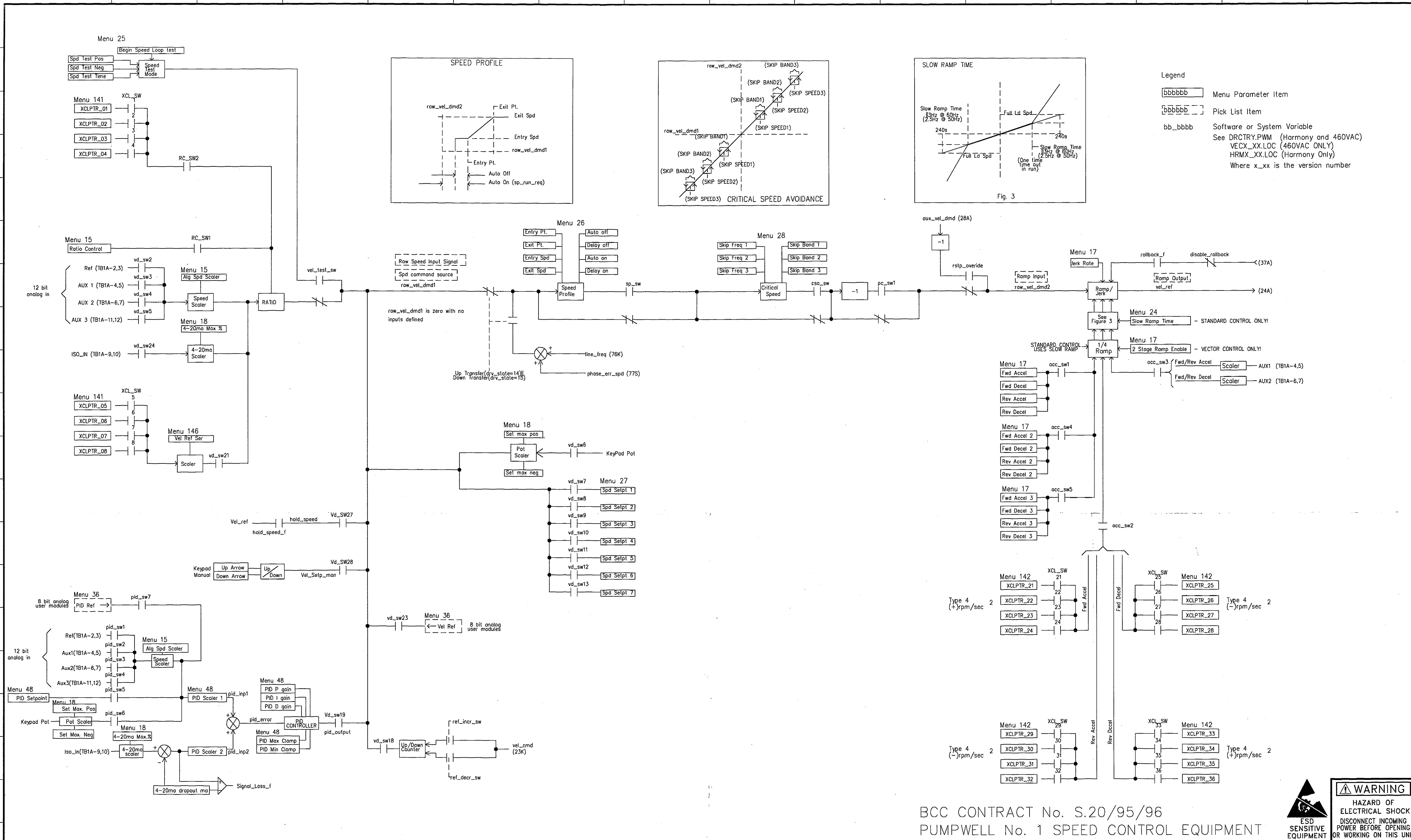
500 Hunt Valley Dr., New Kensington, PA 15068

CUSTOMER: ROBICON
WORK ORDER: STD.

TITLE: CONTROL DIAGRAM VECTOR CONTROL/HARMONY
DWG NO: 479333
REVISION: G
CAD FILE: 479333G.02
SHEET NO.: 2



BCC CONTRACT No. S.20/95/96

PUMPWELL No. 1 SPEED CONTROL EQUIPMENT

REVISIONS						
DFTG CODE NO.				02813	03414	04068
Revised Cnt Diagram MFA 1/10/95	Revised Cnt Diagram MSW 6-8-95	Revised Cnt Diagram JTP 01/29/96	Revised Cnt Diagram ELB 4/3/97	ADDED UP/DOWN TRANSFER ELB 6/30/97	Revised Cnt Diagram JDR 4/5/98	
A	B	C	D	E	G	

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS IN INCHES INTERPRET DRAWING PER ASME Y14.5M-1994
TOLERANCES: .XX ± .03 .XXX ± .015 ANGLES ± 1°
THIRD ANGLE PROJECTION

SCALE NTS
LAYER N/A
DATE 11/28/94
DFTR MFA
ENGR MFA

ROBICON
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CUSTOMER ROBICON
CUST ORDER NUMBER STD

TITLE CONTROL DIAGRAM VECTOR CONTROL/HARMONY
DWG NO 479333 REV G
CAD FILE 479333G.01
SHEET NO 1 OF 8
DBORDF

APPENDIX A3: WARRANTY POLICY AND PRODUCT LIABILITY

This appendix details the warranty policy of ROBICON products as well as product liability information. ROBICON's standard warranty policy is listed below. Note that the warranty policy for a particular job agreement may be different from the standard policy. When in doubt about warranty information, consult the factory.C

A3.1. Guarantee and Product Liability

ROBICON's "standard" warranty policy is listed as follows. When in doubt about warranty and/or product liability issues, consult the factory.

All products are warranted for a period of 18 months from the date of original receipt, not to exceed 1 year from the date of start-up, against defects in materials or workmanship. Guarantee repairs are to be performed FOB (free on board) ROBICON factory to qualify for no charges. ROBICON's liability and customer's exclusive remedy under this warranty are expressly limited to repair, replacement, or repayment of the purchase price. Whether there shall be repair, replacement, or repayment is to be exclusively ROBICON's decision. ROBICON is not liable for incidental and consequential damages.

This warranty shall not apply to major devices or equipment such as transformers and motors not manufactured by the seller or to equipment or parts which shall have been repaired or altered by others than the seller so as, in its judgment, to affect adversely the same, or which shall be subject to negligence, accident, or damage by circumstances beyond the seller's control. For equipment and parts not manufactured by the seller, the warranty obligations of the seller shall in all respects conform and be limited to the warranty extended to the seller by the supplier.

A3.2. In-house Repair Services

For **all** repair service at ROBICON, you will need a Repair Service Order (SO) number. Call **(412) 339-9307** and request a Repair Service Order (SO) number. Please reference this number when making any inquiries. Use the shipping address below for returns:

ROBICON
500 Hunt Valley Drive
New Kensington PA 15068
Attention: Repair Department/SO # (   )

Prepay the shipment and include the following information if you are not using a ROBICON Return Repair Tag: the Repair Service Order (SO) number, part number, a description of the problem, contact phone number, a technical contact phone number (if different) and any additional comments. Put the Repair Service Order (SO) number on the label.

Warranty Repairs: In addition to securing Repair Service Order (SO) number, please supply the **System CO number** (found on the system, usually on the tag inside the cabinet door), whenever possible.

Non-Warranty Repairs: Secure a Repair Service Order (SO) number from ROBICON. Secure your Purchase Order for $500 per item being returned. You will be contacted if the estimated repairs exceed the Purchase Order amount. Include this Purchase Order with the part. Expedited services are available upon request.

> Before sending a printed circuit board to ROBICON for repair, please make a list of parameter values first, then be sure to follow proper ESD precautions when handling boards.

A3

A3.3. Field Service Repairs

If guarantee repairs are performed in the field, a per-diem charge will be made for the serviceman or engineer's travel, living expenses and all time short of the repair time required.

Determination of warranty vs. non-warranty issues will be determined by ROBICON. Call ROBICON at (412) 339-9501 for information on pricing for on-site evaluations.

A3.4. Terms and Conditions

A3.4.1. Warranty

- Repairs will be at ROBICON's expense. Acts of God and use outside of design specification are excluded. Determination will be made by ROBICON.
- Standard warranties are two (2) years for Heating and Regulating equipment, except 1 kHz power supplies and turbos, one (1) year from startup OR 18 months from shipment for all others. **Exceptions: Units with valid extended warranty or preventive maintenance agreements.**
- Decisions to repair or replace with **NEW** or voided warranties will be determined by ROBICON.
- Call tags will be issued as necessary.
- A repair will be warranted for the remainder of the original equipment warranty.
- A minimum evaluation fee will be billed for each unit that is evaluated and which proves to be non-defective. *This fee will be credited to the order if a new unit is purchased. No evaluation fee will be assessed for units that are repaired.*
- A 25% restocking fee will be assessed for any units that are returned to ROBICON stock for credit to you.

Decision of reparability will be determined by ROBICON.

- The warranty on repairs is 30 days from date of repair.
- Shipping will be prepaid and billed.
- Repair system testing at your site may be required.
- If, after best effort, a unit is found to be "beyond economical repair" (BER), it will be returned immediately after you are contacted. You may request the unit be scrapped at ROBICON. With your approval, a fully tested, refurbished unit maybe purchased (based on availability) in place of a repair. A 90-day warranty will apply to the refurbished unit.

A3.4.2. Expedited Service

- The feasibility of expedited service will be determined by ROBICON after examining the unit. *Expedited service cannot be promised for all units.*

Expedited Service may be available at the following levels: one (1) day, (2) day, (3) day or one (1) business week.

- A refurbished unit may be substituted for the returned unit pending availability and your approval.

Prices and Conditions Are Subject to Change Without Notice.

∇ ∇ ∇

APPENDIX A4: PARAMETER SUMMARY

Harmony PWM Parameter Dump (Ver 1.10 6-20-97) 7/23/97 7:33:37

description	change	range	xcl#	lev	hmpd
Main Menu (5)					
Motor Menu (1)		(submenu)		0	0000
Drive Menu (2)		(submenu)		0	0000
Stability Menu (3)		(submenu)		0	0000
Auto Menu (4)		(submenu)		0	0000
Log Control (6)		(submenu)		0	0000
Drive Protect Menu (7)		(submenu)		0	0000
Meter Menu (8)		(submenu)		0	0000
Communications Menu (9)		(submenu)		0	0000
Enter Security Code		(function)		0	0000
Change Security Codes		(function)		2	1000
Security Edit (0)		(submenu)		7	1000
Motor Menu (1)					
Motor Param Menu (11)		(submenu)		0	0000
Encoder Menu (12)		(submenu)		0	0000
Motor Flux Menu (13)		(submenu)		0	0000
Drive Menu (2)					
Drive Param Menu (14)		(submenu)		0	0000
Speed Setup (15)		(submenu)		0	0000
Torq Ref Menu (16)		(submenu)		0	0000
Ramp Setup Menu (17)		(submenu)		0	0000
Pot Setup Menu (18)		(submenu)		0	0000
Timebase Setup (19)		(submenu)		0	0000
Hardware Scale Menu (20)		(submenu)		0	0000
Cell Menu (21)		(submenu)		0	0000
Transfer Menu (200)		(submenu)		7	1000
Stability Menu (3)					
Current Loop Setup (22)		(submenu)		0	0000
Vector Control Tune (23)		(submenu)		0	0000
Std Control Setup (24)		(submenu)		0	0000
Control Loop Test (25)		(submenu)		0	0000
Auto Menu (4)					
Speed Profile Menu (26)		(submenu)		0	0000
Speed Setpoint Menu (27)		(submenu)		0	0000
Critical Speed Menu (28)		(submenu)		0	0000
Comparator Setup (29)		(submenu)		7	1000
PID Select Menu (48)		(submenu)		0	0000
Log Control (6)					
Memory Functions (30)		(submenu)		0	0000
Diagnostic Log Menu (31)		(submenu)		0	0000
Historic Log Menu (32)		(submenu)		0	0000
Fault Log Menu (33)		(submenu)		0	0000
Drive Protect Menu (7)					
Overload Menu (34)		(submenu)		0	0000
Limit Menu (35)		(submenu)		0	0000
Meter Menu (8)					
Analog I/O Setup (36)		(submenu)		0	0000
Display Var. Menu (37)		(submenu)		0	0000
Trim Analog Meters (38)		(submenu)		0	0000
Loc. Alg. Meters (39)		(submenu)		0	0000
Loc. Dig. Meters (40)		(submenu)		0	0000
Communications Menu (9)					
RS232 Functions (41)		(submenu)		0	0000
Remote I/O Menu (42)		(submenu)		0	0000
XCL Send Setup (43)		(submenu)		7	1000
XCL Recv Setup (44)		(submenu)		7	1000
RS232 input- (empty)		(list)		0	0000
RS232 out - (empty)		(list)		0	0000

A4

Parameter Summary

Harmony PWM Parameter Dump (Ver 1.10 6-20-97) 7/23/97 7:33:37

description		change	range		xcl#	lev	hmpd
Motor Param Menu(11)							
Motor Freq	60 Hz	______	15	120	1101	0	0000
Number of poles	4	______	2	36	1102	0	0000
Motor eff	0.93	______	0.60	0.99	1103	0	0000
Full Ld Spd	1780 rpm	______	1	7200	1104	0	0000
Motor voltage	4160 V	______	380	9000	1105	0	0000
Full load curr	100 A	______	12	1500	1106	0	0000
Motor KW	373 KW	______	10	10000	1107	0	0000
Encoder Menu (12)							
Encoder1 PPR	720	______	1	4000	1201	0	0000
Encoder2 PPR	720	______	1	4000	1202	0	0000
Motor Flux Menu (13)							
Motor V Trim	1.000	______	0.050	2.000	1301	0	0000
Volts/Hz gain	1.00	______	0.00	10.00	1302	0	0000
Mag Current	25.0 A	______	0.1	1500.0	1303	0	0000
Extended Enable	0	______	0	1	1304	0	0000
Flux Pause Level	10 %	______	0	100		0	0000
Flux pause	1.00 sec	______	0.01	8.00		0	0000
Drive Param Menu(14)							
Drive current	100 A	______	12	1500	1401	0	0000
Drive Rated Out	4160 V	______	200	15000	1402	0	0000
Drive Input Vlt	4160 V	______	200	15000	1403	0	0000
Auto reset enable	0	______	0	1	1404	0	0000
Aut rst time	1.00 sec	______	1.00	120.00	1405	0	0000
Spinning Load Select	0	______	0	1	1407	0	0000
Vector Control Select	0	______	0	1	1408	7	1001
Ramp Stop Select	1	______	0	1	1409	0	0000
Hall Effect Select	0	______	0	1		7	1001
Reduced Voltage Oper.	0	______	0	1		7	0000
Display Version Number			(function)			0	0000
Customer Order	0	______	0	999999		0	0000
Customer Drive	1	______	0	20		0	0000
Speed Setup (15)							
Ratio Control	1.000	______	-125.000	125.000	1501	0	0000
Spd Fwd Lim	100 %	______	0	200	1502	0	0000
Spd Rev Lim	-100 %	______	-200	0	1503	0	0000
Zero Speed	1 %	______	0	100	1504	0	0000
Alg Spd Scaler	100 %	______	0	250	1505	0	0000
Aux Spd Scaler	100 %	______	0	250	1506	0	0000
Spd Fwd Lim 2	100 %	______	0	200	1507	7	1000
Spd Rev Lim 2	-100 %	______	-200	0	1508	7	1000
Spd Fwd Lim 3	100 %	______	0	200	1509	7	1000
Spd Rev Lim 3	-100 %	______	-200	0	1510	7	1000
Encoder filter adj	0	______	0	6	1511	7	1000
Torq Ref Menu (16)							
Alg Trq Scaler	100 %	______	0	250	1601	0	0000
Aux Trq Scaler	100 %	______	0	250	1602	0	0000
Trq Setpoint	50 %	______	0	250	1603	0	0000
Holding Torque	0 %	______	-250	250	1604	7	1000
Alg hold Trq Scl	0 %	______	0	250	1605	7	1000
Trq Ramp incr	1.00 sec	______	0.00	999.99	1606	0	0000
Trq Ramp decr	1.00 sec	______	0.00	999.99	1607	0	0000

A4

Harmony PWM Parameter Dump (Ver 1.10 6-20-97) 7/23/97 7:33:37

description		change	range		xcl#	lev	hmpd
Ramp Setup Menu (17)							
Fwd Accel	5.0 sec	______	0.0	3200.0	1701	0	0000
Fwd Decel	5.0 sec	______	0.0	3200.0	1702	0	0000
Rev Accel	5.0 sec	______	0.0	3200.0	1703	0	0000
Rev Decel	5.0 sec	______	0.0	3200.0	1704	0	0000
Jerk Rate	0.10 sec	______	0.00	78.12	1705	0	0000
2 Stage Ramp Enable	0	______	0	1	1706	0	0000
Fwd Accel 2	5.0 sec	______	0.0	3200.0	1707	7	1000
Fwd Decel 2	5.0 sec	______	0.0	3200.0	1708	7	1000
Rev Accel 2	5.0 sec	______	0.0	3200.0	1709	7	1000
Rev Decel 2	5.0 sec	______	0.0	3200.0	1710	7	1000
Fwd Accel 3	50 sec	______	0	32000	1711	7	1000
Fwd Decel 3	50 sec	______	0	32000	1712	7	1000
Rev Accel 3	50 sec	______	0	32000	1713	7	1000
Rev Decel 3	50 sec	______	0	32000	1714	7	1000
Pot Setup Menu (18)							
Set max pos	100 %	______	0	200	1801	0	0000
Set max neg	-100 %	______	-200	0	1802	0	0000
4-20ma Max	100.0 %	______	1.0	150.0	1803	0	0000
4-20ma Dropout	4.0 ma	______	0.0	10.0	1804	0	0000
Timebase Setup (19)							
Cond Stop Tmr	0.8 sec	______	0.0	999.9	1901	0	0000
Cond Run Tmr	0.8 sec	______	0.0	999.9	1902	0	0000
Cycle Timer	0 Hrs	______	0	10000	1903	0	0000
Hour Meter Setup	(50)		(submenu)			0	0000
Set the Clock time			(function)			0	0000
Hardware Scale Menu(20)							
Mot V fb	1000 v/v	______	1	3000	2001	0	0000
Line V fb	1000 v/v	______	1	9000	2002	0	0000
Ib Offset Adjust	7F	______	00	FF	2003	0	0000
Ic Offset Adjust	7F	______	00	FF	2004	0	0000
Std Mot V Trim	8.000 V	______	0.000	10.000	2006	0	0000
Cell Menu (21)							
Installed Stages	5	______	3	7	2101	0	0000
Minimum Stage Count	3	______	1	6	2102	0	0000
Auto Bypass Enable	0	______	0	1	2103	0	0000
Print Cell Status			(function)			0	0000
Display Cell Fault(s)			(function)			0	0000
Print Cell Fault(s)			(function)			0	0000
RS232 Diag Bypass	1	______	0	1		7	1000
Current Loop Setup(22)							
I quad I gain	0.000	______	0.000	0.996	2201	0	0000
I quad P gain	0.000	______	0.000	0.996	2202	0	0000
I direct I gain	0.000	______	0.000	0.996	2203	0	0000
I direct P gain	0.000	______	0.000	0.996	2204	0	0000
Vector Control Tune(23)							
Vel P gain	5.000	______	0.000	127.996	2301	0	0000
Vel I gain	4.000	______	0.000	255.996	2302	0	0000
Imag P gain	0.062	______	0.000	127.996	2303	0	0000
Imag I gain	0.933	______	0.000	127.996	2304	0	0000
Slip P gain	0.062	______	0.000	127.996	2305	0	0000
Slip I gain	0.933	______	0.000	127.996	2306	0	0000
Vel P gain 2	5.000	______	0.000	127.996	2307	7	1000
Vel I gain 2	4.000	______	0.000	255.996	2308	7	1000
Vel P gain 3	5.000	______	0.000	127.996	2309	7	1000
Vel I gain 3	4.000	______	0.000	255.996	2310	7	1000

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description		change	range		xcl#	lev	hmpd
Std Control Setup(24)							
Std Volts/Hz	1.000		-127.996	127.996	2401	0	0000
Volt P gain	0.312		-127.996	127.996	2402	0	0000
Volt I gain	0.312		-127.996	127.996	2403	0	0000
Vel P gain	5.000		0.000	127.996	2404	0	0000
Vel I gain	4.000		0.000	255.996	2405	0	0000
Trq P gain	0.011		0.000	127.996	2406	0	0000
Trq I gain	0.300		0.000	255.996	2407	0	0000
Voltage Min Boost	0.0 %		0.0	6.0	2408	7	1000
Slow Ramp Time	3.00 sec		0.00	9.99	2409	0	0000
Mot trq limit	100 %		0	300	2410	0	0000
Regen trq limit	3.0 %		0.2	10.0	2411	0	0000
Energy Saver	0 %		0	100	2412	0	0000
Flux Shape	1.00		0.01	1.10	2413	7	1000
Spin Load Thresh	4.3 %		0.0	50.0	2414	0	0000
Spin Flux Scale	6.25 %		1.00	15.00	2415	0	0000
Flux Ramp	7.0 sec		0.1	15.0	2416	0	0000
Freq Scan Rate	5.0 sec		1.5	9.0	2417	0	0000
Freq Drop Level	5.0 %		0.0	12.0	2418	0	0000
Vel P gain 2	5.000		0.000	127.996	2419	7	1000
Vel I gain 2	4.000		0.000	255.996	2420	7	1000
Vel P gain 3	5.000		0.000	127.996	2421	7	1000
Vel I gain 3	4.000		0.000	255.996	2422	7	1000
Trq P gain 2	0.011		0.000	127.996	2423	7	1000
Trq I gain 2	0.300		0.000	255.996	2424	7	1000
Trq P gain 3	0.011		0.000	127.996	2425	7	1000
Trq I gain 3	0.300		0.000	255.996	2426	7	1000
Mot trq limit 2	100 %		0	300	2427	7	1000
Regen trq limit 2	3.0 %		0.2	10.0	2428	7	1000
Mot trq limit 3	100 %		0	300	2429	7	1000
Regen trq limit 3	3.0 %		0.2	10.0	2430	7	1000
Control Loop Test(25)							
Spd Test Pos	30 %		-200	200		0	0000
Spd Test Neg	-30 %		-200	200		0	0000
Spd Test Time	30.1 sec		0.0	500.0		0	0000
Begin Speed Loop test			(function)			0	0000
Stop Speed Loop test			(function)			0	0000
Trq Test Pos	23 %		-200	200		0	0000
Trq Test Neg	-23 %		-200	200		0	0000
Trq Test Time	0.67 sec		0.00	91.00		0	0000
Begin Torque Loop test			(function)			0	0000
Stop Torque Loop test			(function)			0	0000
Start Diagnostic Log			(function)			0	0000
Select Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Speed Profile Menu(26)							
Entry Pt.	0.0 %		0.0	150.0	2601	0	0000
Exit Pt.	150.0 %		0.0	150.0	2602	0	0000
Entry Spd	0.0 %		0.0	150.0	2603	0	0000
Exit Spd	150.0 %		0.0	150.0	2604	0	0000
Auto off	0.0 %		0.0	100.0	2605	0	0000
Delay off	0.5 sec		0.5	100.0	2606	0	0000
Auto on	0.0 %		0.0	100.0	2607	0	0000
Delay on	0.5 sec		0.5	100.0	2608	0	0000
Speed Setpoint Menu(27)							
Spd Setpt 1	0 rpm		-9999	9999	2701	0	0000
Spd Setpt 2	0 rpm		-9999	9999	2702	0	0000
Spd Setpt 3	0 rpm		-9999	9999	2703	0	0000
Spd Setpt 4	0 rpm		-9999	9999	2704	0	0000
Spd Setpt 5	0 rpm		-9999	9999	2705	0	0000
Spd Setpt 6	0 rpm		-9999	9999	2706	0	0000
Spd Setpt 7	0 rpm		-9999	9999	2707	0	0000

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description		change	range		xcl#	lev	hmpd
Critical Speed Menu(28)							
Skip Freq 1	15.0 Hz	______	0.0	120.0	2801	0	0000
Skip Freq 2	30.0 Hz	______	0.0	120.0	2802	0	0000
Skip Freq 3	45.0 Hz	______	0.0	120.0	2803	0	0000
Skip band 1	0.0 Hz	______	0.0	6.0	2804	0	0000
Skip band 2	0.0 Hz	______	0.0	6.0	2805	0	0000
Skip band 3	0.0 Hz	______	0.0	6.0	2806	0	0000
Comparator Setup(29)							
Compare 1 Setup	(121)		(submenu)			7	1000
Compare 2 Setup	(122)		(submenu)			7	1000
Compare 3 Setup	(123)		(submenu)			7	1000
Compare 4 Setup	(124)		(submenu)			7	1000
Compare 5 Setup	(125)		(submenu)			7	1000
Compare 6 Setup	(126)		(submenu)			7	1000
Compare 7 Setup	(127)		(submenu)			7	1000
Compare 8 Setup	(128)		(submenu)			7	1000
Compare 9 Setup	(129)		(submenu)			7	1000
Compare 10 Setup	(130)		(submenu)			7	1000
Compare 11 Setup	(131)		(submenu)			7	1000
Compare 12 Setup	(132)		(submenu)			7	1000
Compare 13 Setup	(133)		(submenu)			7	1000
Compare 14 Setup	(134)		(submenu)			7	1000
Compare 15 Setup	(135)		(submenu)			7	1000
Compare 16 Setup	(136)		(submenu)			7	1000
PID Select Menu (48)							
PID scaler 1	0.390	______	-127.996	127.996	4801	0	0000
PID scaler 2	-0.390	______	-127.996	127.996	4802	0	0000
PID P Gain	0.390	______	0.000	98.996	4803	0	0000
PID I Gain	0.390	______	0.000	98.996	4804	0	0000
PID D Gain	0.000	______	0.000	98.996	4805	0	0000
PID Min Clamp	0 %	______	-200	200	4806	0	0000
PID Max Clamp	100 %	______	-200	200	4807	0	0000
PID Setpoint	0 %	______	-200	200	4808	7	1000
Memory Functions(30)							
Read Memory Byte			(function)			0	0000
Read Memory Word			(function)			0	0000
Write Memory Byte			(function)			0	0000
Write Memory Word			(function)			0	0000
Copy from RAM to EEPROM			(function)			0	0000
Copy from EEPROM to RAM			(function)			0	0000
Diagnostic Log Menu(31)							
Log var1	- (empty)		(list)			0	0000
Log var2	- (empty)		(list)			0	0000
Log var3	- (empty)		(list)			0	0000
Log var4	- (empty)		(list)			0	0000
Diag Log Time	3.6 sec	______	0.0	310.0		0	0000
Select Diagnostic Log			(function)			0	0000
Start Diagnostic Log			(function)			0	0000
Diagnostic Log Upload			(function)			0	0000
Historic Log Menu(32)							
Select Historic Log			(function)			0	0000
Hist var1	-M % spd		(list)			0	0000
Hist var2	-Mtr Freq		(list)			0	0000
Hist var3	-Trq cmd		(list)			0	0000
Hist var4	-Trq I Fb		(list)			0	0000
Hist var5	-Mtr V fb		(list)			0	0000
Hist var6	-I sum fb		(list)			0	0000
Hist var7	-V Avail		(list)			0	0000
Historic Log Upload			(function)			0	0000
Fault Log Menu (33)							
Fault Log Display			(function)			0	0000
Fault Log Upload			(function)			0	0000

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description		change	range		xcl#	lev	hmpd
Overload Menu (34)							
Overld Select	1	______	0	2	3401	0	0000
I overload	150 %	______	20	210	3402	0	0000
I timeout	60.00 sec	______	0.01	300.00	3403	0	0000
Motor Trip volts	4800 V	______	5	9999	3404	0	0000
OverSpeed	120 %	______	0	250	3405	0	0000
Encoder Loss Thsh	0 %	______	0	75	3406	0	0000
Drive IOC Setpt	150 %	______	50	200	3407	0	0000
I overload 2	150 %	______	20	210	3408	7	1000
I timeout 2	60.00 sec	______	0.01	300.00	3409	7	1000
I overload 3	150 %	______	20	210	3410	7	1000
I timeout 3	60.00 sec	______	0.01	300.00	3411	7	1000
Enter for Fault Reset			(function)			0	0000
Clear Fault Message			(function)			7	1000
Limit Menu (35)							
Mot trq limit	100 %	______	0	300	3501	0	0000
Reg trq limit	2.0 %	______	0.0	30.0	3502	0	0000
Mot Alg limit	100 %	______	0	300	3503	0	0000
Regen Alg limit	2.0 %	______	0.0	30.0	3504	0	0000
Mot trq limit 2	100 %	______	0	300	3505	7	1000
Reg trq limit 2	2.0 %	______	0.0	30.0	3506	7	1000
Mot trq limit 3	100 %	______	0	300	3507	7	1000
Reg trq limit 3	2.0 %	______	0.0	30.0	3508	7	1000
Analog I/O Setup(36)							
Alg var1	- (empty)		(list)			0	0000
Alg var2	- (empty)		(list)			0	0000
Analog TP 1	10.000 V	______	-20.000	20.000		0	0000
Analog TP 2	10.000 V	______	-20.000	20.000		0	0000
Alg In Scaler	100 %	______	0	250		0	0000
Analog Output 1	(111)		(submenu)			7	1000
Analog Output 2	(112)		(submenu)			7	1000
Analog Output 3	(113)		(submenu)			7	1000
Analog Output 4	(114)		(submenu)			7	1000
Analog Output 5	(115)		(submenu)			7	1000
Analog Output 6	(116)		(submenu)			7	1000
Analog Output 7	(117)		(submenu)			7	1000
Analog Output 8	(118)		(submenu)			7	1000
Analog Input 1	(181)		(submenu)			7	1000
Analog Input 2	(182)		(submenu)			7	1000
Analog Input 3	(183)		(submenu)			7	1000
Analog Input 4	(184)		(submenu)			7	1000
Analog Input 5	(185)		(submenu)			7	1000
Analog Input 6	(186)		(submenu)			7	1000
Analog Input 7	(187)		(submenu)			7	1000
Analog Input 8	(188)		(submenu)			7	1000
Vel Ref	- (empty)		(list)			7	1000
PID Ref	- (empty)		(list)			7	1000
Aux Vel Ref	- (empty)		(list)			7	1000
Trq Ref	- (empty)		(list)			7	1000
Display Var. Menu(37)							
Disp var0	-Spd Input		(list)			0	0000
Disp var1	-Mtr Freq		(list)			0	0000
Disp var2	-Mtr rpm		(list)			0	0000
Disp var3	-Trq I Fb		(list)			0	0000
Trim Analog Meters(38)							
Trim local meter 1			(function)			0	0000
Trim local meter 2			(function)			0	0000
Trim local meter 3			(function)			0	0000
Trim local meter 4			(function)			0	0000
Trim local meter 5			(function)			0	0000
Trim local meter 6			(function)			0	0000
Trim local meter 7			(function)			0	0000
Trim local meter 8			(function)			0	0000

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        description          change             range      xcl# lev hmpd

      Loc. Alg. Meters(39)
   Analog Meter 1      (51)                   (submenu)           0  0000
   Analog Meter 2      (52)                   (submenu)           0  0000
   Analog Meter 3      (53)                   (submenu)           0  0000
   Analog Meter 4      (54)                   (submenu)           0  0000
   Analog Meter 5      (55)                   (submenu)           0  0000
   Analog Meter 6      (56)                   (submenu)           0  0000
   Analog Meter 7      (57)                   (submenu)           0  0000
   Analog Meter 8      (58)                   (submenu)           0  0000

      Loc. Dig. Meters(40)
   Digital Meter 1     (61)                   (submenu)           0  0000
   Digital Meter 2     (62)                   (submenu)           0  0000
   Digital Meter 3     (63)                   (submenu)           0  0000
   Digital Meter 4     (64)                   (submenu)           0  0000
   Digital Meter 5     (65)                   (submenu)           0  0000
   Digital Meter 6     (66)                   (submenu)           0  0000
   Digital Meter 7     (67)                   (submenu)           0  0000

      RS232 Functions (41)
   System Program Download                    (function)          0  0000
   System Program Upload                      (function)          0  0000
   Display Sys Prog Name                      (function)          0  0000
   Download entire EEPROM                     (function)          0  0000
   Upload entire EEPROM                       (function)          0  0000
   Parameter Data Download                    (function)          0  0000
   Parameter Data Upload                      (function)          0  0000
   RS232 Echo-back test                       (function)          0  0000
   Parameter Log Upload                       (function)          0  0000
   Onboard RS232          1   ______       0            1         7  1000

      Remote I/O Menu (42)
   Read user module                           (function)          0  0000
   Write user module                          (function)          0  0000

       XCL Send Setup (43)
   XCL Global Send     (145)                  (submenu)           7  1001
   XCL Send Reg 1-31   (147)                  (submenu)           7  1000
   XCL Send Reg 33-63(148)                    (submenu)           7  1000
   XCL Node Address      10   ______       0          128         7  1001
   CAB Configuration   0000   ______    0000         FFFF         0  0001

      XCL Global Send(145)
   XCL send01 - (empty)                         (list)            0  0000
   XCL send02 - (empty)                         (list)            0  0000
   XCL send03 - (empty)                         (list)            0  0000
   XCL send04 - (empty)                         (list)            0  0000
   XCL send05 - (empty)                         (list)            0  0000
   XCL send06 - (empty)                         (list)            0  0000
   XCL send07 - (empty)                         (list)            0  0000
   XCL send08 - (empty)                         (list)            0  0000
   XCL send09 - (empty)                         (list)            0  0000
   XCL send10 - (empty)                         (list)            0  0000
   XCL send11 - (empty)                         (list)            0  0000
   XCL send12 - (empty)                         (list)            0  0000
   XCL send13 - (empty)                         (list)            0  0000
   XCL send14 - (empty)                         (list)            0  0000
   XCL send15 - (empty)                         (list)            0  0000
   XCL send16 - (empty)                         (list)            0  0000
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Harmony PWM Parameter Dump (Ver 1.10 6-20-97) 7/23/97 7:33:37 description	change	range		xcl# lev	hmpd
XCL Send Reg 1-31(147)					
XCLreg001 -Spd Input %		(list)		0	0000
XCLreg003 -Ramp Out %		(list)		0	0000
XCLreg005 -Freq Dmd %		(list)		0	0000
XCLreg007 -Tot I Fb %		(list)		0	0000
XCLreg009 -Mtr V fb %		(list)		0	0000
XCLreg011 -KW output %		(list)		0	0000
XCLreg013 -Serial flg1		(list)		0	0000
XCLreg015 -Heartbt		(list)		0	0000
XCLreg017 - (empty)		(list)		0	0000
XCLreg019 - (empty)		(list)		0	0000
XCLreg021 - (empty)		(list)		0	0000
XCLreg023 - (empty)		(list)		0	0000
XCLreg025 - (empty)		(list)		0	0000
XCLreg027 - (empty)		(list)		0	0000
XCLreg029 - (empty)		(list)		0	0000
XCLreg031 - (empty)		(list)		0	0000
XCL Send Reg 33-63(148)					
XCLreg033 - (empty)		(list)		0	0000
XCLreg035 - (empty)		(list)		0	0000
XCLreg037 - (empty)		(list)		0	0000
XCLreg039 - (empty)		(list)		0	0000
XCLreg041 - (empty)		(list)		0	0000
XCLreg043 - (empty)		(list)		0	0000
XCLreg045 - (empty)		(list)		0	0000
XCLreg047 - (empty)		(list)		0	0000
XCLreg049 - (empty)		(list)		0	0000
XCLreg051 - (empty)		(list)		0	0000
XCLreg053 - (empty)		(list)		0	0000
XCLreg055 - (empty)		(list)		0	0000
XCLreg057 - (empty)		(list)		0	0000
XCLreg059 - (empty)		(list)		0	0000
XCLreg061 - (empty)		(list)		0	0000
XCLreg063 - (empty)		(list)		0	0000
XCL Recv Setup (44)					
XCL Vel Ref (141)		(submenu)		7	1000
XCL Vel Ctrl (142)		(submenu)		7	1000
XCL Trq Ctrl (143)		(submenu)		7	1000
XCL Com Flags (144)		(submenu)		7	1000
Ser Input Scalers (146)		(submenu)		7	1001
XCL Vel Ref (141)					
XCLPTR_01 00:000	______	000	099	0	0001
XCLPTR_02 00:000	______	000	099	0	0001
XCLPTR_03 00:000	______	000	099	0	0001
XCLPTR_04 00:000	______	000	099	0	0001
XCLPTR_05 99:065	______	000	099	0	0001
XCLPTR_06 00:000	______	000	099	0	0001
XCLPTR_07 00:000	______	000	099	0	0001
XCLPTR_08 00:000	______	000	099	0	0001
XCLPTR_09 00:000	______	000	099	0	0001
XCLPTR_10 00:000	______	000	099	0	0001
XCLPTR_11 00:000	______	000	099	0	0001
XCLPTR_12 00:000	______	000	099	0	0001

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description		change	range		xcl#	lev	hmpd
XCL Vel Ctrl (142)							
XCLPTR_13	00:000	______	000	099		0	0001
XCLPTR_14	00:000	______	000	099		0	0001
XCLPTR_15	00:000	______	000	099		0	0001
XCLPTR_16	00:000	______	000	099		0	0001
XCLPTR_17	00:000	______	000	099		0	0001
XCLPTR_18	00:000	______	000	099		0	0001
XCLPTR_19	00:000	______	000	099		0	0001
XCLPTR_20	00:000	______	000	099		0	0001
XCLPTR_21	00:000	______	000	099		0	0001
XCLPTR_22	00:000	______	000	099		0	0001
XCLPTR_23	00:000	______	000	099		0	0001
XCLPTR_24	00:000	______	000	099		0	0001
XCLPTR_25	00:000	______	000	099		0	0001
XCLPTR_26	00:000	______	000	099		0	0001
XCLPTR_27	00:000	______	000	099		0	0001
XCLPTR_28	00:000	______	000	099		0	0001
XCLPTR_29	00:000	______	000	099		0	0001
XCLPTR_30	00:000	______	000	099		0	0001
XCLPTR_31	00:000	______	000	099		0	0001
XCLPTR_32	00:000	______	000	099		0	0001
XCLPTR_33	00:000	______	000	099		0	0001
XCLPTR_34	00:000	______	000	099		0	0001
XCLPTR_35	00:000	______	000	099		0	0001
XCLPTR_36	00:000	______	000	099		0	0001
XCL Trq Ctrl (143)							
XCLPTR_37	00:000	______	000	099		0	0001
XCLPTR_38	00:000	______	000	099		0	0001
XCLPTR_39	00:000	______	000	099		0	0001
XCLPTR_40	00:000	______	000	099		0	0001
XCLPTR_41	00:000	______	000	099		0	0001
XCLPTR_42	00:000	______	000	099		0	0001
XCLPTR_43	00:000	______	000	099		0	0001
XCLPTR_44	00:000	______	000	099		0	0001
XCLPTR_45	00:000	______	000	099		0	0001
XCLPTR_46	00:000	______	000	099		0	0001
XCLPTR_47	00:000	______	000	099		0	0001
XCLPTR_48	00:000	______	000	099		0	0001
XCLPTR_49	00:000	______	000	099		0	0001
XCLPTR_50	00:000	______	000	099		0	0001
XCLPTR_51	00:000	______	000	099		0	0001
XCLPTR_52	00:000	______	000	099		0	0001
XCL Com Flags (144)							
COMM_F01	99:067	______	000	099		0	0001
COMM_F02	99:069	______	000	099		0	0001
COMM_F03	00:000	______	000	099		0	0001
COMM_F04	00:000	______	000	099		0	0001
COMM_F05	00:000	______	000	099		0	0001
COMM_F06	00:000	______	000	099		0	0001
COMM_F07	00:000	______	000	099		0	0001
COMM_F08	00:000	______	000	099		0	0001
COMM_F09	00:000	______	000	099		0	0001
COMM_F10	00:000	______	000	099		0	0001
COMM_F11	00:000	______	000	099		0	0001
COMM_F12	00:000	______	000	099		0	0001
COMM_F13	00:000	______	000	099		0	0001
COMM_F14	00:000	______	000	099		0	0001
COMM_F15	00:000	______	000	099		0	0001
COMM_F16	00:000	______	000	099		0	0001
Ser Input Scalers(146)							
Vel Ref Ser	1.000	______	-125.000	125.000	4601	7	1000
V Aux Ref Ser	1.000	______	-125.000	125.000	4602	7	1000
V Ref P Lm Ser	1.000	______	-125.000	125.000	4603	7	1000
V Ref N Lm Ser	1.000	______	-125.000	125.000	4604	7	1000
Trq Cmd Ser	1.000	______	-125.000	125.000	4605	7	1000
Aux Trq Ser	1.000	______	-125.000	125.000	4606	7	1000

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Trq P Lim Ser	1.000	______	-125.000	125.000	4607	7	1000
Trq N Lim Ser	1.000	______	-125.000	125.000	4608	7	1000

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description		change		range	xcl#	lev	hmpd
Hour Meter Setup(50)							
Display Hour Meter				(function)		0	0000
KW Hours Consumed				(function)		0	0000
Analog Meter 1 (51)							
Meter 1 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 2 (52)							
Meter 2 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 3 (53)							
Meter 3 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 4 (54)							
Meter 4 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 5 (55)							
Meter 5 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 6 (56)							
Meter 6 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 7 (57)							
Meter 7 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Analog Meter 8 (58)							
Meter 8 var- (empty)				(list)		0	0000
Full Scale	000000	______	000000	400000		0	0000
Zero Position	1	______	0	1		0	0000
Digital Meter 1 (61)							
Meter 1 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 2 (62)							
Meter 2 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 3 (63)							
Meter 3 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 4 (64)							
Meter 4 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000
Digital Meter 5 (65)							
Meter 5 var- (empty)				(list)		0	0000
Rated Value	000000	______	000000	400000		0	0000
Decimal Places	0	______	0	4		0	0000

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Harmony PWM Parameter Dump (Ver 1.10 description	change	6-20-97)	7/23/97 range	7:33:37 xcl# lev	hmpd
Digital Meter 6 (66)					
Meter 6 var- (empty)			(list)	0	0000
Rated Value 000000	______	000000	400000	0	0000
Decimal Places 0	______	0	4	0	0000
Digital Meter 7 (67)					
Meter 7 var- (empty)			(list)	0	0000
Rated Value 000000	______	000000	400000	0	0000
Decimal Places 0	______	0	4	0	0000
Analog Output 1(111)					
Analog var1- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var1 type - (empty)			(list)	7	1000
Analog Output 2(112)					
Analog var2- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var2 type - (empty)			(list)	7	1000
Analog Output 3(113)					
Analog var3- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var3 type - (empty)			(list)	7	1000
Analog Output 4(114)					
Analog var4- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var4 type - (empty)			(list)	7	1000
Analog Output 5(115)					
Analog var5- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var5 type - (empty)			(list)	7	1000
Analog Output 6(116)					
Analog var6- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var6 type - (empty)			(list)	7	1000
Analog Output 7(117)					
Analog var7- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var7 type - (empty)			(list)	7	1000
Analog Output 8(118)					
Analog var8- (empty)			(list)	7	1000
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var8 type - (empty)			(list)	7	1000
Compare 1 Setup(121)					
Comp 1 A in- (empty)			(list)	0	0000
Comp 1 B in- (empty)			(list)	0	0000
Compare 1 - (empty)			(list)	0	0000
Compare 2 Setup(122)					
Comp 2 A in- (empty)			(list)	0	0000
Comp 2 B in- (empty)			(list)	0	0000
Compare 2 - (empty)			(list)	0	0000
Compare 3 Setup(123)					
Comp 3 A in- (empty)			(list)	0	0000
Comp 3 B in- (empty)			(list)	0	0000
Compare 3 - (empty)			(list)	0	0000

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Harmony PWM Parameter Dump (Ver 1.10   6-20-97)  7/23/97    7:33:37
          description         change               range      xcl# lev hmpd

          Compare 4  Setup(124)
      Comp 4 A in- (empty)                         (list)           0  0000
      Comp 4 B in- (empty)                         (list)           0  0000
      Compare 4  - (empty)                         (list)           0  0000

          Compare 5  Setup(125)
      Comp 5 A in- (empty)                         (list)           0  0000
      Comp 5 B in- (empty)                         (list)           0  0000
      Compare 5  - (empty)                         (list)           0  0000

          Compare 6  Setup(126)
      Comp 6 A in- (empty)                         (list)           0  0000
      Comp 6 B in- (empty)                         (list)           0  0000
      Compare 6  - (empty)                         (list)           0  0000

          Compare 7  Setup(127)
      Comp 7 A in- (empty)                         (list)           0  0000
      Comp 7 B in- (empty)                         (list)           0  0000
      Compare 7  - (empty)                         (list)           0  0000

          Compare 8  Setup(128)
      Comp 8 A in- (empty)                         (list)           0  0000
      Comp 8 B in- (empty)                         (list)           0  0000
      Compare 8  - (empty)                         (list)           0  0000

          Compare 9  Setup(129)
      Comp 9 A in- (empty)                         (list)           0  0000
      Comp 9 B in- (empty)                         (list)           0  0000
      Compare 9  - (empty)                         (list)           0  0000

        Compare 10 Setup(130)
      Comp 10 A i- (empty)                         (list)           0  0000
      Comp 10 B i- (empty)                         (list)           0  0000
      Compare 10 - (empty)                         (list)           0  0000

        Compare 11 Setup(131)
      Comp 11 A i- (empty)                         (list)           0  0000
      Comp 11 B i- (empty)                         (list)           0  0000
      Compare 11 - (empty)                         (list)           0  0000

        Compare 12 Setup(132)
      Comp 12 A i- (empty)                         (list)           0  0000
      Comp 12 B i- (empty)                         (list)           0  0000
      Compare 12 - (empty)                         (list)           0  0000

        Compare 13 Setup(133)
      Comp 13 A i- (empty)                         (list)           0  0000
      Comp 13 B i- (empty)                         (list)           0  0000
      Compare 13 - (empty)                         (list)           0  0000
        Compare 14 Setup(134)
      Comp 14 A i- (empty)                         (list)           0  0000
      Comp 14 B i- (empty)                         (list)           0  0000
      Compare 14 - (empty)                         (list)           0  0000
        Compare 15 Setup(135)
      Comp 15 A i- (empty)                         (list)           0  0000
      Comp 15 B i- (empty)                         (list)           0  0000
      Compare 15 - (empty)                         (list)           0  0000
        Compare 16 Setup(136)
      Comp 16 A i- (empty)                         (list)           0  0000
      Comp 16 B i- (empty)                         (list)           0  0000
      Compare 16 - (empty)                         (list)           0  0000
          Analog Input 1(181)
      Full Range       0.0 %  ______      0.0       300.0           7  1000
      Module Address       0  ______        0          15           7  1000
      Var1 type    - (empty)                         (list)           7  1000
```

Harmony PWM Parameter Dump (Ver 1.10 6-20-97) description	change		7/23/97 range	7:33:37 xcl# lev	hmpd
Analog Input 2(182)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var2 type - (empty)			(list)	7	1000
Analog Input 3(183)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var3 type - (empty)			(list)	7	1000
Analog Input 4(184)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var4 type - (empty)			(list)	7	1000
Analog Input 5(185)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var5 type - (empty)			(list)	7	1000
Analog Input 6(186)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var6 type - (empty)			(list)	7	1000
Analog Input 7(187)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var7 type - (empty)			(list)	7	1000
Analog Input 8(188)					
Full Range 0.0 %	______	0.0	300.0	7	1000
Module Address 0	______	0	15	7	1000
Var8 type - (empty)			(list)	7	1000
Transfer Menu (200)					
Phase I gain 2	______	0	15	7	1000
Phase P shft 4	______	1	12	7	1000
Phase offset 0.0 deg	______	0.0	180.0	7	1000
Hardwr offst 0.0 deg	______	-180.0	180.0	7	1000
Phase err thrsh 1.5 deg	______	0.0	5.0	0	0000
Line sync source 0	______	0	2	7	1001

End of Harmony PWM Parameter Dump

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APPENDIX A5: SOLID-STATE VARIAC OPTION

In This Section:

A5.1. Introduction

This appendix contains information on the Solid State Variac manufactured by ROBICON. Two versions are available: a 480 VAC, 25 A version (P/N 430278.00) and a 480 VAC, 50 A version (P/N 430278.01). The variac is an option when a Perfect Harmony is purchased.

The ROBICON solid-state variac is a light-weight way of supplying a variable voltage source for back-feeding Perfect Harmony drives. It can also be used for supplying power to an individual cell being tested.

> Use of this supply for back-feeding systems is reserved for ROBICON qualified service personnel.

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A5.2. Protective Circuits

The ROBICON solid-state variac contains built-in current limiting circuitry and input power fuses for protection. The variac contains solid-state *current limit control* that limits the variac output to the maximum rated output current. In addition, *input power fuses* are supplied to protect the supply from internal short circuits.

> **Lethal voltages** are present when this equipment is in normal use. Users who have not been specifically trained to operate in this type of environment should contact qualified personnel.

> Before connecting the solid-state variac to a drive (or other device), be sure that all power to the drive (or device) is turned off at the source. Be sure to follow proper lock-out/tag-out instructions.

A5.3. Operation

Use the connection diagram shown in Figure A5-1 when connecting the ROBICON solid-state variac to a cell for testing. Follow the steps outlined below.

- After the unit is connected, check that the voltage adjust potentiometer is fully rotated to the counter-clockwise (CCW) position, and the On/Off switch is in the "off" position. Refer to Figure A5-2.

> **WARNING!** An SCR does not completely isolate the load when switched to the "off" position. Before voltage is supplied to the variac, be sure the load is ready for voltage.

- Set the On/Off switch to the "on" position.
- Adjust the voltage as needed by the cell test procedure.

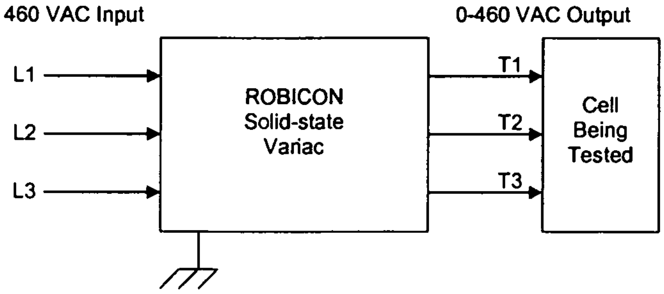

Figure A5-1. Cell Test Connection Diagram

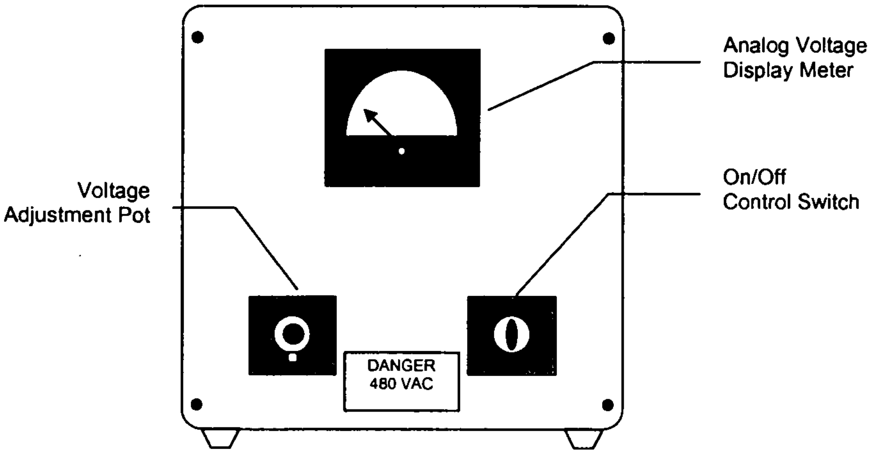

Figure A5-2. Variac Controls

A5.4. Troubleshooting

Table A5-1 lists some common troubleshooting issues related to the solid-state variac.

Table A5-1. Common Troubleshooting Issues

Problem	Possible Cause	Possible Solution
No output voltage...	Is the unit switched "on"?	Switch unit to "on" position.
	Pot not properly adjusted?	Adjust voltage adjustment potentiometer clock-wise (CW).
	Input voltage is incorrect?	Correct the input source according to the specifications in Table A5-2.
	Blown power fuse(s)?	Replace blown power fuse(s). Also, do a power bridge test to check for

Problem	Possible Cause	Possible Solution
		shorted SCRs.
	Defective control circuit?	Replace control cards.
Full output voltage...	Load is not connected?	If the variac has input voltage with no load connected, full voltage will appear on the output. This is due to the inherent leakage from the SCRs.
	Defective control circuit?	Replace control cards.

A5.4.1. SCR Power Bridge Test

The ROBICON solid-state variac uses a set of back-to-back SCRs as illustrated in Figure A5-3. A VOM (volt/Ohm meter) can be used to test the resistance across the SCR switch. A zero Ohm reading (0 Ω) indicates a defective SCR. To test, connect one lead to **L1** and the other to **T1**. Repeat the test for **L2** to **T2** and **L3** to **T3**. Replace any SCRs that are shorted. The VOM test meter should be set to the Ohm scale (R×1).

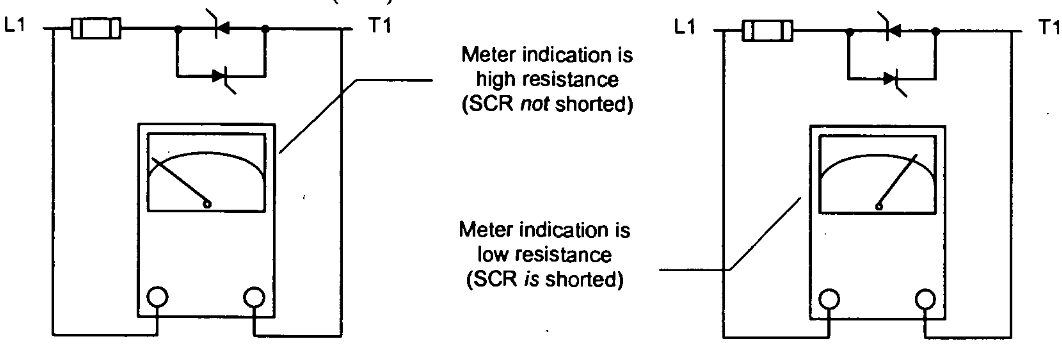

Figure A5-3. Sample Power Bridge Test Results

A5.4.2. Power Fuse Replacement

Follow the instructions listed below for proper power fuse replacement.

1. Disconnect the input voltage to the variac.
2. Fuse access is provided via the back panel of the variac. Refer to Figure A5-4.

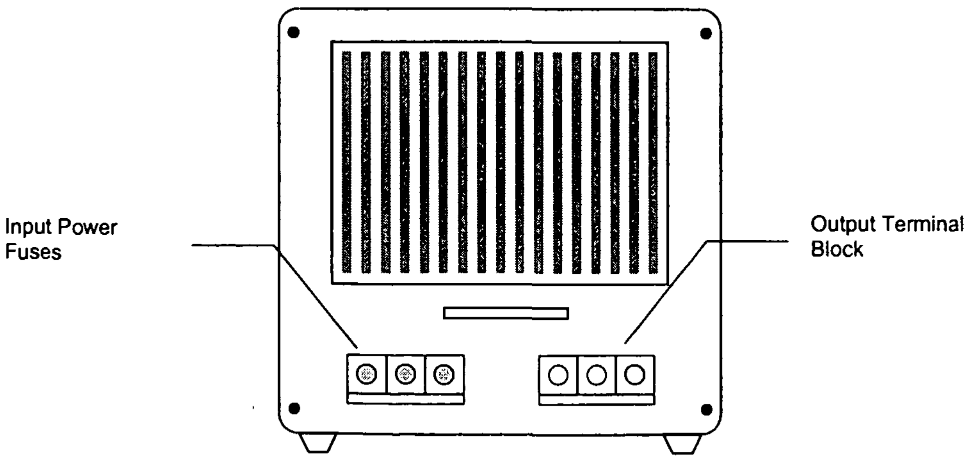

Figure A5-4. Solid-state Variac (Rear View)

A5.5. Warranty

ROBICON warrants each solid-state variac for 90 days from the date of shipment. ROBICON will repair or replace (without charging for parts or labor) any part of the variac if it is deemed defective in material or workmanship within reasonable judgment by ROBICON. This warranty will not cover damage due to misuse or misapplication. All products intended for service must be sent to the ROBICON factory. Refer to Appendix C for shipping information.

A5.6. Specifications

Specifications for the ROBICON solid-state variac are outlined in Table A5-2.

Table A5-2. Solid State Variac Specifications

Item	Description (P/N 430278.00)	Description (P/N 430278.01)
Input Voltage	460 VAC +10% to -5%, 3-phase, 60 Hz	460 VAC +10% to -5%, 3-phase, 60 Hz
Input Current	25 Amps AC (max)	50 Amps AC (max)
Output Voltage	0-460 VAC phase angle output	0-460 VAC phase angle output
Output Current	25 Amps AC (max)	50 Amps AC (max)
Ambient Temperature	0-40° C	0-40° C
Humidity	95% non-condensing	95% non-condensing
Altitude	Maximum 3,300 ft (MSL)	Maximum 3,300 ft (MSL)

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