FIELD ENGINEERING EAST.

J. & P. RICHARDSON INDUSTRIES PTY. LTD.
A.C.N. 001 952 325

ADMINISTRATION AVE.

BRISBANE CITY COUNCIL

METROPLEX ON GATEWAY

SEWERAGE PUMPING STATION

OPERATION AND MAINTENANCE MANUAL

BY
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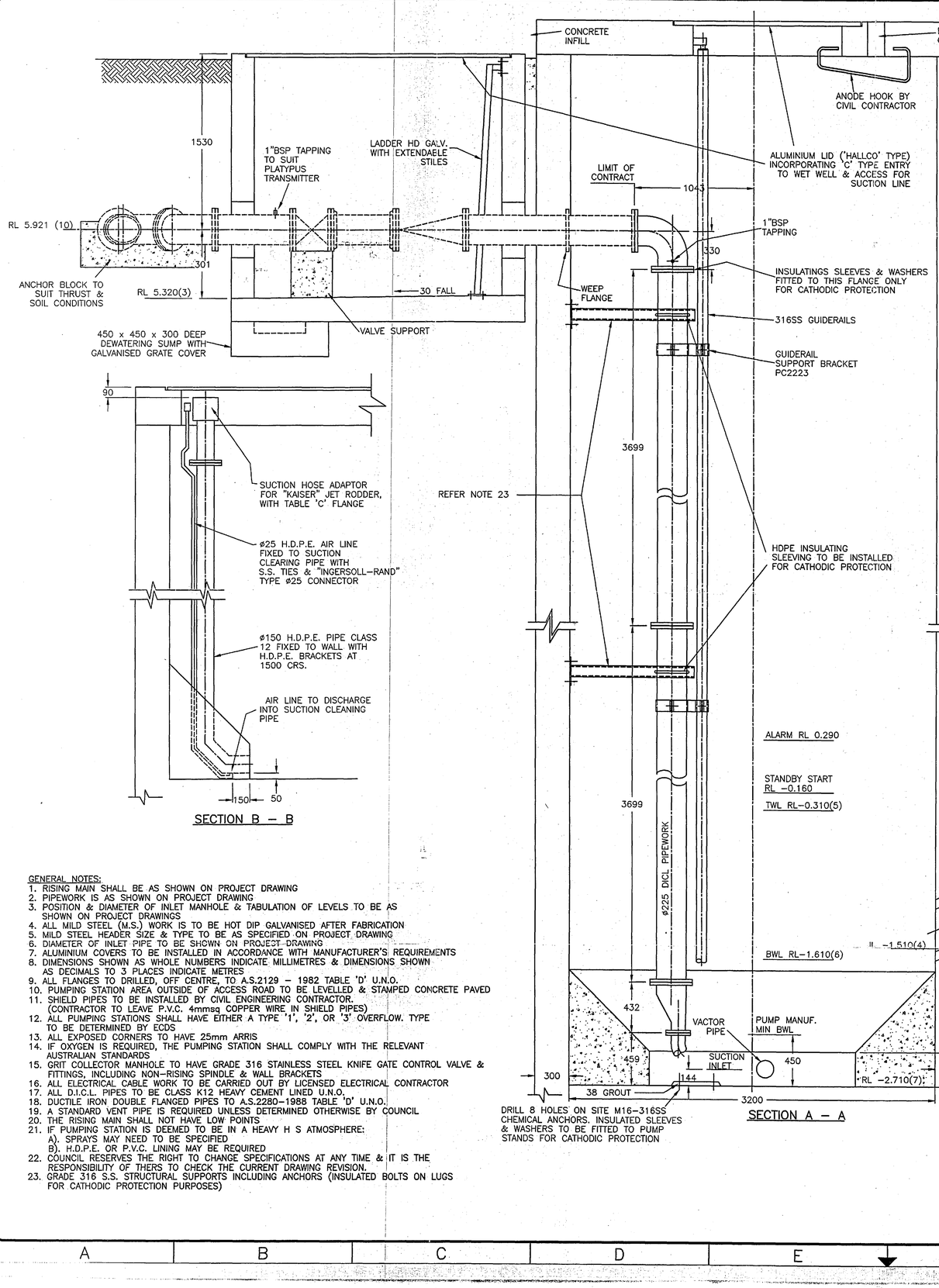

SECTION B — B

SECTION A — A

DRILL 8 HOLES ON SITE M16-316SS CHEMICAL ANCHORS. INSULATED SLEEVES & WASHERS TO BE FITTED TO PUMP STANDS FOR CATHODIC PROTECTION

GENERAL NOTES:
1. RISING MAIN SHALL BE AS SHOWN ON PROJECT DRAWING
2. PIPEWORK IS AS SHOWN ON PROJECT DRAWING
3. POSITION & DIAMETER OF INLET MANHOLE & TABULATION OF LEVELS TO BE AS SHOWN ON PROJECT DRAWINGS
4. ALL MILD STEEL (M.S.) WORK IS TO BE HOT DIP GALVANISED AFTER FABRICATION
5. MILD STEEL HEADER SIZE & TYPE TO BE AS SPECIFIED ON PROJECT DRAWING
6. DIAMETER OF INLET PIPE TO BE SHOWN ON PROJECT DRAWING
7. ALUMINIUM COVERS TO BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S REQUIREMENTS
8. DIMENSIONS SHOWN AS WHOLE NUMBERS INDICATE MILLIMETRES & DIMENSIONS SHOWN AS DECIMALS TO 3 PLACES INDICATE METRES
9. ALL FLANGES TO DRILLED, OFF CENTRE, TO A.S.2129 – 1982 TABLE 'D' U.N.O.
10. PUMPING STATION AREA OUTSIDE OF ACCESS ROAD TO BE LEVELLED & STAMPED CONCRETE PAVED
11. SHIELD PIPES TO BE INSTALLED BY CIVIL ENGINEERING CONTRACTOR. (CONTRACTOR TO LEAVE P.V.C. 4mmsq COPPER WIRE IN SHIELD PIPES)
12. ALL PUMPING STATIONS SHALL HAVE EITHER A TYPE '1', '2', OR '3' OVERFLOW. TYPE TO BE DETERMINED BY ECDS
13. ALL EXPOSED CORNERS TO HAVE 25mm ARRIS
14. IF OXYGEN IS REQUIRED, THE PUMPING STATION SHALL COMPLY WITH THE RELEVANT AUSTRALIAN STANDARDS
15. GRIT COLLECTOR MANHOLE TO HAVE GRADE 316 STAINLESS STEEL KNIFE GATE CONTROL VALVE & FITTINGS, INCLUDING NON-RISING SPINDLE & WALL BRACKETS
16. ALL ELECTRICAL CABLE WORK TO BE CARRIED OUT BY LICENSED ELECTRICAL CONTRACTOR
17. ALL D.I.C.L. PIPES TO BE CLASS K12 HEAVY CEMENT LINED U.N.O.
18. DUCTILE IRON DOUBLE FLANGED PIPES TO A.S.2280-1988 TABLE 'D' U.N.O.
19. A STANDARD VENT PIPE IS REQUIRED UNLESS DETERMINED OTHERWISE BY COUNCIL
20. THE RISING MAIN SHALL NOT HAVE LOW POINTS
21. IF PUMPING STATION IS DEEMED TO BE IN A HEAVY H S ATMOSPHERE:
    A). SPRAYS MAY NEED TO BE SPECIFIED
    B). H.D.P.E. OR P.V.C. LINING MAY BE REQUIRED
22. COUNCIL RESERVES THE RIGHT TO CHANGE SPECIFICATIONS AT ANY TIME & IT IS THE RESPONSIBILITY OF THERS TO CHECK THE CURRENT DRAWING REVISION.
23. GRADE 316 S.S. STRUCTURAL SUPPORTS INCLUDING ANCHORS (INSULATED BOLTS ON LUGS FOR CATHODIC PROTECTION PURPOSES)

NOTE:
1. PUMPS FORRERS MODEL E100-380 40kW 4 POLE TYPE TLC
2. PIPEWORK SHOWN DOTTED BY OTHERS

"AS CONSTRUCTED"

RL No.	DESCRIPTION	LEVEL
RL 1	SURFACE LEVEL	7.450
RL 2	IL OF INLET & OUTLET OF GRIT COLLECTOR	-0.210
RL 3	TOP OF BASE OF REFLUX VALVE PIT	5.320
RL 4	IL OF INLET SEWER AT PUMP WELL	-1.510
RL 5	TOP WATER LEVEL AT PUMP WELL	-0.310
RL 6	BOTTOM WATER LEVEL AT PUMP WELL	-1.610
RL 7	TOP OF BASE SLAB OF PUMP WELL	-2.710
RL 8	BOTTOM OF BASE SLAB OF PUMP WELL	-3.010
RL 9	TOP OF ROOF SLAB OF PUMP WELL	7.750
RL 10	IL OF RISING MAIN THROUGH VALVE PIT WALL	5.808
RL 11	TOP OF BASE OF GRIT COLLECTOR MANHOLE	-1.070

No.	DATE	AMENDMENT	INITIALS
B	7/98	BCC TITLE BLOCK ADDED	P.H.
A	7/98	RL No.9 AMENDED AS PER DORMWAY FAX DATED 1-7-98	P.H.

DIRECTOR OF P.D. & P.S. — DATE

ENGINEER IN CHARGE — DATE

SUPERVISING ENGINEER — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN		
DRAWN	JPR-P.H.	20-6-98
CHECKED	Jwl.	30/6/98.

Brisbane City

JOB FILE	JPR No.P98-A20999/X1		
AUTOCAD FILE	A20999X1	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water — Professional Services — Engineering

PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

TITLE
SEWERAGE PUMPING STATION
PIPEWORK LAYOUT

SCALE: 1:20 | No.2 OF 2 SHEETS

DRAWING N° P98-A20999/X1 | AMEND. B

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3.0 TELEMETRY AND CATHODIC PROTECTION

4.0 "AS CONSTRUCTED" DRAWINGS

JPR Ref:- (A20999.001) Revision 0 December 7, 1998

[redacted]

[redacted]

1.0 PUMPS

SUPPLIER: KSB AJAX
CARBERRY STREET
EBBW VALE QLD 4304

PH: (07) 3282 1766
FAX: (07) 3816 0172

MODEL: -	E100-380 4PL TYPE TLC
SERIAL NO:	F51274-1 & F51274-2
MOTOR KW RATING:	40KW
MOTOR SPEED:	1470RPM
FULL LOAD CURRENT:	67.0AMPS
VOLTAGE:	415V

JPR Ref:- (A20999.001) Revision 0 December 7, 1998

SERVICE MANUAL

KSB Ajax Pumps Pty. Ltd.

KSB

KSB AJAX PUMPS PTY LTD

IPSWICH WORKS

All members of the KSB Ajax Pumps Works staff are pleased to have been part of the team who produced your unit. Every effort is made by us to ensure the product you have purchased is finished to the highest standard.

Our Ref: Submersible-D300-Version 1.0
Manual Part Number: 5399D30

PROJECT DETAILS

Pump Model: E100-380 TLC
Motor: 40 KW 4 Pole
Project Drawings: N/A
Pump Serial Number: F51274-1/2

PERFORMANCE DETAIL

Duty: 58 L/s @ 32 M
Pump Efficiency: 64%
Motor Efficiency: 92%
KWH/KL: 0.1486

SPECIAL CONSTRUCTION DETAILS

Cable Length: 20 MTRS
Thermistors Fitted: YES
Water Sensor Fitted: NO
Cable Connection: DELTA

CLIENT

Customer: J & P RICHARDSON INDUSTRIES
Project: BRISBANE CITY COUNCIL
Pump Station: METROFLEX ON GATEWAY
Contract Number: N/A

FOR AFTER SALES AND SERVICE CONTACT YOUR LOCAL KSB AJAX PUMPS BRANCH:

HEAD OFFICE & EXPORT
27 Indwe Street
TOTTENHAM VIC 3012
Ph 03 9314 0611
Fax 03 9314 7435

NEW SOUTH WALES
28 Skinner Avenue
RIVERWOOD NSW 2210
Ph. 02 9584 2099
Fax. 02 9584 2111

QUEENSLAND SALES AND IPSWICH WORKS
1 Carberry Street
EBBW VALE QLD 4305
Ph. 07 3282 1766
Fax 07 3816 0225

SOUTH AUSTRALIA
226 Richmond Road
MARLESTON SA 5033
Ph. 08 8234 0066
Fax 08 8443 5411

WESTERN AUSTRALIA
Unit 2
30-32 Vinnicombe Drive
CANNING VALE WA 6165
Ph 09 9455 7900
Fax 09 9455 7800

NEW ZEALAND
Unit 5
110 Mays Road
PENROSE AUCKLAND NEW ZEALAND
Ph 64 9 634 4020
Fax 64 9 634 6282

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1.0 TECHNICAL DATA

1.1 PUMP TECHNICAL DATA

1.1.1 DESCRIPTION

Pump Manufacturer:	KSB AJAX PUMPS IPSWICH PUMP WORKS

1.1.2 PUMP DRAWINGS

Sectional Arrangement:	REFER APPENDICES 12.1
Dimension Drawing:	REFER APPENDICES 12.6

1.1.3 PUMP WEIGHT

Pump Components Weight:	REFER APPENDICES 12.6

1.1.4 MOTOR TECHNICAL DATA

1.1.5 DESCRIPTION

Motor Manufacturer:	KSB AJAX PUMPS FORRERS PUMP WORKS

1.1.6 MOTOR PERFORMANCE DETAILS & MOTOR HARDWARE DETAILS

REFER APPENDICES 12.7 (MOTOR TECHNICAL DATA)

Motor Weight: REFER APPENDICES 12.7 (MOTOR TECHNICAL DATA)

1.1.7 MOTOR DRAWINGS

Sectional Arrangement:	REFER APPENDICES 12.1
Mechanical Seal:	REFER APPENDICES 12.1
Wiring Diagram:	REFER APPENDICES 12.8

1.2 PUMP IDENTIFICATION

To ensure the correct procedure is followed when working on equipment and ordering spares it is essential you identify equipment correctly.

Pump units are fitted with an identification similar to:

KSB AJAX PUMPS PTY LTD

SUBMERSIBLE INDUCTION MOTOR (AS1359) AND PUMP

CONTRACT NO. _____ SEAL NO. _____

PUMP TYPE _____ MOTOR _____

VOLTS 3 PHASE HERTZ _____ AMPS

RATING S1 INSUL F DESIGN _____ CONN _____

KW _____ RPM _____ L/SEC _____ HEAD _____ M

MADE IN AUSTRALIA 199_ IPSWICH PUMP WORKS

DETAILS ARE:

Contract Number - filled in with clients contract number if known.

Serial Number - special serial number for this unit. This number must be quoted to ensure correct spares are supplied.

Pump Type - details specific pump model.

Motor - this nominates the motor frame size. This allows the client to follow correct procedure in the following manual eg. FR300 refers to a motor with a stator diameter nominally 300mm.

Volts - indicates correct operating volts.

Hertz - indicates correct operating frequency.

Amps - indicates motor full load current.

2.0 PRINCIPLES OF OPERATION

2.1 PUMP DESCRIPTION

This pump unit is a submersible, wet well, sewage pump close coupled to a submersible motor. The non clog impeller is double shrouded non-clog design with open passages to minimise the possibility of blockages while pumping sewage. The impeller and pump case are fitted with replaceable wear rings on the suction side of the impeller to maximise the life of the major components. The impeller is mounted directly onto the motor shaft via a key and positively locked by means of a lock nut. The impeller is balanced at the factory before dispatch. Motor and pump are fitted with a one piece stainless steel shaft.

Also available is a cutter pump where an open vane impeller operates against serrated suction cover. This creates a shearing action which is particularly effective for breaking down plastics and rags.

The pump and motor are normally mounted vertically. In the most common configuration a discharge stand is permanently fixed to the wet well floor. The discharge of the pump is fitted with a locking plate, which forms an automatic seal with the discharge stand when the pump is lowered onto the stand. Guide rails run from the stand to the top well opening to guide the pump onto the stand. Should maintenance on the pump or motor be required the whole unit may be lifted from the well even if the well is full.

The pump is also available in a free standing configuration, different guide arrangement or a dry well application in which the motor is fitted with a cooling jacket.

Once installed the pump will operate continuously provided there is fluid present to be pumped.

Automatic control of the pump can be achieved with a variety of electrical or mechanical controls. The pump may be stopped by isolating the motor from the power supply. **For the safety of maintenance staff it is recommended that a remote lockout type stop button or isolator is provided near the well in case of emergency.**

This is particularly important if the switchboard controlling the pump is remote from the pump station.

The pump end is normally constructed of a heavy duty high quality cast iron. All fixings are stainless steel (special materials of construction are used when specified).

2.2 MOTOR DESCRIPTION

This motor is a KSB Ajax Pumps, Forrers Works submersible motor. The motor is cooled by the pumping medium around the outside of the motor frame in the well. It is recommended that the motor operates submerged during its normal pumping cycle. With jacketed motors product fluid is circulated through jacket to provide cooling. It is recommended (although not essential) where possible to circulate clean water through this jacket. The motor frame is designed for heavy duty application and is constructed from cast iron. The stator assembly consists of laminations of low loss electrical grade steel clamped together with cleats in dovetail slots.

The windings are copper wire coated with polyester imide to a thickness complying with AS1194 Grade 2 insulations. The insulation material is Class F to BS2757. The winding overhangs are laced together securely then impregnated with a Class F varnish and baked at high temperature to cure the varnish to a solid homogeneous mass. Insulation is carried out using a vacuum impregnation process.

The winding tails consist of tinned, flexible copper wire of sufficient diameter to ensure that the current density at the rated load does not exceed 3.5 Amperes per square millimetre. The tails are insulated with Class F material. The winding tails are run to a terminal box. Motors below 3kw use a 3 wire star connection. 3kw and above have 6 wires to the terminal block.

The stator windings contain one positive temperature coefficient (P.T.C.) thermistor per phase in the overhang. The three thermistors are connected in series and the wires taken to a terminal block in the terminal box.

The rotor core is made of laminations of low loss electrical grade steel. These are stacked and fixed by pressure case aluminium or copper bars. The rotor is shrunk onto a stainless steel shaft and dynamically balanced.

The motor is sealed from the pump by a double mechanical seal. Seals consist of tandem seal configuration. In standard arrangement the upper seal is silicon carbide against carbon with the lower seal being silicon carbide against silicon carbide. Upper and lower seal faces are separated by an oil filled chamber.

NOTE:Motors manufactured at KSB Ajax - Ipswich Works use a white mineral oil (Whiterex 307) or equivalent which is low-toxic and environmentally friendly.

3.0 OPERATING PROCEDURE

3.1 CAUTION

NOTE: ANY INTERFERENCE WITH THE ENCLOSURE OF THE ELECTRIC MOTOR VOIDS ANY WARRANTY ON THE ELECTRIC WINDINGS AND TERMINALS. ENSURE CORRECT SUPPLY VOLTAGE AND PHASE ROTATION IS SUPPLIED TO MOTOR AS INCORRECT ROTATION CAN CAUSE PERMANENT DAMAGE TO EQUIPMENT.

3.2 STARTING

3.2.1 Check that the complete rotating element is free to turn prior to connecting electrical power.

3.2.2 Ensure pump and motor are fully submersed prior to operating. In the case of a dry well application ensure volute is full of fluid and a positive head exists on the inlet of the pump.

NOTE: WHERE STARTING CONDITIONS HAVE BEEN CHECKED THE PUMP MAY BE STARTED WITH AN OPEN DELIVERY VALVE. AS WITH ANY CENTRIFUGAL PUMP PROLONGED OPERATION AGAINST A CLOSED DISCHARGE VALVE IS NOT RECOMMENDED.

3.2.3 Where the discharge line has not been charged with fluid it is permissible to operate the pump against a partially closed discharge valve.

3.2.4 Ensure there is sufficient fluid in the well and then start the motor. Ensure equal and correct voltage is supplied to each phase.

3.2.5 Open the pump delivery valve slowly until the required pressure or flow is obtained.

CAUTION: 1. PROLONGED RUNNING WITH A CLOSED DELIVERY VALVE CAN DAMAGE PUMP INTERNAL COMPONENTS AND MUST BE AVOIDED.

3.3 **CONTINUOUS OPERATION**

Most pump installations run under automatic control so providing the pump unit has been commissioned correctly and maintenance schedules are maintained the pump unit requires little additional supervision unless there is a duty change required.

3.4 **STOPPING**

Isolate the motor from the mains and mechanically lock the isolator out. If work is to be carried out on the pump unit ensure that the isolator is mechanically locked open and power supply is isolated from motor. **Do not restart the motor before it has fully stopped.** Restarting the motor results in very high current fluctuations in the motor windings and pressure surges in the rising main and may cause serious damage to the unit or the system.

3.5 **EMERGENCY STOPPING**

Follow the procedure outlined in Section 3.4 above. It is recommended that lock out isolators be installed at all points where work is to be carried out on the pump or its associated equipment.

3.6 **ENSURING MAXIMUM LIFE FOR YOUR UNIT**

In the interest of ensuring maximum benefit and life from equipment the following basic recommendations should be followed:

a) Operate with correct power supply,
b) Provide adequate protection for equipment in the form of thermistor protection, and overload protection set to suit motor rating,
c) Do not run dry or without an adequate supply of fluid (run with motor submersed),
d) Run units in correct rotation (clockwise when viewed from drive end),

e) Operate pump in its correct range of design flow and discharge pressure.
f) Use pump in pumping medium for which unit was designed.
g) Ensure regular maintenance of station pumping units and ancillary equipment is carried out.

4.0 GOODS INSPECTION AND STORAGE

4.1 INSPECTION

4.1.1 Immediately on receipt of the equipment, inspect it thoroughly. Examine the crate and the wrapping before discarding them, since parts or accessories are sometimes wrapped individually or fastened to the crate.

4.1.2 Report any damage or shortage to KSB Ajax Pumps and the carrier immediately. All claims must be made (or confirmed) in writing within seven days.

4.1.3 If the equipment is not being installed immediately, it must be stored under suitable conditions.

4.2 STORAGE

4.2.1 SHORT TERM

4.2.1.1 When it is necessary to store a pump for a short time before it is installed, place it in a dry location. Ensure cable ends are kept dry and cable is protected against mechanical damage.

4.2.1.2 To prevent rusting-in or seizing, lubricate the unit before storing paying particular attention to components which run in close tolerance, eg. wear rings, etc. Turn the pumpset by hand at least once a week. Extreme care should be exercised with regard to the motor cables: ensure, that the pump dose not stand on the motor cables and that the cable seal on the end of the cable is not damaged as it prevents water entering the cable.

4.2.2 **LONG TERM**

4.2.2.1 More thorough precautions are required if the pump is to be stored for an extended period of time. Refer to IPSWICH PUMPS WORKS for full information on long term storage.

Do not store any equipment in any area which is subject to either direct or indirect vibration as this can have a detrimental effect on bearings.

5.0 PIPEWORK INSTALLATION

5.1 DELIVERY PIPEWORK

5.1.1 It is essential to ensure that the delivery pipework is adequately supported and anchored to resist hydraulic thrust.

5.1.2 If the delivery pipe does not rise continuously air pockets can form in the pipe at high spots. If is good pumping practice to remove these air pockets in the pipe by venting the air through an air release.

6.0 PUMPSET INSTALLATION

6.1 PROCEDURES PRIOR TO INSTALLATION

6.1.1 CLEANING PRIOR TO INSTALLATIONS

6.1.1.1 All packing and crating should be removed and discarded prior to starting the installation procedure. Check all the packing before discarding it to ensure that no parts or accessories are attached to it in individual wrappings.

6.1.1.2 All parts of the assembly must be thoroughly cleaned before installation begins. All traces of rust preventative must be removed from the discharge and suction faces, exposed shafting, and all coupling surfaces.

6.1.2 LAY-OUT OF PUMP PARTS FOR INSTALLATION

6.1.2.1 Care must be taken to avoid damage to components whenever handling or installing them.

6.1.2.2 If suitable lifting tackle is not available, skids must be employed to transfer heavy weights at ground level. Loaded crates, individual components or subassemblies must never be dropped to the ground from a transport vehicle.

6.1.2.3 Individual components should be layed out on clean dry timbers or on a suitably cleaned surface in the order which they will be installed.

6.1.2.4 Any packing or other protective material must be removed before starting the installation procedure.

6.2 PUMPSET FOUNDATION

6.2.1 An adequate pump foundation is essential. It should consist of a solid block of concrete brickwork or masonry sufficiently massive and rigid to provide continuous support for the pump pedestal throughout the pumps life.

6.2.2 The top of the foundation plinth should be 25mm to 38mm below the required finished height of the stand's lower flange. This is to allow the discharge stand to be adjusted and levelled during installation. The remaining gap is filled with grout after levelling to provide support to the discharge stand.

6.2.3 Foundation bolt holes should be prepared in the foundation plinth to match the discharge stand holes. Each hole should be drilled the correct diameter to accept the masonry anchor.

6.3 PEDESTAL STAND LEVELLING

6.3.1 Position the masonry anchors or fixings using stand or dimension drawing as a guide.

6.3.2 Place solid packers approximately 30mm high on either side of each masonry anchor.

6.3.3 Sling the stand and lift it onto the anchors so that it sits on the packers. Level the discharge stand by placing shims between the packers and the stand.

6.3.4 Once the stand is level place a washer on each masonry anchor and screw on the nuts. Tension the nuts, until the masonry anchor has gripped firmly and the stand is clamped tight. Check stands for level after tensioning.

6.4 **GROUTING**

6.4.1 The use of good grout is important when installing a pump as it prevents lateral movement of the pedestal stand and damps vibration. The use of a non-shrink grout or other available propietry product is recommended. (Hilti provide a range of suitable fixings, adhesives & grouts).

6.4.2 After levelling and alignment is completed and all foundation bolts pulled down tightly, preparation for grouting the stand can commence. Boxing should be placed around the stand's lower flange to contain the grout when it is poured.

6.4.3 Manufacturer recommendations for application of grouting material should be followed.

NOTE: IT IS IMPORTANT THAT THE GROUT FILLS THE CAVITY BETWEEN THE LOWER FLANGES AND THE FOUNDATION SO THAT FULL SUPPORT IS GIVEN TO THE STAND. IF NECESSARY USE A VIBRATING TOOL TO SETTLE. IT SHOULD BE CHECKED THAT THE GROUT DOES NOT SHRINK FROM THEN STAND'S FLANGE AFTER CURING.

6.4.4 The exposed surfaces should be covered and allow to cure before loading as per Manufacturer recommendation.

6.4.5 When the grout is set, the boxing should be removed and a smooth finish given to the grout and foundation surfaces. Manufacturer recommendations should be followed.

6.4.6 After curing, where applicable guide rails and top bracket can be fitted.

6.5 CONNECTING THE PUMP

6.5.1 SUBMERSIBLE

Before lowering the pumpset onto the discharge stand the motor and pump should be checked as per Section 3 of this manual.

6.5.2 After carrying out the above checks the pumpset is ready to be installed on the discharge stand. Attach a sling to the lifting points on the motor and position the pumpset across to the well opening and lower it onto the guide rail. Lower the unit down the guide rail until it locks onto the discharge stand. It may be necessary to manipulate the unit by hand while supported to ensure that it has seated home correctly and that the seal between the pump and discharge stand is complete. Keep the pump completely vertical when lowering into position.

6.5.3 FREE STANDING

In the case of free standing pump, discharge pipework is securely attached to the pump discharge prior to lowering into position. It is advantageous to fit pipework with a quick connect type coupling. Ensure the pump is mounted on level foundations and slung to prevent turning.

6.5.4 DRYWELL

Pipework is connected to inlet and outlet.

NOTE: UNDER ALL CIRCUMSTANCES WHEN CONNECTING PIPEWORK, DO NOT FORCE OR LOAD JOINTS. NO LOAD SHOULD BE TRANSFERRED TO PUMPS OR PEDESTALS. WHERE NECESSARY USE RUBBER STYLE JOINTS TO PREVENT TRANSFER OF VIBRATION OR LOAD TO PUMPS.

6.6 COMMISSIONING THE PUMPSET

6.6.1 Start the pump unit as per Section 3 of this manual.

6.6.2 Allow it to run for approximately ten minutes to fill the pipeline with fluid and stabilise in its operation. Test readings of head, flow, voltage, current and power should then be taken to check that the unit is operating correctly. If flow measurement equipment is not available then the flow may be calculated by measuring the rate at which the fluid level drops in the wet well. The flow may be adjusted by altering the setting of the discharge pipe valve. Where pumps start against an empty rising main, operate against a partially closed valve.

6.6.3 Once the commissioning procedure outlined above has been finished the pump unit should be shut down as per Section 3 of this manual.

7.0 MAINTENANCE SCHEDULES

7.1 ROUTINE MAINTENANCE

ALWAYS COMPLY WITH CORRECT PROCEDURES WHEN MAINTAINING PUMPING EQUIPMENT. UNDER ALL CIRCUMSTANCES SAFETY FIRST.

When a pump station is initially commissioned it should be visited daily for the first two weeks to check that all the systems are working correctly. Particular care should be taken with a new installation that foreign matter such as concrete, tins, timber or tools do not foul the pump. The wet well should be hosed down and pumped to its minimum level each day to check for such foreign matter. All such material should be removed.

Each time the pump station is visited readings of the hours run, voltage and current should be taken and recorded in a station log book for each pump. Abnormalities in these readings are often the first sign that maintenance is required on the pump unit. Ideally the station should be visited on a daily basis to check the pumps operation, record the above data and clean any build ups of fats or foreign material in the wet well. The required frequency of visits to the well can often be established by the attention required during the daily visits for the two weeks following commissioning.

7.2 PERIODIC MAINTENANCE

7.2.1 The tables in Appendix 12.2 give the recommended times for periodic maintenance checks. The major check required is a six monthly or 1500 hour inspection of the motor. The procedure to be followed in this check is detailed in the following section.

7.2.2 The pump unit requires a complete overhaul once either the delivery head drops below an unacceptable level or the power consumption rises significantly. The establishing of acceptable variation to the installed performance is normally left to the maintenance engineer's discretion, however a variation of 15% in power, flow or head usually warrants investigation. The unit should then be returned to KSB Ajax Pumps or the instructions in Sections 8 to 11 followed to repair the unit.

7.2.3 Where a pump station involves sub-contractors associated equipment it is important that their instructions are read so that a fully comprehensive maintenance schedule can be drawn up for the station.

7.2.4 **SIX MONTHLY OR 1500 HOUR INSPECTION**

7.2.4.1 The pump and motor should be checked every six months or 1500 hours of operation, whichever comes first. The checks cover the condition of the electrical insulation in the motor windings, condition of the mechanical seal and the wear of the pump components.

7.2.4.2 Refer to Section 8 to electrically disconnect the motor and lift the motor-pump from the pump well. Where possible, the incoming power isolator should be padlocked in the **'OFF'** position. Any electrical work on the enclosure of the electrical motor, should be carried out by suitably qualified personnel. Any work should be conducted following good safety procedures.

7.2.4.3 Inspect the pump end for wear or damage. Ensure all the fasteners are tight. Inspect the discharge sealing ring (120) for damage or excessive wear.

7.2.4.4 Refer to section 8 for instructions on disassembly of pump.

7.2.4.5 Check the diametrical clearance between the impeller wear rings and the case wear rings. If the diametrical clearance is greater than 1.5mm the wear rings will require replacement. Refer to section 8 for wear ring removal..

7.2.4.6 After the inspection refer to Section 11 for instructions on the procedure for replacement of pump components.

7.2.4.7 The mechanical seal should be checked to ensure it is sealing correctly. Leaving pump/motor upright remove the upper plug (15B) sealing the oil reservoir in the lower end of the motor. Draw off a small sample of oil (approx. 100mls) and put into a clean glass container. Allow the oil to settle. Inspect the oil to see that it is not milky or that water has not settled at the bottom of the container. Caution should be taken when removing the taper plugs as the oil may spray out if the pressure remains in the oil chamber.

7.2.4.8 If the oil contains water and it has been ascertained that it has not leaked through the plugs the mechanical seal may require reconditioning. Refer to Section 9 for the procedure to remove the mechanical seal.

It is quite acceptable under normal operating conditions for a small amount of water to infiltrate into the seal chamber. Above 5 percent contamination normally indicates a problem with the seal.

7.2.4.9 Refer section 1 for motor frame identification.

If the oil tested is only milky (less than 5%) it is acceptable practice to drain the oil chamber and refill with Mobil Whiterex Type 307 white mineral oil or equivalent.

For motor frame 300 lay motor on side. Remove plugs 15(c) & 15(b) then roll motor over to drain oil into a suitable container.

Roll unit over with motor still on its side and plug holes to top. Fill chamber completely with oil. After applying thread sealant replace plugs 15(c) and 15(b).

7.2.4.10 If the motor was previously stripped refer to Section 10 for motor assembly and mechanical seal assembly. Ensure that the impeller is free and revolving truly and reinstall pump-motor unit back into the pump station.

7.2.4.11 Refer to Section 3 for the procedure for reconnecting the motor to the switchboard and starting the pump.

8.0 TO DISASSEMBLE THE PUMP

8.1 PREPARATION PRIOR TO DISASSEMBLY

8.1.1 Isolate the electric motor from the mains by opening the main isolator supplying power to the switchboard or lock the power isolator and control circuit isolator for the unit (remember safety first) in the **'OFF'** position.

8.1.2 Disconnect power and control cables.

8.1.3 Close the discharge isolating valve.

8.1.4 Remove the pump from the well and thoroughly clean down the outside of the pumpset. In the case of dry well pumps it is often easier to leave volute in line and remove motor with impeller fitted.

8.1.5 The highest possible standard of cleanliness must be maintained throughout any maintenance operation.

8.2 DISASSEMBLY PROCEDURE (REFER SECTION 12 FOR SECTIONAL ARRANGEMENT DRAWING)

For Non Clog Pumps

8.2.1 **To remove the impeller**

8.2.1.1 Stand the pump-motor unit upright on clean, dry timbers, ensuring that it is stable. Chock it securely.

8.2.1.2 Remove the nuts, which secure the motor to the volute.

8.2.1.3 Attach a sling to the lifting points on the motor and using suitable safe lifting equipment lift the motor off the pump end. If the gasket will not release the motor from the pump end raise the pump-motor unit approximately 5mm off the timber and strike the volute with a soft hammer onto a piece of timber. The motor complete with impeller can be withdrawn from volute.

8.2.1.4 Remove gasket /O Ring between volute and motor (113) if damaged in any way.

8.2.1.5 Position the motor unit on a bench at a suitable working height and chock it securely.

8.2.1.6 Secure the impeller (102) to prevent rotation.

8.2.1.7 Remove the locknut (103) and washer (104). Using a puller remove the impeller (102) from the shaft. The impeller is driven by the shaft using a tapered drive and key. The impeller may require a gentle impact to remove. In the case of an impeller being difficult to remove the application of heat to the impeller will assist in its removal. Rapid heating of impeller minimising heat transfer to the shaft provides best results. When impeller has parallel bore an impeller puller is required to jack impeller off shaft.

8.2.2 Complete disassembly.

8.2.2.1 Check the diametral clearance between the volute wear rings (108) and the impeller wear rings (107). if the diametral clearance is greater than 1.5mm the wear rings will require replacement. Replacement if also recommended if significant scoring of wear rings has occurred. Excessive wear of wear rings result in less efficient operation of pumps, flow loss and head loss, therefore resulting in higher operating costs.

8.2.2.2 To remove the impeller wear rings (107) set the impeller in a lathe and machine if off. If a lathe is not available grind a flat through one side of the wear ring and knock the wear ring off. Ensure the original machine surface of impeller under wear ring is not damaged.

8.2.2.3 To remove the case wear ring (108) press the wear ring out of the volute.

8.2.2.4 Remove the key (33) from the shaft (4).

8.2.2.5 Discard any gasket if damaged.

8.2.2.6 Remove the discharge sealing ring (120) if it is worn, perished or damaged.

8.2.2.7 Clean all the components thoroughly and lay them out ready for reassembly.

8.3 **DISASSEMBLY OF CUTTER PUMPS.**

8.3.1 Remove Suction Cover.

8.3.2 Remove impeller lock nut then remove impeller (a puller will be required). Procedure is similar to non-clog pumps for other disassembly work.

9.0 TO DISASSEMBLE THE MOTOR (REFER SECTION 12 FOR SECTIONAL ARRANGEMENT DRAWINGS)

9.1 TO REMOVE THE MECHANICAL SEAL

9.1.1 Introduction

9.1.1.1 Once the mechanical seal has been removed from the motor it should not be reinstalled. The seal should be reconditioned or replaced.
REMEMBER: THE MECHANICAL SEAL IS THE HEART OF THE SUBMERSIBLE MOTOR. LAY MOTOR ON ITS SIDE AND DRAIN OIL AS PER SECTION 7.

9.1.1.2 The area in which the motor is worked on MUST be very clean and extreme care should be taken not to damage or scratch the sealing area on the shaft or any of the seal components. The faces of the mechanical seal are lapped to obtain a flatness not achievable in the field and rapid deterioration of the seal faces may occur unless the instructions are followed implicitly. External seal faces are silicon carbide. This material is very hard but brittle and should be handled with extreme care.

9.1.1.3 Clean shaft under seal. Remove retaining circlip 21B and back up washer 21A. Remove external seal 21 by sliding off shaft. After being installed the rubber bellows will adhere to the shaft. The bellows may require slight compression to break the adhesion to shaft. The seal will require reasonable force to slide off the shaft.

9.1.1.4 Remove set screws (13) and spring washers (9) securing seal plate (12) to motor housing (1). Slide the seal plate (12) over the shaft (4) taking care not to let the seal seat of the external seal (21) come in contact with the shaft. Remove air compensator bag (17).

9.1.1.5 Place seal plate on a flat surface with rag placed beneath the seal seat area. Push the seal seat out from the top of the plate so that the seat is caught on the rag.

9.1.1.6 Remove retaining circlip, back up washer and seal head of the internal seal (97) with bellows as per external seal.

9.2 TO REMOVE THE CABLE ASSEMBLY

9.2.1 Attach support to the cables and take the weight of the cables.

9.2.2 Remove the hex head set screws (26) and (22) and spring washers (27) holding the terminal box (16) to the motor housing (1).

9.2.3 Move the terminal box (16) away from the side of the motor a sufficient amount to be able to access the terminal blocks (232). Be careful not to strain the cable leads or the motor tails which connect to the terminal blocks.

9.2.4 Disconnect cable after recording their position.

9.2.5 Lift the entire cable assembly clear of the motor and place it in an area which is clean and dry.

9.2.6 Remove the O-ring (11E).

9.2.7 **To check the cables**

9.2.7.1 Inspect the inside of the terminal box for any signs of water leaking into the motor. If water is present check the O-ring (11E) and the condition of the sealant (210). Also thoroughly inspect the cable for any nicks and cuts on the outer sheath.

9.2.7.2 Check the continuity of each lead in the cable with a multimeter. The resistance of the leads should be equal.

9.2.7.3 Check the insulation between each cable and all the rest of the cables with a 500 volt Meggar meter. The insulation between each lead and the terminal box should also be checked. All readings should be infinity.

If readings are irregular disconnect stator winding tails from terminal blocks (232) then carry out above continuity & insulation checks.

9.3 DISASSEMBLY PROCEDURE

9.3.1 Remove the set screws (35) and spring washers (36) from the top bearing cap (34). Remove the top bearing cap (34) from the motor housing (1).

9.3.2 Discard the O-ring (11C) from the top bearing cap (34) if O-ring (11C) is not in perfect condition.

9.3.3 See note below. Remove the set screws (9) and spring washers (13) holding the motor housing (1) to the bottom bearing bracket (7).

9.3.4 Using the jacking screw holes provided jack the motor housing (1) off the bottom bearing bracket (7).

9.3.5 Lift the entire motor frame vertically until it clears the top of end of the shaft (4). Lift with extreme care to ensure windings are not damaged. The slightest bump can result in permanent damage. The inner ring of the top bearing (5) remains on the shaft, sliding through the rollers of the bearing and through the oil seal (96). Place the motor frame on clean dry timbers.

NOTE: The motor housing should only be initially lifted 100mm. The lead to the water sensor probe (32) should be disconnected before lifting the motor completely off the bottom bearing bracket.

9.3.6 Discard the O-ring (11A) if not in perfect condition.

9.3.7 Remove the oil seal (96) by tapping it down, out of the bore, allowing it to drop through the motor housing.

9.3.8 Remove the outer race of the top bearing (5) from the motor housing (1). Do this by using a bearing puller or by inverting the housing and tapping the race out of the bore.

9.3.9 Clean the recess where the top bearing (5) seats.

9.3.10 If the stator (2) needs to be pressed out of the motor housing (1) the position of the stator in the housing should be measured and recorded so that it may be replaced in the same position when it is re-installed. Stator is an interference fit in the housing and requires a press to remove.

9.3.11 With 300fr motors remove fasteners (41 & 65) retaining bearing cap (40).

9.3.12 Lift the shaft (4) complete with top bearing inner ring (5), rotor (3) and bottom bearing (6) out of the bottom bearing bracket (7). If the outer race of the bottom bearing bracket (6) will not slide out of the bottom bearing bracket it may be necessary to apply heat quickly and uniformly around the boss of the bottom bearing bracket which houses the bottom bearing.

9.3.13 Lay the shaft on a clean bench at a suitable working height.

9.3.14 Remove the bottom bearing (6) with a bearing puller taking care not to damage the shaft particularly in the area where the mechanical seal sits.

9.3.15 Remove the inner ring of the top bearing (5) from the shaft with a bearing puller. It is permissible to grind a flat through one side of the ring and knock the ring off the shaft however, **extreme care must be taken** not to damage the shaft.

9.3.16 Thoroughly clean all the components and lay them out on a clean, dry surface for re-assembly.

9.4 COOLING JACKET

9.4.1 For special applications and dry well units, motors are fitted with a cooling jacket. The jacket consists of a cast iron chamber which allows fluid to circulate around motor housing.

9.4.2 When product is used to provide cooling, it is recommended that hoses be removed at 6 month intervals to allow jacket to be flushed out. Flushing interval can be adjusted depending on the conditions on site.

9.4.3 Jacket is a sliding fit. Remove retaining screws at top of jacket and slide jacket over housing. Under normal circumstances it should not be necessary to remove the jacket for repairs on the motor.

10.0 TO ASSEMBLE THE MOTOR (REFER SECTION 12 FOR SECTIONAL ARRANGEMENT DRAWINGS)

10.1 ASSEMBLY PROCEDURE

10.1.1 All parts including stator should be thoroughly cleaned before reassembly. If stator has been contaminated then clean and revarnish. Before the motor is re-assembled the motor housing (1) with the stator (2), shaft (4) with the rotor (3), desiccating bag (57), bottom bearing bracket (7) and seal plate (12) should all be placed in a drying oven at 80 - 90 degrees celsius overnight. The motor must be assembled on the same day that the components are removed from the drying oven, preferably while still warm. This ensures maximum displacement of any moisture from stator.

10.1.2 After the stator has been taken from the drying oven it should have the electrical checks detailed in section 3 carried out on it. It is important to carry these checks out at this stage so that it is confirmed that the stator is sound before assembly commences.

10.1.3 Before commencing to re-assemble the motor check that all the replacement parts are to hand. It is recommended that no O-rings, bearings or seals are reused when the motor is rebuilt.

10.1.4 Place the shaft (4) on a clean bench at a suitable working height.

10.1.5 Thoroughly clean the area on the shaft (4) where the bottom bearing (6) will sit with acetone to remove all traces of grease or oil. With 300fr motor, slide bearing cap (40) over shaft.

10.1.6 Clean out bottom bearing. Heat the bottom bearing (6) slightly so that it just slides onto the shaft. Do not over heat bearing. If it is necessary to apply pressure to seat the bearing against the shaft shoulder a dolly should be used to apply the force to the inner ring of the bearings. Pack bearing with grease SKFLGHT 3/1 (do not over grease). Spin bearing by hand and remove excess grease.
NOTE: Double row bearing to be fitted on shaft with filling slot facing the product end of shaft. Refer Section 12 - Bottom Bearing Installation.

10.1.7 Lift the shaft and position it above the bottom bearing bracket (7) after fitting circlip (39).

10.1.8 Lower the shaft (4) and allow the bearing to slide into the bottom bearing bracket (7). If the outer race of the bearing will not slide into the bottom bearing bracket apply heat quickly and uniformly around the boss which houses the bottom bearing. Care should be taken not to raise the temperature to a point where the grease begins to break down.

10.1.9 For 300fr fix retaining cap (40) with fixings (41 & 65).

10.1.10 Fit the inner race of the top bearing (5) to the shaft (4) using the same procedure outlined in section 10.1.5 to 10.1.7.

10.1.11 Fit the oil seal (96) to the motor housing (1) by tapping it down into its bore so that the top edge is level with the bearing bore. Ensure its correct orientation when fitting. (To retain grease).

10.1.12 Fit the outer race and rollers of the top bearing (5) to the motor housing (1). Apply heat quickly and uniformly around the boss which houses the bearing until the outer race just slides to the bottom of the bore.

Care should be taken not to raise the temperature to the point where the bearing or grease seal is affected. Use a press and suitably sized pipe jig to press outer race into place.

10.1.13 Lightly grease both the bearing race and oil seal (96) with SKF LGHT 3/1 high temperature grease.

10.1.14 Cover the top bearing (5) with a clean, dry, dust free cloth to keep dust and dirt out of the bearing.

10.1.15 If the stator (2) was pressed out of the motor housing (1) in section 9.3.5 it should be pressed back into the housing paying particular attention that it is in its original position and that the winding overhangs are not damaged in any way. Feed stator tails through side of housing and reconnect to terminal block.

The correct position of the stator (2) is centralised around the rotor.

10.1.16 Replace the O-ring (11a) on the bottom bearing bracket (7).

10.1.17 Lift the motor housing (1) across to the bottom bearing bracket. Position the housing above the shaft (4) and rotor (3) and slowly lower the housing over the rotor ensuring that the stator does not scrape down the side of the rotor.

The motor housing (1) should be held approximately 100mm above the bottom bearing bracket (7) while the control wire is connected to the water sensor (32).

10.1.18 The motor housing may require rotation to line it up with the holes in the bottom bearing bracket (7).

Care should be taken that the O-ring (11a) is not pinched as the housing seats home.

The insulation between the water sensor probe (32) and the motor housing should be checked with a 500 volt MEGGER. Test from the water sensor lead to the motor housing. The reading should show infinity.

10.1.20 Replace the fixings (9 & 13) and tighten. Through out the assembly procedure turn shaft by hand ensuring it is free to rotate at all times.

10.1.21 Replace the O-ring (11C) to the top bearing cap (34). Fit the top bearing cap (34) to the motor housing (1). Replace the set screws (35) and spring washers (36) to the top bearing cap (34) and tighten.

10.1.22 Lift the motor at its lifting points and lay it on a bench at a suitable working height.

10.2 **CABLE ASSEMBLY**

10.2.1 Lift the cable assembly (16) across to the motor.

10.2.2 Renew the O-ring (11E).

10.2.3 Position the terminal box so that the motor tails and leads reach the terminal blocks (232). Reconnect wires as per original connection.

10.2.4 Wire the earth leads to the motor housing (1) using the earth screw (29) and spring washer (28).

10.2.5 Feed the motor tails back into the motor as the terminal box (16) is placed into position against the motor housing (1).

10.2.6 Replace the set screws (26) and (22) with the spring washers (27) then tighten. Carry out insulation & continuity checks through cable to ensure no damage has occurred during assembly.

10.3 **TO ASSEMBLE THE MECHANICAL SEAL**

10.3.1 **NOTE: Seal seats and heads are silicon carbide or carbon. They must be treated with extreme care as any impact can cause chipping or breaking.**

Thoroughly inspect the shaft (4), bottom bearing bracket (7) and seal chamber (12) in the areas which the mechanical seal (21) will seat. They should be free from scratches and burrs and be spotlessly clean. Pressure compensator (12) is fitted. Replace if it has collapsed.

10.3.2 Lubricate the shaft and elastomer components with detergent and water to assist in the assembly. Under no circumstances should grease or oil be used to assist assembly.

10.3.3 Check that the o-ring is properly seated in both of the seal seat assemblies.

10.3.4 Fit the seal seat assembly into the bottom bearing bracket (7). If the seal seat is difficult to push into the recess it is permissible to cover the seal seat with a clean piece of cardboard fashioned to slide over the shaft and exert pressure on the cardboard with a jig. Both seal seats are silicon carbide. The upper rotating seal head can be carbon or silicon carbide (carbon is standard). Do not fit carbon seal head to external seal.

10.3.5 Wipe the faces of the seal with a clean, dry, dust free piece of cloth so that it is thoroughly clean.

10.3.6 Slide upper seal head along shaft until faces contact. The seal head incorporate bellows which make it quite tight to press onto the shaft.

10.3.7 Compress bellow, slide on backing ring (21A) and retaining circlip (21B) into place. It is recommended to carry out final compression of seal with circlip and washer to prevent over compression of seal.

10.3.8 Replace air compensator (17) which is held in place by locating lugs in seal chamber (12).

10.3.9 Replace the O-ring (11b) on bottom bearing bracket (7), then fix seal plate (12) to bottom bearing bracket (7) with fixings (13), nuts (31) and spring washers (85). Fit seal seat in seal plate (12).

10.3.10 Slide product end seal head onto the shaft and fit using the same procedure noted above for internal seal. (Care should be taken not to damage the lapped face). Note the bottom product faces are silicon carbide to silicon carbide).

NOTE: Seal must not be allowed to rest on the shaft too long before the backing washer and circlip is placed in position, as the bellows has a tendency to adhere to the shaft.

Oil chamber must be filled (as per maintenance instruction) before the pump is run. Bellow seals are often tight on the shaft requiring extra pressure and lubrication (with detergent) to fit.

NEVER RUN THE SEAL DRY !!

10.3.11 Fill the oil chamber with Mobil Whiterex 307 or an equivalent. Unit is filled through (15B) with level plugs (15A). Fill chamber through 15B until oil just starts to flow out of 15A. Lay motor on its side for this filling operation. Replace plugs 15A and 15B after cleaning and applying a thread sealant.

10.3.12 Hold motor vertically. Run the motor for a maximum of three minutes. Let it stand for a further thirty minutes. Check the shaft for any oil due to the seals leaking. If the amount of oil showing is only very slight clean the shaft carefully and repeat run.

If oil still leaks from the seal they have not been fitted correctly and their installation should be checked, especially the O-rings.

10.3.13 Replace the key (33).

10.3.14 Turn the motor shaft by hand to ensure that no binding has occurred. Shaft runout should be checked to ensure it is running true (within 0.05mm).

10.3.15 Remove the plug (15A) in the motor housing (1). Screw in a T-piece fitted with stop valves. Attach a vacuum pump to one branch and a bottle of dry nitrogen to the other. Evacuate the motor to a pressure of -50 to -60 Kpa (gauge pressure) and isolate the vacuum pump with the valve. Check that the motor will hold this vacuum for ten minutes. If the vacuum diminishes it is possible that an O-ring has been damaged during assembly and the O-ring will require replacement. If vacumn holds open the valve to the nitrogen tank and charge the motor with nitrogen to a pressure of 30 Kpa (gauge pressure). Repeat this procedure to ensure all air is purged from the motor.

10.4 COOLING JACKET

Clean surfaces of housing and inside jacket. Fit o'rings and lightly grease with rubber grease. Lower jacket onto housing.
Using lifting bolt fixing holes put a plate across the top of motor and jack the jacket into place with threaded rod. Reconnect cooling lines.

11.0 TO ASSEMBLE THE PUMP

11.1 ASSEMBLY PROCEDURE (NON CLOG PUMP)

11.1.1 Using new gaskets/O Rings recommended during the assembly procedure below. Use anti-seize on all threads.

11.1.2 Renew the discharge sealing ring (120) if required.

11.1.3 Lay the motor unit on bench at a suitable working height.

11.1.4 If the impeller wear ring (107) was removed refit a new wear ring by heating the new ring and pressing in onto the impeller (102). "Scotch key" impeller wear ring to impeller.

11.1.5 Fit the key (33) into the shaft. Ensure key is a tight fit and all burrs in keyway and key have been removed.

11.1.6 Fit the impeller (102) onto the shaft and ensure the shaft and impeller are correctly engaged. Take care that there are no burrs, defects or dirt on the shaft or impeller bore as this will affect the fit. Prior to fitting impeller balance should be checked to ensure normal wear has not caused imbalance.

11.1.7 Fit the locknut washer (104) and screw the locknut (103) onto the thread. Locknut is the nyloc type and particular care should be taken not to damage thread on the pump shaft (4).

11.1.8 Tighten the locknut (3).

11.1.9 Check runout of impeller using a dial gauge. Runout should be within 0.2mm.

11.1.10 If the case wear ring (108) requires replacing in section 8 replace the new wear ring by pressing it into the volute (101).

11.1.11 Where fitted, fit motor adaptor (114) and replace gasket. Attach a sling to the motor complete with impeller and lift the motor over to where the pump volute is supported on clean, dry timbers.

11.1.12 Renew the gasket (113) which will be between the motor and the volute (101).

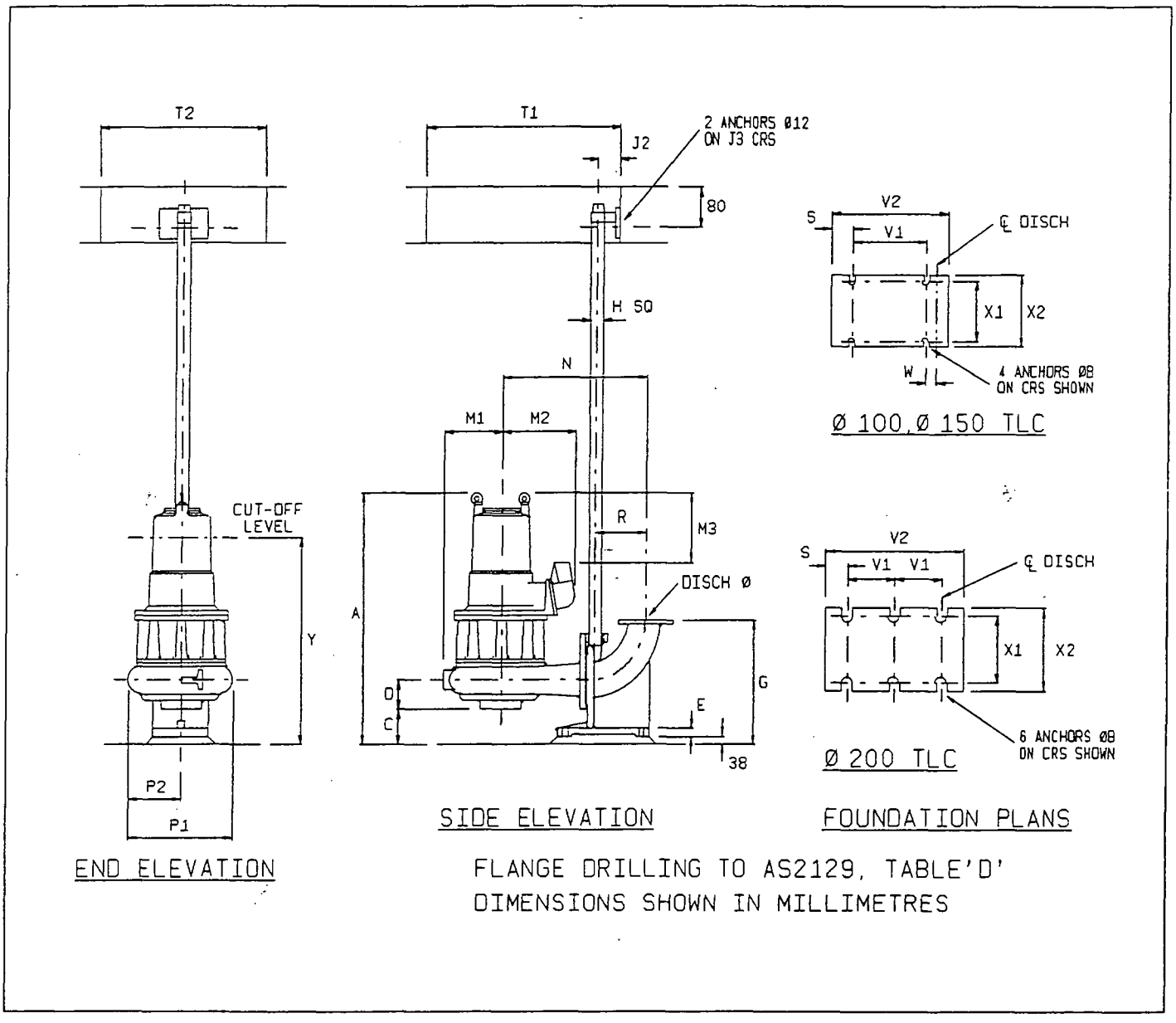
11.1.13 Lower the motor onto the double ended studs (117) making sure that the lifting points on the motor are on the same centre line as the discharge of the pump.

11.1.14 Screw the nuts (112) onto the double ended studs (117). Tighten the nuts (112) to tension.

11.1.15 Turn impeller by hand to ensure it is free. Before running the pumpset the installation procedure in section 6 should be followed through thoroughly.

12.0 APPENDICES

12.1 SECTIONAL AND DIMENSIONAL DRAWINGS


T2
CUT-OFF LEVEL
Y
P2
P1
END ELEVATION
T1
J2
2 ANCHORS Ø12 ON J3 CRS
80
H SQ
N
M1
M2
R
M3
DISCH Ø
A
D
C
E
G
38
SIDE ELEVATION
V2
S
V1
℄ DISCH
X1
X2
W
4 ANCHORS Ø8 ON CRS SHOWN
Ø 100, Ø 150 TLC
V2
S
V1 V1
℄ DISCH
X1
X2
6 ANCHORS Ø8 ON CRS SHOWN
Ø 200 TLC
FOUNDATION PLANS
FLANGE DRILLING TO AS2129, TABLE'D'
DIMENSIONS SHOWN IN MILLIMETRES

MODEL	MOTOR FRAME	DISCH	A	B	C	D	E	G	H	J2	J3	M1	M2	M3	N	P1	P2	R	S	T1	T2	V1	V2	W	X1	X2	Y
E100-280	150	100	806	12	135	106	28	459	50	86	121	205	N/A	N/A	568	408	204	199	31	900	700	300	362	12	179	220	668
	165	100	828	12	135	106	28	459	50	86	121	205	185	277	568	408	204	199	31	900	700	300	362	12	179	220	760
	203	100	925	12	135	106	28	459	50	86	121	205	294	265	568	408	204	199	31	900	700	300	362	12	179	220	810
	260	100	1005	12	135	106	28	459	50	86	121	205	294	387	568	408	204	199	31	900	700	300	362	12	179	220	759
E100-340	203	100	924	12	138	103	28	459	50	86	121	244	294	265	566	489	256	199	31	900	700	300	362	12	179	220	759
	260	100	1071	12	138	103	28	459	50	86	121	244	294	387	566	489	256	199	31	900	700	300	362	12	179	220	859
E100-350	260	100	1071	16	127	114	28	459	50	86	121	319	294	387	598	548	274	199	31	900	800	300	362	12	179	220	859
E100-380	260	100	1108	16	146	95	28	459	50	86	121	280	294	387	613	560	280	199	31	900	800	300	362	12	179	220	913
	300	100	1162	16	146	95	28	459	50	86	121	280	274	435	613	560	280	199	31	900	800	300	362	12	179	220	922
E100-405	260	100	1076	16	127	114	28	459	50	86	121	319	294	387	598	548	274	199	31	900	800	300	362	12	179	220	881
	300	100	1137	16	127	114	28	459	50	86	121	319	274	435	598	548	274	199	31	900	800	300	362	12	179	220	897
	350	100	1267	16	127	114	28	459	50	86	121	319	442	416	598	548	274	199	31	900	800	300	362	12	179	220	987
K150-330	203	150	1000	16	186	122	28	463	75	121	171	242	294	265	654	484	242	234	32	900	800	375	438	N/A	225	275	835
	260	150	1147	16	186	122	28	463	75	121	171	242	294	387	654	484	242	234	32	900	800	375	438	N/A	225	275	952
	300	150	1165	16	186	122	28	463	75	121	171	242	274	435	654	484	242	234	32	900	800	375	438	N/A	225	275	925
	350	150	1334	16	186	122	28	463	75	121	171	242	442	416	654	484	242	234	32	900	800	375	438	N/A	225	275	1054
K150-350	260	150	1136	16	151	157	28	463	75	121	171	289	294	387	683	572	315	234	32	1000	800	375	438	N/A	225	275	941
	300	150	1210	16	151	157	28	463	75	121	171	289	274	435	683	572	315	234	32	1000	800	375	438	N/A	225	275	970
	350	150	1334	16	151	157	28	463	75	121	171	289	442	416	683	580	315	234	32	1000	800	375	438	N/A	225	275	1054
	370	150	1334	16	151	157	28	463	75	121	171	289	442	416	683	580	315	234	32	1000	800	375	438	N/A	225	275	1054
K150-405	260	150	1142	16	218	90	28	463	75	121	171	283	294	387	781	569	305	234	32	900	800	375	438	N/A	225	275	947
	300	150	1204	16	218	90	28	463	75	121	171	283	274	435	781	569	305	234	32	900	800	375	438	N/A	225	275	964
	350	150	1334	16	218	90	28	463	75	121	171	283	442	416	781	569	305	234	32	900	800	375	438	N/A	225	275	1054
	370	150	1334	16	218	90	28	463	75	121	171	283	442	416	781	569	305	234	32	900	800	375	438	N/A	225	275	1054
K200-360	260	200	1369	20	370	132	35	695	75	146	241	330	294	387	936	635	350	302	51	1000	800	254	610	N/A	305	406	1174
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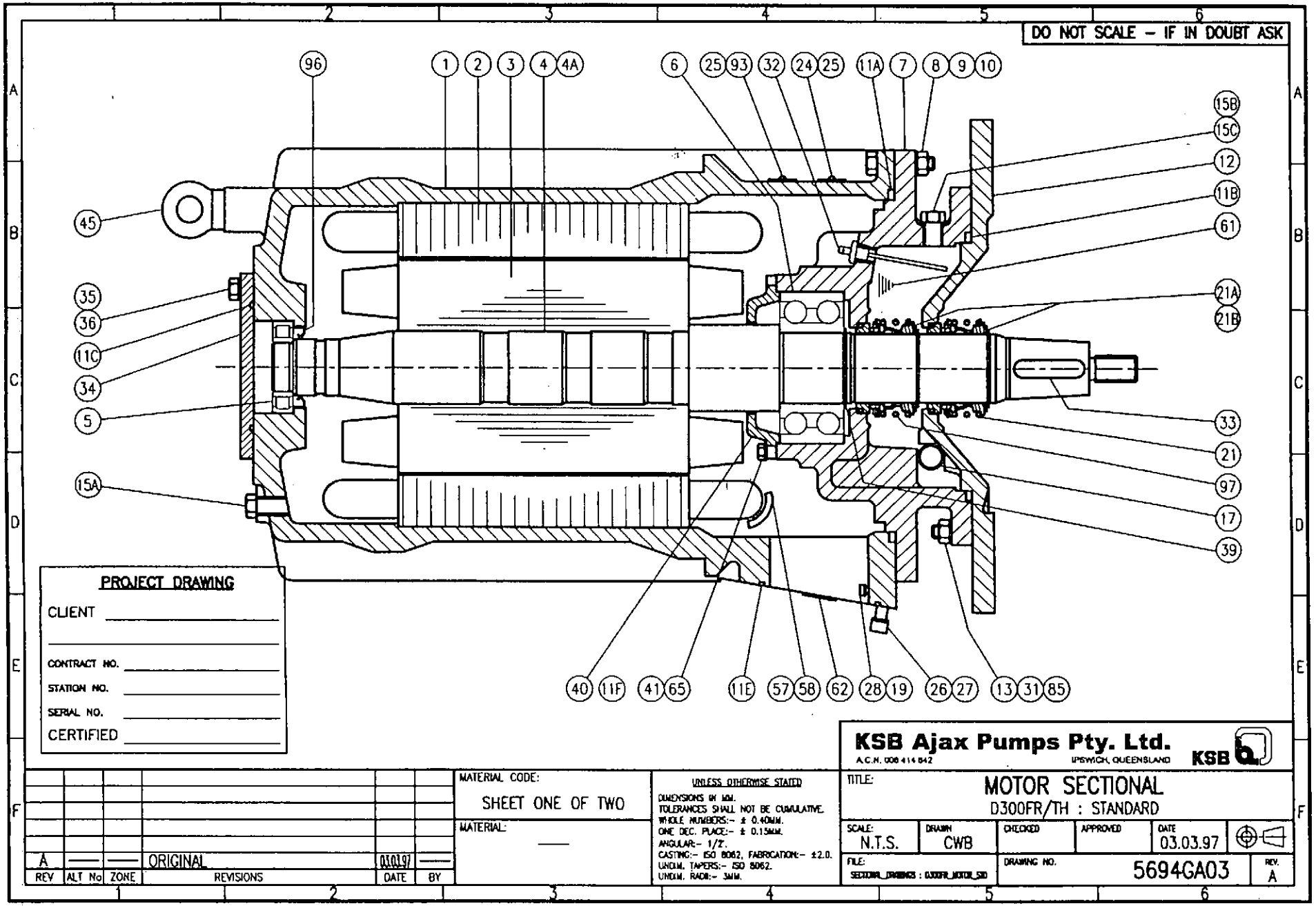
	350	200	1527	20	370	132	35	695	75	146	241	330	442	416	936	635	350	302	51	1000	800	254	610	N/A	305	406	1247
	370	200	1527	20	370	132	35	695	75	146	241	330	442	416	936	635	350	302	51	1000	800	254	610	N/A	305	406	1247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4A
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10
15B
15C
12
11B
61
45
35
36
11C
34
5
15A
21A
21B
33
21
97
17
39
40
11F
41
65
11E
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62
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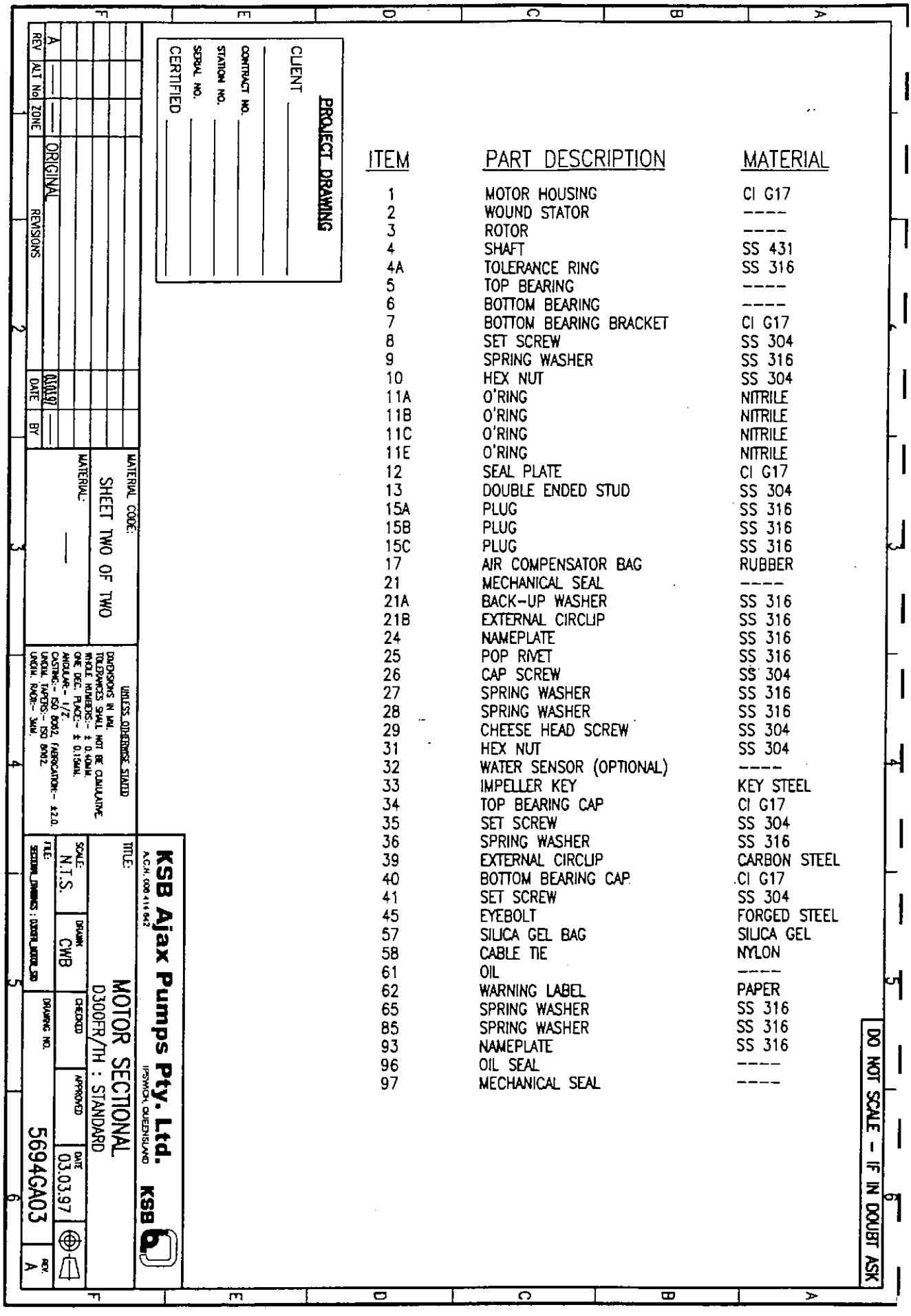
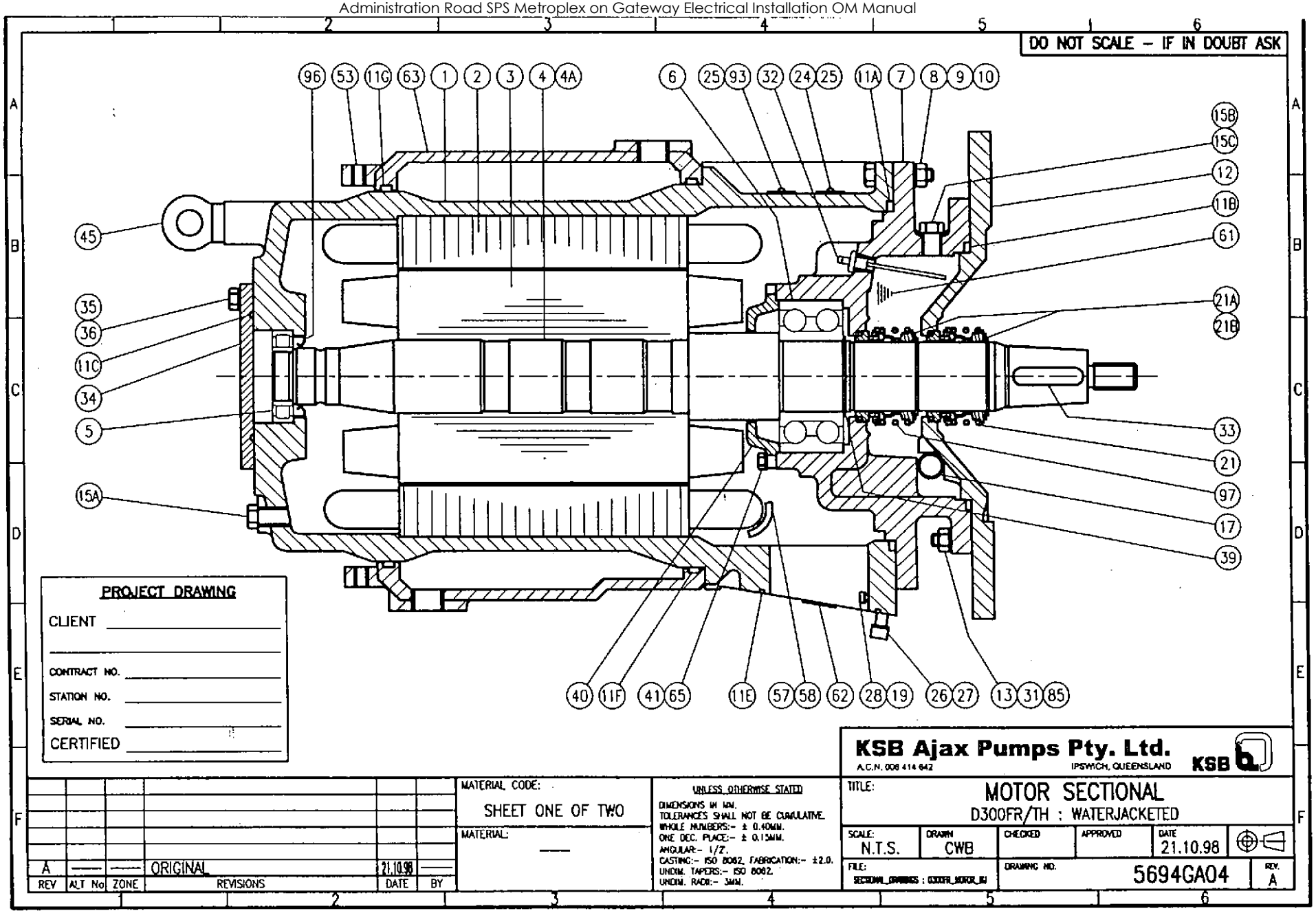
85
PROJECT DRAWING
CLIENT
CONTRACT NO.
STATION NO.
SERIAL NO.
CERTIFIED
KSB Ajax Pumps Pty. Ltd.
A.C.N. 008 414 842
IPSWICH, QUEENSLAND
KSB
MATERIAL CODE:
SHEET ONE OF TWO
MATERIAL:
UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:- ± 0.40MM.
ONE DEC. PLACE:- ± 0.15MM.
ANGULAR:- 1/2°.
CASTING:- ISO 8062, FABRICATION:- ±2.0.
UNDIM. TAPERS:- ISO 8062.
UNDIM. RADII:- 3MM.
TITLE:
MOTOR SECTIONAL
D300FR/TH : STANDARD
SCALE: N.T.S.
DRAWN CWB
CHECKED
APPROVED
DATE 03.03.97
FILE:
DRAWING NO. 5694GA03
REV. A
A — — ORIGINAL 030197 —
REV ALT No ZONE REVISIONS DATE BY



ITEM	PART DESCRIPTION	MATERIAL
1	MOTOR HOUSING	CI G17
2	WOUND STATOR	----
3	ROTOR	----
4	SHAFT	SS 431
4A	TOLERANCE RING	SS 316
5	TOP BEARING	----
6	BOTTOM BEARING	----
7	BOTTOM BEARING BRACKET	CI G17
8	SET SCREW	SS 304
9	SPRING WASHER	SS 316
10	HEX NUT	SS 304
11A	O'RING	NITRILE
11B	O'RING	NITRILE
11C	O'RING	NITRILE
11E	O'RING	NITRILE
12	SEAL PLATE	CI G17
13	DOUBLE ENDED STUD	SS 304
15A	PLUG	SS 316
15B	PLUG	SS 316
15C	PLUG	SS 316
17	AIR COMPENSATOR BAG	RUBBER
21	MECHANICAL SEAL	----
21A	BACK-UP WASHER	SS 316
21B	EXTERNAL CIRCLIP	SS 316
24	NAMEPLATE	SS 316
25	POP RIVET	SS 316
26	CAP SCREW	SS 304
27	SPRING WASHER	SS 316
28	SPRING WASHER	SS 316
29	CHEESE HEAD SCREW	SS 304
31	HEX NUT	SS 304
32	WATER SENSOR (OPTIONAL)	----
33	IMPELLER KEY	KEY STEEL
34	TOP BEARING CAP	CI G17
35	SET SCREW	SS 304
36	SPRING WASHER	SS 316
39	EXTERNAL CIRCLIP	CARBON STEEL
40	BOTTOM BEARING CAP	CI G17
41	SET SCREW	SS 304
45	EYEBOLT	FORGED STEEL
57	SILICA GEL BAG	SILICA GEL
58	CABLE TIE	NYLON
61	OIL	----
62	WARNING LABEL	PAPER
65	SPRING WASHER	SS 316
85	SPRING WASHER	SS 316
93	NAMEPLATE	SS 316
96	OIL SEAL	----
97	MECHANICAL SEAL	----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6 25 93 32 24 25 11A 7 8 9 10
15B 15C 12 11B 61
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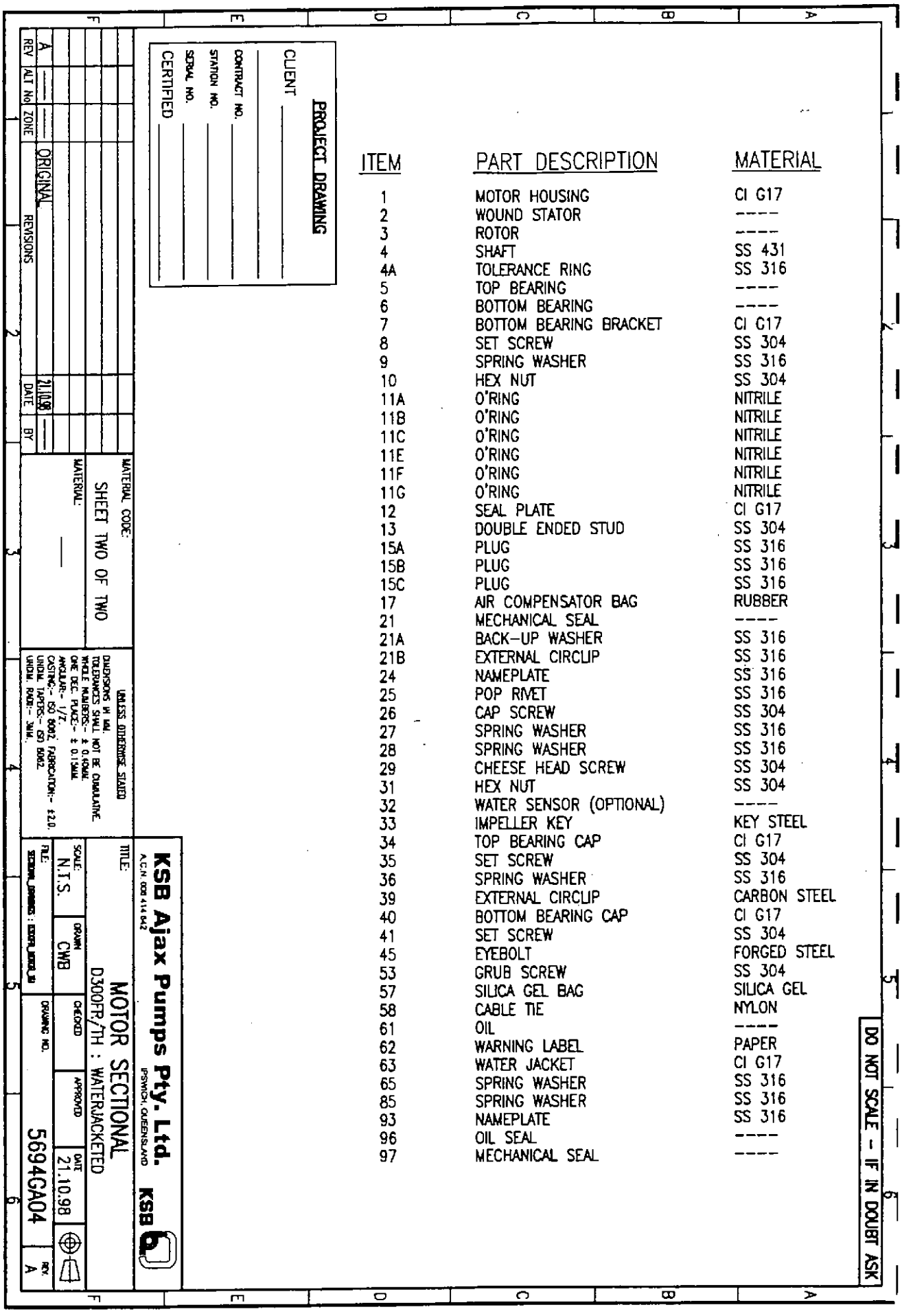
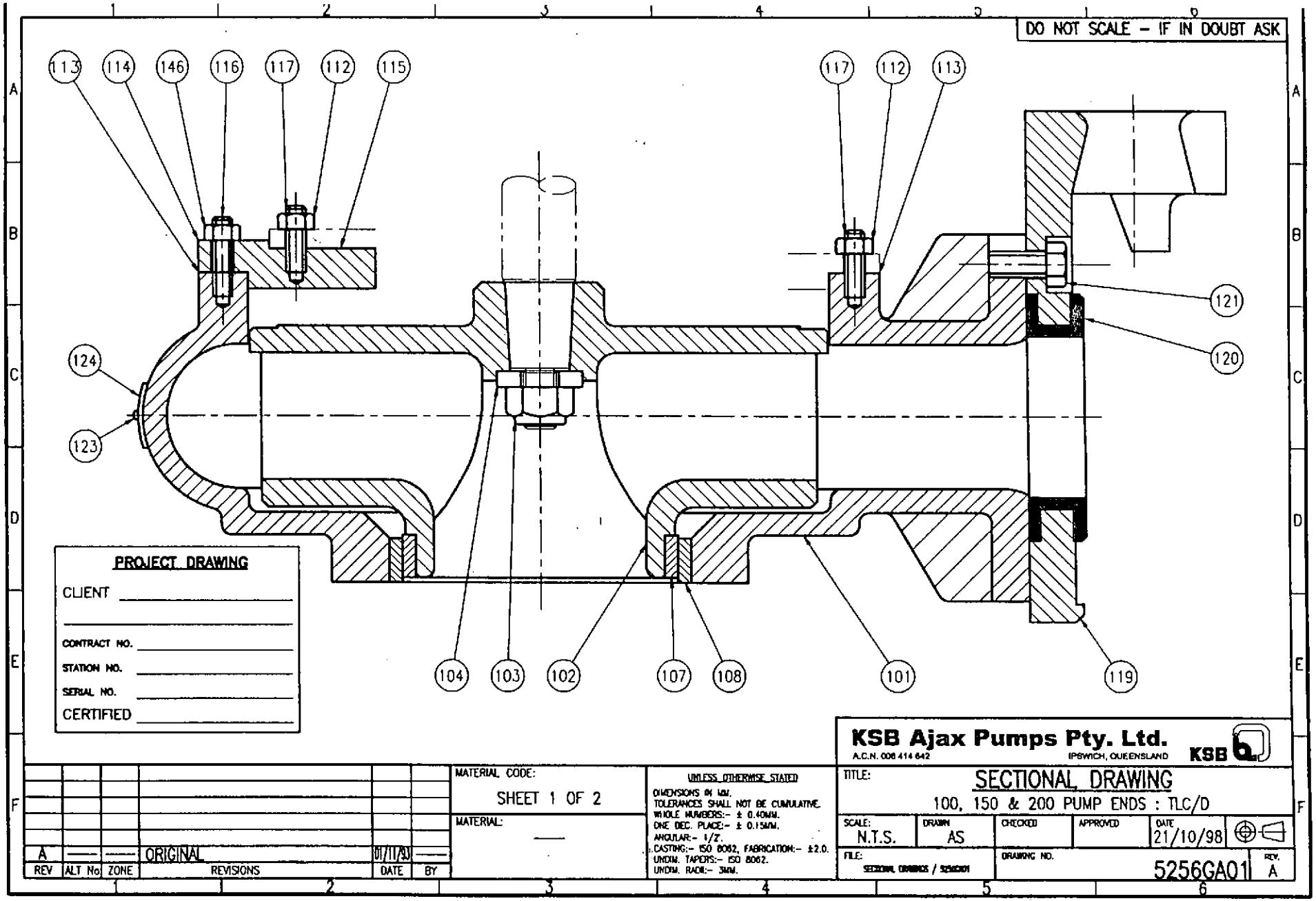
35 36 11C 34 5
21A 21B
33 21 97 17 39
15A
40 11F 41 65 11E 57 58 62 28 19 26 27 13 31 85
PROJECT DRAWING
CLIENT
CONTRACT NO.
STATION NO.
SERIAL NO.
CERTIFIED
KSB Ajax Pumps Pty. Ltd.
A.C.N. 008 414 642
IPSWICH, QUEENSLAND
KSB
MATERIAL CODE:
SHEET ONE OF TWO
MATERIAL:
UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:- ± 0.40MM.
ONE DEC. PLACE:- ± 0.15MM.
ANGULAR:- 1/2.
CASTING:- ISO 8062, FABRICATION:- ±2.0.
UNDIM. TAPERS:- ISO 8062.
UNDIM. RADII:- 3MM.
TITLE:
MOTOR SECTIONAL
D300FR/TH : WATERJACKETED
SCALE: N.T.S.
DRAWN CWB
CHECKED
APPROVED
DATE 21.10.98
FILE:
DRAWING NO. 5694GA04
REV. A
A — — ORIGINAL 21.10.98
REV ALT No ZONE REVISIONS DATE BY



ITEM	PART DESCRIPTION	MATERIAL
1	MOTOR HOUSING	CI G17
2	WOUND STATOR	----
3	ROTOR	----
4	SHAFT	SS 431
4A	TOLERANCE RING	SS 316
5	TOP BEARING	----
6	BOTTOM BEARING	----
7	BOTTOM BEARING BRACKET	CI G17
8	SET SCREW	SS 304
9	SPRING WASHER	SS 316
10	HEX NUT	SS 304
11A	O'RING	NITRILE
11B	O'RING	NITRILE
11C	O'RING	NITRILE
11E	O'RING	NITRILE
11F	O'RING	NITRILE
11G	O'RING	NITRILE
12	SEAL PLATE	CI G17
13	DOUBLE ENDED STUD	SS 304
15A	PLUG	SS 316
15B	PLUG	SS 316
15C	PLUG	SS 316
17	AIR COMPENSATOR BAG	RUBBER
21	MECHANICAL SEAL	----
21A	BACK-UP WASHER	SS 316
21B	EXTERNAL CIRCLIP	SS 316
24	NAMEPLATE	SS 316
25	POP RIVET	SS 316
26	CAP SCREW	SS 304
27	SPRING WASHER	SS 316
28	SPRING WASHER	SS 316
29	CHEESE HEAD SCREW	SS 304
31	HEX NUT	SS 304
32	WATER SENSOR (OPTIONAL)	----
33	IMPELLER KEY	KEY STEEL
34	TOP BEARING CAP	CI G17
35	SET SCREW	SS 304
36	SPRING WASHER	SS 316
39	EXTERNAL CIRCLIP	CARBON STEEL
40	BOTTOM BEARING CAP	CI G17
41	SET SCREW	SS 304
45	EYEBOLT	FORGED STEEL
53	GRUB SCREW	SS 304
57	SILICA GEL BAG	SILICA GEL
58	CABLE TIE	NYLON
61	OIL	----
62	WARNING LABEL	PAPER
63	WATER JACKET	CI G17
65	SPRING WASHER	SS 316
85	SPRING WASHER	SS 316
93	NAMEPLATE	SS 316
96	OIL SEAL	----
97	MECHANICAL SEAL	----


DO NOT SCALE – IF IN DOUBT ASK
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PROJECT DRAWING
CLIENT
CONTRACT NO.
STATION NO.
SERIAL NO.
CERTIFIED
KSB Ajax Pumps Pty. Ltd.
A.C.N. 006 414 642
IPSWICH, QUEENSLAND
KSB
MATERIAL CODE:
SHEET 1 OF 2
MATERIAL:
UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:- ± 0.40MM.
ONE DEC. PLACE:- ± 0.15MM.
ANGULAR:- 1/2°.
CASTING:- ISO 8062, FABRICATION:- ±2.0.
UNDIM. TAPERS:- ISO 8062.
UNDIM. RADII:- 3MM.
TITLE:
SECTIONAL DRAWING
100, 150 & 200 PUMP ENDS : TLC/D
SCALE: N.T.S.
DRAWN AS
CHECKED
APPROVED
DATE 21/10/98
FILE:
DRAWING NO. 5256GA01
REV. A
REV ALT No ZONE REVISIONS DATE BY
A — ORIGINAL 01/11/93 —

DO NOT SCALE – IF IN DOUBT ASK

ITEM	DESCRIPTION	MATERIAL
101	VOLUTE	C.I. G17
102	IMPELLER	C.I. G17
103	IMPELLER NUT	SS 316
104	IMPELLER WASHER	SS 316
107	WEAR RING – IMPELLER	MILD STEEL
108	WEAR RING – VOLUTE	NI CR IRON
112	NUT	SS 304
113	GASKET	BA UNIT
117	FASTENER	SS 304
119	LOCKING PLATE	C.I. G17
120	DISCHARGE SEALING RING	RUBBER
121	FASTENER	SS 304
123	NAME PLATE	SS 316
124	RIVET	SS 316
	MOTOR ADAPTOR STYLE	
114	MOTOR ADAPTOR	C.I. G17
115	GASKET	BA UNIT
116	FASTENER	SS 304
146	NUT	SS 304

PROJECT DRAWING

CLIENT _____

CONTRACT NO. _____

STATION NO. _____

SERIAL NO. _____

CERTIFIED _____

REV	ALT No	ZONE	REVISIONS	DATE	BY
A	——	——	ORIGINAL	01/11/93	——

MATERIAL CODE: SHEET 2 OF 2

MATERIAL: ——

UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:– ± 0.40MM.
ONE DEC. PLACE:– ± 0.15MM.
ANGULAR:– 1/2°.
CASTING:– ISO 8062, FABRICATION:– ±2.0.
UNDIM. TAPERS:– ISO 8062,
UNDIM. RADII:– 3MM.

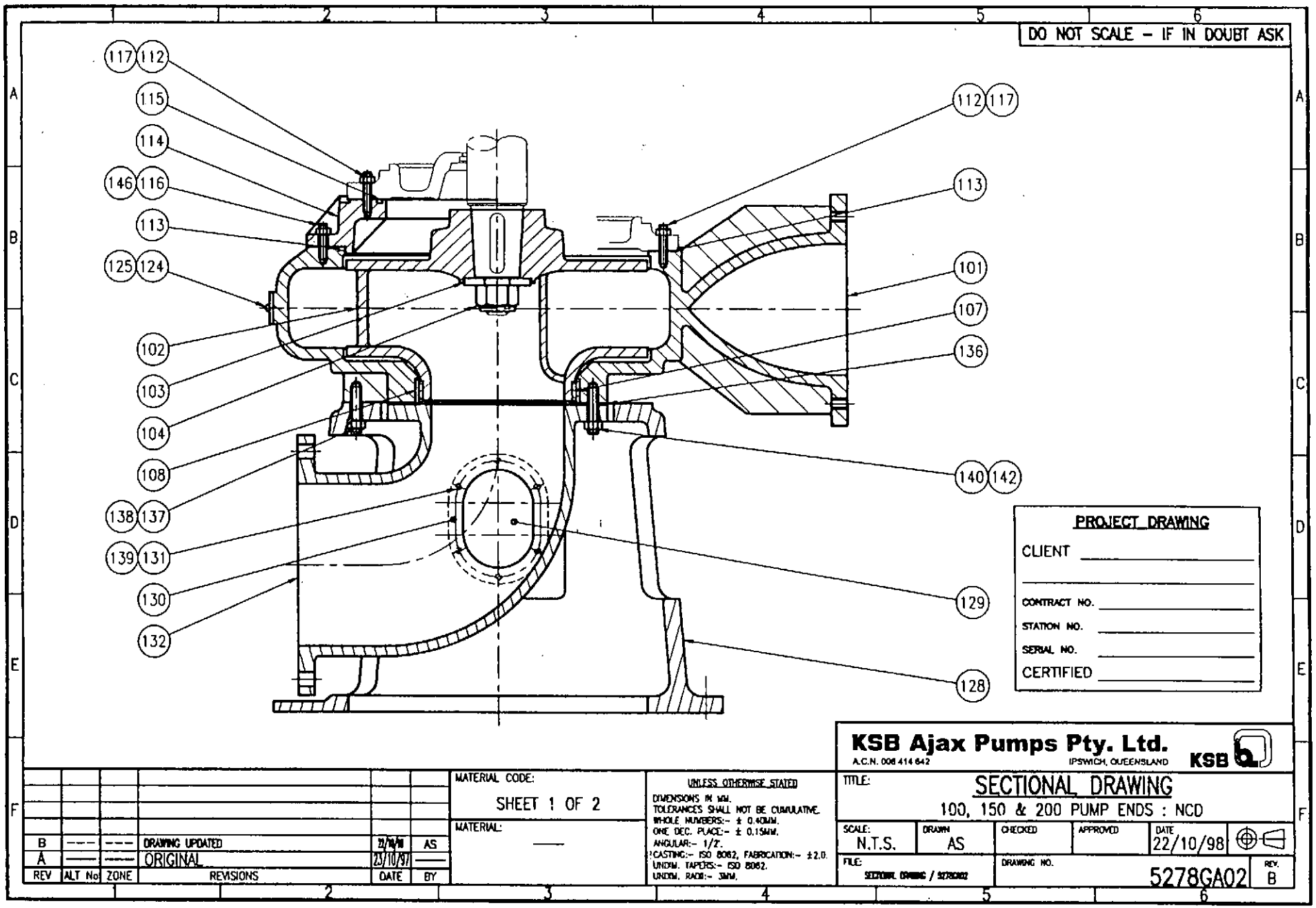
KSB Ajax Pumps Pty. Ltd.
A.C.N. 008 414 842 IPSWICH, QUEENSLAND KSB

TITLE: SECTIONAL DRAWING
100, 150 & 200 PUMP ENDS : TLC/D

SCALE:	DRAWN	CHECKED	APPROVED	DATE
N.T.S.	AS			21/10/98

FILE: SECTIONAL DRAWINGS / 5256A01

DRAWING NO. 5256GA01 REV. A


DO NOT SCALE – IF IN DOUBT ASK
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142
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128
PROJECT DRAWING
CLIENT
CONTRACT NO.
STATION NO.
SERIAL NO.
CERTIFIED
KSB Ajax Pumps Pty. Ltd.
A.C.N. 008 414 642
IPSWICH, QUEENSLAND
KSB
MATERIAL CODE:
SHEET 1 OF 2
MATERIAL:
UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:- ± 0.40MM.
ONE DEC. PLACE:- ± 0.15MM.
ANGULAR:- 1/2°.
CASTING:- ISO 8062, FABRICATION:- ±2.0.
UNDIM. TAPERS:- ISO 8062.
UNDIM. RADII:- 3MM.
TITLE:
SECTIONAL DRAWING
100, 150 & 200 PUMP ENDS : NCD
SCALE: N.T.S.
DRAWN AS
CHECKED
APPROVED
DATE 22/10/98
FILE:
DRAWING NO. 5278GA02
REV. B
B --- --- DRAWING UPDATED 22/10/98 AS
A --- --- ORIGINAL 23/10/97 ---
REV ALT No ZONE REVISIONS DATE BY

DO NOT SCALE – IF IN DOUBT ASK

ITEM	DESCRIPTION	MATERIAL
101	VOLUTE	C.I. G17
102	IMPELLER	C.I. G17
103	IMPELLER NUT	SS 316
104	IMPELLER WASHER	SS 316
107	WEAR RING – IMPELLER	MILD STEEL
108	WEAR RING – VOLUTE	NI CR IRON
112	NUT	SS 304
113	O RING	NITRILE
114	MOTOR ADAPTOR	C.I. G17
115	O RING	NITRILE
116	FASTENER	SS 304
117	FASTENER	SS 304
124	NAME PLATE	SS 316
125	RIVET	SS 316
128	PEDESTAL	C.I. G17
129	CLEAN-OUT PLATE	C.I. G17
130	GASKET	NEOPRENE
131	FASTENER	SS 304
132	SUCTION BEND	C.I. G17
136	GASKET	NEOPRENE
137	FASTENER	SS 304
138	NUT	SS 304
139	NUT	SS 304
140	NUT	SS 304
142	FASTENER	SS 304
146	NUT	SS 304

MOTOR ADAPTOR STYLE

114	MOTOR ADAPTOR	C.I. G17
115	GASKET	BA UNIT
116	FASTENER	SS 304
146	NUT	SS 304

PROJECT DRAWING

CLIENT _____

CONTRACT NO. _____

STATION NO. _____

SERIAL NO. _____

CERTIFIED _____

KSB Ajax Pumps Pty. Ltd. KSB

A.C.N. 008 414 842 IPSWICH, QUEENSLAND

REV	ALT No	ZONE	REVISIONS	DATE	BY
B	---	---	DRAWING UPDATED	22/10/98	AS
A	---	---	ORIGINAL	23/10/97	---

MATERIAL CODE: SHEET 2 OF 2

MATERIAL: ---

UNLESS OTHERWISE STATED
DIMENSIONS IN MM.
TOLERANCES SHALL NOT BE CUMULATIVE.
WHOLE NUMBERS:- ± 0.40MM.
ONE DEC. PLACE:- ± 0.15MM.
ANGULAR:- 1/2°.
CASTING:- ISO 8062, FABRICATION:- ±2.0.
UNDIM. TAPERS:- ISO 8062.
UNDIM. RADII:- 3MM.

TITLE: SECTIONAL DRAWING
100, 150 & 200 PUMP ENDS : NCD

SCALE:	DRAWN	CHECKED	APPROVED	DATE
N.T.S.	AS			22/10/98

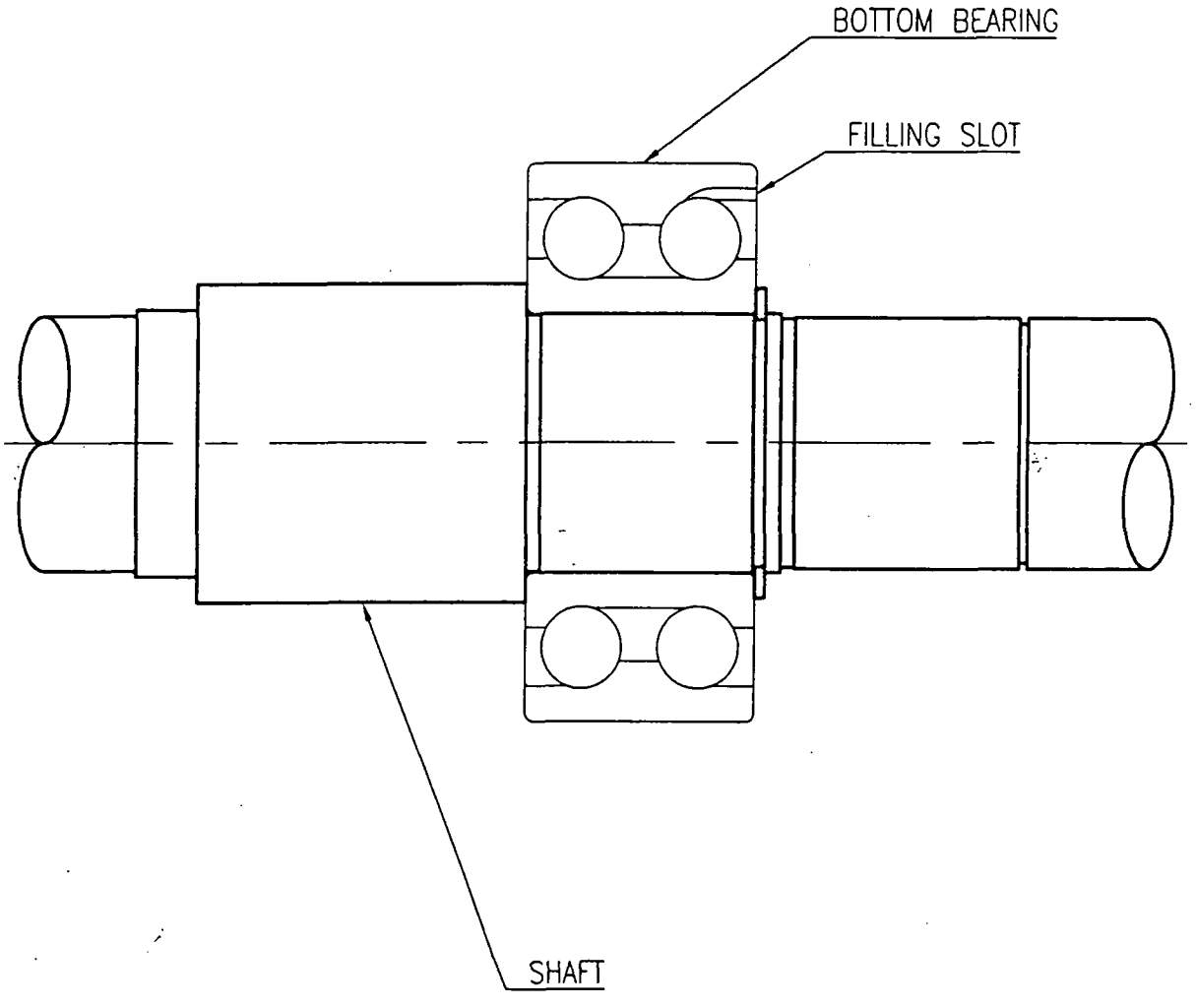
FILE: SECTIONAL DRAWING / 5278GA02

DRAWING NO. 5278GA02 REV. B

KSB

D300FR MOTOR

BOTTOM BEARING INSTALLATION



D300FR_BTM_BRG

12.2 TABLES FOR ROUTINE MAINTENANCE

MAINTENANCE CHART

	DAILY	WEEKLY	MONTHLY	3 MONTHLY	6 MONTHLY	YEARLY	REMARKS
Check for leaks.							Extend to monthly if proved satisfactory during running-in.
Check electrical continuity & insulation resistance.							Extend to 6 monthly if proved satisfactory during running-in.
Check oil in seal chamber, drain & refill.							Extend to 12 monthly if proved satisfactory during running in and 1500 hrs. Running not exceeded.
Check for vibration.							Extend to weekly if proved satisfactory during running-in.
Check cable for damage.							Depending on environmental condition.
Inspect wear rings.							Frequency can be changed depending on findings and pumping conditions.
Check for undue wear or corrosion of volute or impeller.							Check at end of first 3 months. Extend to yearly dependant on environmental and pumping conditions.
Check holding down bolts for tightness							Check at end of running in period, then at 12 monthly intervals.
Remove Water jacket and clean out all feeder lines. (if applicable)							Depending on environmental condition.

PUMP OVERHAUL

The pump should be completely overhauled if the discharge pressure drops below an acceptable level the overhaul procedure is detailed in the maintenance instructions.

MOTOR OVERHAUL

The motor requires overhauling if an excessive amount of water is present in the seal chamber. The motor bearings should be replaced at each major overhaul.

PROBLEM SOLVING FOR KSB AJAX PUMPS PTY LTD SUBMERSIBLE PUMP & MOTOR

PROBLEM SOLVING AND REMEDIAL ACTION REQUIRED

(A)	Power failure.	- Restore power.
(B)	Damaged cable.	- Repair or replace cable.
(C)	Blown fuses.	- Check to ensure the correct rating is being used. Check that the pump is not jammed. Check voltage supply. Carry out insulation and continuity checks. Remove cause of overload, rectify electrical problems. Replace fuse.
(D)	Thermistor failure.	- Check thermistors using a low voltage multimeter resistance. Should be 60 OHMS to 500 OHMS. Check for open circuit in thermistor wiring. Check backup relay. Check if more than 2.5 volts has been applied across thermistors. Repair Thermistor Circuit or replace damaged components.
(E)	Overload tripped.	- Reset. Follow procedure as for Item C.
(F)	Circuit breaker tripped.	- Reset. Follow procedure as for Item C.
(G)	Jammed/choked impeller.	- Remove cause of blockage. Check wet well for foreign material.
(H)	Restriction/discharge line.	- Remove restriction. Check gate valve.
(I)	Worn wear ring.	- Replace wear rings.
(J)	Excess air in liquid.	- Check inlet lines into station and baffle or relocate if necessary. Check level in well.
(K)	Head higher than design head.	- Check systems. Check for blockages in system.
(L)	Loose or damaged wiring.	- Repair or replace as required.
(M)	Open circuit/burnt-out stator.	- Replace, repair or rewind stator as required.
(N)	Loose plug/seal compartment.	- Tighten.

(O)	Damaged/worn mechanical seal.	- Replace or repair. NOTE - In some cases mechanical seals are suitable for re-installation after relapping or replacement of carbide faces.
(P)	"O" ring/gasket failure.	- Replace.
(Q)	Casting fracture/failure.	- Repair or replace as required.

TROUBLE SHOOTING FOR KSB AJAX PUMPS PTY LTD SUBMERSIBLE PUMP AND MOTOR

PUMP WILL NOT START

(A) Power failure.
(B) Damaged cable.
(C) Blown fuse.
(D) Thermistor failure.
(E) Jammed impeller.
(F) Overload tripped.
(G) Circuit breaker tripped.
(H) Electrical switch board fault.
(I) Motor incorrectly connected.
(J) Faulty motor winding.

PUMP STARTS BUT MOTOR HAS EXCESS CURRENT and/or LOW SPEED

(A) Wrong direction of rotation.
(B) Over or under voltage.
(C) Clogged impeller.
(D) Failed bearing.
(E) Fault in the motor.
(F) Incorrect motor connection.
(G) Pump installed in wrong system or system change to pipework change or failure.

PUMP RUNS BUT CAPACITY LOW

(A) Wrong direction of rotation.
(B) Impeller choked or inlet restricted.
(C) Restriction of discharge line.
(D) Wear rings worn excessively.
(E) Excessive air in liquid.
(F) Head higher than design head.
(G) Leakage from discharge.
(H) Supply voltage incorrect.

LOW RESISTANCE READING or SHORT

(A) Water in cone housing.
(B) Cable damaged.
(C) Water in stator housing.
(D) Stator burnt out.
(E) Loose wire.
(F) Wire clamped.

HIGH CONTINUITY READING

(A) Open circuit in stator / stator burnt out.
(B) Broken wire or loose connection.
(C) Damaged cable.

12.3 RECOMMENDED SPARES & LUBRICANTS

RECOMMENDED SPARE PARTS LIST

DESCRIPTION	ITEM NO:
Bearing Upper	5
Bearing Lower	6
Mechanical Seal - Inner	97
Mechanical Seal - Outer	21
Locknut	103
Wear Ring Impeller	107
Wear Ring Volute	108
Sealing Ring	120
'O' Ring & Gasket Set	

When ordering spare parts quote the serial number of the pump.

RECOMMENDED LUBRICANTS

Oil for Seal Chamber - Mobil Whiterex 307 (FR300 - 2.5 Lit.)

Bearing Grease - SKF LGHT 3/1 High Temperature Grease

12.4 RECOMMENDED TOOL LIST

This equipment can be serviced using standard equipment normally available to Electrical and Mechanical Tradespersons.

Meggar
Multimeter
Screwdrivers
Open ended spanners
Socket spanners & extension bars

Major overhauls should be carried out in a workshop containing the following:-

Presses
Heating Apparatus - Induction Heater
- Gas Flame Heater
- Oven
Bearing Pullers
Impeller Puller

12.5 PUMP PERFORMANCE CURVES AND SHEETS

KSB Ajax Pumps Pty. Ltd. Submersible Electric Pump Test Data

Customer: *J&P RICHARDSON*
Project: *BRISBANE C.C METROFLEX ON GATEWAY*
Unit Serial No.: *F51274-1*

Measuring Instruments:

Flow: Magna Flow Meter
Discharge Head: 0-160 PRESSUREGAUGE
Power: kWH Meters

PUMP

Make:	FORRERS	
Type:	Submersible	
Model:	E100-380 TLC	
Impeller Dia.:	352	mm
Suction Pipe Dia.:	100000	mm
Discharge Pipe Dia.:	100	mm
Gauge Hight Cor.:	0	m

DUTY

Flow:	58	l / s
Head:	32	M
Speed:	1470	rpm
Power:	40	kW
Efficiency Pump:	64	
Motor Efficiency:	92	
kWh / kl:	0.1486	

MOTOR

Make:	Forrer	
Frame:	300	
Speed:	1470	rpm
Supply:	415 / 3 ph	/ 50 Hz
Type:	Submersible	
Serial No.:	F51274-1	
Power:	40.0	kW
Amps:	67.0	A

Barometric Pressure: XX mbar
Water Temperature: XX °C
Meter Constant in Revs/KWH: 266.6
No. of Revs: 10
Current Transformer Meters: N

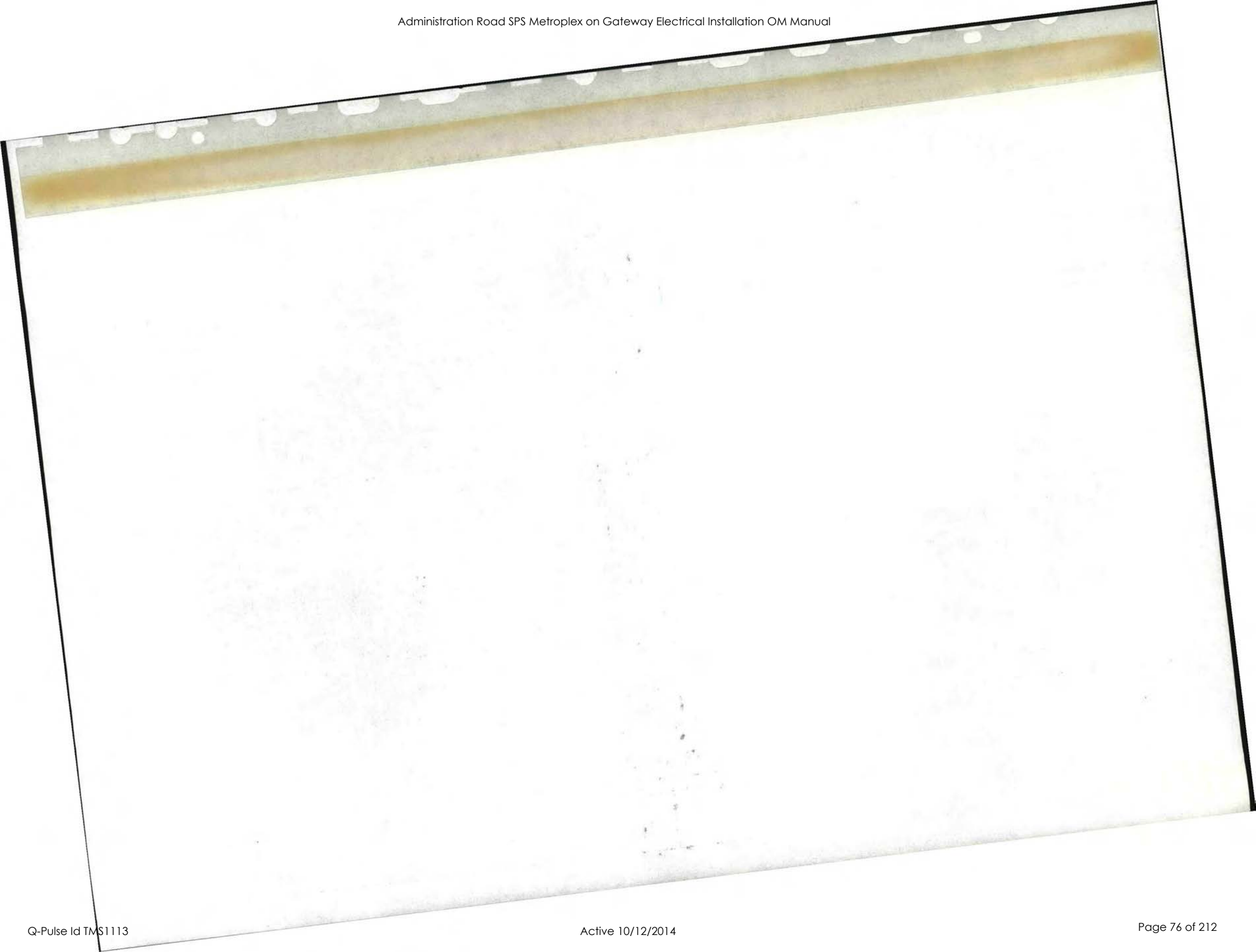
Works Test AS 2417 Part 2 - 1980			
Quoted	**With Toler.**	**As Tested**	
0.1486	0.1556	0.1381	**KWH/KL**
64.00	60.80	70.50	**EFF.**
58.00	$\left[\frac{H_G \times X_H}{\Delta H}\right]^2 + \left[\frac{Q_G \times X_Q}{\Delta Q}\right]^2$	59.50	**L/S**
32.00		32.90	**MHD**
	2.10	1.00	ΔH
		6.00	ΔQ

Point No	Flow l/s	Suction Head m	Delivery Head m	Correction Head m	KWH Meter W1	W2	W3	Amps A	Power in (Motor) kW	Motor Eff'y	DVH m	Speed rpm	Flow l / s	Total Head m	Power in (pump) kW	Pump Eff'y	O/All Eff'y	Energy per Vol kWh/kl
1	0.00	XX	45.30	XX						92	0.00	1470	0.00	45.30			0.00	0.0000
2	18.60	XX	40.90	XX	19.44	20.91	20.31	37 / 34 / 36	20.03	92	0.29	1470	18.60	41.19	18.43	40.75	37.49	0.2988
3	30.60	XX	37.30	XX	17.60	18.84	18.28	40 / 37 / 38	22.21	92	0.77	1470	30.60	38.07	20.43	55.90	51.43	0.2014
4	41.50	XX	34.20	XX	16.00	16.97	16.53	44 / 40 / 42	24.55	92	1.42	1470	41.50	35.62	22.59	64.17	59.04	0.1641
5	54.30	XX	31.30	XX	13.97	14.90	14.47	50 / 45 / 47	28.04	92	2.44	1470	54.30	33.74	25.80	69.62	64.05	0.1433
6	59.50	XX	30.00	XX	13.25	14.09	13.72	52 / 46 / 48	29.60	92	2.93	1470	59.50	32.93	27.23	70.54	64.90	0.1380
7	64.60	XX	28.30	XX	12.78	13.32	13.10	54 / 48 / 51	31.00	92	3.45	1470	64.60	31.75	28.52	70.50	64.86	0.1331
8	75.90	XX	24.20	XX	11.50	12.10	12.03	59 / 53 / 55	34.11	92	4.76	1470	75.90	28.96	31.38	68.68	63.19	0.1247
9	87.50	XX	19.40	XX	10.25	10.68	10.59	66 / 60 / 62	38.56	92	6.33	1470	87.50	25.73	35.47	62.23	57.25	0.1223

Reliability Test (Yes/No) -: XX **(If Yes) Hours:** XX

Test Officer: DAN MACKINNON X Signed:
Witnessed by: Signed:

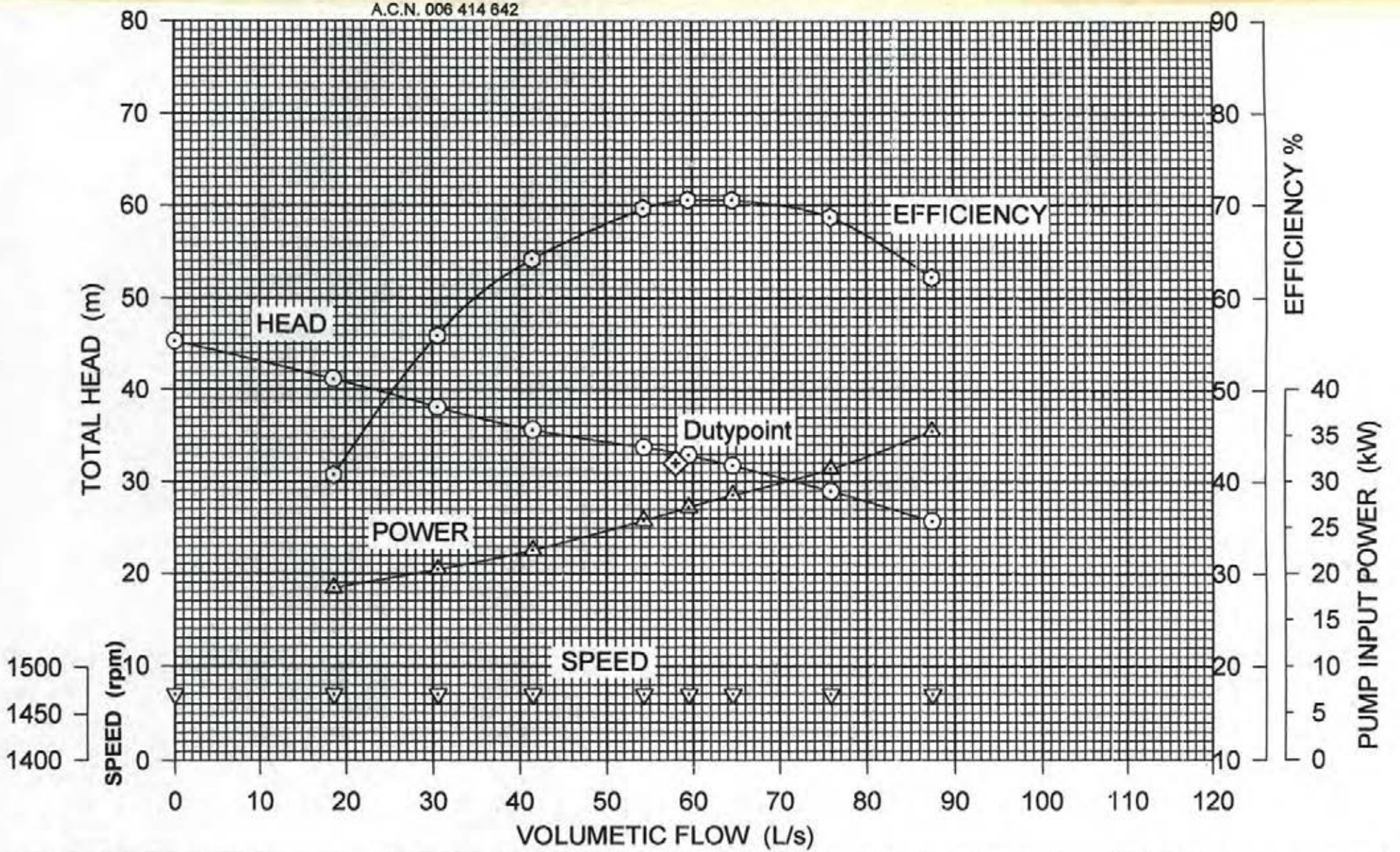
Date: 17/11/98 **Comments:**



KSB AJAX PUMPS PTY LTD

ELECTRIC PUMP PERFORMANCE CURVE

A.C.N. 006 414 642



CLIENT AND REFERENCE	SERIAL No.	IMPELLER DIAMETER	NOMINAL SPEED	KSB AJAX	CURVE No. F51274-1	
J&P RICHARDSON BRISBANE C.C METROFLEX ON GATEWAY	F51274-1	352MM	1470 RPM	E100-380 TLC	DATE 17-11-98	ISSUE 1

KSB Ajax Pumps Pty. Ltd. Submersible Electric Pump Test Data

Customer: *J&P RICHARDSON*
Project: *BRISBANE C.C METROFLEX OF GATEWAY*
Unit Serial No.: *F51274-2*

Measuring Instruments:

Flow:	Magna Flow Meter
Discharge Head:	0-160 PRESSURE GAUGE
Power:	kWH Meters

PUMP

Make:	FORRERS	
Type:	Submersible	
Model:	E100-380 TLC	
Impeller Dia.:	352	mm
Suction Pipe Dia.:	100000	mm
Discharge Pipe Dia.:	100	mm
Gauge Hight Cor.:	0	m

DUTY

Flow:	58	l / s
Head:	32	M
Speed:	1470	rpm
Power:	40	kW
Efficiency Pump:	64	
Motor Efficiency:	92	
kWh / kl:	0.1486	

MOTOR

Make:	Forrer	
Frame:	300	
Speed:	1470	rpm
Supply:	415 / 3 ph / 50 Hz	
Type:	Submersible	
Serial No.:	F51274-2	
Power:	40.0	kW
Amps:	67.0	A

Barometric Pressure:	XX	mbar
Water Temperature:	XX	°C
Meter Constant in Revs/KWH:	266.6	
No. of Revs:	10	
Current Transformer Meters:	N	

Works Test AS 2417 Part 2 - 1980			
Quoted	**With Toler.**	**As Tested**	
0.1486	0.1556	0.1373	**KWH/KL**
64.00	60.80	70.60	**EFF.**
58.00	$\left[\frac{H_Q \times X_H}{\Delta H}\right]^2 + \left[\frac{Q_Q \times X_Q}{\Delta Q}\right]^2$	60.10	**L/S**
32.00		32.77	**MHD**
	1.43	1.30	ΔH
		6.00	ΔQ

Point No	Flow l/s	Suction Head m	Delivery Head m	Correction Head m	KWH Meter W1	W2	W3	Amps A	Power in (Motor) kW	Motor Eff'y	DVH m	Speed rpm	Flow l / s	Total Head m	Power in (pump) kW	Pump Eff'y	O/All Eff'y	Energy per Vol kWh/kl
1	0.00	XX	45.50	XX						92	0.00	1470	0.00	45.50			0.00	0.0000
2	18.90	XX	41.10	XX	17.50	18.82	18.40	40 / 37 / 38	22.21	92	0.30	1470	18.90	41.40	20.43	37.54	34.54	0.3260
3	30.20	XX	37.50	XX	17.16	18.38	18.00	42 / 38 / 39	22.70	92	0.75	1470	30.20	38.25	20.88	54.24	49.90	0.2085
4	42.40	XX	34.20	XX	16.00	17.12	16.72	44 / 40 / 41	24.38	92	1.49	1470	42.40	35.69	22.43	66.13	60.84	0.1596
5	55.30	XX	31.20	XX	13.50	14.72	14.18	51 / 46 / 47	28.66	92	2.53	1470	55.30	33.73	26.37	69.35	63.80	0.1438
6	60.10	XX	29.80	XX	13.22	13.97	13.72	52 / 47 / 49	29.71	92	2.99	1470	60.10	32.79	27.33	70.69	65.03	0.1371
7	65.50	XX	28.30	XX	12.56	13.50	13.09	54 / 49 / 51	31.04	92	3.55	1470	65.50	31.85	28.56	71.61	65.88	0.1315
8	76.60	XX	23.70	XX	11.50	12.03	11.75	59 / 53 / 56	34.45	92	4.85	1470	76.60	28.55	31.69	67.66	62.25	0.1248
9	87.50	XX	19.00	XX	10.34	11.15	10.78	65 / 58 / 61	37.66	92	6.33	1470	87.50	25.33	34.65	62.72	57.70	0.1194

Reliability Test (Yes/No) -: XX **(If Yes) Hours:** XX

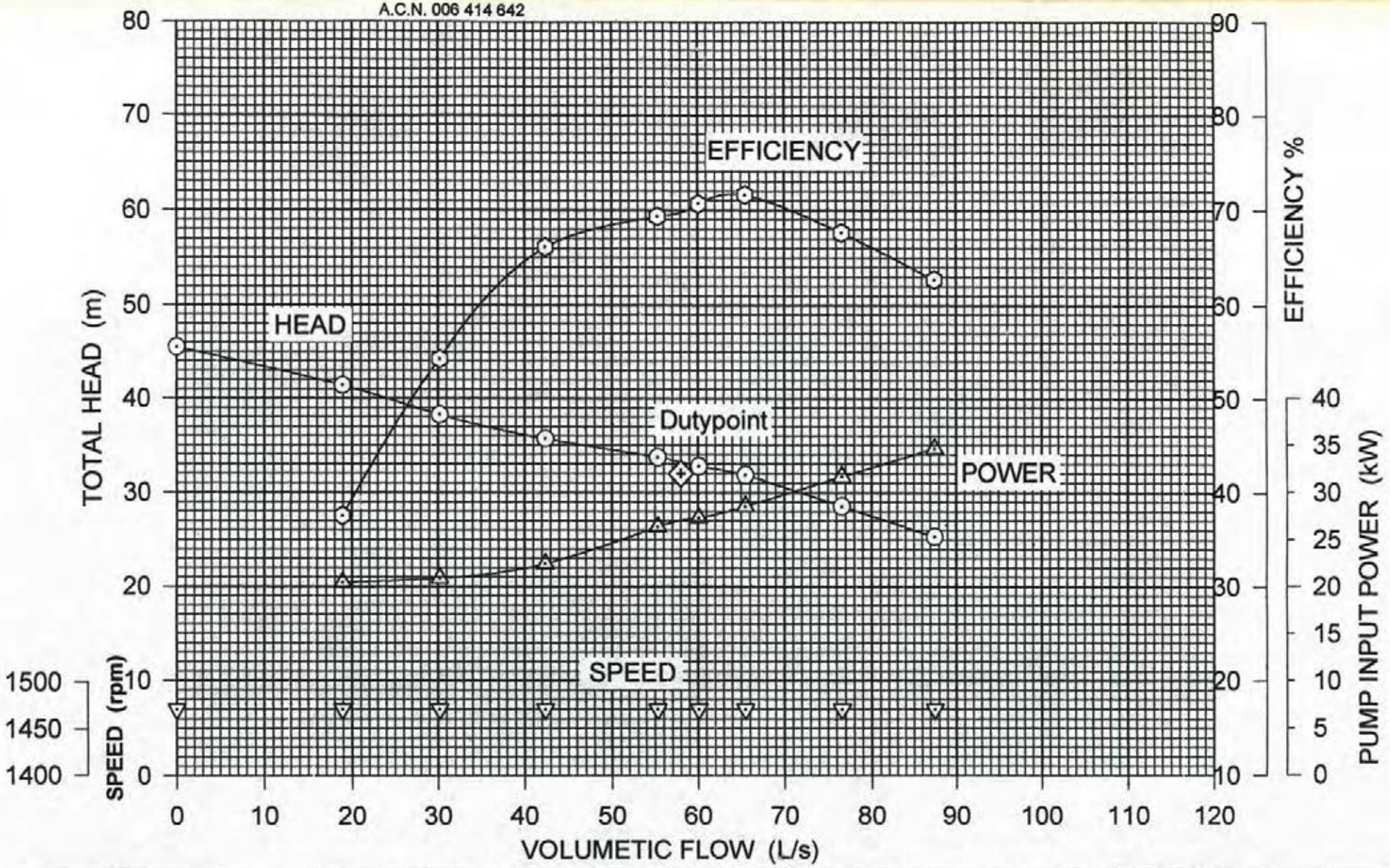
Test Officer: W.P. O' DOHERTY 1 Signed:
Witnessed by: Signed:

Date: 17/11/98 **Comments:**

KSB AJAX PUMPS PTY LTD

ELECTRIC PUMP PERFORMANCE CURVE

A.C.N. 006 414 642



CLIENT AND REFERENCE	SERIAL No.	IMPELLER DIAMETER	NOMINAL SPEED	KSB AJAX	CURVE No. F51274-2	
J&P RICHARDSON BRISBANE C.C METROFLEX ON GATEWAY	F51274-2	352MM	1470 RPM	E100 - 380 TLC	DATE 17-11-98	ISSUE 1

12.6 PUMP TECHNICAL DATA & DIMENSION SHEETS

FORRERS PUMP DETAILS

Model (Old Model No)	SP280	SGV100-150	SGV280	4S250/3	4S330/3
Model (New Model No)				E100-280	E100-340
Discharge Diameter	75	75	75	100	100
Inlet Diameter	75	75	75	125	170
Impeller Type	Shredder	Shredder	Shredder	Non Clog	Non Clog
Impeller Fixing	Locknut	Locknut	Locknut	Taper/Locknut	Taper/Locknut
Rang to fit pump	180 - 100	150 - 100	180 - 100	277 - 185	340 - 275
W/ring Diametrical Clearance	N/A	N/A	N/A	0.82-0.61	340 - 275
W/ring Fixing	N/A	N/A	N/A	Pressed	Pressed
Min Submergence - TLC	440	440	440	440	440
Weight - Pump Only	40	38	40	96	114

FORRERS PUMP DETAILS

Model (Old Model No.)	4S350/3	4S380/4	4S405/3	6D330/3.5	6D350/4
Model (New Model No.)	E100-350	E100-380	E100-405	K150-330	K150-350
Discharge Diameter	100	100	100	150	150
Inlet Diameter	168	100	185	125	150
Impeller Type	Non Clog	Non Clog	Non Clog	Non Clog	Non Clog
Impeller Fixing	Taper/Lockn ut	Taper/Lockn ut	Taper/Lockn ut	Taper/Lockn ut	Taper/Locknut
Range to fit pump	355 - 340	370 - 270	406 - 346	330 - 250	344 - 265
W/ring Diametrical Clearance	0.81-0.71	0.81-0.71	0.81 -0.71	0.81-0.71	0.81-0.71
W/ring Fixing	Pressed	Pressed	Pressed	Pressed	Pressed
Min Submergence - TLC	440	450	440	550	550
Weight - Pump Only	135	131	155	170	198

FORRERS PUMP DETAILS

Model (Old Model No)	6D405/3	6D430/4	6D480/3	8D360/4	8D405/4
Model (new Model No)	K150-405	K150-430	K150-480	K200-360	K200-405
Discharge Diameter	150	150	150	200	200
Inlet Diameter	170	168	157	185	212
Impeller Type	Non Clog	Non Clog	Non Clog	Non Clog	Non Clog
Impeller Fixing	Taper/Lockn ut	Taper/Lockn ut	Taper/Lockn ut	Taper/Lockn ut	Taper/Lockn ut
Range to fit pump	406 - 345	440 - 342	485 - 435	364 - 272	406 - 350
W/ring Diametrical Clearance	0.81-0.71	0.81-0.71	0.71-0.71	0.89-0.64	0.79-0.64
W/ring Fixing	Pressed	Pressed	Pressed	Pressed	Pressed
Weight - Pump Only	190	218	340	310	320

12.7 MOTOR TECHNICAL DATA SHEETS

MOTOR TECHNICAL DATA
(COMMON CONSTRUCTION DETAIL)

Frame Size	300
Enclosure	IP68
Insulation Class	F
Mechanical Seal Size	63
Seal Face Material	EXTERNAL SIC/SIC INTERNAL SIC/C
Seal Style	TANDEM FIGURE 3
NDE Bearing	NU209 EC-C3
Size	Dia. 45
D.E. Bearing	3313 C3
Size	Dia. 65
Bearing Lubrication	Sealed/ Grease
Weight	315

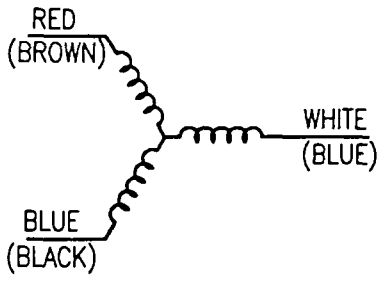
Note: Bearing Types - Examples 6302 VV-C3 indicates ball bearing
NU204EC-C3 indicates roller bearing
7315BECB-C3 indicates to matched angular contact ball bearings

12.8 WIRING DIAGRAM

MOTOR CONNECTION FOR SUBMERSIBLE MOTORS (FORRERS)

POWER CABLE - OLEX

1



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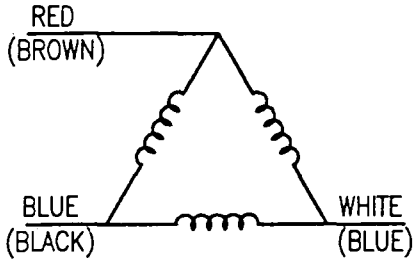

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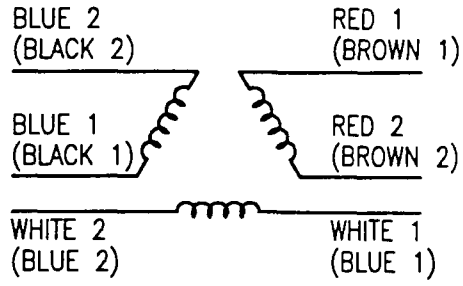

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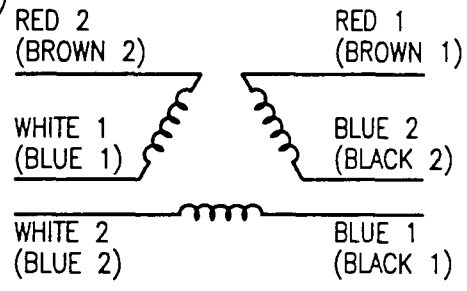


CONTROL CABLES

5 TWO BLACKS IN MAIN CABLE
WINDING THERMISTORS

6 TWO BLACKS IN MAIN CABLE
WATER SENSOR

7 TWO BLACKS IN MAIN CABLE 1
WINDING THERMISTORS

8 TWO BLACKS IN MAIN CABLE 2
WATER SENSOR

9 SEPARATE CABLE
RED & BLUE – WINDING THERMISTORS
(BROWN & BLUE)
GREEN & WHITE – WATER SENSOR
(GREEN & BLACK)

10 SEPARATE CABLE
RED & BLACK – WATER SENSOR
(BROWN & BLUE)

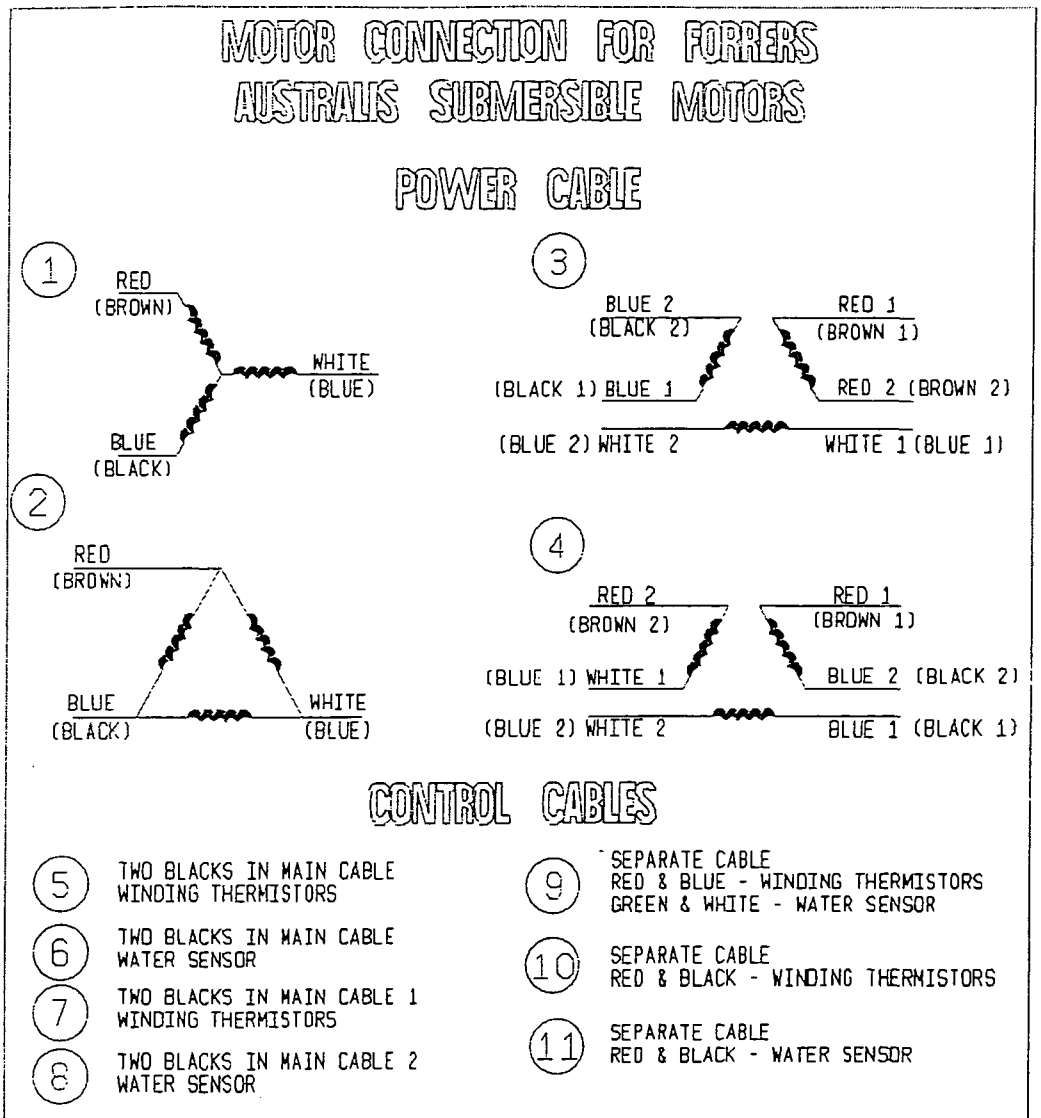
11 SEPARATE CABLE
RED & BLACK – WINDING THERMISTORS
(BROWN & BLUE)

FOR CORRECT ROTATION, DE, LOOKING INTO EYE OF IMPELLER
CONNECT R.W.B. TO R.W.B. OF A SUPPLY WITH A
TIME SEQUENCE R.W.B.

	STANDARD MOTOR CONNECTION			STAR/DELTA MOTOR CONNECTION		
RATING	STANDARD THERMS	STANDARD THERMS & SENSOR	STANDARD SENSOR	STAR/DELTA THERMS	STAR/DELTA THERMS & SENSOR	STAR/DELTA THERMS
3kW TO 75kW	2, 11	2, 9	2, 10	3, 11	3, 9	3, 10
ABOVE 90kW	4, 11	4, 9	4, 10	3, 11	3, 9	3, 10

Master_Cable_Diagram_Ole

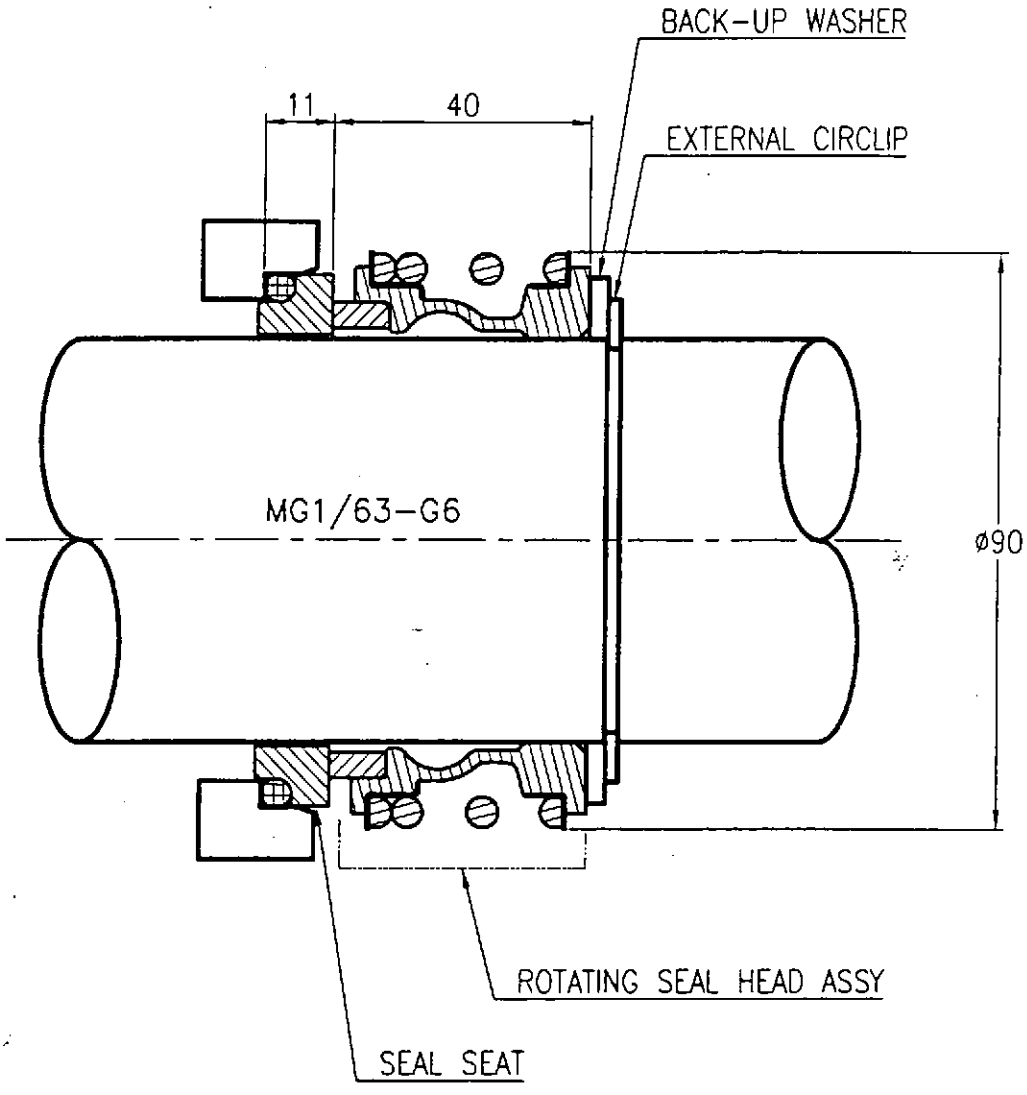
12.9 MECHANICAL SEAL DATA



	STANDARD MOTOR CONECTION			STAR/DELTA MOTOR CONNECTION		
RATING	STANDARD THERMS	STANDAR THERMS & SENSOR	STANDARD SENSOR	STAR/DELTA THERMS	STAR/DELTA THERMS & SENSOR	STAR/DELTA SENSOR
BELOW 3kW	1,5	1,5,11	1,6	N/A	N/A	N/A
3kW TO 45kW	2,5	2,5,11	2,6	3,7	3,7,8	3,8
55kW TO 120kW	4,7	4,7,8	4,8	3,7	3,7,8	3,8
ABOVE 120kW	4,10	4,9	4,11	3,10	3,9	3,11

MECHANICAL SEAL

BURGMANN – MG1



NOTES:
1. USE NORMAL OR SOAPY WATER TO MOUNT ELASTOMER BELLOW SEALS ONTO SHAFT.
2. NEVER USE OIL OR GREASE.
3. CHECK THAT THE RINGS, SPRINGS AND SEAL FACE SIT CORRECTLY.

MG1_63_G6_Manual

KSB Ajax Pumps Pty. Ltd. Submersible Electric Pump Test Data

Customer: *J&P RICHARDSON*
Project: *BRISBANE C.C METROFLEX ON GATEWAY*
Unit Serial No.: *F51274-1*

Measuring Instruments:

Flow:	Magna Flow Meter
Discharge Head:	0-160 PRESSUREGAUGE
Power:	kWH Meters

PUMP

Make:	PORRERS	
Type:	Submersible	
Model:	E100-380 TLC	
Impeller Dia.:	352	mm
Suction Pipe Dia.:	100000	mm
Discharge Pipe Dia.:	100	mm
Gauge Hight Cor.:	0	m

DUTY

Flow:	58	l / s
Head:	32	M
Speed:	1470	rpm
Power:	40	kW
Efficiency Pump:	64	
Motor Efficiency:	92	
kWh / kl:	0.1486	

MOTOR

Make:	Porrer	
Frame:	300	
Speed:	1470	rpm
Supply:	415 / 3 ph	/ 50 Hz
Type:	Submersible	
Serial No.:	F51274-1	
Power:	40.0	kW
Amps:	67.0	A

Barometric Pressure:	XX mbar
Water Temperature:	XX °C
Meter Constant in Revs/KWH:	266.6
No. of Revs:	10
Current Transformer Meters:	N

Works Test AS 2417 Part 2 - 1980			
Quoted	With Toler.	As Tested	
0.1486	0.1556	0.1381	KWH/KL
64.00	60.80	70.50	EFF.
58.00	$\left[\frac{H_G \times X_H}{\Delta H}\right]^2 \cdot \left[\frac{Q_Q \times X_Q}{\delta Q}\right]^2$	59.50	L/S
32.00		32.90	MHD
	2.10	1.00	ΔH
		6.00	ΔQ

Point No	Flow l/s	Suction Head m	Delivery Head m	Correction Head m	KWH Meter W1	W2	W3	Amps A	Power In (Motor) kW	Motor Effy	DVH m	Speed rpm	Flow l / s	Total Head m	Power In (pump) kW	Pump Effy	O/All Effy	Energy per Vol kWh/kl
1	0.00	XX	45.30	XX						92	0.00	1470	0.00	45.30			0.00	0.0000
2	18.60	XX	40.90	XX	19.44	20.91	20.31	37 / 34 / 36	20.03	92	0.29	1470	18.60	41.19	18.43	40.75	37.49	0.2988
3	30.60	XX	37.30	XX	17.60	18.84	18.28	40 / 37 / 38	22.21	92	0.77	1470	30.60	38.07	20.43	55.90	51.43	0.2014
4	41.50	XX	34.20	XX	16.00	16.97	16.53	44 / 40 / 42	24.55	92	1.42	1470	41.50	35.62	22.59	64.17	59.04	0.1641
5	54.30	XX	31.30	XX	13.97	14.90	14.47	50 / 45 / 47	28.04	92	2.44	1470	54.30	33.74	25.80	69.62	64.05	0.1433
6	59.50	XX	30.00	XX	13.25	14.09	13.72	52 / 46 / 48	29.60	92	2.93	1470	59.50	32.93	27.23	70.54	64.90	0.1380
7	64.60	XX	28.30	XX	12.78	13.32	13.10	54 / 48 / 51	31.00	92	3.45	1470	64.60	31.75	28.52	70.50	64.86	0.1331
8	75.90	XX	24.20	XX	11:50	12.10	12.03	59 / 53 / 55	34.11	92	4.76	1470	75.90	28.96	31.38	68.68	63.19	0.1247
9	87.50	XX	19.40	XX	10.25	10.68	10.59	66 / 60 / 62	38.56	92	6.33	1470	87.50	25.73	35.47	62.23	57.25	0.1223

Reliability Test (Yes/No) -: XX **(If Yes) Hours:** XX

Test Officer: DAN MACKINNON X **Signed:** **Date:** 17/11/98 **Comments:**
Witnessed by: **Signed:**

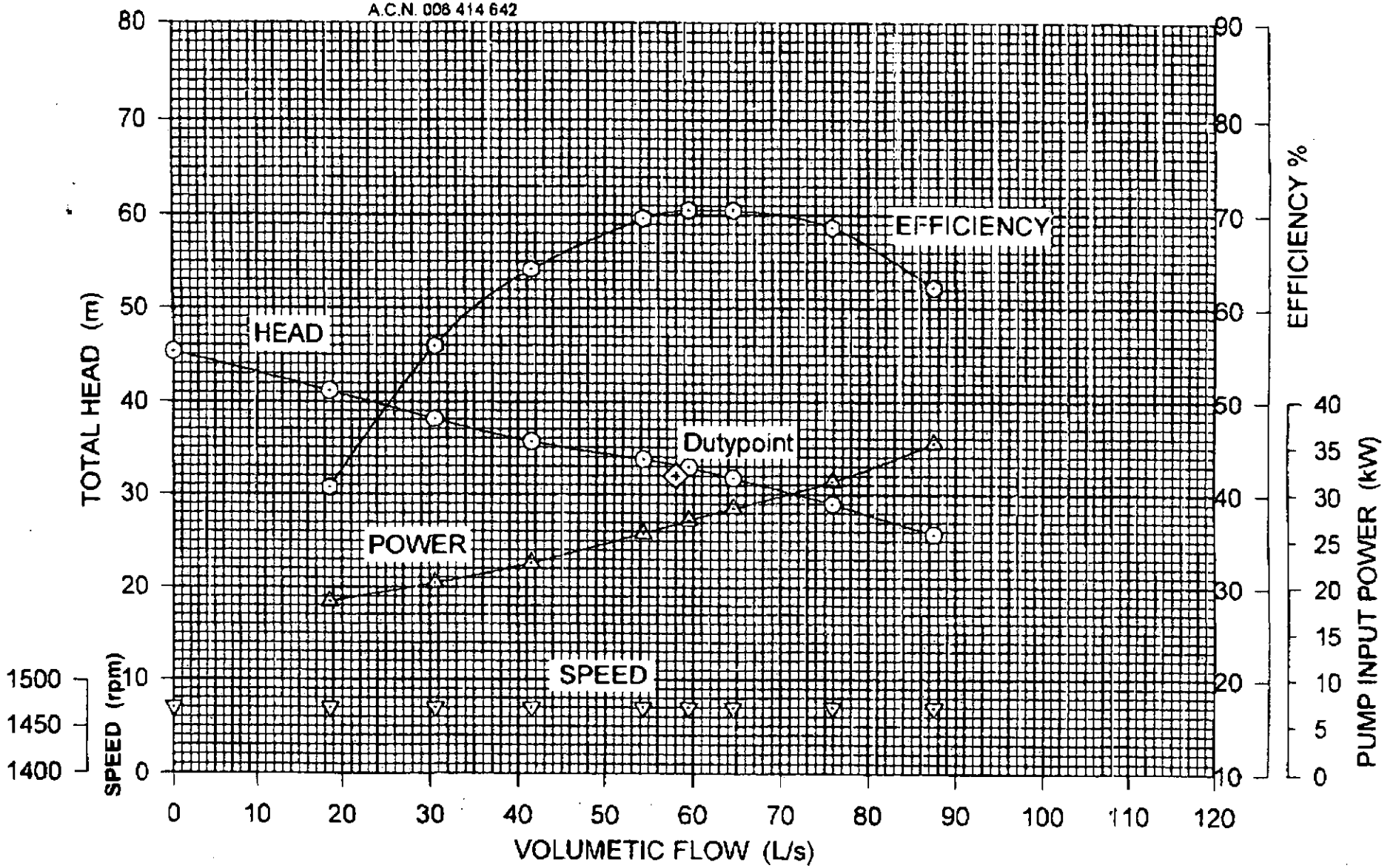
DATE - 12/09/97

PAGE - 1 OF 1

KSB AJAX PUMPS PTY LTD

A.C.N. 008 414 642

ELECTRIC PUMP PERFORMANCE CURVE



CLIENT AND REFERENCE	SERIAL No.	IMPELLER DIAMETER	NOMINAL SPEED	KSB AJAX	CURVE No. F51274-1	
J&P RICHARDSON BRISBANE C.C METROFLEX ON GATEWAY	F51274-1	352MM	1470 RPM	E100-380 TLC	DATE 17-11-98	ISSUE 1

KSB Ajax Pumps Pty. Ltd. Submersible Electric Pump Test Data

Customer: *J&P RICHARDSON*
Project: *BRISBANE C.C METROFLEX OF GATEWAY*
Unit Serial No.: *F51274-2*

Measuring Instruments:

Flow: Magna Flow Meter
Discharge Head: 0-160 PRESSURE GAUGE
Power: kWH Meters

PUMP

Make:	FORRERS	
Type:	Submersible	
Model:	E100-380 TLC	
Impeller Dia.:	352	mm
Suction Pipe Dia.:	100000	mm
Discharge Pipe Dia.:	100	mm
Gauge Hight Cor.:	0	m

DUTY

Flow:	58	l / s
Head:	32	M
Speed:	1470	rpm
Power:	40	kW
Efficiency Pump:	64	
Motor Efficiency:	92	
kWh / kl:	0.1486	

MOTOR

Make:	Forrer	
Frame:	300	
Speed:	1470	rpm
Supply:	415	/ 3 ph / 50 Hz
Type:	Submersible	
Serial No.:	F51274-2	
Power:	40.0	kW
Amps:	67.0	A

Barometric Pressure: XX mbar
Water Temperature: XX °C
Meter Constant in Revs/KWH: 266.6
No. of Revs: 10
Current Transformer Meters: N

Works Test AS 2417 Part 2 - 1980			
Quoted	**With Toler.**	**As Tested**	
0.1486	0.1556	0.1373	KWH/KL
64.00	60.80	70.60	EFF.
58.00	$\left\lvert\frac{H_Q \times \Delta H}{\Delta H}\right\rvert^3 \cdot \left\lvert\frac{Q_Q \times \Delta Q}{\Delta Q}\right\rvert^2$	60.10	L/S
32.00		32.77	MHD
	1.43	1.30	ΔH
		6.00	ΔQ

Point No	Flow l/s	Suction Head m	Delivery Head m	Correction Head m	KWH Meter W1	KWH Meter W2	KWH Meter W3	Amps A	Power In (Motor) kW	Motor Effy	DVH m	Speed rpm	Flow l / s	Total Head m	Power In (pump) kW	Pump Effy	O/All Effy	Energy per Vol kWh/kl
1	0.00	XX	45.50	XX						92	0.00	1470	0.00	45.50			0.00	0.0000
2	18.90	XX	41.10	XX	17.50	18.82	18.40	40 / 37 / 38	22.21	92	0.30	1470	18.90	41.40	20.43	37.54	34.54	0.3260
3	30.20	XX	37.50	XX	17.16	18.38	18.00	42 / 38 / 39	22.70	92	0.75	1470	30.20	38.25	20.88	54.24	49.90	0.2085
4	42.40	XX	34.20	XX	16.00	17.12	16.72	44 / 40 / 41	24.38	92	1.49	1470	42.40	35.69	22.43	66.13	60.84	0.1596
5	55.30	XX	31.20	XX	13.50	14.72	14.18	51 / 46 / 47	28.66	92	2.53	1470	55.30	33.73	26.37	69.35	63.80	0.1438
6	60.10	XX	29.80	XX	13.22	13.97	13.72	52 / 47 / 49	29.71	92	2.99	1470	60.10	32.79	27.33	70.69	65.03	0.1371
7	65.50	XX	28.30	XX	12.56	13.50	13.09	54 / 49 / 51	31.04	92	3.55	1470	65.50	31.85	28.56	71.61	65.88	0.1315
8	76.60	XX	23.70	XX	11.50	12.03	11.75	59 / 53 / 56	34.45	92	4.85	1470	76.60	28.55	31.69	67.66	62.25	0.1248
9	87.50	XX	19.00	XX	10.34	11.15	10.78	65 / 58 / 61	37.66	92	6.33	1470	87.50	25.33	34.65	62.72	57.70	0.1194

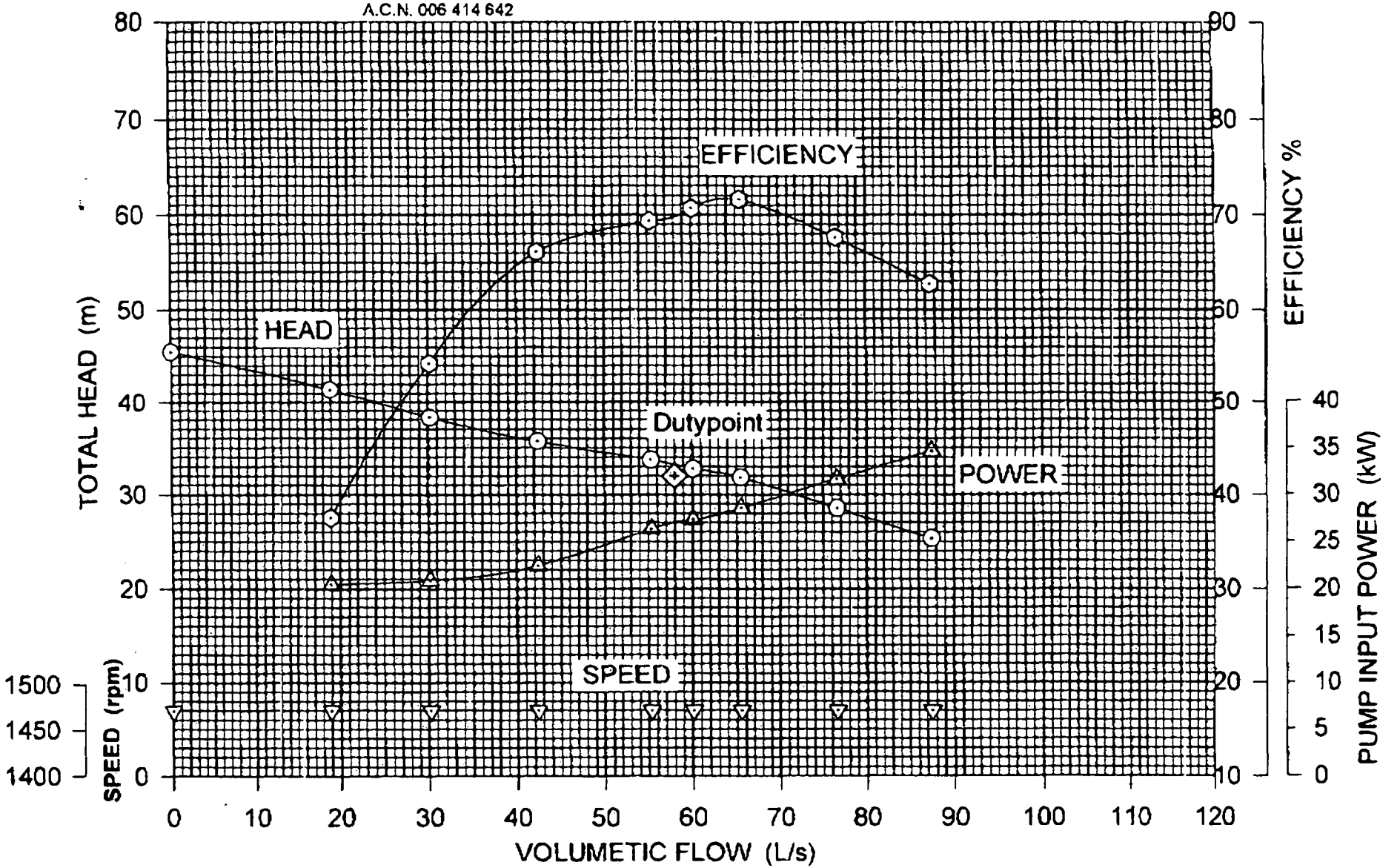
Reliability Test (Yes/No) -: XX **(If Yes) Hours:** XX

Test Officer: W.P. O' DOHERTY 1 **Signed:** **Date:** 17/11/98 **Comments:**
Witnessed by: **Signed:**

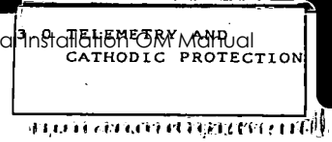
KSB AJAX PUMPS PTY LTD

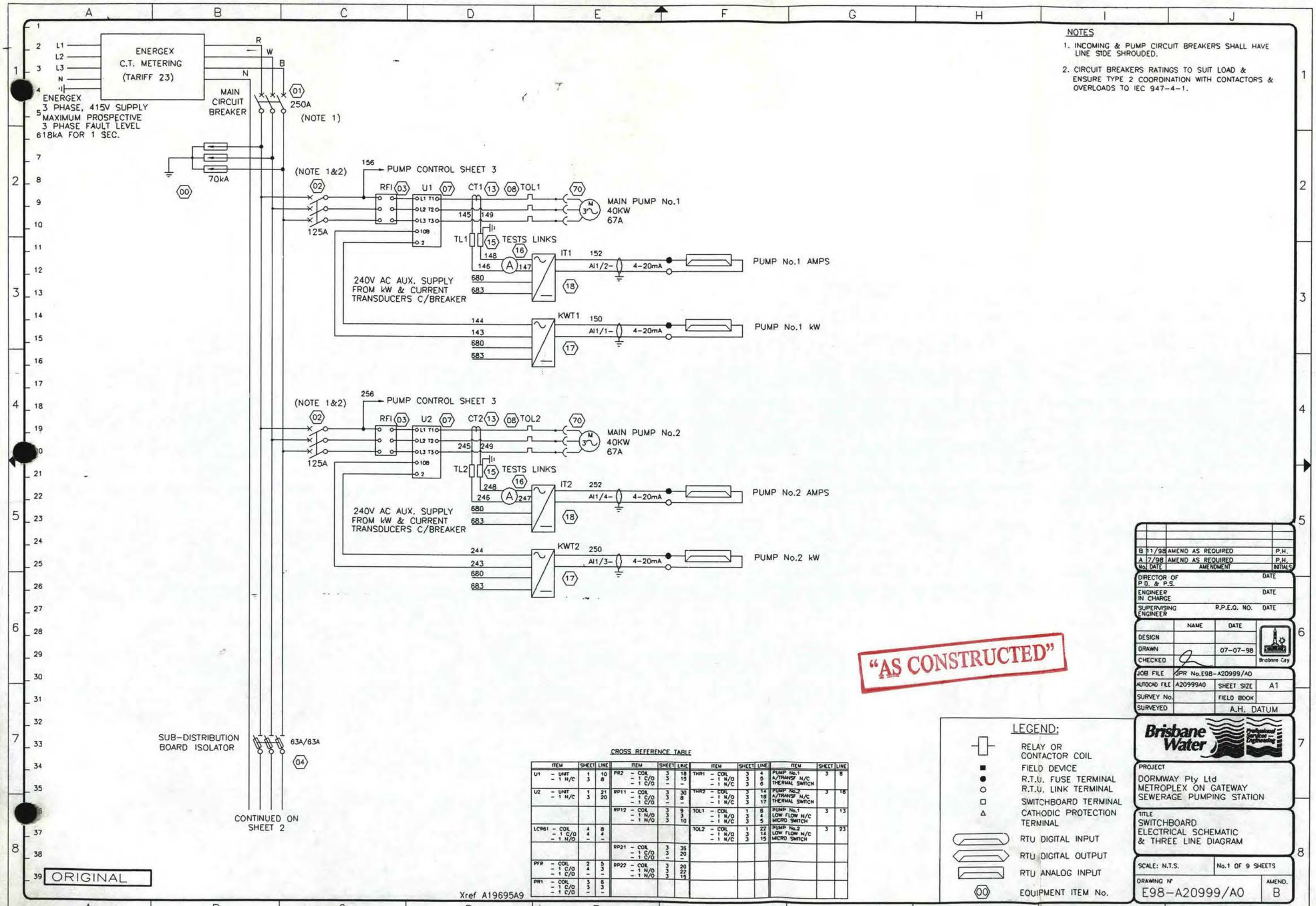
A.C.N. 006 414 642

ELECTRIC PUMP PERFORMANCE CURVE



CLIENT AND REFERENCE	SERIAL No.	IMPELLER DIAMETER	NOMINAL SPEED	KSB AJAX	CURVE No. F51274-2	
J&P RICHARDSON BRISBANE C.C METROFLEX ON GATEWAY	F51274-2	352MM	1470 RPM	E100 - 380 TLC	DATE 17-11-98	ISSUE 1


3 TELEMETRY AND
CATHODIC PROTECTION



NOTES

1. INCOMING & PUMP CIRCUIT BREAKERS SHALL HAVE LINE SIDE SHROUDED.
2. CIRCUIT BREAKERS RATINGS TO SUIT LOAD & ENSURE TYPE 2 COORDINATION WITH CONTACTORS & OVERLOADS TO IEC 947-4-1.

CROSS REFERENCE TABLE

ITEM	SHEET	LINE	ITEM	SHEET	LINE	ITEM	SHEET	LINE	ITEM	SHEET	LINE
U1 - UNIT	1	10	PR2 - COIL	3	18	THR1 - COIL	3	4	PUMP No.1 A/TRANSF N/C	3	8
- 1 N/C	3	8	- 1 C/O	3	19	- 1 N/O	3	5	THERMAL SWITCH		
			- 1 C/O	-	-	- 1 N/C	3	6			
U2 - UNIT	1	21	PR11 - COIL	3	30	THR2 - COIL	3	14	PUMP No.2 A/TRANSF N/C	3	18
- 1 N/C	3	20	- 1 C/O	3	8	- 1 N/O	3	18	THERMAL SWITCH		
			- 1 C/O	-	-	- 1 N/C	3	17			
			PR12 - COIL	3	9	TOL1 - COIL	1	8	PUMP No.1	3	13
			- 1 N/O	3	3	- 1 N/O	3	4	LOW FLOW N/C		
			- 1 N/O	3	10	- 1 N/C	3	5	MICRO SWITCH		
LCP61 - COIL	4	8				TOL2 - COIL	1	22	PUMP No.2	3	23
- 1 C/O	4	4				- 1 N/O	3	14	LOW FLOW N/C		
- 1 N/O	-	-				- 1 N/C	3	15	MICRO SWITCH		
			RP21 - COIL	3	35						
			- 1 C/O	3	20						
			- 1 C/O	-	-						
PFR - COIL	2	5	RP22 - COIL	3	20						
- 1 C/O	4	3	- 1 N/O	3	22						
- 1 C/O	-	-	- 1 N/O	3	15						
PR1 - COIL	3	6									
- 1 C/O	3	3									
- 1 C/O	-	-									

"AS CONSTRUCTED"

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- 00 EQUIPMENT ITEM No.

No.	DATE	AMENDMENT	INITIALS
B	11/98	AMEND AS REQUIRED	P.H.
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S.		DATE
ENGINEER IN CHARGE		DATE
SUPERVISING ENGINEER	R.P.E.Q. NO.	DATE

	NAME	DATE
DESIGN		
DRAWN		07-07-98
CHECKED		

Brisbane City

JOB FILE	SPR No.E98-A20999/A0		
AUTOCAD FILE	A20999A0	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

TITLE
SWITCHBOARD
ELECTRICAL SCHEMATIC
& THREE LINE DIAGRAM

SCALE: N.T.S. | No.1 OF 9 SHEETS

DRAWING N° E98-A20999/A0 | AMEND. B

CONTINUED FROM —SHEET 1

N R W B

(20) 6A 670 671 672 — PFR (19) POWER FAILURE RELAY (N1) — SURCHARGE IMMINENT ELECTRODE RELAY

(21) 20A 673 674 675 — (61) 3 PHASE 20 AMP OUTLET

(62) N2 — GPO (N2)

(22) 16A 676

(24) 16A N3 677 — RTU LAPTOP G.P.O. (10A) (N3)

(25) 6A N4 678 — SWITCHBOARD FLUORESCENT (DOOR SWITCHED) (N4)

(26) 6A N5 679 — CATHODIC PROTECTION UNIT (N5) (NOTE 1)

(28) 6A 680 / 683 — kW & CURRENT TRANSDUCERS AUX. SUPPLY (N6)

(29) 6A N7 681 — (57) SRF — (27) 683 / 682 6A — 683 / 684 — RTU POWER SUPPLY

(30) 6A 683 685 — (58) 240/24VDC — 686 — (23) 6A 687 (−) 688 (+) — PLC I/O SUPPLY

(31) 6A N8 689 — SPARE (N8)

(31) 6A N9 690 — SPARE (N9)

(31) 6A N10 691 — SPARE (N10)

(31) 6A N11 692 — SPARE (N11)

(31) 6A N12 693 — SPARE (N12)

(31) 6A N13 694 — SPARE (N13)

NOTES

1. CATHODIC PROTECTION – FUTURE. THIS UNIT TO BE SUPPLIED BY OTHERS. A 240VAC CABLE TO BE INSTALLED TO PROPOSED CATHODIC PROTECTION AREA TERMINAL STRIP FOR CONNECTION BY OTHERS

CROSS REFERENCE TABLE

ITEM	SHEET	LINE
U1 – UNIT – 1 N/C	1 3	10 8
U2 – UNIT – 1 N/C	1 3	21 20
LCR81 – COIL – 1 C/O – 1 N/O	4 4 –	8 4 –
PFR – COIL – 1 C/O – 1 C/O	2 4 –	5 3 –
PR1 – COIL – 1 C/O – 1 C/O	3 3 –	6 3 –
PR2 – COIL – 1 C/O – 1 C/O	3 3 –	18 15 –
RP11 – COIL – 1 C/O – 1 C/O	3 3 –	30 6 –
RP12 – COIL – 1 N/O – 1 N/O	3 3 3	9 5 10
RP21 – COIL – 1 C/O – 1 C/O	3 3 –	35 20 –
RP22 – COIL – 1 N/O – 1 N/O	3 3 3	20 22 15
THR1 – COIL – 1 N/O – 1 N/C	3 3 3	4 5 6
THR2 – COIL – 1 N/O – 1 N/C	3 3 3	14 16 17
TOL1 – COIL – 1 N/O – 1 N/C	1 3 3	8 4 5
TOL2 – COIL – 1 N/O – 1 N/C	1 3 3	22 14 15
PUMP No.1 A/TRANSF N/C THERMAL SWITCH	3	8
PUMP No.2 A/TRANSF N/C THERMAL SWITCH	3	18
PUMP No.1 LOW FLOW N/C MICRO SWITCH	3	13
PUMP No.2 LOW FLOW N/C MICRO SWITCH	3	23

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- (00) EQUIPMENT ITEM No.

"AS CONSTRUCTED"

No.	DATE	AMENDMENT	INITIALS
B	11/98	AMEND AS REQUIRED	P.H.
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S. — DATE

ENGINEER IN CHARGE — DATE

SUPERVISING ENGINEER — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN		
DRAWN		08-07-98
CHECKED		

Brisbane City

JOB FILE	JPR No.E98-A20999/A1		
AUTOCAD FILE	A20999A1	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water — Professional Services Engineering

PROJECT: DORMWAY Pty Ltd METROPLEX ON GATEWAY SEWERAGE PUMPING STATION

TITLE: SWITCHBOARD ELECTRICAL SCHEMATIC & THREE LINE DIAGRAM

SCALE: N.T.S. — No.2 OF 9 SHEETS

DRAWING N° E98-A20999/A1 — AMEND. B

ORIGINAL

ELV CONTROL

(NOTE 1)

	RTU INPUTS	
PR1-1	I1/00	PUMP No.1 POWER ON
TOL1-2	I1/01	THERMAL OVERLOAD
47	I1/02	START
48	I1/03	EMERGENCY STOP
THR1-2	I1/04	THERMISTOR
1U1-1 (07) 17 18	I1/09	DRIVE FAULT
49	I1/05	LOCAL RESET
PR12-1 (43)	I1/07	VFD RUN CONTACT
PR2-1	I2/00	PUMP No.2 POWER ON
TOL2-2	I2/01	THERMAL OVERLOAD
47	I2/02	START
48	I2/03	EMERGENCY STOP
THR2-2	I2/04	THERMISTOR
2U1 (07) 17 18	I2/09	DRIVE FAULT
49	I2/05	LOCAL RESET
PR22-1 (43)	I2/07	VFD RUN CONTACT

24V DC + 24V DC -

RTU OUTPUTS

01/00 R (46)	PUMP No.1 PUMP STATUS
01/01 RP11 (42)	RUN RELAY
01/04 R (46)	PUMP No.2 PUMP STATUS
01/05 RP21 (42)	RUN RELAY

240V AC CONTROL

240V AC FROM PUMP CONTROL CIRCUIT (SHT.1) (NOTE 3)

156 (37) 6A 240V AC 125 RP12-2 126 (38) h N14

THR1 (39)
125
135
MOTOR THERMISTOR 136
THR1-1 127 TOL1-1 128 129
PR1 (41)

RP11-1
U1
1
2
12A (07)
RP12 (43)
14
+24VDC
-24VDC 2
DRIVE FAULT 17
SHEET 3/8 18

125 TOL1 (08)
RP21
(99)

240V AC FROM PUMP CONTROL CIRCUIT (SHT.1) (NOTE 3)

256 (37) 6A 240V AC 225 RP22-2 226 (38) h N15

THR2 (39)
225
235
MOTOR THERMISTOR 236
THR2-1 227 TOL2-1 228 229
PR2 (41)

RP21-1
U2
1
2
12A (07)
RP22 (43)
14
+24VDC
-24VDC 2
DRIVE FAULT 17
SHEET 3/20 18

225 TOL2 (08)
RP11
(99)

MAIN PUMP No.1 HOURS RUN	
THERMISTOR RELAY (AUTO RESET)	
CONTROL CIRCUIT POWER ON	
INVERTER RUN SIGNAL	
INVERTER RUNING SIGNAL	
INVERTER FAULT SIGNAL	
OVERLOAD AUX. SUPPLY VFD CUBICLE FAN	
MAIN PUMP No.2 HOURS RUN	
THERMISTOR RELAY (AUTO RESET)	
CONTROL CIRCUIT POWER ON	
INVERTER RUN SIGNAL	
INVERTER RUNING SIGNAL	
INVERTER FAULT SIGNAL	
OVERLOAD AUX. SUPPLY VFD CUBICLE FAN	

NOTES

1. 24V DC INPUT / OUTPUT INDIVIDUAL PROTECTION FUSES NOT SHOWN. (i.e. PART OF INTERFACE TERMINAL STRIP)
2. ALL WIRES & CABLE CORES TO BE FERRULED WITH GRAFOPLAST COMPATIBLE LABELLING.
   THE FOLLOWING PREFIXES SHALL BE USED:
   MAIN PUMP No. 1 = 1
   MAIN PUMP No. 2 = 2
   COMMON WIRING = 6 (i.e. FLOW, LEVEL, PRESSURE)
3. PUMP CONTROL CIRCUIT BREAKERS RATED AT 9KA FOR 1 SEC.

ORIGINAL

"AS CONSTRUCTED"

CROSS REFERENCE TABLE

ITEM	SHEET	LINE	ITEM	SHEET	LINE	ITEM	SHEET	LINE	ITEM	SHEET	LINE
U1 - UNIT	1	10	PR2 - COIL	3	18	THR1 - COIL	3	4	PUMP No.1 A/TRANSF N/C	3	8
- 1 N/C	3	8	- 1 C/O	3	15	- 1 N/O	3	5	THERMAL SWITCH		
			- 1 C/O	-	-	- 1 N/C	3	6			
U2 - UNIT	1	21	PR11 - COIL	3	30	THR2 - COIL	3	14	PUMP No.2 A/TRANSF N/C	3	18
- 1 N/C	3	20	- 1 C/O	3	8	- 1 N/O	3	16	THERMAL SWITCH		
			- 1 C/O	-	-	- 1 N/C	3	17			
			RP12 - COIL	3	9	TOL1 - COIL	1	8	PUMP No.1 LOW FLOW N/C	3	13
			- 1 N/O	3	3	- 1 N/O	3	4	MICRO SWITCH		
			- 1 N/O	3	10	- 1 N/C	3	5			
LORS1 - COIL	4	8				TOL2 - COIL	1	22	PUMP No.2 LOW FLOW N/C	3	23
- 1 C/O	4	4				- 1 N/O	3	14	MICRO SWITCH		
- 1 N/O	-	-				- 1 N/C	3	15			
			RP21 - COIL	3	35						
			- 1 C/O	3	20						
			- 1 C/O	-	-						
PFR - COIL	2	5	RP22 - COIL	3	20						
- 1 C/O	4	3	- 1 N/O	3	22						
- 1 C/O	-	-	- 1 N/O	3	15						
PR1 - COIL	3	6									
- 1 C/O	3	3									
- 1 C/O	-	-									

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- (00) EQUIPMENT ITEM No.

No	DATE	AMENDMENT	INITIALS
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S. — DATE

ENGINEER IN CHARGE — DATE

SUPERVISING ENGINEER — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN		
DRAWN		08-07-98
CHECKED		

Brisbane City

JOB FILE	JPR No.E98-A20999/A2		
AUTOCAD FILE	A20999A2	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water — Professional Services Engineering

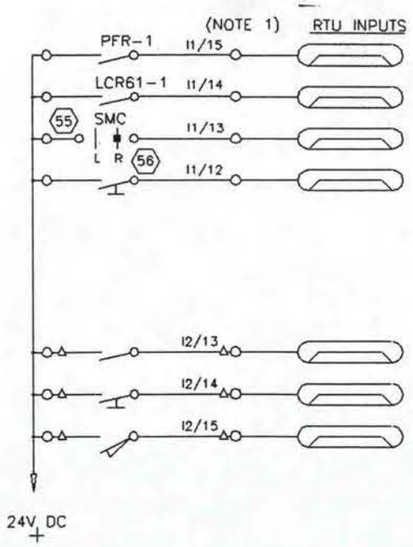
PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

TITLE
SWITCHBOARD
ELECTRICAL SCHEMATIC

SCALE: N.T.S. — No.3 OF 9 SHEETS

DRAWING N° E98-A20999/A2 — AMEND. A

ELV CONTROL



COMMON CONTROL
SITE POWER ON

SURCHARGE IMMINENT ALARM

LOCAL REMOTE

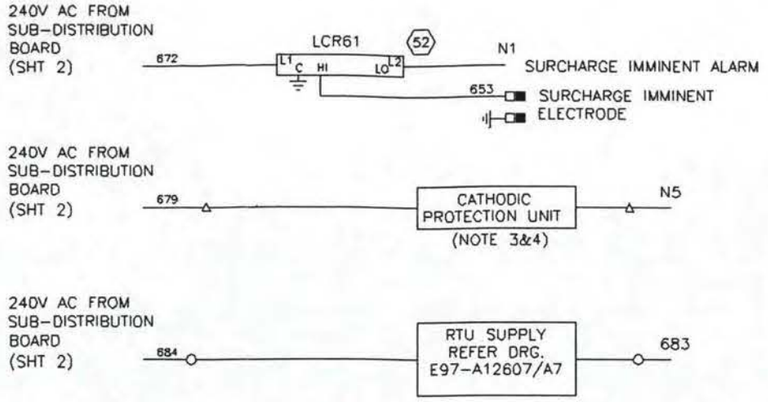
SITE ATTENTION ALARM
RESET PUSHBUTTON

CATHODIC PROTECTION
CONTROL CIRCUIT ENERGISED

RESET PUSHBUTTON

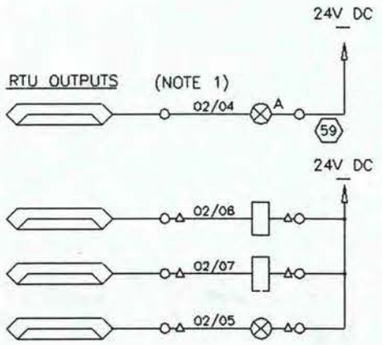
DOOR SWITCH
(NOT USED)

240V AC CONTROL

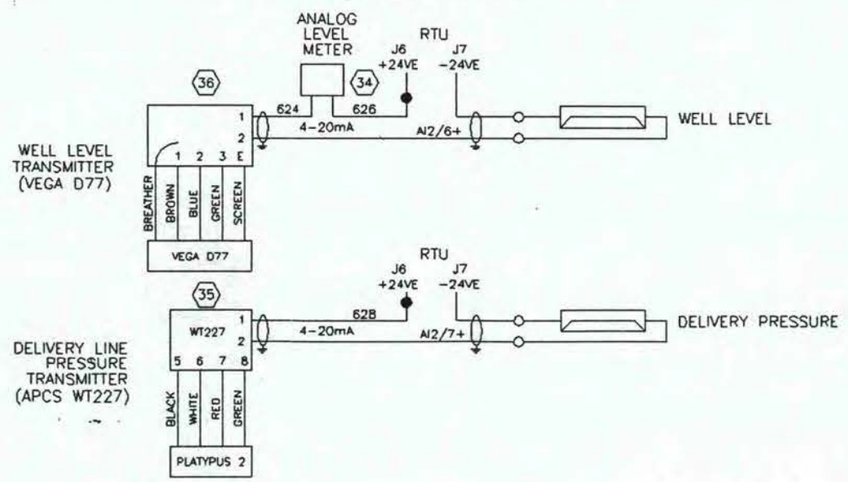


NOTES

1. 24V DC INPUT / OUTPUT INDIVIDUAL PROTECTION FUSES NOT SHOWN. (i.e. PART OF INTERFACE TERMINAL STRIP)
2. ALL WIRES & CABLE CORES TO BE FERRULED WITH GRAFOPLAST COMPATIBLE LABELLING.
   THE FOLLOWING PREFIXES SHALL BE USED:
   MAIN PUMP No. 1 = 1
   MAIN PUMP No. 2 = 2
   COMMON WIRING = 6 (i.e. FLOW, LEVEL, PRESSURE)
3. CATHODIC PROTECTION – FUTURE
   THIS UNIT IS TO BE SUPPLIED BY OTHERS.
   RTU I/O CABLING TO BE INSTALLED TO PROPOSED CATHODIC PROTECTION TERMINAL STRIP FOR CONNECTION BY OTHERS.
4. ITEMS SHOWN AS DOTTED ARE FOR FUTURE ONLY.
5. TRANSIENT PROTECTION INTEGRAL TO RTU DIGITAL AND ANALOGUE I/O CIRCUITRY.

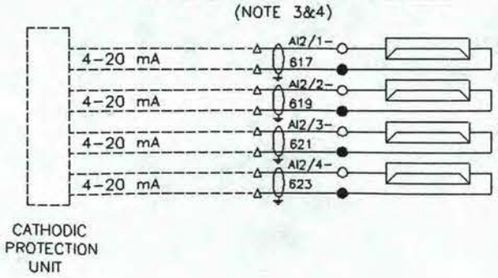


RTU ANALOG INPUTS FOR INSTRUMENTS



RTU ANALOG INPUTS FOR CATHODIC PROTECTION

(NOTE 3&4)



ORIGINAL

"AS CONSTRUCTED"

CROSS REFERENCE TABLE

ITEM	SHEET	LINE
C11 – COIL	3	7
– 3 N/O	1	5
– 1 N/O	3	10
C12 – COIL	3	8
– 3 N/O	1	4
– 1 N/O	3	11
– 1 N/C	3	9
C13 – COIL	3	9
– 3 N/O	1	8
– 1 N/O	3	12
– 1 N/C	3	8
– 1 N/O	3	3
C21 – COIL	3	17
– 3 N/O	1	19
– 1 N/O	3	20
C22 – COIL	3	18
– 3 N/O	1	18
– 1 N/O	3	21
– 1 N/C	3	19
C23 – COIL	3	19
– 3 N/O	1	22
C23 – 1 N/O (CONT)	3	22
– 1 N/C	3	18
– 1 N/O	3	13
LCR61 – COIL	4	8
– 1 C/O	4	4
– 1 N/O	–	–
PFR – COIL	2	5
– 1 C/O	4	3
– 1 C/O	–	–
PR1 – COIL	3	3
– 1 C/O	3	3
– 1 C/O	–	–
PR2 – COIL	3	20
– 1 C/O	3	13
– 1 C/O	–	–
RP11 – COIL	3	30
– 1 C/O	3	7
– 1 C/O	–	–
RP12 – COIL	3	31
– 1 C/O	3	8
– 1 C/O	–	–
RP13 – COIL	3	32
– 1 C/O	3	14
– 1 C/O	–	–
RP21 – COIL	3	35
– 1 C/O	3	17
– 1 C/O	–	–
RP22 – COIL	3	36
– 1 C/O	3	18
– 1 C/O	–	–
RP23 – COIL	3	37
– 1 C/O	3	19
– 1 C/O	–	–
THP1 – COIL	3	4
– 1 N/O	3	5
– 1 N/C	3	6
THP2 – COIL	3	15
– 1 N/O	3	16
– 1 N/C	3	17
TOL1 – COIL	1	8
– 1 N/O	3	4
– 1 N/C	3	5
TOL2 – COIL	1	22
– 1 N/O	3	14
– 1 N/C	3	15
TOL5 – COIL	1	30
– 1 N/O	–	–
– 1 N/C	4	2
PUMP No.1 A/TRANSF N/C THERMAL SWITCH	3	6
PUMP No.2 A/TRANSF N/C THERMAL SWITCH	3	18
PUMP No.1 LOW FLOW N/C MICRO SWITCH	3	13
PUMP No.2 LOW FLOW N/C MICRO SWITCH	3	23

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- 00 EQUIPMENT ITEM No.

No.	DATE	AMENDMENT	INITIALS
B	9/98	AMEND AS REQUIRED	P.H.
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — DATE
SUPERVISING ENGINEER — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN		
DRAWN		08-07-98
CHECKED		

Brisbane City

JOB FILE	JPR No.E98-A20999/A3		
AUTOCAD FILE	A20999A3	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

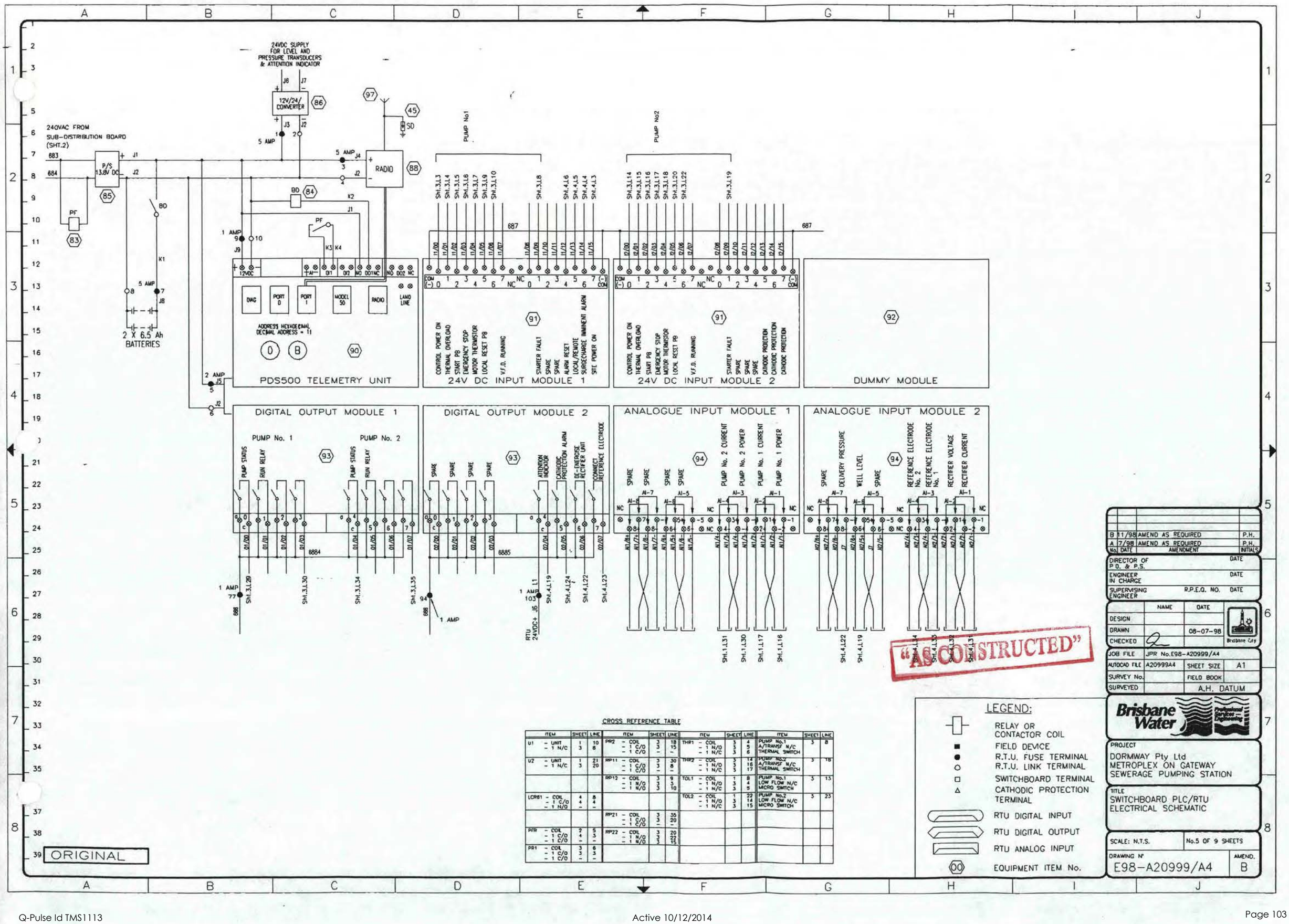
Brisbane Water

PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

TITLE
SWITCHBOARD
ELECTRICAL SCHEMATIC

SCALE: N.T.S. — No.4 OF 9 SHEETS

DRAWING N° E98-A20999/A3 — AMEND. B



CROSS REFERENCE TABLE

ITEM	SHEET	LINE
U1 – UNIT	1	10
– 1 N/C	3	8
U2 – UNIT	1	21
– 1 N/C	3	20
LCRB1 – COIL	4	8
– 1 C/O	4	4
– 1 N/O	1	–
PTR – COIL	2	5
– 1 C/O	4	3
– 1 C/O	–	1
PR1 – COIL	3	6
– 1 C/O	3	3
– 1 C/O	1	–
PR2 – COIL	3	18
– 1 C/O	3	15
– 1 C/O	–	–
RP11 – COIL	3	30
– 1 C/O	3	8
– 1 C/O	–	1
RP12 – COIL	3	9
– 1 N/O	3	3
– 1 N/O	3	10
RP21 – COIL	3	35
– 1 C/O	3	28
– 1 C/O	1	–
RP22 – COIL	3	33
– 1 N/O	3	28
– 1 N/O	–	1

ITEM	SHEET	LINE
THR1 – COIL	3	4
– 1 N/O	3	5
– 1 N/C	3	6
THR2 – COIL	3	14
– 1 N/O	3	16
– 1 N/C	3	17
TOL1 – COIL	1	8
– 1 N/O	3	4
– 1 N/C	3	5
TOL2 – COIL	1	22
– 1 N/O	3	14
– 1 N/C	3	15

ITEM	SHEET	LINE
PUMP No.1 A/TRANSF N/C THERMAL SWITCH	3	8
PUMP No.2 A/TRANSF N/C THERMAL SWITCH	3	18
PUMP No.1 LOW FLOW N/C MICRO SWITCH	3	13
PUMP No.2 LOW FLOW N/C MICRO SWITCH	3	23

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- 00 EQUIPMENT ITEM No.

No.	DATE	AMENDMENT	INITIALS
B	11/98	AMEND AS REQUIRED	P.H.
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S. DATE

ENGINEER IN CHARGE DATE

SUPERVISING ENGINEER R.P.E.Q. NO. DATE

	NAME	DATE
DESIGN		
DRAWN		08-07-98
CHECKED		

Brisbane City

JOB FILE	JPR No.E98-A20999/A4		
AUTOCAD FILE	A20999A4	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water

PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

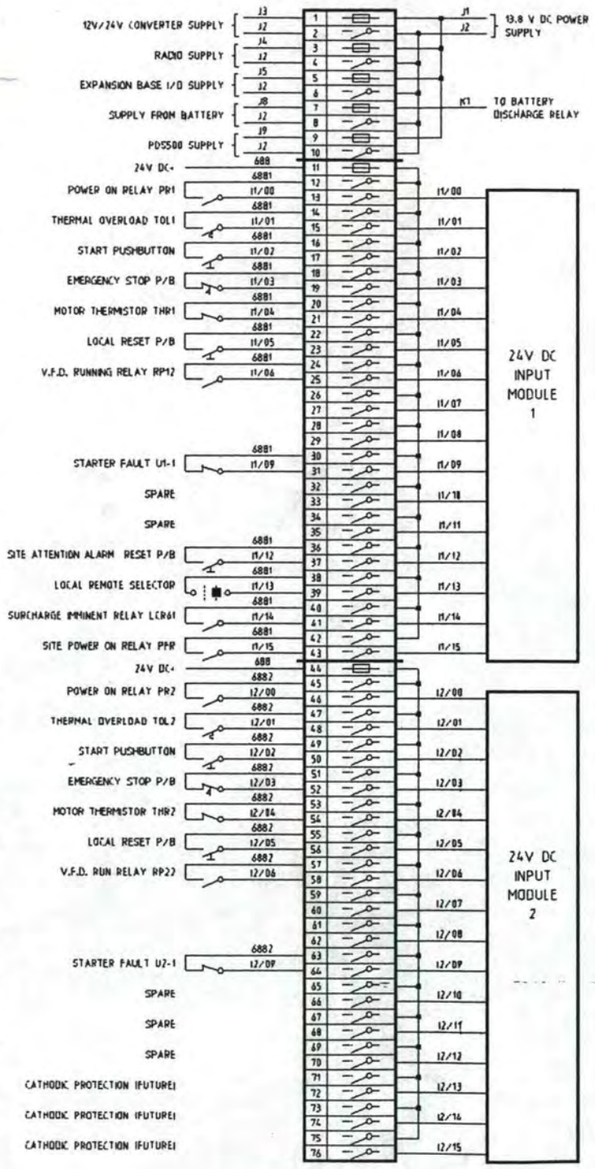
TITLE
SWITCHBOARD PLC/RTU
ELECTRICAL SCHEMATIC

SCALE: N.T.S. No.5 OF 9 SHEETS

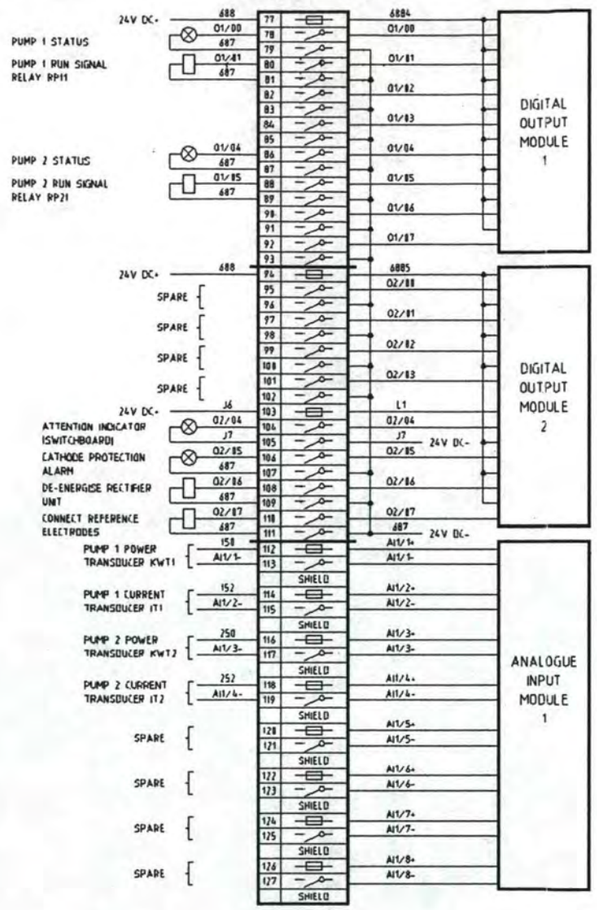
DRAWING N° E98-A20999/A4 AMEND. B

ORIGINAL

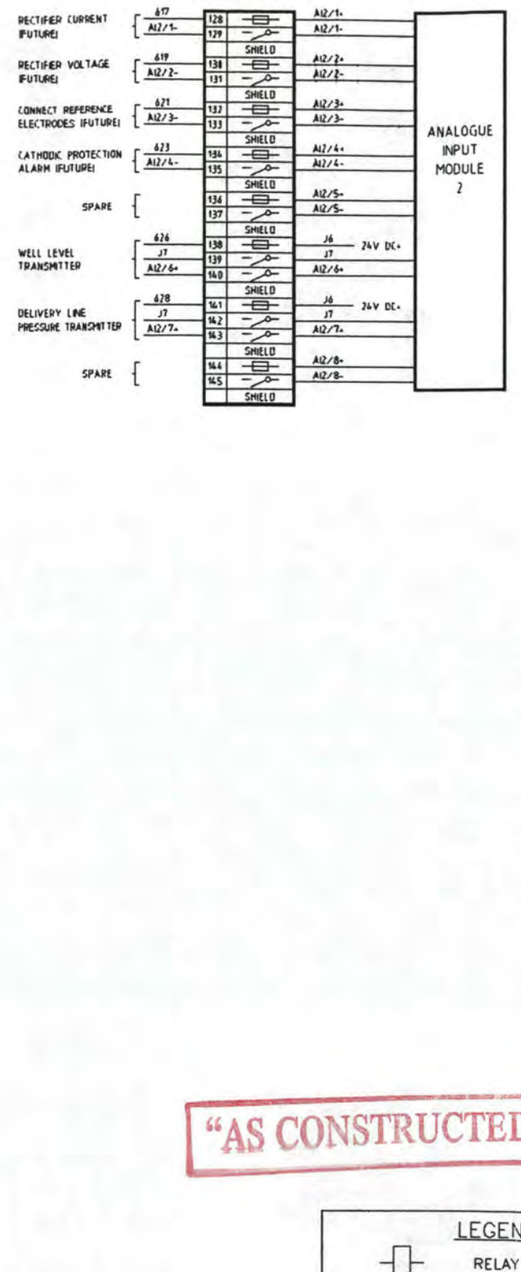
RTU TERMINAL STRIP



RTU TERMINAL STRIP



RTU TERMINAL STRIP



No.	DATE	AMENDMENT	INITIALS
B	11/98	AMEND AS REQUIRED	P.H.
A	7/98	AMEND AS REQUIRED	P.H.

DIRECTOR OF P.D. & P.S. — DATE
ENGINEER IN CHARGE — DATE
SUPERVISING ENGINEER — R.P.E.Q. NO. — DATE

	NAME	DATE
DESIGN		
DRAWN		08-07-98
CHECKED		

Brisbane City

JOB FILE	JPR No.E98-A20999/A5		
AUTOCAD FILE	A20999A5	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

"AS CONSTRUCTED"

LEGEND:

- RELAY OR CONTACTOR COIL
- FIELD DEVICE
- R.T.U. FUSE TERMINAL
- R.T.U. LINK TERMINAL
- SWITCHBOARD TERMINAL
- CATHODIC PROTECTION TERMINAL
- RTU DIGITAL INPUT
- RTU DIGITAL OUTPUT
- RTU ANALOG INPUT
- EQUIPMENT ITEM No.

Brisbane Water

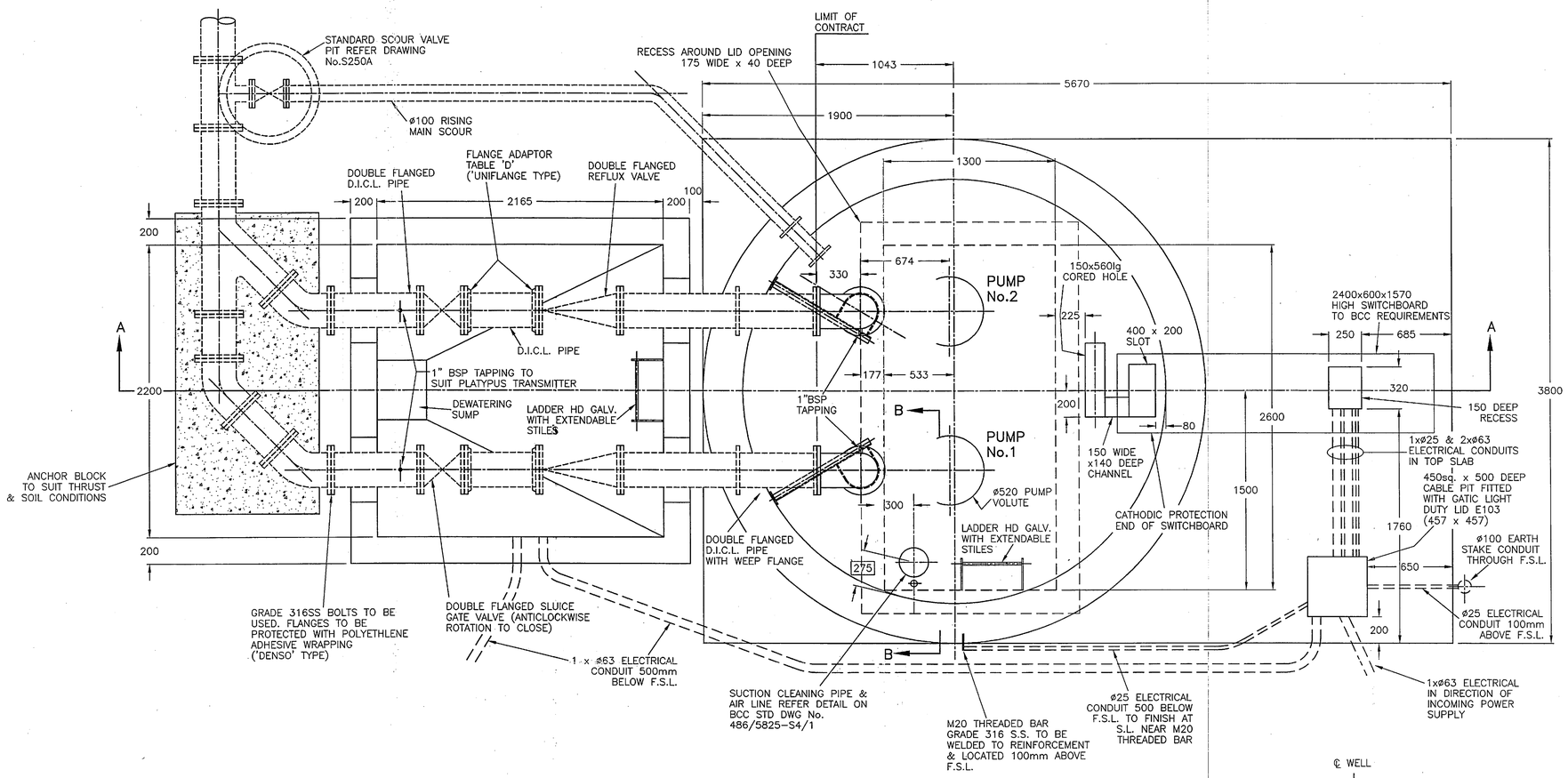
PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

TITLE
SWITCHBOARD PLC/RTU TERMINATION DIAGRAM

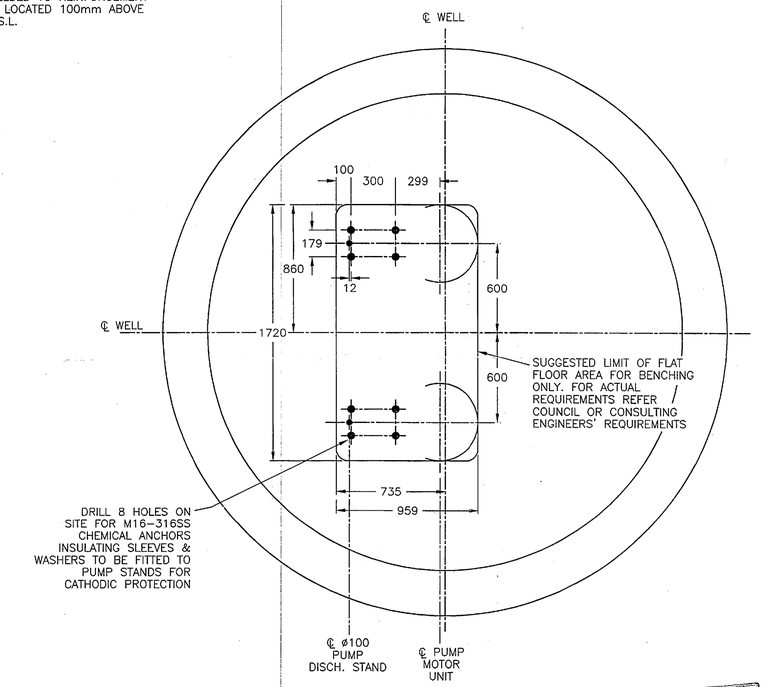
SCALE: N.T.S. | No.8 OF 9 SHEETS

DRAWING N° E98-A20999/A5 | AMEND. B

ORIGINAL



PLAN



FOUNDATION DETAIL

"AS CONSTRUCTED"

NOTE:
1. PUMPS FORRERS MODEL E100-380 40kW 4 POLE TYPE TLC
2. PIPEWORK SHOWN DOTTED BY OTHERS

No.	DATE	AMENDMENT	INITIALS
A	7/98	BCC TITLE BLOCK ADDED	P.H.

DIRECTOR OF P.D. & P.S.		DATE
ENGINEER IN CHARGE		DATE
SUPERVISING ENGINEER	R.P.E.Q. NO.	DATE

	NAME	DATE
DESIGN		
DRAWN	JPR-P.H.	20-6-98
CHECKED	JWL.	30/6/98

Brisbane City

JOB FILE	JPR No.P98-A20999/X0		
AUTOCAD FILE	A20999X0	SHEET SIZE	A1
SURVEY No.		FIELD BOOK	
SURVEYED		A.H. DATUM	

Brisbane Water — Professional Services Engineering

PROJECT
DORMWAY Pty Ltd
METROPLEX ON GATEWAY
SEWERAGE PUMPING STATION

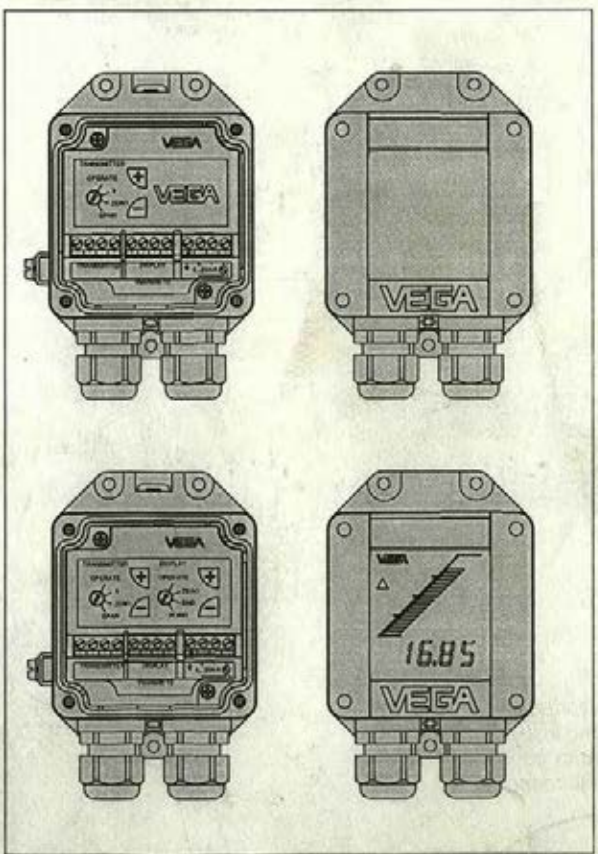
TITLE
SEWERAGE PUMPING STATION
PIPEWORK LAYOUT

SCALE: 1:20	No.1 OF 2 SHEETS
DRAWING N° P98-A20999/X0	AMEND. A

Level and Pressure

Operating Instruction

VEGADIS 12



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Safety information

The described module must only be inserted and operated as described in this operating instruction. Please note that other action can cause damage for which VEGA does not take responsibility.

1 Product description

1.1 Function and configuration

VEGADIS 12 is an external connection housing with integral adjustment. It is connected to a hydrostatic pressure transmitters D80 ... D 87 or D77 via the VEGA-special cable with breather capillaries or a three-wire standard line. VEGADIS 12 is looped into the supply and signal circuit of the pressure transmitter and does not require a separate external energy. The pressure transmitter must be equipped as follows:

- electronics E, G or H or
- direct cable outlet or
- terminal insert for external adjustment (can be equipped later).

VEGADIS 12 has the following function:

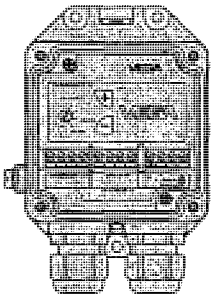
- adjustment of zero, span and t_i
- atmospheric pressure compensation for the pressure transmitter
- indication of measured value (optional).

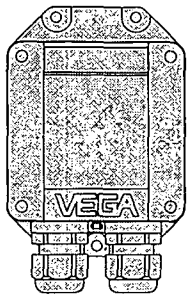
VEGADIS 12 is provided as a standard feature with an adjustment module for the pressure transmitter. The optional indication is located in the housing cover and is provided with a bargraph and a digital indication. In this version additional adjustment modules for indication scaling are integrated.

We applied for approval for hazardous areas acc. to CENELEC EEx ia IIC.

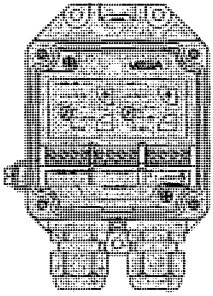
1.2 Types and versions

VEGADIS 12 without indication



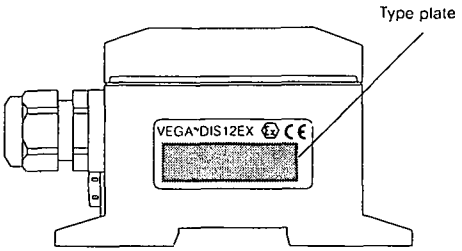


VEGADIS 12 with indication



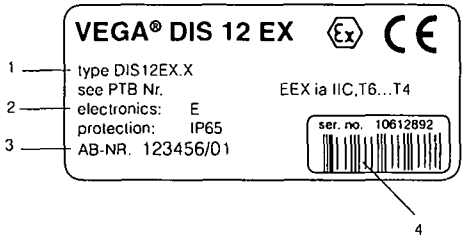
1.3 Type plate and order code

Check before mounting and electrical connection that the instrument is suitable. Hence note the type plate which is located as follows:



The type plate contains important data required for mounting and connection. The configuration and contents of the type plate are described in the following example.

Configuration of the type plate:



1 Master data of the order no.
2 Data of the electronics
E = with indication and scaling
3 No. of the order confirmation
4 Series number

Configuration of the master data of the order number:

type DIS12EX.X

- Approval acc. to CENELEC EEx ia IIC
- External housing VEGADIS 12

Determine the data of your VEGADIS 12 as shown above by means of the order code in this instruction or in the VEGA-pricelist.

1.4 Approvals

When the pressure transmitter or the external housing is used in hazardous areas, approved versions must be used.

For these applications note the appropriate legal documents (test report, test certificates and conformity certificates). These are supplied with the appropriate instrument.

Survey on applied approvals

CENELEC EEx ia IIC	BVS-Zone 10 StEx	GL (German Lloyd)
•	•	•

1.5 Technical data and dimensions

Standard data

Materials and weight

Housing	high resistance plastic PBT (Polyester)
Earth terminals	StSt 1.4305
Window of the indication	glass
Breather facility	PTFE-filter element [1]
Weight	appr. 0,5 kg

Operating and indicating elements

Operating elements	2 keys, 1 rotating switch
Operating elements with indication	2 x 2 keys, 2 x 1 rotating switch
Indication (option)	LC-multi-function display - bargraph (20 segments) - digital value (4-digit) - tendency indicator for raising and falling values

Connection

Cable entry	2 x Pg 13,5 (for cable-ø 5 ... 10 mm)
Screw terminals	for cross-section area of conductor to 2,5 mm²

Operating circuit

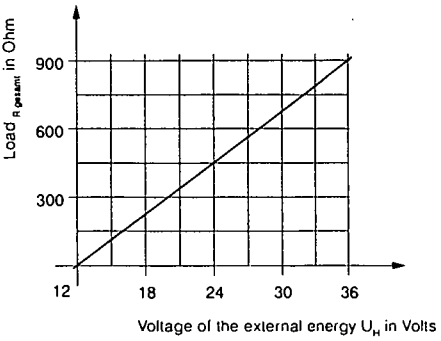
Connection to	pressure transmitter D80 ... D87, D77 with - electronics E, G or H or - direct cable outlet or - terminal insert for external adjustment (can be equipped later)
Connection line	VEGA-special cable with breather capillaries or 3-wire standard line
Line length	max. 200 m

[1] air permeable and humidity blocking

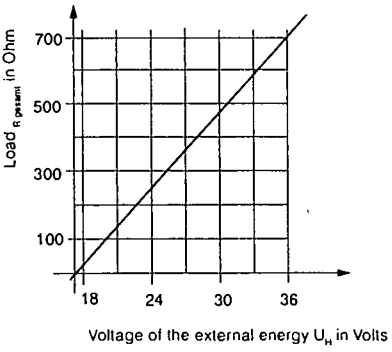
Supply and signal circuit (analog transmission, 4 ... 20 mA)

Supply voltage for presure transmitter in conjunction with VEGADIS 12	
- without indication	12 ... 36 V DC
- with indication	17 ... 36 V DC
Max. input current	150 mA
Range for current signal	3,5 ... 22 mA
Max. permissible load	dependent on supply voltage (see load diagram)

Load diagram without indication



Load diagram with indication



Protective measures

Housing	IP 65
Protection class	III
Overvoltage category	III

CE-protective measures

VEGADIS 12 or VEGADIS 12 Ex external housings meet the protective regulations of EMVG (89/336/EWG) and NSR (73/23/EWG). The conformity has been judged acc. to the following standards:

EMVG	Emission	EN 50 081
	Susceptibility	EN 50 082
NSR		EN 61 010

NAMUR-regulations

The NAMUR-regulations NE21, May 1993 have been met.

Ambient conditions

Ambient temperature	
- VEGADIS 12	-40°C ... +85°C
- VEGADIS 12 with indication	-10°C ... +70°C
Storage and transport temperature	-40°C ... +85°C

Ex-technical data, CENELEC

(applied for approval)

Classification

Classification	EEx ia IIC T6, T5, T4

Intrinsically safe input VEGADIS 12 Ex

Classification	EEx ia IIC
Internal effective capacitance	C_{int} negligible
Internal effective inductance	L_{int} negligible

Intrinsically safe indicating circuit

Classification	EEx ia IIC
Max. values	
- supply voltage	U_o = 7,8 V
- current	I_o = 260 mA
- power	P_o = 507 mW
Max. permissible outer capacitance	L_o = 960 nF
Max. permissible outer inductance	L_o = 0,78 mH
Characteristics	linear
only for connection	of the indication

Intrinsically safe supply and signal circuit

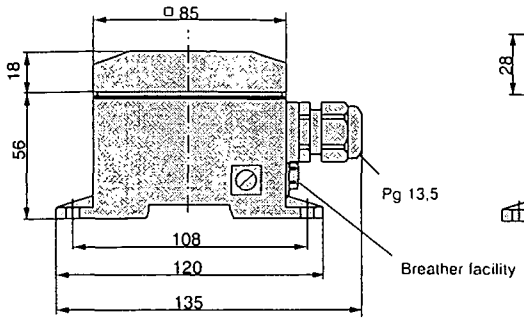
Classification	EEx ia IIC
Max. values	
- supply voltage	U_o = 60 V
- current	I_K = 150 mA
- power	P = 841 mW
Internal effective capacitance	C_{int} < 300 pF
Internal effective inductance	L_{int} < 0,1 mH

Ambient conditions

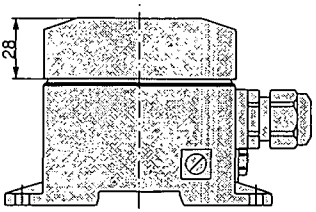
Ambient temperature	Temperature class	Ignition temperature
-40°C ... +50°C	T6	85 °C
-40°C ... +65°C	T5	100°C
-40°C ... +70°C	T4	135°C

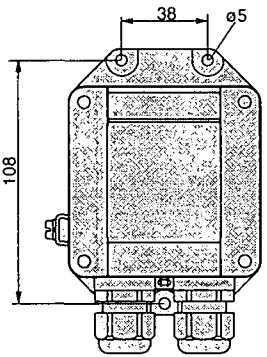
VEGADIS 12

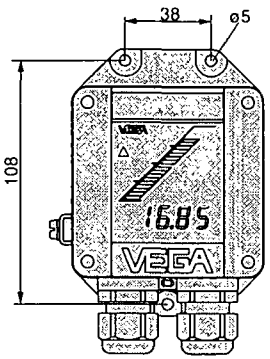
without indication



with indication







2 Mounting

VEGADIS 12 can be mounted in the following ways:
- on carrier rail 35 x 7,5 acc. to EN 50 022
- on mounting sheet or to the wall.

With vertical wall mounting the cable entries must point downwards to avoid humidity ingress.

If VEGADIS 12 is additionally used for atmospheric pressure compensation for the pressure transmitter, note the following:

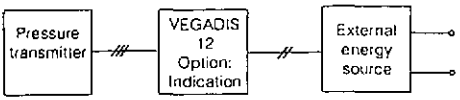
- the breather facility must not be polluted.

3 Electrical connection

3.1 Wiring instructions

VEGADIS 12 is looped into the supply and signal circuit of the pressure transmitter and does not require a separate external energy.

Block diagram



The electronics in the pressure transmitter are made in two-wire technology and requires a supply voltage of 12 ... 36 V DC, 17 ... 36 V DC with indication. Supply voltage and current signal are led via the same two-wire connection cable to the terminals. The third line between pressure transmitter and VEGADIS 12 is used for transmission of the adjustment data.

The external energy is provided via a separate supply unit:
- power supply unit, e.g. VEGASTAB 690
- processing unit with integral DC voltage source (e.g. active DCS-input)

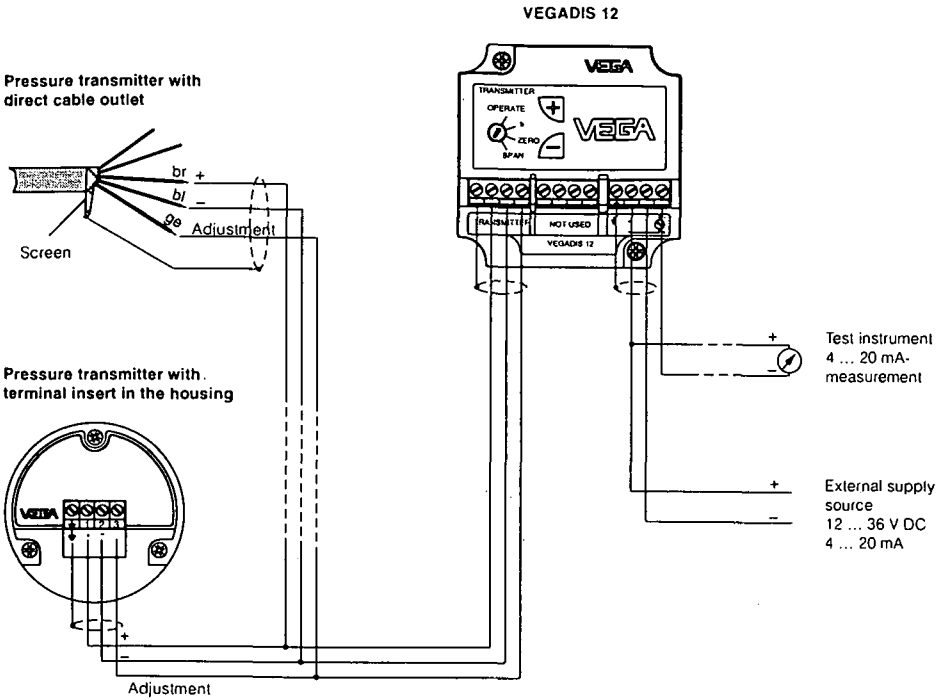
Note that the external energy source is reliably separated from the mains circuits acc. to DIN VDE 0106, part 101. The above mentioned VEGA-instruments meet these requirements and protection class III is therefore guaranteed.

The external energy source must deliver a terminal voltage of at least 12 V or 17 V to the transmitter. The actual terminal voltage on the transmitter depends on the following factors:
- output voltage U_N of the external energy source under nominal load.
- load resistors of the instruments in the circuit.

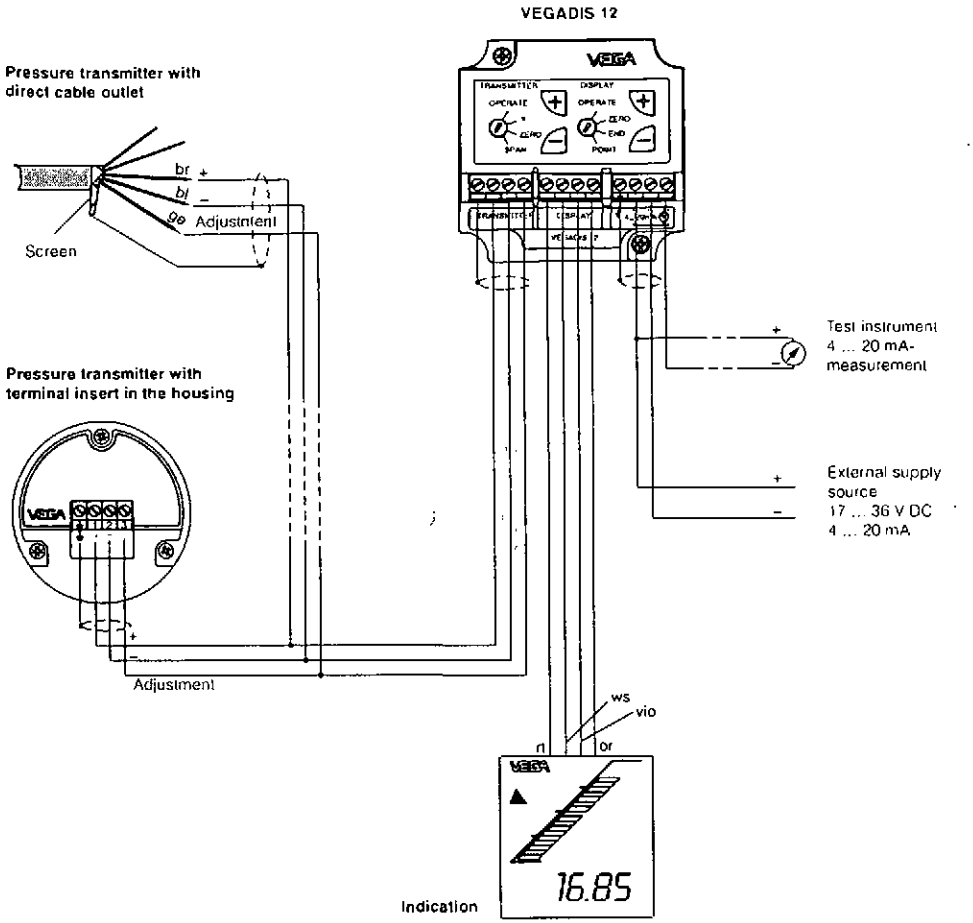
For electrical connection the following instructions must be generally observed:
- The connection must be made acc. to the national standards (e.g. in Germany acc. to the appropriate VDE-regulations).
- The terminal voltage must not exceed 36 V to avoid damage to the electronics.
- The electrical connection has a reverse battery protection.
- The wiring between pressure transmitter and VEGADIS 12 as well as between VEGADIS 12 and power supply can be made with standard three or two-wire cable.
- If strong electromagnetic interference is expected, we recommend use of screened cable. The screening must be earthed at one sensor end.

3.2 Wiring plan

VEGADIS 12 without indication

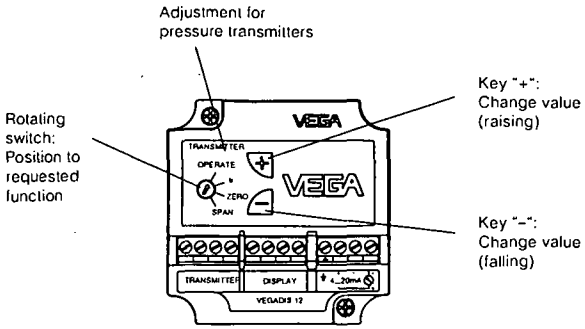


VEGADIS 12 with indication



4 Set-up

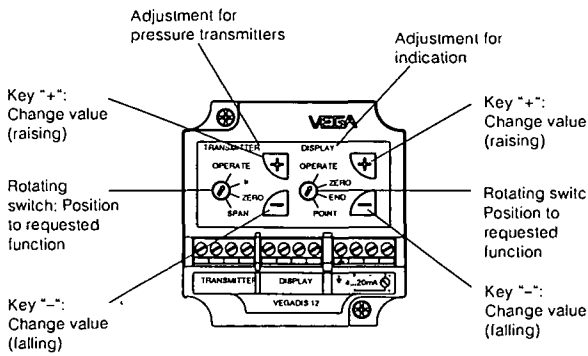
4.1 Adjustment elements



Adjustment system (transmitter)

- Select the function with the rotating switch.
- With keys + and – change the signal current to the desired values or adjust the suitable integration time.
- Then turn the rotating switch to "OPERATE" position. The adjusted values are transferred to the EEPROM-memory and remain even in the case of voltage failure.

4.2 Operating and indicating elements (version with indication)

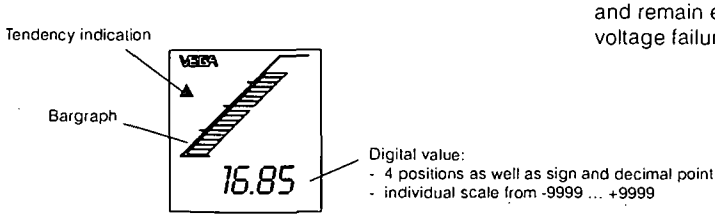


Adjustment system (transmitter)

(see paragraph 4.1)

Adjustment system (display)

- Select the function with the rotating switch.
- With keys + and – change the digital indication to the desired values or adjust the suitable decimal point.
- Then turn the rotating switch to "OPERATE" position. The adjusted values are transferred to the EEPROM-memory and remain even in the case of voltage failure.



4.3 Adjustment of transmitter

Adjustment

For adjustment of zero and span first connect terminal 10 and 12 to a current meter. The measured value is identical with the output current.

1 Adjust zero
(vessel empty)
- Set rotating switch to zero.
- Adjust a current of 4 mA by pushing the keys + or –.

Adjustment range of zero:
-20 % ... +95 % of the nominal meas. range (corresponds to a turn up to +95 %).

2 Adjust span
(max. vessel level)
- Set the rotating switch to span.
- Adjust a current of 20 mA by pushing the keys + or –.

Adjustment range of measuring range final value:
3,3 % ... 120 % of nominal meas. range (corresponds to turn down 1 : 30)

Instructions for adjustment:
- A change of zero does not influence the adjusted span.
- It is possible to adjust currents for part fillings, e.g. 8 mA for 25 % and 16 mA for 75 %. The electronics then calculates automatically the current values for 0 % and 100 % (only possible with a $\Delta \geq 3{,}3$ %).
- The modification of the current values is first made in 10 µA-steps, after pushing for appr. 10 sec. in appr. 300 µA-steps.
- When the current values react on this adjustment with a time delay, there can be two reasons:
  - the last adjustment was carried out with a level, strongly deviating from the actual level,
  - an integration time had been adjusted.

Integration time

For damping of level fluctuations an integration time t_i of 0 ... 5 secs. can be adjusted.

Procedure:
- Set rotating switch to t_i.
- By pushing the - key 10 times ensure that the integration time is set to 0 sec.
- For each 0,5 secs. of the desired integration time push the + key once.

The integration time is the time required by the current output signal to reach 90% of the actual level after a fluctuating level change.

4.4 Scaling of the indication

The indication provides the current values 4 ... 20 mA as a bargraph and as digital value.

Bargraph
No segment of the bargraph appears at 4 mA, all segments appear with 20 mA. This coordination is fixed.

Digital value
The digital value can be individually scaled via the adjustment module between -9999 ... +9999.

1 Adjust zero
- Set the rotating switch to zero.
- Adjust the requested value, e.g. 0 by pushing the keys + or –.

2 Adjust end
- Set the rotating switch to End.
- Adjust the requested value, e.g. 1000 by pushing the keys + or –.

3 Adjust decimal point (point)
- Set the rotating switch to Point.
- Adjust the requested values, e.g. 8888 (no decimal point) by pushing the keys + or –.

5 Diagnosis

5.1 Maintenance

VEGADIS 12 is maintenance free.

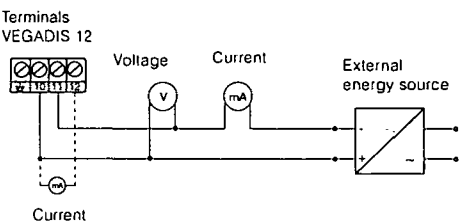
5.2 Error removal

In case of failure please check:
- the atmospheric pressure compensation (only with low pressure ranges),
- the electrical connections and components.

Check atmospheric pressure compensation

First open the cover of the housing. The indicated measured value must not change. However if the indicated measured value changes, the compensation of the atmospheric pressure is not ensured (wrong measured value). Therefore check:
- the breather facility on the housing
- the capillaries in the special cable.

Check electrical components



Instructions for Ex-applications
Deviating from the previous co-ordination, terminals 10 and 12 are here used for short-term connection to a certified active floating (max. value: 470 mW) or an individual passive floating measuring instrument. For connection the regulations for intrinsically safe circuits (measuring instrument, supply and signal circuit) have to be noted.

Voltage

- Check the terminal voltage on VEGADIS 12 (must be at least 12 V DC or 17 V DC with indication).

Current

Current value	Condition
3,8 ... 20,6 mA	standard range for output current
0 mA	signal line interrupted
< 3,6 mA	adjustment, electronics or pressure sensor element defect
> 21,6 mA	fail-safe, short-circuit in the signal line, adjustment, electronics or pressure sensor element defect

6 Instrument modification

6.1 Equip terminal insert

If your pressure transmitter is not equipped with the suitable terminal insert for connection of VEGADIS 12, the terminal insert must be fitted:

- remove available terminal insert
- insert new terminal insert
- set-up pressure transmitter

Remove available terminal insert

- Disconnect pressure transmitter from the power supply.
- Unscrew cover of the connection housing or loosen the screws on the cover of the external housing.
- Remove cover.
- Loosen connection lines on the terminal insert.
- Loosen the three screws on the terminal insert.
- Remove terminal insert and separate plug connection.

Insert new terminal insert

- Provide plug connection to the terminal insert (must snap in).
- Insert the terminal insert into the housing and fasten via the three screws.
- Return the connection lines to the terminals and connect to VEGADIS 12.
- Screw the cover.
- Connect VEGADIS 12 again to the power supply.

Set-up the pressure transmitter
see section 4 of this instruction.

VEGA Grieshaber KG
Am Hohenstein 113
D-77761 Schiltach
Phone (0 78 36) 50 - 0
Fax (0 78 36) 50 - 201
Fax (0 78 36) 50 - 203

AC Tech

Variable Speed AC Motor Drives

MC1000 Series
Installation and Operation Manual

Manual Number: 1001.013.4

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1.0 GENERAL

1.1 PRODUCTS COVERED IN THIS MANUAL

This manual covers the AC Tech MC1000 Variable Frequency Drive.

1.2 PRODUCT CHANGES

AC Technology Corporation reserves the right to discontinue or make modifications to the design of its products without prior notice, and holds no obligation to make modifications to products sold previously. AC Technology Corporation also holds no liability for losses of any kind which may result from this action.

1.3 WARRANTY

AC Technology Corporation warrants the MC Series AC motor control to be free of defects in material and workmanship for a period of eighteen months from the date of sale to the user, or two years from the date of shipment, which ever occurs first. Any control component, which under normal use, becomes defective, within the stated warranty time period, shall be returned to AC Technology Corporation, freight prepaid, for examination. AC Technology Corporation reserves the right to make the final determination as to the validity of a warranty claim, and sole obligation is to repair or replace only components which have been rendered defective due to faulty material or workmanship. No warranty claim will be accepted for components which have been damaged due to mis-handling, improper installation, unauthorized repair and/or alteration of the product, operation in excess of design specifications or other misuse, or improper maintenance. AC Technology Corporation makes no warranty that its products are compatible with any other equipment, or to any specific application, to which they may be applied and shall not be held liable for any other consequential damage or injury arising from the use of its products.

This warranty is in lieu of all other warranties, expressed or implied. No other person, firm or corporation is authorized to assume, for AC Technology Corporation, any other liability in connection with the demonstration or sale of its products.

1.4 RECEIVING

Inspect all cartons for damage which may have occurred during shipping. Carefully unpack equipment and inspect thoroughly for damage or shortage. Report any damage to carrier and/or shortages to supplier. All major components and connections should be examined for damage and tightness, with special attention given to PC boards, plugs, knobs and switches.

1.5 CUSTOMER MODIFICATION

AC Technology Corporation, its sales representatives and distributors, welcome the opportunity to assist our customers in applying our products. Many customizing options are available to aid in this function. AC Technology Corporation cannot assume responsibility for any modifications not authorized by its engineering department.

2.0 MC1000 SPECIFICATIONS

Storage Temperature	-20° to 70° C
Ambient Operating Temperature (With 2.5 and 8 kHz carrier, derate for higher carriers)	Chassis -10° to 55° C Type 1 (IP 31) -10° to 50° C Type 4 (IP 65) -10° to 40° C Type 12 (IP 54) -10° to 40° C
Ambient Humidity	Less than 95% (non-condensing)
Maximum Altitude	3300 feet (1000 m) above sea level
Input Line Voltages	240/120 Vac, 240/200 Vac, 480/400 Vac, and 590/480 Vac
Input Voltage Tolerance	+10%, -15%
Input Frequency Tolerance	48 to 62 Hz
Output Wave Form	Sine Coded PWM
Output Frequency	0-120 Hz, Optional up to 650 Hz
Carrier Frequency	2.5 kHz to 14 kHz
Frequency Stability	$\pm$ 0.00006% / °C
Service Factor	1.00
Efficiency	> 97% throughout speed range
Power Factor (displacement)	> 0.96
Overload Current Capacity	150% of output rating for 60 seconds 180% of output rating for 30 seconds
Speed Reference Follower	0-10 VDC, 4-20 mA
Control Voltage	15 VDC
Analog Outputs	0 - 10 VDC, or 2 - 10 VDC Proportional to speed or load
Digital Outputs	Form C relay: 2 A at 28 VDC or 120 Vac Open-collector outputs: 40 mA at 30 VDC

3.0 MC1000 MODEL DESIGNATION CODE

The model number of an MC1000 Series drive gives a full description of the basic drive unit (see example below).

EXAMPLE: M1450BP

(MC1000, 480 Vac, 5 HP, Type 1 Enclosure, with a Remote Keypad Assembly)

M1	4	50	B	P

Series:
M1 = MC1000 Series Variable Speed AC Motor Drive

Input Voltage:
1 = 240/120 Vac (For 110, 115, 120, 230 and 240 Vac; 50 or 60 Hz)
2 = 240/200 Vac (For 208 and 240 Vac; 50 or 60 Hz)
4 = 480/400 Vac (For 380, 415, 440, 460 and 480 Vac; 50 or 60 Hz)
5 = 590/480 Vac (For 440, 460, 480, 575 and 600 Vac; 50 or 60 Hz)

Horsepower:

03	= ¼ Hp	30	= 3 Hp	200	= 20 Hp
05	= ½ Hp	50	= 5 Hp	250	= 25 Hp
10	= 1 Hp	75	= 7½ Hp	300	= 30 Hp
15	= 1½ Hp	100	= 10 Hp	400	= 40 Hp
20	= 2 Hp	150	= 15 Hp	500	= 50 Hp

Input:
S = Single phase input.
No character indicates three phase input.

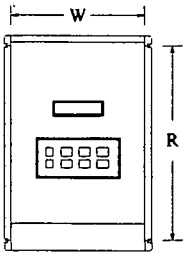
Enclosure Type:
A = Chassis - Open Enclosure with Door Removed
B = NEMA 1 - General Purpose, vented
C = NEMA 4 - Water-tight and Dust-tight
D = NEMA 12 - Dust-tight and Drip-tight
E = NEMA 4X - Water-tight, Dust-tight and Corrosion Resistant

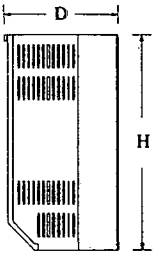
Standard Options:
H = Additional Form "C" Relay circuit board
J = Dynamic Braking circuit board
K = Additional Relay & Dynamic Braking board (not available on all HP sizes – consult factory)
No character when this type of option is not specified.

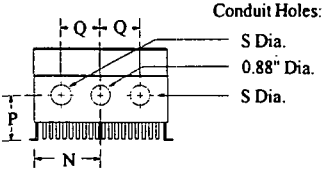
Interface Options:
P = Remote Keypad Assembly
Q = No Keypad
R = No Keypad & No Display
No character when this type of option is not specified.

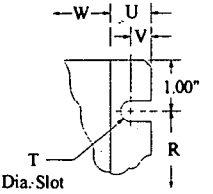
4.0 MC1000 DIMENSIONS

4.1 CHASSIS AND TYPE 1 ENCLOSED







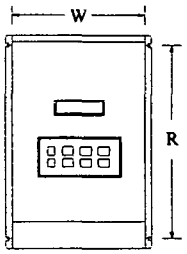


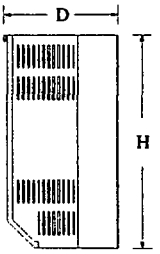
Mounting Tab Detail

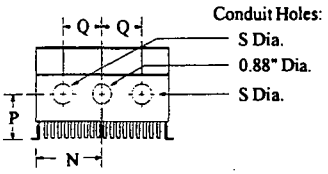
IF W ≤ 7.86"
T = 0.20"
U = 0.34"
V = 0.19"

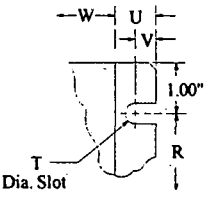
IF W = 10.26"
T = 0.28"
U = 0.44"
V = 0.24"

HP	INPUT VOLTAGE	MODEL	H	W	D	N	P	Q	R	S
0.25	240 / 120	M1103S	7.50	4.70	3.33	2.35	1.60	1.37	5.50	0.88
0.5	240 / 120	M1105S	7.50	6.12	3.63	3.77	1.80	1.37	5.50	0.88
	240	M1205S	7.50	4.70	3.63	2.35	1.90	1.37	5.50	0.88
	240 / 200	M1205	7.50	4.70	3.63	2.35	1.90	1.37	5.50	0.88
1	240 / 120	M1110S	7.50	6.12	4.22	3.77	2.40	1.37	5.50	0.88
	240	M1210S	7.50	4.70	4.33	2.35	2.60	1.37	5.50	0.88
	240 / 200	M1210	7.50	4.70	4.33	2.35	2.60	1.37	5.50	0.88
	480 / 400	M1410	7.50	4.70	3.63	2.35	1.90	1.37	5.50	0.88
	590	M1510	7.50	4.70	3.63	2.35	1.90	1.37	5.50	0.88
1.5	240 / 120	M1115S	7.50	6.12	4.22	3.77	2.40	1.37	5.50	0.88
	240	M1215S	7.50	6.12	4.22	3.77	2.40	1.37	5.50	0.88
	240 / 200	M1215	7.50	4.70	4.33	2.35	2.60	1.37	5.50	0.88
2	240	M1220S	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	240 / 200	M1220	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	480 / 400	M1420	7.50	6.12	4.22	3.77	2.40	1.37	5.50	0.88
	590	M1520	7.50	6.12	4.22	3.77	2.40	1.37	5.50	0.88
3	240	M1230S	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	240 / 200	M1230	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	480 / 400	M1430	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	590	M1530	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88









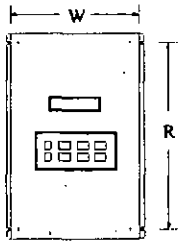
Mounting Tab Detail

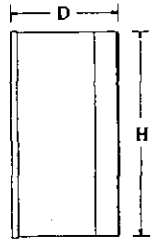
IF W ≤ 7.86"
T = 0.20"
U = 0.34"
V = 0.19"

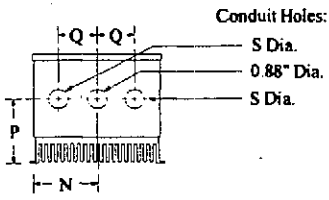
IF W = 10.26"
T = 0.28"
U = 0.44"
V = 0.24"

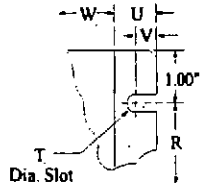
HP	INPUT VOLTAGE	MODEL	H	W	D	N	P	Q	R	S
5	240 / 200	M1250	7.88	7.86	5.94	5.13	3.95	1.50	5.88	1.13
	480 / 400	M1450	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
	590	M1550	7.50	6.12	5.12	3.77	3.30	1.37	5.50	0.88
7.5	240 / 200	M1275	9.38	7.86	6.84	3.93	4.19	2.00	5.88	1.13
	480 / 400	M1475	9.38	7.86	6.25	5.13	3.95	1.50	5.88	1.13
	590	M1575	9.38	7.86	6.25	5.13	3.95	1.50	5.88	1.13
10	240 / 200	M12100	11.25	7.86	6.84	3.93	4.19	2.00	7.75	1.38
	480 / 400	M14100	9.38	7.86	6.84	3.93	4.19	2.00	5.88	1.13
	590	M15100	9.38	7.86	7.40	3.93	4.19	2.00	5.88	1.13
15	240 / 200	M12150	12.75	7.86	6.84	3.93	4.19	2.00	9.25	1.38
	480 / 400	M14150	11.25	7.86	6.84	3.93	4.19	2.00	7.75	1.38
	590	M15150	12.75	7.86	6.84	3.93	4.19	2.00	9.25	1.38
20	240 / 200	M12200	12.75	10.26	7.74	5.13	5.00	2.50	9.25	1.38
	480 / 400	M14200	12.75	7.86	6.84	3.93	4.19	2.00	9.25	1.38
	590	M15200	12.75	7.86	7.40	3.93	4.19	2.00	9.25	1.38
25	480 / 400	M14250	12.75	10.26	7.74	5.13	5.00	2.50	9.25	1.38
	590	M15250	12.75	10.26	7.74	5.13	5.00	2.50	9.25	1.38
30	480 / 400	M14300	12.75	10.26	7.74	5.13	5.00	2.50	9.25	1.38
	590	M15300	12.75	10.26	8.25	5.13	5.00	2.50	9.25	1.38
40	480/400	M14400	15.75	10.26	7.74	5.13	5.00	2.50	12.25	1.38
	590	M15400	15.75	10.26	7.74	5.13	5.00	2.50	12.25	1.38

4.2 TYPE 4 AND 4X ENCLOSED







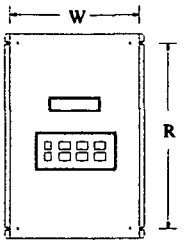


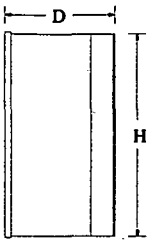
Mounting Tab Detail

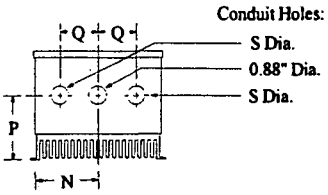
IF W ≤ 7.86"
T = 0.20"
U = 0.34"
V = 0.19"

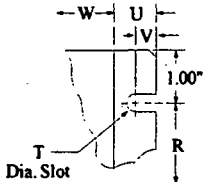
IF W = 10.26"
T = 0.28"
U = 0.44"
V = 0.24"

HP	INPUT VOLTAGE	MODEL	H	W	D	N	P	Q	R	S
0.25	240 / 120	M1103S	7.88	6.12	3.63	3.06	2.00	1.37	5.88	0.88
0.5	240 / 120	M1105S	7.88	7.86	3.75	4.80	2.10	1.37	5.88	0.88
	240	M1205S	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
	240 / 200	M1205	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
1	240 / 120	M1110S	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	240	M1210S	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
	240 / 200	M1210	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
	480 / 400	M1410	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
	590	M1510	7.88	6.12	4.35	3.06	2.70	1.37	5.88	0.88
1.5	240 / 120	M1115S	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	240	M1215S	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	240 / 200	M1215	7.88	6.12	5.25	3.06	3.60	1.37	5.88	0.88
2	240	M1220S	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	240 / 200	M1220	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	480 / 400	M1420	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	590	M1520	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
3	240	M1230S	7.88	7.86	5.90	4.80	4.25	1.37	5.88	0.88
	240 / 200	M1230	7.88	7.86	5.90	4.80	4.25	1.37	5.88	0.88
	480 / 400	M1430	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88
	590	M1530	7.88	7.86	4.90	4.80	3.25	1.37	5.88	0.88









Mounting Tab Detail

IF W ≤ 7.86"
T = 0.20"
U = 0.34"
V = 0.19"

IF W = 10.26"
T = 0.28"
U = 0.44"
V = 0.24"

HP	INPUT VOLTAGE	MODEL	H	W	D	N	P	Q	R	S
5	240 / 200	M3250	10.25	10.26	7.20	5.13	5.25	2.00	6.38	1.13
	480 / 400	M3450	7.88	7.86	5.90	4.80	4.25	1.37	5.88	0.88
	590	M3550	7.88	7.86	5.90	4.80	4.25	1.37	5.88	0.88
7.5	240 / 200	M3275	13.25	10.26	8.35	5.13	5.75	2.00	11.25	1.38
	480 / 400	M3475	10.25	10.26	7.20	5.13	5.25	2.00	6.38	1.13
	590	M3575	10.25	10.26	7.20	5.13	5.25	2.00	6.38	1.13
10	240 / 200	M32100	13.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
	480 / 400	M34100	11.75	10.26	8.35	5.13	5.75	2.00	9.75	1.13
	590	M35100	11.75	10.26	8.35	5.13	5.75	2.00	9.75	1.13
15	240 / 200	M32150	15.75	10.26	8.35	5.13	5.75	2.00	13.75	1.38
	480 / 400	M34150	13.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
	590	M35150	13.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
20	240 / 200	M32200*	15.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
	480 / 400	M34200	15.75	10.26	8.35	5.13	5.75	2.00	13.75	1.38
	590	M35200	15.75	10.26	8.35	5.13	5.75	2.00	13.75	1.38
25	480 / 400	M34250*	15.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
	590	M35250*	15.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
30	480 / 400	M34300*	15.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38
	590	M35300*	15.75	10.26	8.35	5.13	5.75	2.00	11.75	1.38

* = MODELS AVAILABLE IN NEMA 12 ONLY.

5.0 MC1000 RATINGS

The following tables indicate the input and output ratings of the MC1000 Series drive.

NOTE: The output current ratings are based on operation at carrier frequencies of 8 kHz and below. Operation at carrier frequencies above 8 kHz require derating the drive by multiplying the output current rating by the following factors: 0.94 at 10 kHz, 0.89 at 12 kHz, and 0.83 at 14 kHz. Refer to Parameter 23 - CARRIER in Section 18.0 - DESCRIPTION OF PARAMETERS.

M1100 SERIES RATINGS						
MODEL		INPUT (240 / 120 Vac, 50 - 60 Hz)			OUTPUT (0 - 230 Vac)	
MODEL NUMBER (NOTE 1)	RATED HP	INPUT PHASE	NOMINAL CURRENT (AMPS) (NOTE 2)	POWER (KVA)	NOMINAL CURRENT (AMPS)	POWER (KVA)
M1103S	0.25	1	3.0 / 6.0	0.72	1.4	0.56
M1105S	0.5	1	4.6 / 9.2	1.1	2.2	0.88
M1110S	1	1	8.1 / 16.2	1.9	4.0	1.6
M1115S	1.5	1	10.4 / 20.8	2.5	5.2	2.1

NOTE 1: See Section 3.0 for model number breakdown.
NOTE 2: The higher current rating is for 120 Vac input and the lower current rating is for 240 Vac input.
NOTE 3: See Section 8.0 for recommended fuse type.

M1200 SERIES RATINGS						
MODEL		INPUT (240 Vac, 50 - 60 Hz)			OUTPUT (0 - 230 Vac)	
MODEL NUMBER (NOTE 1)	RATED HP	INPUT PHASE	NOMINAL CURRENT (AMPS) (NOTE 2)	POWER (KVA)	NOMINAL CURRENT (AMPS)	POWER (KVA)
M1205S	1/2	1	5.0	1.2	2.2	0.88
M1205	1/2	3	2.7	1.1	2.2	0.88
M1210S	1	1	9.0	2.2	4.0	1.6
M1210	1	3	4.8	2.0	4.0	1.6
M1215S	1.5	1	11.6	2.8	5.2	2.1
M1215	1.5	3	6.2	2.6	5.2	2.1
M1220S	2	1	14.9	3.6	6.8	2.7
M1220	2	3	8.1	3.4	6.8	2.7
M1230S	3	1	20.9	5.0	9.6	3.8
M1230	3	3	11.3	4.7	9.6	3.8

NOTE 1: See Section 3.0 for model number breakdown.
NOTE 2: For 200 Vac input voltage on THREE PHASE MODELS ONLY, multiply the input and output current ratings by 1.15 and the output voltage by 0.87.
NOTE 3: See Section 8.0 for recommended fuse type.

M1200 SERIES RATINGS						
MODEL		INPUT (240 Vac, 50 - 60 Hz)			OUTPUT (0 - 230 Vac)	
MODEL NUMBER (NOTE 1)	RATED HP	INPUT PHASE	NOMINAL CURRENT (AMPS) (NOTE 2)	POWER (KVA)	NOMINAL CURRENT (AMPS)	POWER (KVA)
M1250	5	3	17.7	7.4	15.2	6.1
M1275	7.5	3	25.5	10.6	22.0	8.8
M12100	10	3	31.8	13.2	28.0	11.2
M12150	15	3	47.6	19.8	42.0	16.7
M12200	20	3	61.0	25.3	54.0	21.5

NOTE 1: See Section 3.0 for model number breakdown.
NOTE 2: For 200 Vac input voltage on THREE PHASE MODELS ONLY, multiply the input and output current ratings by 1.15 and the output voltage by 0.87.
NOTE 3: See Section 8.0 for recommended fuse type.

M1400 SERIES RATINGS						
MODEL		INPUT (480 Vac, 50 - 60 Hz)			OUTPUT (0 - 460 Vac)	
MODEL NUMBER (NOTE 1)	RATED HP	INPUT PHASE	NOMINAL CURRENT (AMPS) (NOTE 2)	POWER (KVA)	NOMINAL CURRENT (AMPS)	POWER (KVA)
M1410	1	3	2.4	2.0	2.0	1.6
M1420	2	3	4.1	3.4	3.4	2.7
M1430	3	3	5.7	4.7	4.8	3.8
M1450	5	3	8.9	7.3	7.6	6.1
M1475	7.5	3	12.8	10.6	11.0	8.8
M14100	10	3	15.9	13.2	14.0	11.2
M14150	15	3	23.8	19.8	21.0	16.7
M14200	20	3	30.5	25.3	27.0	21.5
M14250	25	3	38.4	31.9	34.0	27.1
M14300	30	3	45.2	37.6	40.0	31.9
M14400	40	3	59.0	49.0	52.0	41.4

NOTE 1: See Section 3.0 for model number breakdown.
NOTE 2: For 400 Vac input voltage, multiply the input and output current ratings by 1.15 and the output voltage by 0.87.
NOTE 3: See Section 8.0 for recommended fuse type.

M1500 SERIES RATINGS						
MODEL		INPUT (590 Vac, 50 - 60 Hz)			OUTPUT (0 - 575 Vac)	
MODEL NUMBER (NOTE 1)	RATED HP	INPUT PHASE	NOMINAL CURRENT (AMPS) (NOTE 2)	POWER (KVA)	NOMINAL CURRENT (AMPS)	POWER (KVA)
M1510	1	3	1.9	1.9	1.6	1.6
M1520	2	3	3.3	3.4	2.7	2.7
M1530	3	3	4.6	4.7	3.9	3.9
M1550	5	3	7.1	7.3	6.1	6.1
M1575	7.5	3	10.5	10.7	9.0	8.8
M15100	10	3	12.5	12.8	11.0	11.0
M15150	15	3	19.3	19.7	17.0	16.9
M15200	20	3	24.9	25.4	22.0	21.5
M15250	25	3	30.5	31.2	27.0	26.9
M15300	30	3	36.2	37.1	32.0	31.9
M15400	40	3	46.5	47.5	41.0	40.8

NOTE 1: See Section 3.0 for model number breakdown.
NOTE 2: For 480 Vac input voltage, multiply the input power, output power, and output voltage by 0.83.
NOTE 3: See Section 8.0 for recommended fuse type.

6.0 THEORY

6.1 DESCRIPTION OF AC MOTOR OPERATION

Three phase AC motors are comprised of two major components, the stator and the rotor. The stator is a set of three electrical windings held stationary in the motor housing. The rotor is a metal cylinder, fixed to the motor drive shaft, which rotates within the stator. The arrangement of the stator coils and the presence of three phase AC voltage give rise to a rotating magnetic field which drives the rotor. The speed at which the magnetic field rotates is known as the synchronous speed of the motor. Synchronous speed is a function of the frequency at which the voltage is alternating and the number of poles in the stator windings.

The following equation gives the relation between synchronous speed, frequency, and the number of poles:

$$Ss = 120\ f/p$$

Where: Ss = Synchronous speed (rpm), f = frequency (Hz),
p = number of poles

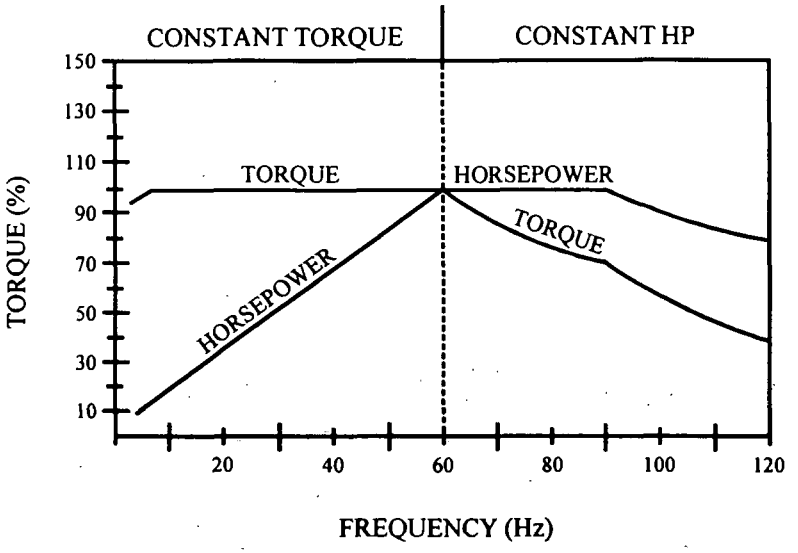
In three phase induction motors the actual shaft speed differs from the synchronous speed as load is applied. This difference is known as "slip". Slip is commonly expressed as a percentage of synchronous speed. A typical value is three percent at full load.

The strength of the magnetic field in the gap between the rotor and stator is proportional to the amplitude of the voltage at a given frequency. The output torque capability of the motor is, therefore, a function of the applied voltage amplitude at a given frequency. When operated below base (rated) speed, AC motors run in the range of "constant torque". Constant torque output is obtained by maintaining a constant ratio between voltage amplitude (Volts) and frequency (Hertz). For 60 Hz motors rated at 230, 460, and 575 Vac, common values for this V/Hz ratio are 3.83, 7.66, and 9.58 respectively. Operating with these V/Hz ratios generally yields optimum torque capability. Operating at lower ratio values results in lower torque and power capability. Operating at higher ratio values will cause the motor to overheat. Most standard motors are capable of providing full torque output from 3 to 60 Hz. However, at lower speeds, where motor cooling fans become less effective, supplemental cooling may be needed to operate at full torque output continuously.

If the frequency applied to the motor is increased while the voltage remains constant, torque capability will decrease as speed increases. This will cause the horsepower capability of the motor to remain approximately constant. Motors run in this mode when operated above base speed, where drive output voltage is limited by the input line voltage. This operating range is known as the "constant horsepower" range. The typical maximum range for constant horsepower is about 2.3 to 1 (60 to 140 Hz). The diagram below depicts the characteristics of a typical AC induction motor with a 60 Hz base speed.

WARNING!

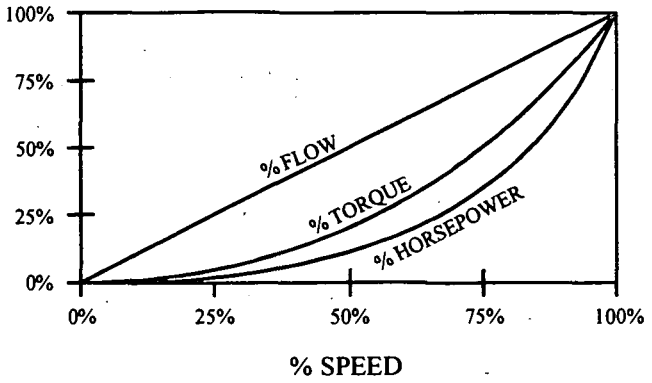
Consult motor manufacturer before operating motor and/or driven equipment above base speed.



6.1.1 VARIABLE TORQUE VS. CONSTANT TORQUE

Variable frequency drives, and the loads they are applied to, can generally be divided into two groups: constant torque and variable torque. Constant torque loads include: vibrating conveyors, punch presses, rock crushers, machine tools, and just about every other application that is not considered variable torque. Variable torque loads include centrifugal pumps and fans, which make up the majority of HVAC applications.

Variable torque loads are governed by the affinity laws, which define the relationships between speed, flow, torque and horsepower. The diagram below illustrates these relationships:



"Variable torque" refers to the fact that the torque required varies with the square of the speed. Also, the horsepower required varies with the cube of the speed, resulting in a large reduction in horsepower for even a small reduction in speed. It is easily seen that substantial energy savings can be achieved by reducing the speed of a fan or pump. For example, reducing the speed to 50% results in a 50 HP motor having to produce only 12.5% of rated horsepower, or 6.25 HP. Variable torque drives usually have a low overload capacity (110% - 120% for 60 seconds), because variable torque applications rarely experience overload conditions. To optimize efficiency and energy savings, variable torque drives are usually programmed to follow a variable V/Hz ratio.

The term "constant torque" is not entirely accurate in terms of the actual torque required for an application. Many constant torque applications have reciprocating loads, such as vibrating conveyors and punch presses, where the rotational motion of the motor is being converted to a linear motion. In such cases, the torque required can vary greatly at different points in the cycle. For constant torque loads, this fluctuation in torque is not a direct function of speed, as it is with a variable torque load. As a result, constant torque drives typically have a high overload rating (150% for 60 seconds) in order to handle the higher peak torque demands. To achieve maximum torque, constant torque drives follow a constant V/Hz ratio.

Both MC Series product lines (MC1000 and MC3000) have full overload capacity (150% for 60 seconds, 180% for 30 seconds), so that either one can be used for either type of application. The V/Hz ratio can also be changed to optimize performance for either type of application.

6.2 DRIVE FUNCTION DESCRIPTION

The MC Series is a 16 bit microprocessor based, keypad programmable, variable speed AC motor drive. There are four major sections: an input diode bridge and filter, a power board, a control board, and an output intelligent power module.

6.2.1 DRIVE OPERATION

Incoming AC line voltage is converted to a pulsating DC voltage by the input diode bridge. The DC voltage is supplied to the bus filter capacitors through a charge circuit which limits inrush current to the capacitors during power-up. The pulsating DC voltage is filtered by the bus capacitors which reduces the ripple level. The filtered DC voltage enters the inverter section of the drive, composed of six output intelligent insulated gate bi-polar transistors (IGBTs) which make up the three output legs of the drive. Each leg has one intelligent IGBT connected to the positive bus voltage and one connected to the negative bus voltage. Alternately switching on each leg, the intelligent IGBT produces an alternating voltage on each of the corresponding motor windings. By switching each output intelligent IGBT at a very high frequency (known as the carrier frequency) for varying time intervals, the inverter is able to produce a smooth, three phase, sinusoidal output current wave which optimizes motor performance.

6.2.2 CIRCUIT DESCRIPTION

The control section consists of a control board with a 16 bit microprocessor, keypad and display. Drive programming is accomplished via the keypad or the serial communications port. During operation the drive can be controlled via the keypad, by control devices wired to the control terminal strip, or by the the serial communications port. The Power Board contains the control and protection circuits which govern the six output IGBTs. The Power Board also contains a charging circuit for the bus filter capacitors, a motor current feedback circuit, a voltage feedback circuit, and a fault signal circuit. The drive has several built in protection circuits. These include phase-to-phase and phase-to-ground short circuit protection, high and low line voltage protection, protection against excessive ambient temperature, and protection against continuous excessive output current. Activation of any of these circuits will cause the drive to shut down in a fault condition.

6.2.3 MC1000 ANALOG INPUT SIGNALS

The drive allows for three speed reference input signals: speed potentiometer (10,000 Ohm), 4-20 mA, or 0-10 VDC. For control by a speed pot, the wiper lead is connected to terminal TB-5A, and the high and low end leads are connected to terminals TB-6 and TB-2, respectively. For 4-20 mA control, wire the positive to terminal TB-5B and the negative to terminal TB-2. For 0-10 VDC control, wire the positive to terminal TB-5A and the negative to terminal TB-2. Refer to the diagrams in Section 15.0 - MC1000 CONTROL WIRING DIAGRAMS.

The input impedance of terminal TB-5A (0-10 VDC input) is 200 kilohms, and the input impedance of terminal TB-5B (4-20 mA input) is 100 ohms. Terminal TB-2 is circuit common.

6.2.4 MC1000 ANALOG OUTPUT SIGNALS

There are two terminals that can supply analog output signals proportional to output frequency or load. Terminal TB-10A can provide a 0-10 VDC or a 2-10 VDC signal proportional to output frequency, and TB-10B can provide the same signals proportional to load. The 2-10 VDC signals can be converted to a 4-20 mA signal using a resistor in series with the signal such that the total circuit resistance is 500 Ohms. See Parameters: 42 - TB10A OUT, 43 - @TB10A, 44 - TB10B OUT, and 45 - @TB10B in Section 18.0 - DESCRIPTION OF PARAMETERS.

NOTE: These analog output signals cannot be used with "loop-powered" devices that derive power from a 4-20 mA signal.

6.2.5 MC1000 STATUS OUTPUT RELAYS

The control board has one Form C relay at terminals TB-16, TB-17, and TB-18. Contacts are rated for 2 amps at 28 VDC or 120 Vac.

There are also two open-collector outputs at terminals TB-14 and TB-15. The open-collector circuit is a current sinking type rated at 30 VDC and 40 mA maximum. An external power supply (30 VDC max.) must be used to power the open-collector outputs. The drive does not have a dedicated power supply for the open-collector outputs.

The Form C relay and the open-collector outputs can be programmed to indicate any of the following: RUN, FAULT, /FAULT (INVERSE FAULT), LOCK (FAULT LOCKOUT), @ SPEED (AT SPEED), ABOVE #3, I LIMIT (CURRENT LIMIT), or AUTO/MAN mode. See Parameters: 52 - TB14 OUT, 53 - TB15 OUT, and 54 - RELAY, in Section 18.0 - DESCRIPTION OF PARAMETERS.

The following describes the possible relay output settings:

NONE	This setting disables the relay output.
RUN	The relay energizes when the drive is given a START command, and remains energized until: a STOP command is given and the output frequency has decelerated to 0.5 Hz, the drive has "tripped", or the input voltage is removed. Note that this relay indicates only that the drive is in the RUN mode. It does not necessarily indicate that the motor is turning.

/ FAULT	INVERSE FAULT - The relay energizes when the drive "trips" into a fault condition, and remains energized until the fault condition is cleared.
LOCK	FAULT LOCKOUT - This relay is used when the drive is programmed to automatically restart after a fault. The relay energizes when input voltage is applied to the drive and remains energized until the drive has faulted and unsuccessfully attempted five restarts, or input voltage is removed.
@ SPEED	AT SPEED - The relay energizes when the drive reaches the speed setpoint. To avoid a "chattering" relay (energizing and de-energizing), due to small fluctuations in speed, the relay will remain energized as long as the actual speed is within ± 3 Hz of the speed setpoint.
ABOVE #3	ABOVE SPEED #3 - The relay energizes when the output frequency exceeds the SPEED #3 value, and de-energizes when the output frequency returns to a value lower than the SPEED #3 value. See Parameter 3 - SPEED #3 in Section 18.0 - DESCRIPTION OF PARAMETERS.
I LIMIT	CURRENT LIMIT - The relay energizes when the drive is operating in current limit. Once the current limit relay is energized, it remains energized for a minimum of 500ms, regardless of whether the drive is still in current limit. At the end of the 500ms interval, the relay will de-energize if the drive is no longer in current limit. See Parameter 16 - CURRENT in Section 18.0 - DESCRIPTION OF PARAMETERS.
AUT/MAN	AUTO/MANUAL MODE - The relay energizes when the drive is in the AUTOMATIC mode, and de-energizes in the MANUAL mode. Refer to Section 14.2.6 - SPEED REFERENCE SELECTION.

7.0 INSTALLATION

WARNING!

DRIVES MUST NOT BE INSTALLED WHERE SUBJECTED TO ADVERSE ENVIRONMENTAL CONDITIONS! DRIVES MUST NOT BE INSTALLED WHERE SUBJECTED TO: COMBUSTIBLE, OILY, OR HAZARDOUS VAPORS OR DUST; EXCESSIVE MOISTURE OR DIRT; STRONG VIBRATION; EXCESSIVE AMBIENT TEMPERATURES. CONSULT AC TECHNOLOGY FOR MORE INFORMATION ON THE SUITABILITY OF A DRIVE TO A PARTICULAR ENVIRONMENT.

The drive should be mounted on a smooth vertical surface capable of safely supporting the unit without vibrating. The LCD display has an optimum field of view, this should be considered when determining the mounting position.

Chassis models must be installed in an electrical enclosure which will provide complete mechanical protection and maintain uniform internal temperature within the drive's ambient operating temperature rating. All drive models MUST be mounted in a vertical position for proper heatsink cooling.

Maintain a minimum spacing around the drive 2 inches for units rated 5 HP and below, 4 inches for units rated 7.5-25 HP, and 6 inches for units rated 30-50 HP.

Fans or blowers should be used to insure proper cooling in tight quarters. Do not mount drives above other drives or heat producing equipment that would impede the cooling of the drive. Note the ambient operating temperature ratings for each drive model.

If it is necessary to drill or cut the drive enclosure or panel, extreme care must be taken to avoid damaging drive components or contaminating the drive with metal fragments (which cause shorting of electrical circuits). Cover drive components with a clean cloth to keep out metal chips and other debris. Use a vacuum cleaner to clean drive components after drilling, even if chips do not appear to be present. Do not attempt to use positive air pressure to blow chips out of drive, as this tends to lodge debris under electronic components. Contaminating the drive with metal chips can cause drive failure and will void the warranty.

7.1 INSTALLATION AFTER A LONG PERIOD OF STORAGE

WARNING!
Severe damage to the drive can result if it is operated after a long period of storage or inactivity without reforming the DC bus capacitors!

If input power has not been applied to the drive for a period of time exceeding 6 months (due to storage, etc), the electrolytic DC bus capacitors within the drive can change internally, resulting in excessive leakage current. This can result in premature failure of the capacitors if the drive is operated after such a long period of inactivity or storage.

In order to reform the capacitors and prepare the drive for operation after a long period of inactivity, apply input power to the drive for 2 hours prior to actually operating the drive/motor system.

7.2 EXPLOSION PROOF APPLICATIONS

Explosion proof motors that are not rated for inverter use lose their certification when used for variable speed. Due to the many areas of liability that may be encountered when dealing with these applications, the following statement of policy applies:

"AC Technology Corporation, Inc. inverter products are sold with no warranty of fitness for a particular purpose or warranty of suitability for use with explosion proof motors. AC Technology Corporation, Inc. accepts no responsibility for any direct, or incidental or consequential loss, cost, or damage that may arise through the use of its AC inverter products in these applications. The purchaser expressly agrees to assume all risk of any loss, cost, or damage that may arise from such application. AC Technology Corporation, Inc. or AC Technology Corporation's engineering department will not knowingly approve applications involving explosion proof motors."

8.0 INPUT AC REQUIREMENTS

WARNING!

Hazard of electrical shock! Disconnect incoming power and wait three minutes before servicing the drive. Capacitors retain charge after power is removed.

8.1 INPUT AC POWER REQUIREMENTS

8.1.1 VOLTAGE:

The input voltage must match the drive's nameplate voltage rating. Voltage fluctuation must not vary by greater than 10% overvoltage or 15% undervoltage.

NOTE: Drives with dual rated input voltage must be programmed for the proper supply voltage - see Parameter 0 - LINE VOLTS in Section 18.0 - DESCRIPTION OF PARAMETERS SECTION.

The drive is suitable for use on a circuit capable of delivering not more than 18,000 RMS symmetrical amperes, at the drive's rated voltage.

Three phase voltage imbalance must be less than 2.0% phase to phase. Excessive phase to phase imbalance can cause severe damage to the drive's power components.

Motor voltage should match line voltage in normal applications. The drive's maximum output voltage will equal the input voltage. Use extreme caution when using a motor with a voltage rating which is different from the input line voltage.

8.1.2 kVA RATINGS:

If the kVA rating of the AC supply transformer is greater than ten times the input kVA rating of the drive, a drive isolation transformer, or a 2 - 3% input line reactor (also known as a choke) must be added.

8.2 INPUT FUSING AND DISCONNECT REQUIREMENTS

A circuit breaker or a disconnect switch with fuses must be provided in accordance with the National Electric Code (NEC) and all local codes.

The MC1000 drive is capable of withstanding up to 150% current overload for 60 seconds. Select a fuse or magnetic trip circuit breaker rated at 1.5 times the input current rating of the drive (the minimum fuse size should be 10 amps, regardless of input current rating). Refer to Section 5.0 – MC1000 RATINGS.

Minimum voltage rating of the protection device should be 250 Vac for 240/120 Vac and 240/200 Vac rated drives, and 600 Vac for 480/400 Vac and 590/480 Vac drives.

Current limiting type fuses should be used when input fusing is required. Select fuses with low I^2T values, rated at 200,000 AIC. Recommended fuses are Bussman type KTK-R. Similar fuses with equivalent ratings by other manufacturers may also be acceptable.

9.0 VOLTAGE SELECTION

9.1 INPUT VOLTAGE RATINGS

M1100 Series drives are rated for 240/120 Vac, 50-60 Hz input. The drive will function with input voltage of 120 Vac (+ 10%, -15%) at 48 to 62 Hz when wired for 120 Vac input, or with input voltage of 240 Vac (+ 10%, - 15%), at 48 to 62 Hz, when wired for 240 Vac input.

M1200 Series drives are rated for 240/200 Vac, 50-60 Hz input. The drive will function with input voltages of 200 to 240 Vac (+ 10%, - 15%), at 48 to 62 Hz.

M1400 Series drives are rated for 480/400 Vac, 50-60 Hz input. The drive will function with input voltages of 400 to 480 Vac (+ 10%, - 15%), at 48 to 62 Hz.

M1500 Series drives are rated for 590/480 Vac, 50-60 Hz input. The drive will function with input voltages of 480 to 590 Vac (+ 10%, - 15%), at 48 to 62 Hz.

NOTE: Parameter 0 - LINE VOLTS must be programmed according to the applied input voltage. See Section 18.0 - DESCRIPTION OF PARAMETERS.

10.0 POWER WIRING

WARNING!

Hazard of electrical shock. Disconnect incoming power and wait three minutes before servicing the drive. Capacitors retain charge after power is removed.

Note drive input and output current ratings and check applicable electrical codes for required wire type and size, grounding requirements, over-current protection, and incoming power disconnect, before wiring the drive. Size conservatively to minimize voltage drop.

Input fusing and a power disconnect switch or contactor MUST be wired in series with terminals L1, L2, and L3 (L1 and L2 if input is single phase). If one has not been supplied by AC Technology Corporation, a disconnect means must be wired during installation. This disconnect must be used to power down the drive when servicing, or when the drive is not to be operated for a long period of time, but should not be used to start and stop the motor. Repetitive cycling of a disconnect or input contactor (more than once every two minutes) may cause damage to the drive.

10.1 WIRING FOR SINGLE PHASE OR THREE PHASE INPUT

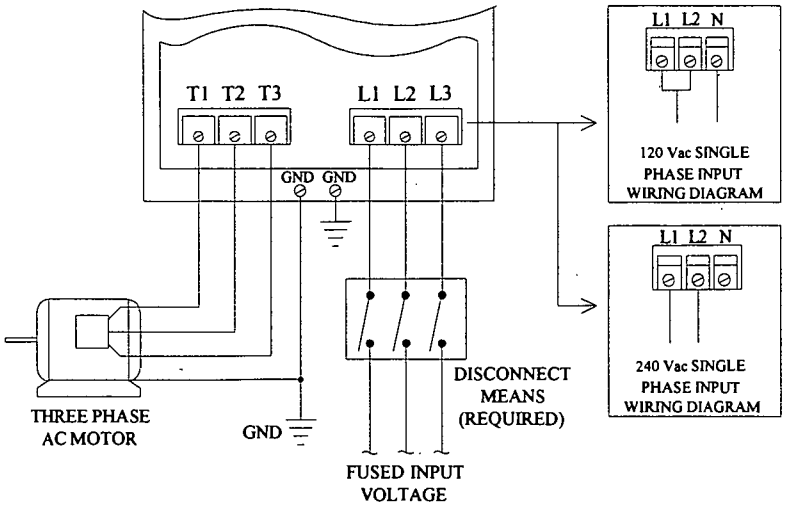
If the drive is nameplated for 240/120 Vac single phase input, wire the input to terminals L1 and N and jumper terminals L1 to L2 for 120 Vac input voltage, or wire to terminals L1 and L2 (do not wire to N) for 240 Vac input voltage. Refer to Section 11.0 - MC3000 POWER WIRING DIAGRAM.

If the drive is nameplated for three phase input only, wire the input to terminals L1, L2, and L3.

All three power output wires, from terminals T1, T2, and T3 to the motor, must be kept tightly bundled and run in a separate conduit away from all other power and control wiring.

Do not install contactors between the drive and motor without consulting AC Technology Corporation for more information.

11.0 MC1000 POWER WIRING DIAGRAM



WARNING!

Do not connect incoming AC power to output terminals T1, T2, or T3. Severe damage to the drive will result.

INSTALL, WIRE, AND GROUND IN ACCORDANCE WITH ALL APPLICABLE CODES.

NOTES:

1. Wire the motor for the proper voltage per the output rating of the drive. Motor wires MUST be run in a separate steel conduit away from control wiring and incoming AC power wiring.
2. Do not install contactors between the drive and the motor without consulting AC Technology for more information. Failure to do so may result in drive damage.
3. Remove any existing, and do not install, power factor correction capacitors between the drive and the motor. Failure to do so will result in drive damage.
4. Use only UL and CSA listed and approved wire.
5. Minimum wire voltage ratings: 300 V for 120, 200 and 240 Vac systems, and 600 V for 400, 480, and 590 Vac systems.
6. Wire guage must be based on a minimum of 150% of the rated output current of the drive, and a minimum 75°C insulation rating. Use copper wire only.
7. Wire and ground in accordance with NEC or CEC, and all applicable local codes.

12.0 INITIAL POWER UP

WARNING!

Hazard of electrical shock! Wait three minutes after disconnecting incoming power before servicing drive. Capacitors retain charge after power is removed.

Before attempting to operate the drive, motor, and driven equipment be sure all procedures pertaining to installation and wiring have been properly followed.

WARNING!

Severe damage to the drive can result if it is operated after a long period of storage or inactivity without reforming the DC bus capacitors!

If input power has not been applied to the drive for a period of time exceeding 6 months (due to storage, etc), the electrolytic DC bus capacitors within the drive can change internally, resulting in excessive leakage current. This can result in premature failure of the capacitors if the drive is operated after such a long period of inactivity or storage.

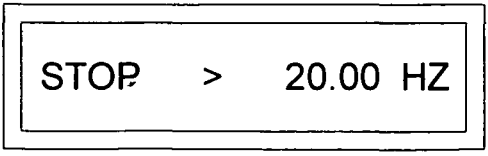
In order to reform the capacitors and prepare the drive for operation after a long period of inactivity, apply input power to the drive for 2 hours prior to actually operating the drive/motor system.

Disconnect the driven load from the motor. Verify that the drive input terminals (L1, L2, and L3) are wired to the proper input voltage per the nameplate rating of the drive.

WARNING!

DO NOT connect incoming AC power to output terminals T1, T2, and T3! Do not cycle input power to the drive more than once every two minutes. Damage to the drive will result.

Energize the incoming power line. The LCD display should light and flash "TESTING" and then show the voltage and horsepower rating of the drive. The display should then show "STOP > 20.00 HZ" which indicates that the drive is in a STOP condition, and the speed setpoint is 20.00 Hz:



If the display does not appear, remove the incoming power, wait three minutes for the bus capacitors to discharge, and verify correct installation and wiring. If the wiring is correct, re-apply incoming power and note the display for drive status. If the display still does not appear call the factory for assistance. If the drive powers up correctly, follow the procedure given below to check the motor rotation:

1. Use the DOWN ARROW key to decrease the speed setpoint to the minimum value allowed (.50 Hz if Parameter 10 - MIN FRQ has not been changed).

2. Press the START key. The drive should indicate RUN, but if the speed setpoint is .50 Hz, the motor may not rotate. Press the UP ARROW key to increase the speed setpoint until the motor starts to rotate.

3. If the motor is rotating in the wrong direction, press the STOP key and remove power from the drive. Wait three minutes for the bus capacitors to discharge, and swap any two of the motor wires connected to T1, T2, and T3.

NOTE: The drive is phase insensitive with respect to incoming line voltage. Therefore, to change the motor rotation, the phases must be swapped at the drive output terminals or at the motor.

13.0 KEYPAD CONTROL

The drive can be operated in a number of different ways: keypad (LOCAL), control devices wired to the terminal strip (REMOTE), serial communications (SERIAL), or a combination of the terminal strip and either the keypad or serial communications. The drive should first be operated from the keypad during initial start-up. Refer to Sections 14.0 - CONTROL WIRING, and 18.0 - DESCRIPTION OF PARAMETERS for information on remote operation.

13.1 KEYPAD FUNCTIONS

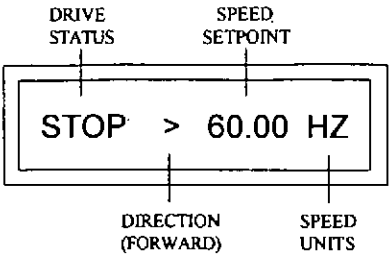
START/STOP	To start the drive, press the START key. To stop the drive, press the STOP key. **NOTE:** The STOP key is active in both LOCAL and REMOTE modes.
SPEED SETPOINT	To increase the speed setpoint, press the UP arrow key. To decrease the speed setpoint, press the DOWN arrow key.
FORWARD/REVERSE	To change rotation direction, press the FWD/REV key and then press the ENTER key within three seconds. **NOTE:** Parameter 27 - ROTATION must be set to FWD & REV for this key to be active.
AUTO/MANUAL	To toggle between AUTOMATIC (terminal strip) and MANUAL (keypad) speed control, press the AUTO/MAN key and then press the ENTER key within three seconds. **NOTE:** Parameter 28 - AUTO/MAN must be set to BOTH for this key to be active. See Section 14.0 - CONTROL WIRING for information on automatic speed references.
FAULT RESET	Use the STOP key to reset a fault. If the fault condition has passed, pressing the STOP key will reset the fault and return the drive to a STOP condition. **NOTE:** If an OUTPUT fault occurs, there will be a 30 second delay before the fault can be cleared using the STOP key.

13.2 MC1000 DISPLAY

The following describes the possible display configurations for the MC1000 Series drive.

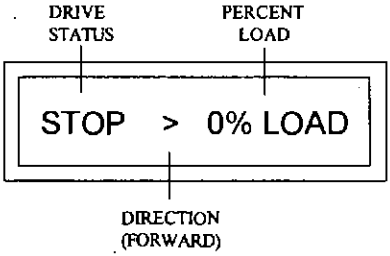
13.2.1 MC1000 DISPLAY IN STOP MODE

When the drive is in the STOP mode, there are three possible displays. The first is the SPEED display, which looks like this:

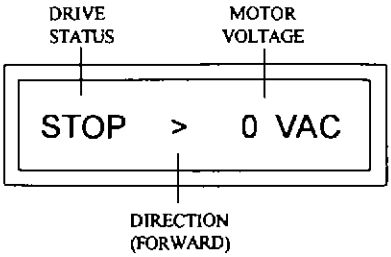


NOTE: See Parameter 31 - UNITS for the SPEED UNITS display options.

Pressing the ENTER key will change the display from the SPEED indication to the % LOAD indication:



Pressing the ENTER key again will change the display from the % LOAD indication to the VAC (motor voltage) indication:



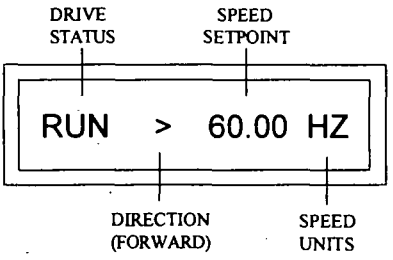
Pressing ENTER again will change the display back to the SPEED indication.

The following table shows the possible DRIVE STATUS indications that can appear on the drive display:

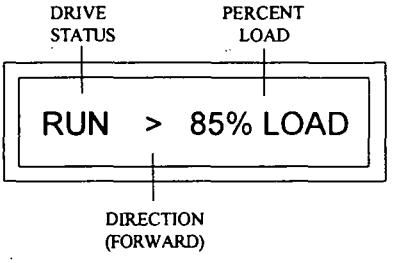
DRIVE STATUS TABLE	
DISPLAY	**DESCRIPTION**
STOP	Drive is in STOP mode - No output to the motor.
RUN	Drive is in RUN mode and is within ± 3 Hz of the speed setpoint.
FAULT	Drive has shut down due to a FAULT condition. If the fault condition has passed, pressing the STOP key will clear the fault and return the drive to the STOP mode.
LOCK	Drive is in FAULT LOCKOUT after five unsuccessful restart attempts.
BRAKE	DC BRAKE is energized.
LIMIT	Drive is in CURRENT LIMIT due to an overloaded motor, or ACCEL is too fast.
F DEC	Drive is in DECEL FREEZE because DECEL is too fast.

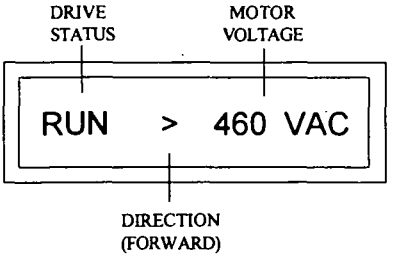
13.2.2 MC1000 DISPLAY IN RUN MODE

When the drive is in the RUN mode, the default display will look like this:



As in the STOP mode, the ENTER key can be used to toggle the display from SPEED to % LOAD to VAC (motor voltage):

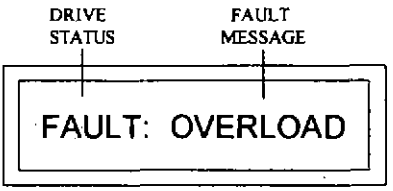




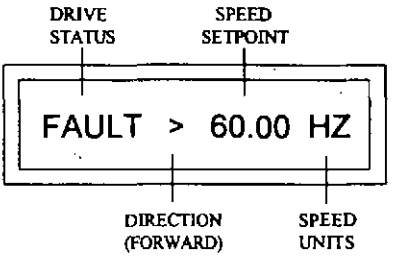
NOTE: During acceleration and deceleration to the SPEED SETPOINT, the DRIVE STATUS will show the actual drive speed. When the SPEED SETPOINT is reached, the DRIVE STATUS will change to RUN (or STOP if the drive is decelerating to a STOP).

13.2.3 MC1000 DISPLAY IN FAULT MODE

When the drive trips into a fault, the display will automatically change to the FAULT display, which indicates the FAULT MESSAGE:



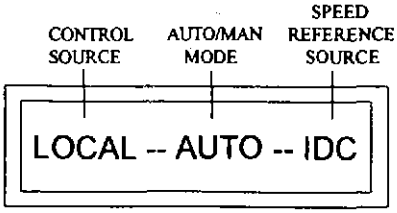
In FAULT mode, the ENTER key will toggle the display between four screens: FAULT, SPEED, % LOAD and VAC. The DRIVE STATUS for these displays will be FAULT. An example is shown below of the drive in the FAULT mode displaying SPEED.



NOTE: To clear a FAULT, press the STOP key, issue a remote STOP command at TB-1, or use TB-13D (refer to Parameter 50 - TB13D).

13.2.4 MC1000 DISPLAY IN AUXILIARY MODE

If the ENTER key is held down, the display will enter the auxiliary mode, which indicates the control source (LOCAL, REMOTE, or SERIAL), AUTO or MANUAL mode, and the speed reference source. When the ENTER key is released, the display will return to the previous screen. Examples of the auxiliary mode displays are shown below:



The table below shows the possible SPEED REFERENCE SOURCE indications for the auxiliary mode display:

SPEED REFERENCE SOURCE TABLE	
DISPLAY	**DESCRIPTION**
KEY	KEYPAD - UP and DOWN arrow keys.
VDC	0 - 10 VDC analog input at TB-5A.
IDC	4 - 20 mA analog input at TB-5B.
SP#1	PRESET SPEED #1
SP#2	PRESET SPEED #2
SP#3	PRESET SPEED #3
SP#4	PRESET SPEED #4
JOG	JOG SPEED - In JOG mode, JOG SPEED = SPEED #2.
MOP	MOTOR OPERATED POT - Increase and decrease drive speed using contact closures at TB-13A (DEC FREQ) mode when the drive is in LOCAL and AUTO mode.

14.0 CONTROL WIRING

14.1 GENERAL

14.1.1 KEYPAD CONTROL

The drive can be controlled by the keypad or by control devices wired to the terminal strip. The drive will run from the keypad "out of the box", requiring no connections to the terminal strip. Refer to Section 13.0 - KEYPAD CONTROL.

14.1.2 CONTROL WIRING VS. POWER WIRING

External control wiring MUST be run in a separate conduit away from all other input and output power wiring. If control wiring is not kept separate from power wiring, electrical noise may be generated on the control wiring that will cause erratic drive behavior. Use twisted wires or shielded cable grounded at the drive chassis ONLY. Recommended control wire is Belden 8760 (2-wire) or 8770 (3-wire), or equivalent.

14.1.3 TB-2: CIRCUIT COMMON

The TB-2 terminals are used as circuit common for the start/stop, forward/reverse, input select, local/remote, analog input, and analog output functions. There are three TB-2 terminals available on the terminal strip, and they are all internally connected to each other on the main control board. If necessary TB-2 may be connected to chassis ground.

NOTE: TB-2 MUST be connected to chassis ground when using serial communications.

14.1.4 SURGE SUPPRESION ON RELAYS

Current and voltage surges and spikes in the coils of contactors, relays, and solenoids, near or connected to the drive can cause erratic drive operation. A snubber circuit should be used on relay and contactor coils associated with the inverter. For AC loads, snubbers should consist of a resistor and a capacitor in series across the coil. For DC loads, a free-wheeling or flyback diode should be placed across the coil.

14.2 START/STOP AND SPEED CONTROL

14.2.1 REMOTE MODE SELECTION

The REMOTE mode can be selected by one of two methods:

1. Program Parameter 30 - CONTROL to REMOTE, or:

2. Program CONTROL to BOTH, set the TB-13A or TB-13C function to LOCAL SELECT, and DO NOT make a contact closure between TB-13A or TB-13C and TB-2 (making the contact closure will select LOCAL mode).

WARNING!

If CONTROL is set to LOCAL, TB-1 is disabled and **CANNOT** be used as a STOP switch! Incorrect use of TB-1 may result in damage to equipment and/or injury to personnel! See Parameter 30 - CONTROL.

WARNING!

STOP (TB-1) and EXTERNAL FAULT (TB-13D) circuitry may be disabled if parameters are reset to factory defaults! The drive must be reprogrammed after a RESET in order to insure proper operation (see Parameter 65 - PROGRAM).

FAILURE TO DO SO MAY RESULT IN DAMAGE TO EQUIPMENT AND/OR INJURY TO PERSONNEL!

14.2.2 TWO-WIRE START/STOP CONTROL

A two-wire start/stop circuit can be accomplished by one of three methods on the MC Series drive. Follow the appropriate procedure listed below:

FORWARD ROTATION ONLY

1. Select REMOTE mode (see above).

2. Connect a jumper between TB-12A and TB-2 to provide a permanent START command to the drive.

3. Wire a normally open maintained contact between TB-1 and TB-2. Closing this contact will RUN the drive and opening this contact will STOP the drive.

FORWARD and REVERSE ROTATION

1. Select REMOTE mode (see above).

2. Program Parameter 27 - ROTATION to FWD & REV to allow rotation in both directions.

3. Program Parameter 49 - TB13C to START REVERSE. This will force TB-12A to act as START FORWARD.

4. Select the desired rotation by closing the appropriate terminal (TB-12A for forward, or TB-13C for reverse) to TB-2. This can be done with a toggle switch or equivalent circuit.

5. Wire a normally open maintained contact between TB-1 and TB-2. Close this contact to RUN the drive, and open this contact to STOP the drive.

14.2.3 ALTERNATE TWO-WIRE START/STOP CONTROL METHOD

WARNING!

This method requires TB-13C to be set for RUN REVERSE, which will disable TB-1 as a STOP switch! Incorrect use of TB-1 may result in damage to equipment and/or injury to personnel! Refer to Parameter 49 - TB13C.

FORWARD ROTATION ONLY

1. Select REMOTE mode (see above).

2. Program Parameter 27 - ROTATION to FWD & REV.

3. Program Parameter 49 - TB13C to RUN REVERSE. This will force TB-12A to act as RUN FORWARD.

4. Wire a normally open maintained contact between TB-12A and TB-2. Close this contact to RUN the drive in FORWARD, and open this contact to STOP the drive.

FORWARD and REVERSE ROTATION with TWO RUN CONTACTS

1. Follow 1-4 above and also wire a normally open maintained contact between TB-13C and TB-2. Close this contact to RUN the drive in REVERSE, and open this contact to STOP the drive.

FORWARD and REVERSE ROTATION with ONE RUN CONTACT

1. Follow 1-3 above and wire a normally open maintained contact between TB-2 and the common of a single-pole, double-throw toggle switch. Wire the poles of the toggle switch to TB-12A and TB-13C. Select the desired rotation with the toggle switch. Close the maintained contact to RUN, and open to STOP.

14.2.4 THREE-WIRE START/STOP CONTROL

A three-wire start/stop circuit can be accomplished by one of two methods on the MC Series drive. Follow the appropriate procedure listed below:

FORWARD ROTATION ONLY

1. Select REMOTE mode (see above).

2. Wire a normally closed momentary STOP contact between TB-1 and TB-2. Momentarily open this contact to STOP the drive.

3. Wire a normally open momentary START contact between TB-12A and TB-2. Momentarily close this contact to START the drive.

FORWARD and REVERSE ROTATION with TWO START CONTACTS

1. Select REMOTE mode (see above).

2. Program Parameter 27 - ROTATION to FWD & REV.

3. Program Parameter 49 - TB13C to START REVERSE.

4. Wire a normally closed momentary STOP contact between TB-1 and TB-2. Momentarily open this contact to STOP the drive.

5. Wire a normally open momentary START FORWARD contact between TB-12A and TB-2. Momentarily close this contact to START the drive in FORWARD.

6. Wire a normally open momentary START REVERSE contact between TB-13C and TB-2. Momentarily close this contact to START the drive in REVERSE.

NOTE: If the drive is operating in one direction, and is given the START command for the opposite direction, the drive will decelerate to 0 Hz and then accelerate back to the speed setpoint in the opposite direction.

FORWARD and REVERSE ROTATION with ONE START CONTACT

1. Follow 1-4 above and wire a normally open momentary contact between TB-2 and the common of a single-pole, double-throw toggle switch. Wire the poles of the toggle switch to TB-12A and TB-13C. See the wiring diagram in Section 15.3.

14.2.5 SPEED REFERENCE SIGNALS

The drive allows for three analog speed reference inputs: a speed potentiometer (10,000 Ohm), 0-10 VDC, or 4-20 mA.

SPEED POT	Connect the wiper to terminal TB-5A, and connect the high and low end leads to terminals TB-6 and TB-2, respectively.
0-10 VDC	Wire the positive to terminal TB-5A and the negative to terminal TB-2. TB-5A input impedance is 200 kilohms.
4-20 mA	Wire the positive to terminal TB-5B and the negative to terminal TB-2. TB-5B input impedance is 100 ohms.

14.2.6 SPEED REFERENCE SELECTION

AUTO/MAN vs. LOCAL/REMOTE

In the MC Series drive, AUTO/MAN refers to speed control, and LOCAL/REMOTE refers to START/STOP control. AUTOMATIC or MANUAL speed control selection is affected by whether the drive is in LOCAL or REMOTE mode.

In LOCAL mode (keypad start/stop control), AUTOMATIC and MANUAL speed control is selected using Parameter 28 - AUTO/MAN. When set to BOTH, the AUTO/MAN button on the keypad is active and is used to toggle between MANUAL (keypad or speed pot) and AUTOMATIC (0-10 VDC, 4-20 mA, or preset speeds) speed control. When set to MANUAL, speed control is governed by Parameter 29 - MANUAL, which selects either KEYPAD or 0-10 VDC (speed pot). When set to AUTOMATIC, one of the TB-13 input selects must be set to the desired speed reference, and that terminal must be closed to TB-2. The drive will then respond to the automatic speed reference. If one of the TB-13 input selects is set for a speed reference, and the contact closure is not made to TB-2, speed control will remain in AUTO mode, but the drive will respond to the keypad or speed pot, depending on Parameter 29 - MANUAL. Therefore, if the Form C relay or open-collector outputs are set to indicate AUTO/MAN mode, they will still indicate AUTO mode.

In REMOTE mode (terminal strip start/stop control), speed control is only selected using the TB-13 input selects. For AUTOMATIC speed control, one of the TB-13 input selects must be set to the desired speed reference, and that terminal must be closed to TB-2. The drive will then respond to the automatic speed reference. If none of the TB-13 input selects are closed to TB-2, speed control will default to MANUAL mode, and the drive will respond to the keypad or speed pot, depending on Parameter 29 - MANUAL. This will cause the Form C relay or open-collector outputs to indicate MANUAL mode if set to indicate AUTO/MAN mode.

0 - 10 VDC and 4 - 20 mA INPUT SIGNALS

TB-13A, TB-13B, and TB-13C can all be programmed to select 0-10 VDC or 4-20 mA input.

PRESET SPEEDS

TB-13A can be programmed to select SPEED #1, TB-13B to select SPEED #2, and TB-13C to select SPEED #3. Closing any two of these terminals to TB-2 will select SPEED #4. Refer to Parameters 1-4: SPEED #1 - #4 in Section 18.0 - DESCRIPTION OF PARAMETERS.

JOG

The JOG function only works when the drive is in REMOTE mode, and only when the drive is in a STOP condition. TB-13B can be programmed to select either JOG FORWARD or JOG REVERSE. The jog speed is set by PRESET SPEED #2. Close TB-13B to TB-2 to JOG, and open the contact to STOP.

WARNING!
When operating in JOG mode, the STOP key **WILL NOT** stop the drive. To stop the drive, the contact between TB-13B and TB-2 must be opened.

MOP - MOTOR OPERATED POT

TB-13A and TB-13B are used for this function, which sets the speed of the drive using contacts wired to the terminal strip. Program TB-13A to select DEC FREQ, and program TB-13B to select INC FREQ. Closing TB-13A to TB-2 will activate the DEC FREQ function, and will cause the speed setpoint to decrease until the contact is opened. DEC FREQ will operate when the drive is in RUN mode or STOP mode. Closing TB-13B to TB-2 will activate the INC FREQ function, and will cause the speed setpoint to increase until the contact is opened. INC FREQ will only operate when the drive is in RUN mode.

NOTE: If TB-13A, TB-13B, and TB-13C are all programmed to select speed references, and two or three of the terminals are closed to TB-2, the higher terminal has priority and will override the others. For example, if TB-13A is programmed to select 0-10VDC, and TB-13C is programmed to select PRESET SPEED #3, closing both terminals to TB-2 will cause the drive to respond to PRESET SPEED #3, because TB-13C overrides TB-13A.

14.2.7 ANALOG OUTPUT SIGNALS

There are two terminals that can supply analog output signals proportional to output frequency or load. Terminal TB-10A can provide a 0-10 VDC or a 2-10 VDC signal proportional to output frequency, and TB-10B can provide the same signals proportional to load. The 2-10 VDC signals can be converted to a 4-20 mA signal using a resistor in series with the signal such that the total load resistance is 500 Ohms. See Parameters: 42 - TB10A OUT, 43 - @TB10A, 44 - TB10B OUT, and 45 - @TB10B in Section 18.0 - DESCRIPTION OF PARAMETERS.

NOTE: These analog output signals cannot be used with "loop-powered" devices that derive power from a 4-20 mA signal.

14.2.8 DRIVE STATUS OUTPUT CONTACTS

The control board has one Form C relay at terminals TB-16, TB-17, and TB-18. Contacts are rated 2 amps at 28 VDC or 120 Vac.

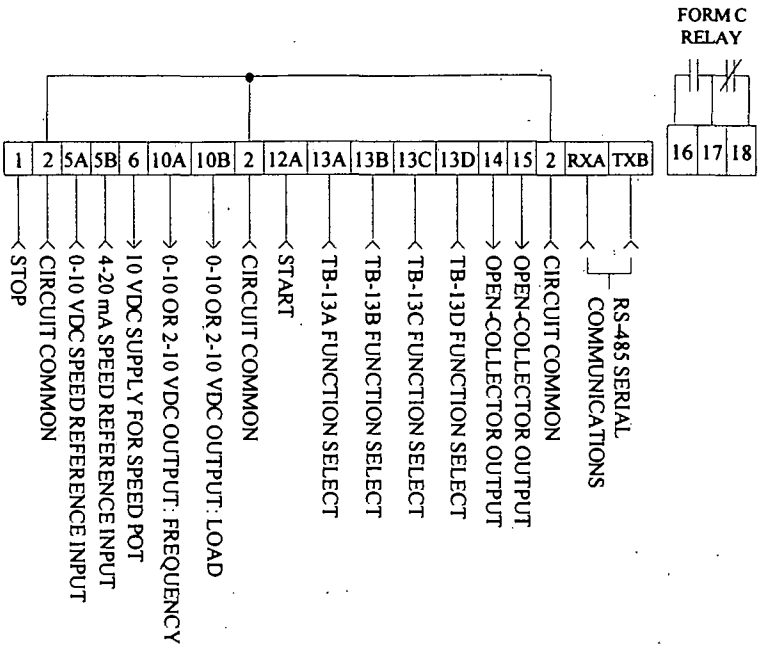
There are also two open-collector outputs at terminals TB-14 and TB-15. The open-collector circuit is a current-sinking type rated at 30 VDC and 40 mA maximum. An external power supply (30 VDC max) must be used to power the open-collector outputs. The drive does not have a dedicated power supply for the open-collector outputs.

The Form C relay and the open collector outputs can be programmed to indicate any of the following: RUN, FAULT, /FAULT (INVERSE FAULT), LOCK (FAULT LOCKOUT), AT SPEED, ABOVE #3, I LIMIT (CURRENT LIMIT), or AUTO/MAN. See Parameters: 52 - TB14 OUT, 53 - TB15 OUT, and 54 - RELAY. Refer to Section 6.2.5 for a complete description of each of these status indications.

15.0 MC1000 CONTROL WIRING DIAGRAMS

15.1 MC1000 TERMINAL STRIP

Shown below is the terminal strip on the main control board, along with a brief description of the function of each terminal. Wiring shown above the terminal strip indicates internal wiring on the main control board.

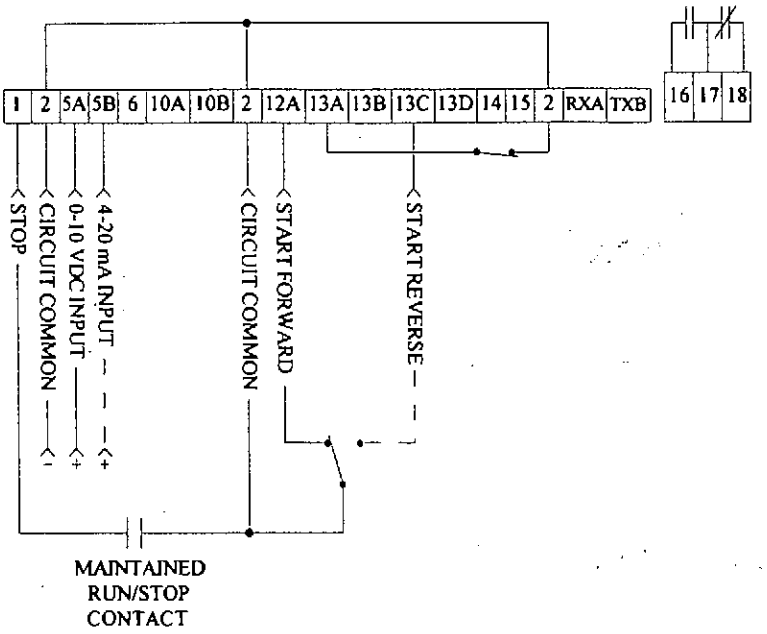


NOTE: The function of terminals TB-10A, TB-10B, TB-13A, TB-13B, TB-13C, TB-13D, TB-14, TB-15, TB-16, and TB-18 are dependent on the programming of certain parameters. In most cases, the name of the parameter matches the number of the terminal, allowing quick and easy programming of the terminals to suit the application. The exception is TB-16 and TB-18, which are governed by Parameter 54 - RELAY.

A complete description of operating the drive in the REMOTE mode can be found in Section 14.2. The following diagrams provide a quick reference to wire the drive for the most common configurations.

15.2 TWO-WIRE START/STOP CONTROL

Shown below is the wiring diagram for a typical two-wire start/stop control scheme, using one maintained contact (such as that from a PLC) for RUN and STOP commands. Close the contact to RUN, and open the contact to STOP. Also shown is the wiring for a 0-10 VDC or 4-20 mA speed reference signal.



NOTES:

1. Close TB-1 to TB-2 to RUN, and open to STOP.

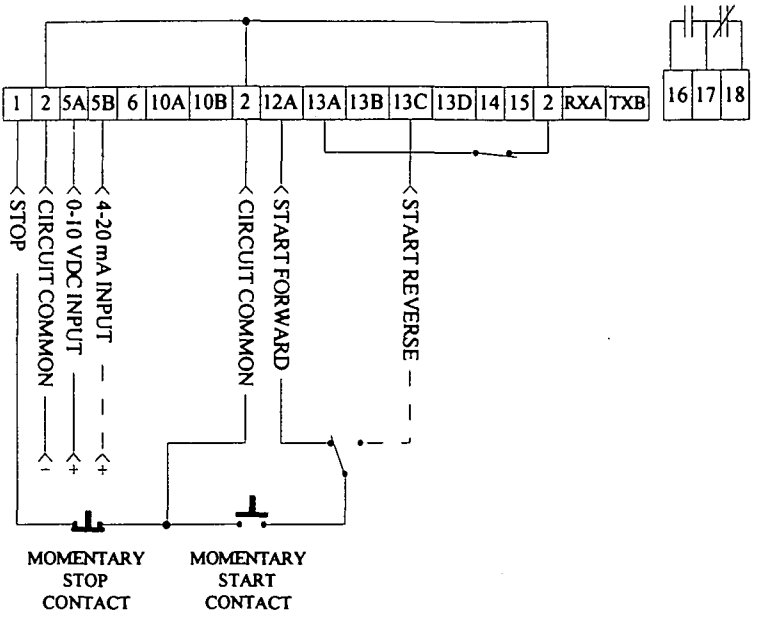
2. If REVERSE direction is required, ROTATION must be set to FWD&REV, and TB-13C must be set to START REVERSE (refer to Parameters: 27 – ROTATION, and 49 - TB13C).

3. Program TB-13A, 13B, or 13C to select the appropriate speed reference signal that will control the drive speed (refer to Parameters 47, 48, and 49). When that TB-13 terminal is closed to TB-2, the drive will respond to the selected speed reference signal. In the diagram above, TB-13A is programmed to select either a 0-10 VDC or 4-20 mA signal.

4. If the contact closure is not made between TB-13A and TB-2 to select a speed reference, the drive will default to MANUAL speed control, which is determined by Parameter 29 - MANUAL.

15.3 THREE-WIRE START/STOP CONTROL

Shown below is the wiring diagram for a typical three-wire start/stop control scheme, using momentary contacts (such as pushbuttons) for START and STOP commands. Also shown is the wiring for a 0-10 VDC or 4-20 mA speed reference signal.



NOTES:

1. Momentarily close TB-12A to TB-2 to START, and momentarily open TB-1 to TB-2 to STOP.

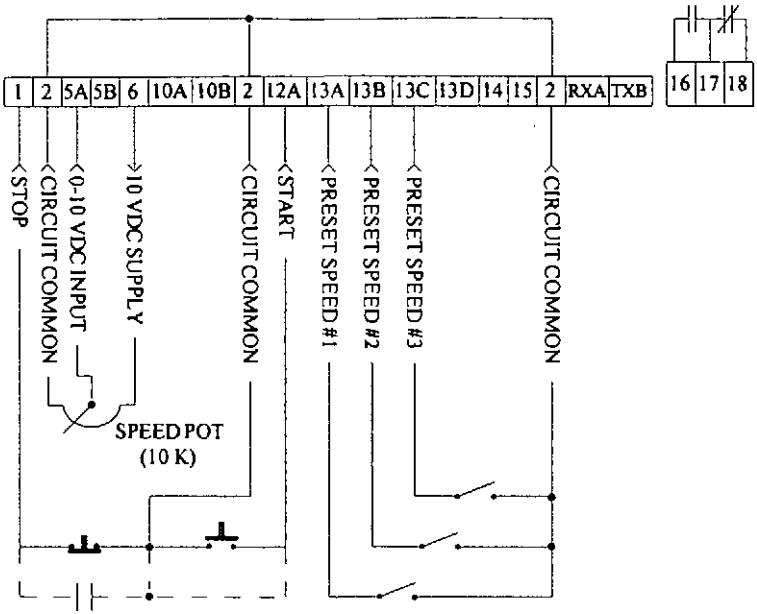
2. If REVERSE direction is required, ROTATION must be set to FWD&REV, and TB-13C must be set to START REVERSE (refer to Parameters: 27 - ROTATION, and 49 - TB13C).

3. Program TB-13A, 13B, or 13C to select the appropriate speed reference signal that will control the drive speed (refer to Parameters 47, 48, and 49). When that TB-13 terminal is closed to TB-2, the drive will respond to the selected speed reference signal. In the diagram above, TB-13A is programmed to select either a 0-10 VDC or 4-20 mA signal.

4. If the contact closure is not made between TB-13A and TB-2 to select a speed reference, the drive will default to MANUAL speed control, which is determined by Parameter 29 - MANUAL.

15.4 SPEED POT AND PRESET SPEED CONTROL

Shown below is the wiring diagram for a control scheme that utilizes a speed pot and PRESET SPEEDS for speed control, and either a two-wire or three-wire START/STOP circuit:



NOTES:

1. Program the PRESET SPEEDS (Parameters 1-4) to the desired values.

2. Program TB-13A to select SPEED #1, TB-13B to select SPEED #2, and TB-13C to select SPEED #3 (refer to Parameters 47, 48, and 49).

3. To select a preset speed, close the appropriate terminal to TB-2. To select SPEED #4, close any two of the preset speed terminals to TB-2.

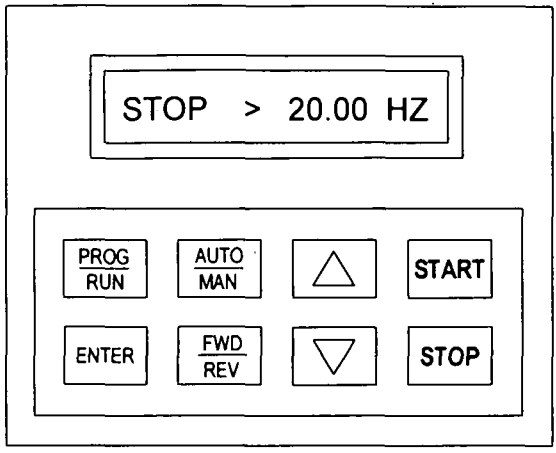
4. Speed pot control can be selected by one of two methods. If none of the preset speeds are selected (all TB-13 terminals are open), the drive will default to speed pot control if Parameter 29 - MANUAL is set to 0-10 VDC. The speed pot can also be selected if one of the TB-13 terminals is programmed to select 0-10 VDC and that terminal is closed to TB-2.

5. If REVERSE rotation is required, TB-13C cannot be used to select SPEED #3. TB-13C must be programmed to select RUN REVERSE or START REVERSE, leaving only TB-13A and TB-13B to select preset speeds.

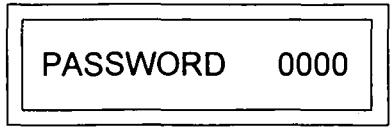
16.0 PROGRAMMING THE MC1000 DRIVE

16.1 PROGRAMMING THE PARAMETERS

The MC1000 keypad serves two purposes: operating the drive when in the LOCAL mode, and programming the parameters for particular applications. The keypad is shown below, along with the display that should appear when the drive is first powered up:



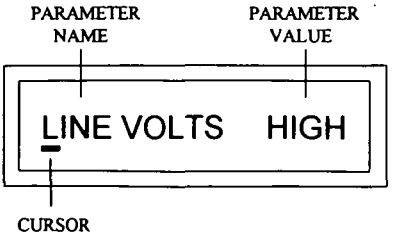
To program the drive, the PROGRAM mode must be entered by pressing the PROG/RUN button. If the password protection is disabled, pressing the PROG/RUN button will result in direct entry into the PROGRAM mode. If the password protection is enabled, the PASSWORD prompt will appear when an attempt is made to enter the PROGRAM mode. The PASSWORD prompt appears as follows:



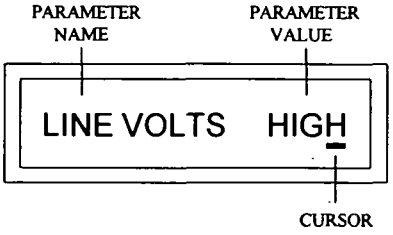
To enter the password, use the UP and DOWN arrow keys to scroll to the password value, and then press the ENTER key.

NOTE: The factory default password is 0019.

Once the correct password is entered, the PROGRAM mode will be entered and the first parameter will be displayed, which is Parameter 0 - LINE VOLTS. This is shown below:



To scroll through the parameters, use the UP and DOWN arrow buttons on the keypad. When the desired parameter is found, press the ENTER key to shift the cursor from the parameter name to the parameter value. In this example, the cursor shifts from LINE VOLTS to HIGH:



The parameter value can then be changed using the UP and DOWN arrow buttons. If the parameter has a numerical value, the UP arrow will increase the value and the DOWN arrow will decrease the value. If the parameter has specific choices that can be selected, the UP and DOWN arrow keys will scroll through the list of possible settings. When the desired value or option is selected, press the ENTER key to store the new setting. If the new setting is not ENTERED, it will not take effect and the old setting will still be valid.

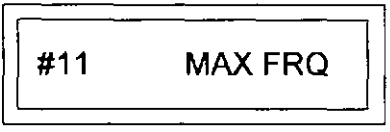
If the PROG/RUN key is pushed while the cursor is highlighting the parameter value, the value will change back to the original setting (if it had been changed, but not ENTERED), and the cursor will shift back to the parameter name. Pressing PROG/RUN again will exit the PROGRAM mode. If the PROGRAM mode is entered again within two minutes, the last parameter that was viewed, or changed, will come up on the display. After two minutes has elapsed, the password will have to be entered again when attempting to access the PROGRAM mode.

16.2 PARAMETER ACCESS USING SPEED DIAL

SPEED DIAL is used to access parameters quickly using the parameter number. Once accessed, the parameter can be programmed as described in Section 16.1. SPEED DIAL is accessed by pressing the AUTO/MAN key while in the PROGRAM mode. This will activate the SPEED DIAL display as shown below:

Once in SPEED DIAL, the UP and DOWN arrow keys will allow the operator to scroll through the parameter numbers. The display will continue to show SPEED DIAL while scrolling through the parameter numbers, as shown below:

When the desired parameter is reached, the SPEED DIAL display will be replaced by the parameter name:



Once the desired parameter is displayed on the screen, press the ENTER key to display the parameter name and present setting. The parameter setting can now be changed by the method described in Section 16.1. Press the AUTO/MAN key to return to SPEED DIAL.

17.0 PARAMETER MENU

PARAMETER MENU			
PARAM. NUMBER	**PARAMETER NAME**	**RANGE OF ADJUSTMENT**	**FACTORY DEFAULT**
0	LINE VOLTS	HIGH, LOW, AUTO	AUTO
1	SPEED #1	MIN FRQ - MAX FRQ	20.00 Hz
2	SPEED #2	MIN FRQ - MAX FRQ	20.00 Hz
3	SPEED #3	MIN FRQ - MAX FRQ	20.00 Hz
4	SPEED #4	MIN FRQ - MAX FRQ	20.00 Hz
5	SKIP #1	.00 Hz - MAX FRQ	.00 Hz
6	SKIP #2	.00 Hz - MAX FRQ	.00 Hz
7	BAND WID	.00 - 10.00 Hz	.00 Hz
8	ACCEL	0.1 - 3600 SEC (NOTE 1)	30.0 SEC
9	DECEL	(NOTE 2)	30.0 SEC
10	MIN FRQ	.00 - 120.0 Hz (NOTE 3)	.50 Hz
11	MAX FRQ	1.00 - 120.0 Hz (NOTE 3)	60.00 Hz
12	DC BRAKE	(NOTE 2)	.0 VDC
13	DC TIME	.0 - 999.9 SEC	.0 SEC
14	DYN BRAKE	OFF, ON	OFF

NOTE 1: RANGE FOR 25, 30, AND 40 HP UNITS: 0.3 - 3600 SEC.
NOTE 2: REFER TO SECTION 18.0 - DESCRIPTION OF PARAMETERS.
NOTE 3: MAX LIMIT IS 650 Hz ON UNITS WITH HIGH FREQ SOFTWARE.

PARAMETER MENU			
PARAM. NUMBER	**PARAMETER NAME**	**RANGE OF ADJUSTMENT**	**FACTORY DEFAULT**
16	CURRENT	25 - 180 % (NOTE 4)	180%
17	MOTOR OL	25 - 100 %	100%
18	BASE	20.00 - 360.0 Hz (NOTE 3)	60.00 Hz
19	FX BOOST	.0 - 30.0 %	(NOTE 2)
20	AC BOOST	.0 - 20.0 %	.0 %
21	SLIP CMP	.0 - 5.0 %	.0 %
22	TORQUE	CONSTANT, VARIABLE, CT / NOCMP	CONSTANT
23	CARRIER	2.5, 6, 8, 10, 12, 14 kHz	2.5 kHz
25	START	NORMAL, POWER-UP, AUTO RE-, RE-BRAKE	NORMAL
26	STOP	RAMP, COAST	COAST
27	ROTATION	FORWARD, REVERSE FWD&REV, FWD@LOC	FORWARD
28	AUTO/MAN	AUTO, MANUAL, BOTH	BOTH
29	MANUAL	KEYPAD, 0-10 VDC	KEYPAD
30	CONTROL	LOCAL, REMOTE, BOTH	LOCAL

NOTE 2: REFER TO SECTION 18.0 - DESCRIPTION OF PARAMETERS.
NOTE 3: MAX LIMIT IS 650 Hz ON UNITS WITH HIGH FREQ SOFTWARE.
NOTE 4: IF LINE VOLTS IS SET TO "LOW", RANGE IS 25 - 150%.

PARAMETER MENU			
PARAM. NUMBER	**PARAMETER NAME**	**RANGE OF ADJUSTMENT**	**FACTORY DEFAULT**
31	HZ UNITS	HERTZ, RPM, % HZ /SEC, /MIN, /HR, NONE	HERTZ
32	HZ MULT	.10 - 650.0	1.00
33	SPEED DP	XXXXX, XXX.X, XX.XX, X.XXX, .XXXX	XXXXX
34	LOAD MLT	95 - 139 %	100%
35	CONTRAST	LOW, MED, HIGH	MED
39	TB5 MIN	.00 - 360.0 Hz (NOTE 3)	.00 Hz
40	TB5 MAX	.00 - 360.0 Hz (NOTE 3)	60.00 Hz
42	TB10A OUT	NONE, 0-10V, 2-10V	NONE
43	@TB10A	3.00 - 360.0 HZ (NOTE 3)	60.00 Hz
44	TB10B OUT	NONE, 0-10V, 2-10V	NONE
45	@TB10B	10 - 200 %	125 %
47	TB13A	NONE, 0-10VDC, 4-20MA, SPEED#1, LOC SEL, DEC FREQ	NONE
48	TB13B	NONE, 0-10VDC, 4-20MA, SPEED#2, INC FREQ, JOG FWD, JOG REV	NONE

NOTE 3: MAX LIMIT IS 650 Hz ON UNITS WITH HIGH FREQ SOFTWARE.

PARAMETER MENU			
PARAM. NUMBER	**PARAMETER NAME**	**RANGE OF ADJUSTMENT**	**FACTORY DEFAULT**
49	TB13C	NONE, 0-10VDC, 4-20MA, SPEED#3, LOC SEL, RUN REV, STRT REV	NONE
50	TB13D	EXT FAULT, EXT /FAULT, EXT CLEAR	EXT FAULT
52 53 54	TB14 OUT TB15 OUT RELAY	NONE, RUN, FAULT, /FAULT, LOCK, @ SPEED, ABOVE#3, I LIMIT, AUT/MAN	NONE
57	SERIAL	DISABLE, ENABLE	DISABLE
58	ADDRESS	1 - 255 (Metasys) 1 - 247 (Modbus)	30
61	PASSWORD	0000 - 9999	0019
63	SOFTWARE	(VIEW - ONLY)	(N/A)
64	MONITOR	OFF, ON	ON
65	PROGRAM	MAINTAIN, RESET 60, RESET 50 (NOTE 3)	RESET 60
66	HISTORY	MAINTAIN, CLEAR	MAINTAIN
69	LANGUAGE	(NOTE 2)	ENGLISH
70	FAULT HISTORY	(VIEW - ONLY)	(N/A)

NOTE 2: REFER TO SECTION 18.0 - DESCRIPTION OF PARAMETERS.
NOTE 3: "RST HIGH" OPTION WILL APPEAR ON UNITS WITH HIGH FREQ SOFTWARE.

18.0 DESCRIPTION OF PARAMETERS

0 LINE VOLTS (LINE VOLTAGE)

This parameter calibrates the drive for the correct input voltage, and can be set to AUTO, HIGH, or LOW.

When set to AUTO, the drive measures the DC bus voltage when power is applied and automatically calibrates itself according to the measured value (DC bus voltage is equal to input voltage multiplied by 1.4).

This parameter can also be set "manually", using the HIGH or LOW settings. For actual line voltages of 230/240 Vac (on 240/200 Vac models), 460/480 Vac (on 480/400 Vac models), or 575/590 Vac (on 590/480 Vac models), set this parameter to HIGH. Also use the HIGH setting for 240/120 Vac single phase input models. Refer to the table below.

For actual line voltages of 200/208 Vac (on 240/200 Vac models), 380/415 Vac (on 480/400 Vac models), or 460/480 Vac (on 590 Vac models), set this parameter to LOW. Refer to the table below.

INPUT LINE VOLTAGE SELECTION				
MODEL	RATED INPUT VOLTAGE	INPUT PHASE	ACTUAL INPUT VOLTAGE	PARAM. SETTING
M1100S	240 / 120 Vac	1	220 - 240 Vac	HIGH
	240 / 120 Vac	1	110 - 120 Vac	HIGH
M1200(S)	240 Vac	1	220 - 240 Vac	HIGH
	240 / 200 Vac	3	220 - 240 Vac	HIGH
	240 / 200 Vac	3	200 - 208 Vac	LOW
M1400	480 / 400 Vac	3	460 - 480 Vac	HIGH
	480 / 400 Vac	3	380 - 415 Vac	LOW
M1500	590 / 480 Vac	3	575 - 600 Vac	HIGH
	590 / 480 Vac	3	460 - 480 Vac	LOW

1-4 SPEED #1- #4 (PRESET SPEEDS #1, #2, #3, AND #4)

PRESET SPEEDS are only active when the drive is in AUTO mode, and are activated via contact closures between terminal TB-2 and terminals TB-13A, TB-13B, and TB-13C. These terminals must be programmed as preset speed selects using Parameters 47 - 49: TB13A, TB13B, and TB13C.

The preset speeds can only be set to values that are within the operating range defined by the minimum and maximum frequency (see Parameters: 10 - MIN FREQ, and 11 - MAX FREQ).

The following table shows how each preset speed is selected using the TB-13 terminals. The terms OPEN and CLOSED refer to the state of the TB-13 terminal relative to TB-2.

PRESET SPEED ACTIVATION			
SPEED #	**TB - 13A**	**TB - 13B**	**TB - 13C**
1	CLOSED	OPEN	OPEN
2	OPEN	CLOSED	OPEN
3	OPEN	OPEN	CLOSED
4	CLOSED CLOSED OPEN	CLOSED OPEN CLOSED	OPEN CLOSED CLOSED

NOTE: SPEED #4 is selected if any two of the three TB-13 terminals are closed to TB-2.

5,6 **SKIP #1 & #2** (SKIP SPEED #1 & #2)
7 **BAND WID** (SKIP BANDWIDTH)

These parameters are used to prevent the drive from operating continuously at critical speeds, or frequencies, that cause excessive mechanical vibration of the driven equipment. The SKIP SPEEDS (Parameters 5 and 6) and the SKIP BANDWIDTH (Parameter 7) are used to define up to two speed avoidance ranges. The SKIP SPEED settings define the starting point of the speed range that is to be avoided, and the SKIP BANDWIDTH setting defines how far the speed range extends beyond SKIP SPEED. Setting the SKIP SPEEDS to .00 Hz disables this function.

Example: The critical frequency is 21 Hz, and a bandwidth of 2 Hz is desired. Therefore, set SKIP #1 to 20 Hz and set SKIP BANDWIDTH to 2 Hz. This results in a speed range from 20 Hz to 22 Hz that the drive will not operate within continuously. If the drive were operating at 25 Hz and then commanded to operate at a speed within the range of avoidance, the drive would decelerate to 22 Hz and remain at that frequency until commanded to 20 Hz or below. The drive would then decelerate through the range of avoidance to the new frequency. Likewise, if the drive were operating at 18 Hz, and then commanded to operate at a speed within the range of avoidance, the drive would accelerate to 20 Hz and remain at that frequency until commanded to a speed of 22 Hz or above. The drive would then accelerate through the range of avoidance to the new frequency.

8 ACCEL (ACCELERATION TIME)

This parameter sets the acceleration rate for all speed reference sources (keypad, speed pot, 4-20 mA, 0-10 VDC, jog, and the preset speeds). The ACCEL setting indicates time to accelerate from 0 Hz to the BASE FREQUENCY (Parameter 18).

Example: If ACCEL is set to 30 seconds, and the BASE FREQUENCY is set for 60 Hz, the drive will ramp from 0 Hz to 60 Hz in 30 seconds. This is a linear function, therefore the drive would ramp up to 30 Hz in 15 seconds, etc.

NOTE: The ability to accelerate a given load at a particular rate will be limited by the output power capability of the drive/motor combination. The acceleration of high-inertia and high-friction loads may be affected by the current limiting characteristics of the drive. See Parameters: 16 - CURRENT, 19 - FX BOOST, and 20 - AC BOOST for more information.

9 DECEL (DECELERATION TIME)

This parameter sets the deceleration rate for all speed reference sources. The DECEL setting indicates the time to decelerate from BASE FREQUENCY to 0 Hz. As with Parameter 8 - ACCEL, this is a linear function. If the drive is set to COAST to stop, this parameter will have no effect when a STOP command is given.

The range of adjustment for DECEL depends on horsepower, voltage, and whether Dynamic Braking (DB) is being used. Refer to the table below:

DECELERATION LIMITS				
HORSEPOWER / VOLTAGE RATING			RANGE OF ADJUSTMENT	
240 / 200 Vac (NOTE 1)	480 / 400 Vac	590 / 480 Vac	WITHOUT DB (NOTE 2)	WITH DB
0.5 - 7.5 HP	1 - 7.5 HP	----	0.3 - 3600 SEC	0.1 - 3600 SEC
10 - 20 HP	10 - 20 HP	1 - 7.5 HP	0.5 - 3600 SEC	0.1 - 3600 SEC
----	25 - 40 HP	10 - 20 HP	1.0 - 3600 SEC	0.2 - 3600 SEC
----	----	25 - 40 HP	2.0 - 3600 SEC	0.2 - 3600 SEC

NOTE 1: 240/120 Vac units have the same limits as 240/200 Vac units.

NOTE 2: The parameter value can be set below the minimum value shown, but the value shown is the operational limit of the drive. For example, if DECEL is set for 0.1 seconds on a 10 HP, 480 Vac drive without dynamic braking, the actual deceleration time would be 0.5 seconds.

If an attempt is made to decelerate a high-inertia load too quickly, the motor will regenerate voltage back into the drive. This will cause the DC bus voltage to rise, which can result in a HI VOLTS fault. In order to prevent faulting, the drive will enter DECEL FREEZE, which halts the deceleration until the DC bus voltage returns to a normal level. The drive will then begin to decelerate again, and if necessary, will enter DECEL FREEZE repeatedly to avoid faulting. If a very short deceleration time is programmed, DECEL FREEZE may not be able to compensate fast enough, resulting in a HI VOLTS fault.

In applications where very short deceleration times are required on high-inertia loads, dynamic braking may be required. Consult the factory for more information on the Dynamic Braking option.

10 **MIN FRQ** (MINIMUM FREQUENCY)

This parameter defines the lower limit of the drive's speed range. MIN FRQ is used in conjunction with MAX FRQ (Parameter 11 below) to define the operating range of the drive.

If MIN FRQ is set to a value above 0.0 Hz, the drive will ramp up from 0.0 Hz when given a start command. Once running, however, the drive will not operate below the MIN FRQ setting unless the rotation is changed, or a stop command is issued and the drive is programmed to ramp to a stop.

If the MINIMUM FREQUENCY is set to 0.0 Hz, the drive may be operated in ZERO SPEED mode (drive is in RUN state, but there is no output to the motor). ZERO SPEED operation can be used in applications requiring the ability to start and stop the drive using only the selected speed reference. The drive will start when the speed reference is raised above 0 VDC or 4 mA, and it will stop when the reference is lowered to 0 VDC or 4 mA. Note that the drive must be initially started using one of the normal start commands (keypad or terminal strip).

11 **MAX FRQ** (MAXIMUM FREQUENCY)

This parameter defines the upper limit of the drive's speed range. MAX FRQ is used in conjunction with MIN FRQ (Parameter 10 above) to define the operating range of the drive.

WARNING!
Consult motor manufacturer before operating motor above rated frequency. Overspeeding the motor and/or driven equipment can cause damage to equipment and injury to personnel!

NOTE: If the drive is equipped with the High Frequency Output option, the range of adjustment will be 1.00 - 650.0 Hz.

12 **DC BRAKE** (DC BRAKE VOLTAGE)

DC braking creates a braking torque by injecting DC voltage into the motor. This parameter sets the magnitude of that DC voltage. The point at which the drive applies DC braking to the motor depends on which STOP mode is programmed (either COAST or RAMP, see Parameter 26 - STOP).

If the drive is set to COAST, DC braking is activated when the stop command is given. In this case, DC braking helps decelerate the motor. This is useful in applications where a quick deceleration is desired on a load that would normally take a long time to coast to a stop.

If the drive is set to RAMP, DC braking is activated when the output frequency reaches 0 Hz. In this case, the drive decelerates the load to a near stop and then DC braking is used to stop and hold the motor. This is useful in applications where the load needs to be stopped in a certain position. Similar applications with high-inertia loads utilize both dynamic braking and DC braking. The dynamic braking allows the high-inertia load to be decelerated quickly, while the DC braking stops the load in the desired position.

Due to heat generated in the motor, DC braking should only be used in applications where the load is stopped infrequently. In high duty-cycle applications, dynamic braking is recommended because the heat is dissipated through external resistor banks, rather than in the motor. When used, DC BRAKE should be set to the lowest voltage that provides satisfactory operation in order to minimize motor heating. The maximum voltage available depends on the voltage rating of the drive. Refer to the table below:

MAXIMUM DC BRAKE VOLTAGE			
MODEL M1100 240 / 120 Vac	**MODEL M1200 240 / 200 Vac**	**MODEL M1400 480 / 400 Vac**	**MODEL M1500 590 / 480 Vac**
24 VOLTS	24 VOLTS	48 VOLTS	59 VOLTS

13 **DC TIME** (DC BRAKE TIME)

This parameter determines the length of time that the DC braking voltage is applied to the motor. DC TIME should be set to the lowest value that provides satisfactory operation in order to minimize motor heating.

NOTE: If this parameter is set to 999.9 seconds (the maximum value), the DC braking will be continuous. If it is set to .0 seconds, it is disabled.

14 **DYN BRAK** (DYNAMIC BRAKE)

This parameter enables the dynamic braking circuit. Set this parameter to ON only if the optional dynamic braking circuit board and resistors are installed.

Dynamic braking is used in applications where high-inertia loads need to be decelerated quickly. When this is attempted, the motor regenerates voltage back into the drive, causing the DC bus voltage to rise, eventually resulting in a HI VOLTS fault. With the dynamic braking option, the DC bus voltage is monitored, and when it reaches a certain level, a transistor is switched on that connects an external resistor bank across the DC bus. This allows the regenerated energy from the motor to be dissipated through the resistors as heat, which keeps the DC bus voltage below the trip level.

16 **CURRENT** (CURRENT LIMIT)

This parameter sets the maximum allowable output current of the drive, which also determines the torque capability of the motor. For most applications, CURRENT is left at the maximum setting, which is 150% or 180% (of the drive's output current rating), depending on the setting of Parameter 0 - LINE VOLTS. Regardless of the CURRENT setting, the drive is capable of delivering a maximum of 150% current for one minute, and 180% current for approximately 30 seconds, before tripping into an OVERLOAD fault. See Parameter 17 – MOTOR OL below.

The drive will enter current limit when the load demands more current than the drive can deliver, which results in a loss of synchronization between the drive and the motor. To correct this condition, the drive will enter FREQUENCY FOLDBACK, which commands the drive to decelerate in order to reduce the output current and regain synchronization with the motor. When the overcurrent condition passes, the drive will return to normal operation and accelerate back to the speed setpoint. However, if FREQUENCY FOLDBACK cannot correct the condition and the drive remains in current limit for too long, it will trip into an OVERLOAD fault. If the drive enters current limit while accelerating, the time required to reach the speed setpoint will be longer than the time programmed into ACCEL (Parameter 8).

17 MOTOR OL (MOTOR OVERLOAD)

The MOTOR OVERLOAD setting is used to protect the motor from overheating due to excessive current draw. The trip time for the MOTOR OVERLOAD setting is based on what is known as an "inverse I^2t" function. This function allows the drive to deliver 150% of the rated output current for one minute, and even higher current levels for shorter periods of time. Once the overload circuit "times out", the drive will trip on an OVERLOAD fault.

The MOTOR OVERLOAD should be set to a value which is equal to the ratio (in percentage) of the motor full load current rating to the drive output current rating. This will result in an overload capacity of 150% of the MOTOR current rating for one minute. If this parameter is set to 100%, the motor will be allowed to draw 150% of the DRIVE output current rating for one minute. This distinction is important in cases where the motor full load current rating is significantly less than the drive output current rating, such as applications where the drive is oversized to meet torque requirements.

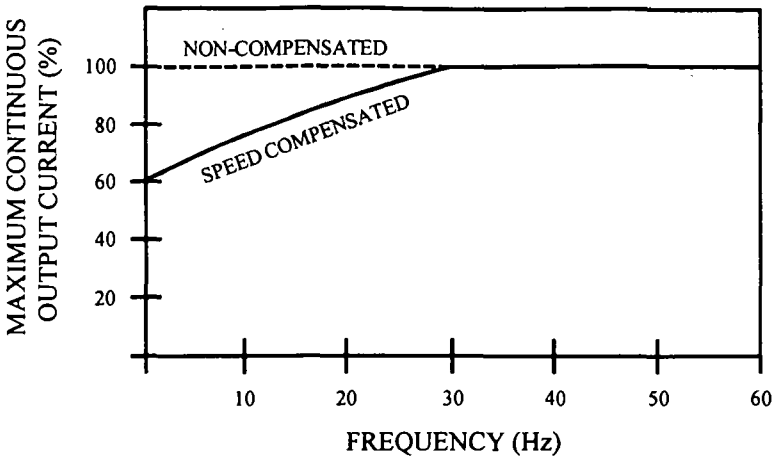
Example: A 5 Hp, 480 Vac drive is operating a 3 HP motor with a full load current rating of 4.8 amps. Divide the motor current rating by the drive output current rating: 4.8 / 7.6 = 63%. Entering this value will allow continuous operation at 4.8 amps, and will also allow the motor to draw 7.2 amps (150% of 4.8 amps) for one minute. If the setting is left at 100%, the motor could draw 11.4 amps (150% of 7.6 amps) for one minute before tripping the drive.

The MC Series drive has two options for thermal overload protection. One depends on the speed of the drive, and the other does not. The diagram below illustrates the difference between "speed compensated" and "non-compensated" thermal overload protection.

The "speed-compensated" thermal overload circuit offers additional protection from high load conditions at low speeds, where motor cooling is often less effective (e.g., motors with shaft-mounted fans). As seen on the diagram below, the drive reduces the allowable continuous output current when operating at frequencies less than 30 Hz.

Example: A 480 Vac, 20 HP drive is operating a motor at 10 Hz. From the diagram, a drive operating at 10 Hz can deliver about 75% of its output current rating continuously. A 480 Vac, 20 HP drive's output current rating is 27 Amps. Therefore, the drive would be able to operate continuously at 20 Amps. The drive would also be able to deliver 150% of that value (30 Amps) for one minute before tripping into an OVERLOAD fault.

The "speed compensated" thermal overload is the factory default and should be used in applications where the motor does not normally experience high loads at low speeds for extended periods of time.



NOTE: The above diagram is based on a MOTOR OL setting of 100%. For lower MOTOR OL settings, reduce the % CURRENT values by the same percentage. For example, if MOTOR OL is set to 75%, reduce the % CURRENT values by 25%. Therefore, the curve shifts down, but the shape of the curve remains the same.

The "non-compensated" thermal overload circuit allows 100% current continuously, and 150% current for one minute, at all speeds. In the example above, the motor operating at 10 Hz without "speed-compensated" protection would be allowed to operate continuously at 27 Amps, and could draw 40.5 Amps for one minute before tripping. Without sufficient motor cooling, this can result in motor failure due to overheating.

The "non-compensated" circuit is selected by setting Parameter 22 - TORQUE to CT/NOCMP. The "non-compensated" setting should only be used in applications where the motor is properly cooled at all speeds, or the motor manufacturer has approved the motor for full-load operation at low speeds.

NOTE: The operation of the motor thermal overload circuit is affected by the setting of Parameter 34 - LOAD MLT.

18 **BASE** (BASE FREQUENCY)

The BASE FREQUENCY determines the V/Hz ratio by setting the frequency at which the drive will output full voltage to the motor. For most applications the base frequency should be set to match the motor's rated frequency.

For example, if the drive is rated for 460 Vac output, and the BASE FREQUENCY is set to 60 Hz, the drive will maintain a constant ratio of 7.66 V/Hz (except when AC BOOST or FX BOOST are active, see Parameters 19 and 20) from 0 Hz to 60 Hz. This range is the region of constant torque. If the motor speed is increased past 60 Hz, the output voltage remains constant while the frequency increases, resulting in a reduced V/Hz ratio. This range, from 60 Hz to about 90 Hz, is the region of constant horsepower. Above 90 Hz, horsepower begins to decrease as frequency increases. Refer to Section 6.1 - DESCRIPTION OF AC MOTOR OPERATION.

19 **FX BOOST** (FIXED BOOST)

This parameter is used in applications which require high starting torque. FX BOOST increases the output voltage at lower output frequencies (below 30 Hz for 60 Hz base frequency), in order to boost the torque capability of the motor. Refer to the diagram below. The factory default for FX BOOST depends on the horsepower rating. Refer to the table below:

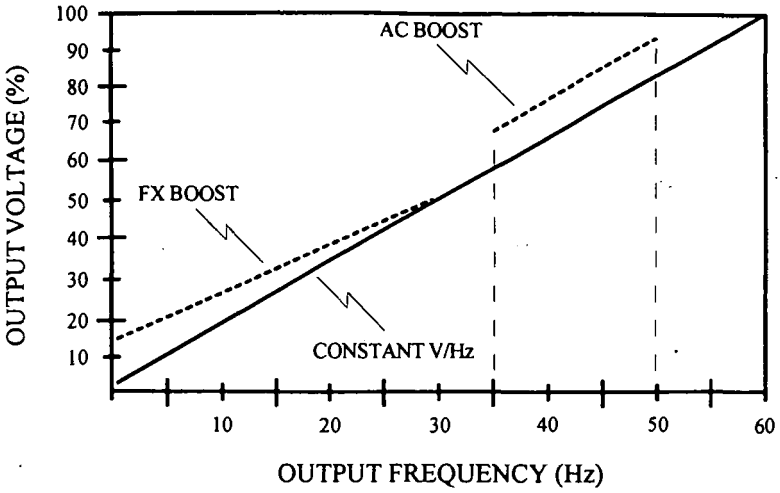
FX BOOST FACTORY DEFAULT SETTINGS			
HP	FACTORY DEFAULT	HP	FACTORY DEFAULT
0.25 - 1	5.30 %	15	2.20 %
1.5 - 2	4.40 %	20	2.00 %
3	3.60 %	25	1.80 %
5	3.00 %	30	1.60 %
7.5	2.70 %	40	1.20 %
10	2.40 %	50	0.80 %

20 **AC BOOST** (ACCELERATION BOOST)

AC BOOST is similar to FX BOOST, but is only active when the drive is accelerating. During acceleration, the output voltage is increased according to the setting of AC BOOST, which increases motor torque. Refer to the diagram below. AC BOOST, like FX BOOST, is used in applications with high-inertia loads.

The diagram below illustrates how FX BOOST and AC BOOST alter the V/Hz ratio to increase motor torque.

FX BOOST sets the boost at 0 Hz (approximately 15% in the example above), and as the output frequency approaches 30 Hz, the boost decreases to zero.



AC BOOST only functions during acceleration. In the diagram above, the drive is operating at 35 Hz and is then commanded to 50 Hz. The output voltage is increased by the AC BOOST setting (approximately 15% in the example above) during acceleration to the new speed setpoint. Once the new setpoint is reached, the output voltage returns to normal.

21 SLIP CMP (SLIP COMPENSATION)

SLIP COMPENSATION is used to compensate for changes in motor speed ("slip") which occur due to changes in load. In a standard AC induction motor, as the load on the motor increases, the motor current increases and the motor shaft speed decreases. By increasing the output frequency in response to the increased motor current, SLIP COMPENSATION is able to counteract the reduction in motor speed due to increased load. This parameter is useful in applications where precise speed regulation is needed, even under changing load conditions. The use of SLIP COMPENSATION can result in speed regulation of less than 1% of base speed in most applications. SLIP COMPENSATION is often set to 3%, which is the standard slip rating of most AC induction motors.

22 TORQUE (TORQUE CURVE SELECTION)

This parameter is used to select whether the output of the drive follows a constant or variable V/Hz curve. The following selections are available:

CONSTANT	Use for constant torque applications to optimize torque.
VARIABLE	Use for variable torque applications to optimize energy savings.

CT / NOCMP — Use for constant torque applications that require full overload capacity at low speeds (see Parameter 17 - MOTOR OL).

23 CARRIER (CARRIER FREQUENCY)

This parameter sets the carrier frequency, or switching frequency of the output IGBT's. Higher switching rates result in less audible noise to be emitted from the motor, but the efficiency of the drive decreases as the carrier frequency increases. Therefore, this parameter should be set to the lowest value which yields acceptable sound levels. Available settings are: 2.5 kHz, 6 kHz, 8 kHz, 10 kHz, 12 kHz and 14 kHz.

NOTE: The 2.5 kHz carrier frequency setting is a variable carrier. The carrier frequency remains fixed at 1.5 kHz up to 25 Hz output frequency. Above 25 Hz, the carrier is a fixed multiple of 60 times the drive's output frequency. For example, if the output frequency of the drive was set to 45 Hz, the carrier frequency would be 2.7 kHz (45 Hz x 60 = 2700 Hz).

NOTE: If the drive is equipped with the High Frequency Output option, and MAX FRQ is set above 120 Hz, the drive will operate with the 14 kHz carrier frequency, regardless of the setting of CARRIER.

NOTE: The ability to operate a drive in the quiet (high carrier frequency) mode is dependent on the drive horsepower rating, driven load, drive enclosure, and the ambient temperature. Operation above 8kHz requires derating the drive by multiplying the output current rating by the following factors: 0.94 at 10 kHz, 0.89 at 12 kHz, and 0.83 at 14 kHz.

25 START (START MODE)

WARNING!

Automatic start of equipment may result in damage to equipment and/or injury to personnel! Automatic start should only be used on equipment that is inaccessible to personnel.

This parameter selects the starting method for the drive, and can be set for one of the following:

NORMAL — The drive will start when the appropriate contact closure is made on the terminal strip (in REMOTE mode), or by pressing the keypad START key (in LOCAL mode). To start the drive in NORMAL mode, a start command must be issued at least two seconds AFTER input power is applied.

POWER UP — The drive will automatically start upon application of input power. The drive MUST be wired for a two-wire start/stop circuit (refer to Section 14.0 - CONTROL WIRING). The start command MUST be present when power is applied for this function to operate.

AUTO RE- — The drive will automatically restart after a protective fault or upon application of input power. As with the POWER-UP option, a start command must be present for this function to operate.

RE-BRAKE — After a fault, the drive will apply DC braking equal to the DC BRAKE setting for 15 seconds and then restart. This is done to ensure the motor is stopped during the restart attempt, as the drive will not start into a spinning motor.

NOTE: POWER UP, AUTO RE-, and RE-BRAKE settings are only active when the drive is in REMOTE mode (see Parameter 30 - CONTROL).

NOTE: After a fault, the drive will attempt to restart five times, and if unsuccessful, will shut down on a FAULT LOCKOUT. Every 15 minutes that passes will decrement the restart counter by one. Therefore, 75 minutes after a successful restart, the restart counter is fully reset, and the drive can once again attempt five restarts.

NOTE: The drive WILL NOT restart after the following faults: CONTROL and PWR SAG. Also, if an OUTPUT fault occurs below 1.5 Hz, only one restart will be attempted, after a four minute delay. If unsuccessful, it will then trip into FAULT LOCKOUT, which will require a manual reset. This is done to protect the drive in case of a shorted motor.

26 **STOP** (STOP MODE)

This parameter selects whether the motor will COAST to a stop, or RAMP to a stop, when the drive is given a stop command.

COAST — When a stop command is given, the drive shuts off the output to the motor, allowing it to coast to a stop. The time required for the motor to stop is governed by the inertia of the driven load.

RAMP — When a stop command is given, the drive will decelerate the motor to a stop over a period of time according to Parameter 8 - DECEL.

27 ROTATION (ROTATION DIRECTION)

WARNING!
If TB-13C is programmed for RUN REVERSE, TB-1 is disabled and **CANNOT** be used as a STOP switch! This is true in LOCAL and REMOTE mode. Incorrect use of TB-1 may result in damage to equipment and/or injury to personnel! Refer to Parameter 49 - TB13C for more information.

This parameter is used to limit the motor rotation direction to forward or reverse, or to allow rotation in both directions. The parameter can be set to one of the following:

FORWARD — Rotation is allowed in the forward direction only. This selection disables the FWD/REV button on the keypad and TB-13C (REVERSE).

REVERSE — Rotation is allowed in the reverse direction only. This selection disables the FWD/REV button on the keypad and TB-12A (FORWARD). TB-13C must be programmed for either RUN REV or STRT REV for this function to operate in the REMOTE mode.

FWD&REV — Rotation is allowed in both directions. The FWD/REV button is enabled. Rotation can be changed from the keypad (LOCAL mode), or the terminal strip (REMOTE mode). In the REMOTE mode, TB-13C must be programmed for either RUN REV or STRT REV for this function to operate.

FWD@LOC — In LOCAL mode, rotation is allowed in the forward direction only. In REMOTE mode, rotation is allowed in both directions.

NOTE: If the rotation is changed while the drive is running, the drive will decelerate to 0 Hz, and then accelerate back up to the speed setpoint in the opposite direction.

28 AUTO / MAN (AUTO / MANUAL SPEED CONTROL)

This parameter is used to select the method of speed control when the drive is in the LOCAL mode. The choices are explained below:

MANUAL — The drive will accept a speed reference from the keypad (UP and DOWN ARROW keys) or a speed potentiometer (wired to TB-2, 5A, and 6). Parameter 29 - MANUAL below selects either keypad or speed potentiometer. The AUTO/MAN button on the keypad is disabled.

AUTO — The drive will accept a 0-10 VDC input signal on TB-5A and TB-2, a 4-20 mA input signal on TB-5B and TB-2, or one of the four PRESET SPEEDS. The programming of TB-13A, TB-13B and TB-13C determines which AUTO reference is selected. The AUTO/MAN button on the keypad is disabled.

BOTH — The AUTO/MAN key on the keypad is enabled and can be used to toggle between MANUAL and AUTO control ONLY if the drive is in LOCAL mode.

NOTE: If the drive is in the AUTO mode, and a speed reference is not selected using TB-13A, TB-13B, or TB-13C, the speed reference source will default to the setting of Parameter 29 - MANUAL (KEYPAD or 0-10 VDC).

29 MANUAL (MANUAL)

This parameter selects the speed reference source when the drive is set for MANUAL speed control (see Parameter 28 - AUTO/MAN above). The speed reference options are KEYPAD (UP and DOWN ARROW keys), or 0 - 10 VDC (from a speed pot wired to TB-2, 5A, and 6; or some other 0-10 VDC source).

30 CONTROL (START/STOP CONTROL)

WARNING!

If CONTROL is set to LOCAL, TB-1 is disabled and **CANNOT** be used as a STOP switch! Incorrect use of TB-1 may result in damage to equipment and/or injury to personnel!

WARNING!

STOP (TB-1) and EXTERNAL FAULT (TB-13D) circuitry may be disabled if parameters are reset to factory defaults! The drive must be reprogrammed after a RESET in order to insure proper operation (see Parameter 65 - PROGRAM).

FAILURE TO DO SO MAY RESULT IN DAMAGE TO EQUIPMENT AND/OR INJURY TO PERSONNEL!

This parameter is used to select the source of the start/stop command and direction control. The following settings are available:

LOCAL — START/STOP and FORWARD/REVERSE commands from the keypad only.

REMOTE — START/STOP and FORWARD/REVERSE commands from the terminal strip only.

BOTH — LOCAL operation if TB-13A or TB-13C is programmed for LOCAL SELECT and a contact closure is made from TB-13A or TB-13C to TB-2. If the contact closure is not made, the drive will be in REMOTE mode.

31 **HZ UNITS** (SPEED UNITS)

HZ UNITS sets the units of the output speed display on the keypad. This parameter can be set to the following speed units: HERTZ, RPM, % HZ, /SEC, /MIN, /HR, and NONE.

NOTE: The intended use of "/SEC", "/MIN", and "/HR" are units per second, units per minute, and units per hour.

32 **HZ MULT** (HERTZ MULTIPLIER)

The HZ MULTIPLIER is used to scale the output speed indication on the display. If HZ UNITS is set for HERTZ or % HZ, this parameter has no effect. Multiplying the output frequency by the HZ MULTIPLIER will yield the desired speed value on the display.

Example: The desired speed units is RPM with a standard 60 Hz, 1800 RPM motor. Set HZ UNITS to RPM and set HZ MULT to 30.00. This will result in a speed display of 1110 RPM for an output frequency of 37 Hz (37 Hz X 30 = 1110 RPM). Also, if there was a 100:1 gear reducer in the system, Parameter 33 - SPEED DP below could be set to XX.XX to represent the output of the gear reducer (11.10 RPM in the example).

33 **SPEED DP** (SPEED DECIMAL POINT)

This parameter is used to move the decimal point location in the speed display. This parameter will not have any effect if HZ UNITS is set to HERTZ or % HZ. The possible settings are: XXXXX, XXX.X, XX.XX, X.XXX, and .XXXX. Refer to Parameter 32 - HZ MULT above for an example on the use of SPEED DP.

34 LOAD MLT (LOAD MULTIPLIER)

This parameter is used to scale the % LOAD display. If the drive output current rating is higher than the motor full load current rating, the drive will not display 100% load when the motor is at full load. Setting this parameter to the ratio (in %) of the drive output current rating to the motor full load current rating will scale the load display to show motor load instead of drive load. This will result in a display of 100% when the motor is at full load.

The motor overload circuitry is also affected by this parameter. When the display reads 150% load, the drive will trip on OVERLOAD in one minute, regardless of the actual motor current. If this parameter is used to scale the display to show actual motor load, then Parameter 16 - MOTOR OL should be left at 100%. Likewise, if MOTOR OL has been set according to the motor full load rating, this parameter should be left at 100%. Changing both parameters will result in an OVERLOAD fault sooner than expected.

The output signal at TB-10B is also affected by this parameter. When set to the ratio of current ratings as explained above, the output signal will be proportional to motor load instead of drive load.

35 CONTRAST (LCD DISPLAY CONTRAST)

This parameter is used to adjust the contrast of the drive display and can be set to LOW, MED, or HIGH in order to obtain the most visible display. If the drive is mounted lower than eye level, a HIGH setting may make the display more visible. Likewise, if the drive is mounted higher than eye level, a LOW setting may make the display more visible.

39 TB5 MIN (TERMINAL TB-5 INPUT)

This parameter selects the output frequency of the drive that will correspond to the minimum analog speed reference input (0 VDC or 4 mA). This parameter is used in conjunction with Parameter 40 - TB5 MAX to define a speed range for the drive that corresponds to the analog speed reference input (0 - 10 VDC or 4 - 20 mA).

40 TB5 MAX (TERMINAL TB-5 INPUT)

This parameter selects the output frequency of the drive that will correspond to the maximum analog speed reference input (10 VDC or 20 mA). This parameter is used in conjunction with Parameter 39 - TB5 MIN to define a speed range for the drive that corresponds to the analog speed reference input (0 - 10 VDC or 4 - 20 mA).

Example: The drive is required to operate from 0 to 60 Hz in response to a 0-5 VDC speed reference signal (rather than the "normal" 0-10 VDC). Because TB5 MAX is based on a 0-10 VDC (or 4-20 mA) signal, the drive will operate at half of the TB5 MAX value if it is given a 5 VDC signal. Therefore, setting TB5 MAX to 120 Hz will cause the drive to run at 60 Hz when it is given a 5 VDC speed reference signal.

NOTE: The drive can be programmed for inverse operation so that as the speed reference increases, the drive speed will decrease, and as the speed reference decreases, the drive speed will increase. This is accomplished by setting TB5 MIN to the desired maximum output frequency, and TB5 MAX to the desired minimum output frequency.

Example: The drive is being controlled by a pressure transducer that provides a 4-20 mA signal proportional to duct pressure. The minimum frequency desired is 20 Hz, and the maximum is 60 Hz. Set TB5 MIN for 60 Hz, and TB5 MAX for 20 Hz. As the duct pressure rises, the output signal from the transducer will increase, causing the speed of the drive to decrease. This results in a decrease in duct pressure and a decreasing transducer signal. The drive responds to the decreasing signal by increasing speed, which again raises the duct pressure. In this way, the average duct pressure can be maintained at a certain level. If the acceleration and deceleration rates are set too fast however, the drive will react quickly to signal changes which will cause the drive speed to "hunt" up and down excessively.

42 **TB10A OUT** (TERMINAL TB-10A OUTPUT)

The analog output signal at TB-10A is proportional to the output frequency of the drive. This parameter selects whether that signal is 0-10 VDC or 2-10 VDC. The 2-10 VDC signal can be converted to a 4-20 mA signal by connecting a resistor in series with the signal such that the total load resistance is 500 Ohms. If set to NONE, the function is disabled.

NOTE: This output cannot be used with "loop-powered" devices that derive power from a 4-20 mA signal.

43 **@ TB10A** (TERMINAL TB-10A SCALING)

This parameter scales the analog output signal at TB-10A. This setting is the output frequency that is indicated when the TB-10A output measures 10VDC.

Example: The drive is part of a control system that requires a 0-5 VDC signal (rather than 0-10 VCD) that is proportional to 0-60 Hz output frequency. The output signal is linear, so setting this parameter to 120 Hz would yield 10 VDC at 120 Hz, and 5 VDC at 60 Hz.

44 **TB10B OUT** (TERMINAL TB-10B OUTPUT)

The analog output signal at TB-10B is proportional to the drive load. This parameter selects whether that signal is 0-10 VDC or 2-10 VDC. The 2-10 VDC signal can be converted to a 4-20 mA signal by connecting a resistor in series with the signal such that the total load resistance is 500 Ohms.

NOTE: This output cannot be used with "loop-powered" devices that derive power from a 4-20 mA signal.

45 **@ TB10B** (TERMINAL TB-10B SCALING)

This parameter scales the analog output signal at TB-10B. This setting is the load (in %) that is indicated when the TB-10B output measures 10 VDC.

Example: The drive is part of a control system that requires a 0-10 VDC signal to indicate 0-150% drive load. If this parameter were set to 150%, the drive would output 10 VDC at 150% load (and about 6.7 VDC at 100% load).

NOTE: The output signal at TB-10B is affected by the setting of Parameter 34 - LOAD MLT.

47 **TB13A** (TB-13A INPUT FUNCTION)

This parameter is used to select the function of terminal TB-13A. Closing TB-13A to TB-2 activates the TB - 13A input function. The following functions can be selected:

NONE	Disables the TB-13A function.
0-10VDC	Selects 0-10 VDC as the AUTO speed reference input. The 0-10 VDC signal is wired to TB-5A and TB-2.
4-20 MA	Selects 4-20 mA as the AUTO speed reference input. The 4-20 mA signal is wired to TB-5B and TB-2.
SPEED#1	Selects PRESET SPEED #1 as the AUTO speed reference.
LOC SEL	Selects LOCAL mode when Parameter 30 - CONTROL is set to BOTH. Drive is in REMOTE mode if contact closure is not made.
DEC FREQ	Decrease frequency setpoint. Used with the MOP (motor operated pot) function. Refer to Section 14.2.6 - SPEED REFERENCE SELECTION.

48 TB13B (TB-13B INPUT FUNCTION)

WARNING!
When operating in JOG mode, the STOP key **WILL NOT** stop the drive. To stop the drive, the contact between TB-13B and TB-2 must be opened.

This parameter is used to select the function of terminal TB-13B. Closing TB-13B to TB-2 activates the TB - 13B function. The following functions can be selected:

NONE	Disables the TB-13B function.
0-10VDC	Selects 0-10 VDC as the AUTO speed reference input. The 0-10 VDC signal is wired to TB-5A and TB-2.
4-20 MA	Selects 4-20 mA as the AUTO speed reference input. The 4-20 mA signal is wired to TB-5B and TB-2.
SPEED#2	Selects PRESET SPEED #2 as the AUTO speed reference.
INC FREQ	Increase frequency setpoint. Used with the MOP (motor operated pot) function. Refer to Section 14.2.6 - SPEED REFERENCE SELECTION.
JOG FWD	Jog in the forward direction. Active only when drive is STOPPED. The jog speed is set by Parameter 2 - SPEED#2.
JOG REV	Jog in the reverse direction. Active only when drive is STOPPED. The jog speed is set by Parameter 2 - SPEED#2.

49 TB13C (TB-13C INPUT FUNCTION)

WARNING!
If TB-13C is programmed for RUN REVERSE, TB-1 is disabled and **CANNOT** be used as a STOP switch! This is true in LOCAL and REMOTE mode. Incorrect use of TB-1 may result in damage to equipment and/or injury to personnel!

This parameter is used to select the function of terminal TB-13C. Closing TB-13C to TB-2 activates the TB - 13C input function. The following functions can be selected:

NONE	Disables the TB-13C function.

0-10VDC	Selects 0-10 VDC as the AUTO speed reference input. The 0-10 VDC signal is wired to TB-5A and TB-2.
4-20 MA	Selects 4-20 mA as the AUTO speed reference input. The 4-20 mA signal is wired to TB-5B and TB-2.
SPEED#3	Selects PRESET SPEED #3 as the AUTO speed reference.
LOC SEL	LOCAL SELECT - Selects LOCAL mode when Parameter 30 - CONTROL is set to BOTH. Drive is in REMOTE mode if contact closure is not made.
RUN REV	RUN REVERSE - Run in reverse direction. Requires a maintained contact closure - close to RUN in reverse direction, open to STOP. This will cause TB-12A to function as RUN FORWARD, also requiring a maintained contact to RUN in forward.
STRT REV	START REVERSE - Start in reverse direction. Requires a momentary contact closure to RUN in reverse direction. A momentary STOP contact must be wired between TB-1 and TB-2. Setting this parameter to START REVERSE causes TB-12A to function as START FORWARD, also requiring a momentary contact closure to RUN in forward.

50 **TB13D** (TB-13D FUNCTION)

WARNING!

STOP (TB-1) and EXTERNAL FAULT (TB-13D) circuitry may be disabled if parameters are reset to factory defaults! The drive must be reprogrammed after a RESET in order to insure proper operation (see Parameter 65 - PROGRAM).

FAILURE TO DO SO MAY RESULT IN DAMAGE TO EQUIPMENT AND/OR INJURY TO PERSONNEL!

This parameter selects the function for TB-13D.

EXT FAULT	Sets TB-13D as a normally open EXTERNAL FAULT contact. Close TB-13D to TB-2 to trip the drive into an EXTERNAL FAULT.
EXT / FAULT	Sets TB-13D as a normally closed EXTERNAL FAULT contact. Open TB-13D to TB-2 to trip the drive into an EXTERNAL FAULT.
EXT CLEAR	Sets TB-13D as a normally open FAULT RESET. Close TB-13D to TB-2 to clear a fault.

NOTE: When set to CLEAR, TB-13D becomes the only terminal that can be used to clear a fault (TB-1 will not work). However, the keypad STOP key can still be used to clear faults.

52 TB14 OUT (TB-14 OPEN COLLECTOR OUTPUT)

This parameter sets the open-collector output indication for terminal TB-14. The following conditions can be selected: NONE, RUN, FAULT, / FAULT (INVERSE FAULT), LOCK (FAULT LOCKOUT), AT SPEED, ABOVE #3, I LIMIT (CURRENT LIMIT), or AUTO/MAN operation. Refer to Section 6.2.5 - MC1000 STATUS OUTPUT RELAYS.

The open-collector output circuit is a current-sinking type rated at 30 VDC and 40 mA maximum. An external power supply (30 VDC max.) must be used to power the open-collector outputs. The drive does not have a dedicated power supply for the open-collector outputs.

53 TB15 OUT (TB-15 OPEN COLLECTOR OUTPUT)

This parameter sets the open-collector output indication for terminal TB-15. It has the same functionality as Parameter 52 - TB14 OUT above.

54 RELAY (RELAY FUNCTION)

The control board has one auxiliary relay which can be programmed to indicate one of the following conditions: NONE, RUN, FAULT, / FAULT (INVERSE FAULT), LOCK (FAULT LOCKOUT), AT SPEED, ABOVE #3, I LIMIT (CURRENT LIMIT), or AUTO/MAN operation. Refer to Section 6.2.5 - MC STATUS OUTPUT RELAYS.

The auxiliary relay has a set of FORM C contacts on TB-16, 17, and 18, rated 2 amps at 28 VDC or 120 Vac. Control wiring diagrams show relays in the rest state (coils NOT energized).

57 SERIAL (SERIAL COMMUNICATIONS)

This parameter is used to activate serial communications. When using this feature, the drive can communicate with a personal computer (PC), programmable logic controller (PLC), or other external device that utilizes RS-485 serial communications for control. The serial interface may be used to read present parameter settings (uploading to the control device), write new parameter settings (downloading from the control device), monitor present drive activity, and control drive activity. The following settings are available:

DISABLE	Serial communication function is disabled.
W / TIMER	Enables serial communications with a watchdog timer. If there is no serial activity (read or write) for more than 10 seconds, serial control will turn off and the drive will stop.
W / O TIMR	Enables serial communications without a watchdog timer. However, after 10 seconds of no serial activity, serial control can be turned off by issuing a STOP command from any source (keypad, terminal strip) other than the serial link.

NOTE: The keypad STOP button is always active, regardless of what method (LOCAL, REMOTE, or SERIAL) is being used to control the drive. The remote STOP input (TB-1) may also be active, depending on how the drive is programmed.

NOTE: If a RESET command (Parameter 65 - PROGRAM) is issued through the serial link, this parameter will not default back to DISABLE. However, explicitly setting this parameter to DISABLE through the serial link will cut off communication with the drive.

If developing an application for serial communications, refer to the RS-232/RS-485 Modbus® or Metasys® Communications Protocol Specification.

58 **ADDRESS** (SERIAL ADDRESS)

This parameter is used with the serial communications feature, and is intended for use in a multiple drive network (RS-485). The serial link will support drives with addresses from 1 up to 255 (Metasys®) or 247 (Modbus®). If the serial communications option is not being used, leave this parameter set to the default setting of 30.

61 **PASSWORD** (PASSWORD NUMBER)

This feature limits access to the programmable parameters for added security. The correct password must be entered in order to change the parameters.

Pressing the PROG/RUN button on the keypad will activate the PASSWORD prompt. If the correct password is entered, the PROGRAM MODE is entered and parameters can be changed.

If the wrong password is entered, the drive will flash ERROR: INCORRECT and then return to the PASSWORD prompt to allow another attempt at entering the correct password.

If the ENTER key is pressed while PASSWORD reads 0000, the MONITOR MODE will be entered (if Parameter 64 - MONITOR, is set to ON), which will allow the parameters to be viewed (except for PASSWORD), but not changed.

NOTE: The factory default value is 0019.

NOTE: If PASSWORD is set to 0000, the function is disabled. Pressing the PROG/RUN key will result in direct entry into the PROGRAM mode without having to enter a password.

63 SOFTWARE (SOFTWARE VERSION)

This parameter displays the software code and revision number of the control board software. This information is useful when contacting the factory for programming or troubleshooting assistance. This is a "view-only" parameter, and cannot be changed.

64 MONITOR (MONITOR)

This parameter is used to enable (ON) or disable (OFF) the MONITOR MODE function. The functionality is explained below:

ON	Pressing the PROG/RUN key will call up the PASSWORD prompt. If the ENTER key is pressed while the password value reads 0000, the MONITOR MODE is entered and parameters can be viewed (except for PASSWORD), but not changed.
OFF	Pressing the PROG/RUN key will call up the PASSWORD prompt. If the ENTER key is pressed while the password value reads 0000 (or any other incorrect value), it will be treated as in incorrect password and the display will flash ERROR: INCORRECT, and then return to the PASSWORD prompt to allow another attempt at entering the correct password.

65 PROGRAM (PROGRAM FACTORY DEFAULTS)

WARNING!

STOP (TB-1) and EXTERNAL FAULT (TB-13D) circuitry may be disabled if parameters are reset to factory defaults! The drive must be reprogrammed after a RESET in order to insure proper operation.

FAILURE TO DO SO MAY RESULT IN DAMAGE TO EQUIPMENT AND/OR INJURY TO PERSONNEL!

This parameter is used to reset the programmable parameters back to the factory default settings. This parameter has four possible settings:

MAINTAIN	Maintain parameter settings as they are.
RESET 60	Resets parameters to factory defaults for 60 Hz base frequency.
RESET 50	Resets parameters to factory defaults for 50 Hz base frequency.
RST HIGH	Resets parameters to factory defaults for 650 Hz base frequency. This option will only appear if the drive is equipped with the High Frequency Output option.

When a factory reset is performed, the following terminals are affected:

TB-1 will be disabled as a STOP input because Parameter 30 - CONTROL will default to LOCAL.

TB-13A, 13B, and 13C will be disabled because Parameters 47, 48, and 49 will default to NONE. If TB-13C was set to RUN REVERSE, TB-12A will default to a momentary START contact.

TB-13D will default to a normally open EXTERNAL FAULT contact because Parameter 50 - TB13D will be reset to EXT FAULT.

NOTE: This parameter will display RESET 60, RESET 50 or RST HIGH until a change is made to one or more of the parameter settings. Once a parameter is changed, the display will change to MAINTAIN.

66 HISTORY (CLEAR FAULT HISTORY)

This parameter is used to clear the previous faults in the FAULT HISTORY. When set to CLEAR and the ENTER key is pushed, the display will change to MAINTAIN, and the FAULT HISTORY will display NO FAULT for each of the eight fault histories.

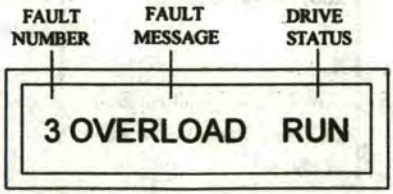
69 LANGUAGE (LANGUAGE SELECTION)

The MC Series drive can support other languages with the addition of an optional LANGUAGE EEPROM chip installed in socket U11 on the control board of the drive. If the EEPROM is not present, the default language will be ENGLISH. Also, this parameter is not affected when the parameters are reset using Parameter 65 - PROGRAM. Therefore, if a language other than ENGLISH is selected, it will remain in effect after a RESET.

70 FAULT HISTORY

The FAULT HISTORY stores the previous eight fault conditions that caused the drive to trip. The information stored here is view-only, it cannot be altered. The FAULT HISTORY can be used to determine if there is a pattern, or trend, to the faults, which may indicate a problem in the system. Refer to Section 19.0 - TROUBLESHOOTING for more information on faults.

The FAULT HISTORY indicates the number of the fault (number 1 is the most recent fault), the fault message, and the status of the drive at the time of the fault. An example is shown below:



In the example above, the third fault log is being viewed, which is an OVERLOAD fault that occurred while the drive was in a RUN state.

19.0 TROUBLESHOOTING

The table below lists the fault conditions that will cause the drive to shut down, as well as some possible causes. Please contact the factory for more information on troubleshooting faults.

NOTE: The drive will not automatically restart after a PWR SAG or a CONTROL fault. Also, if an OUTPUT fault occurs below 1.5 Hz, the drive will only attempt one restart, after a four minute delay. If unsuccessful, it will then trip into FAULT LOCKOUT, which will require a manual reset. This is done to protect the drive in case of a shorted motor.

FAULT MESSAGES

FAULT	DESCRIPTION	POSSIBLE CAUSES
OUTPUT	Output transistor fault: Output current exceeded 200% of drive rating.	Phase to ground short. Phase to phase short. FX BOOST set too high. Bad transistor module (IPM).
LO VOLTS	Low DC Bus Voltage fault: DC bus voltage below 60% of normal.	Low line voltage.
HI VOLTS	High DC Bus Voltage fault: DC bus voltage above 120% of normal.	High line voltage. Overhauling load - DECEL DECEL rate is set too fast.
HI TEMP	Temperature fault: Internal drive temperature too high.	Ambient temperature too high. Fan failure (if equipped).
OVERLOAD	Current Overload fault: Output current rating exceeded for too long.	Drive undersized for the application. Problem with motor and/or driven equipment.
PWR TRAN	Power Transient fault: Low line voltage.	AC line dipped or sagged.

FAULT MESSAGES		
FAULT	**DESCRIPTION**	**POSSIBLE CAUSES**
PWR SAG	Power Sag fault: Control board voltage is below tolerance. A new control board has been installed that is different from the previous version.	Erratic AC line. Perform a factory reset using Parameter 65-PROGRAM. This will update the software and allow the fault to be reset.
LANGUAGE	Language fault: Selected language not present	Defective language EEPROM. Language EEPROM (U11) removed after programming.
EXTERNAL	External fault: TB-13D is open or closed to TB-2, depending on setting of Parameter 50-TB13D.	Check setting of Parameter 50-TB13D. Check devices wired between TB13D and TB-2.
DB ERROR	Dynamic Brake fault: DB circuit has sensed a resistor overload.	The DB duty cycle is too high, causing the resistors to overheat.
CONTROL	Control Board fault: New software has been installed that is different from the previous version.	Perform a factory reset using Parameter 65-PROGRAM. This will update the software and allow the fault to be reset.
INTERNAL INTERN (#)	Internal fault: The micro-processor has sensed a problem.	Electrical noise on control wiring. Defective microprocessor.

20.0 USER SETTING RECORD

PARAMETER MENU: USER SETTING RECORD			
PARAM. NUMBER	**PARAMETER NAME**	**FACTORY DEFAULT**	**USER SETTING**
0	LINE VOLTS	AUTO	
1	SPEED #1	20.00 Hz	
2	SPEED #2	20.00 Hz	
3	SPEED #3	20.00 Hz	
4	SPEED #4	20.00 Hz	
5	SKIP #1	.00 Hz	
6	SKIP #2	.00 Hz	
7	BAND WID	1.00 Hz	
8	ACCEL	30.0 SEC	
9	DECEL	30.0 SEC	
10	MIN FRQ	.50 Hz	
11	MAX FRQ	60.00 Hz	
12	DC BRAKE	.0 VDC	
13	DC TIME	.0 SEC	
14	DYN BRAKE	OFF	
16	CURRENT	180 %	

PARAMETER MENU: USER SETTING RECORD			
PARAM. NUMBER	**PARAMETER NAME**	**FACTORY DEFAULT**	**USER SETTING**
17	MOTOR OL	100%	
18	BASE	60.00 Hz	
19	FX BOOST	(NOTE 1)	
20	AC BOOST	.0 %	
21	SLIP CMP	.0 %	
22	TORQUE	CONSTANT	
23	CARRIER	2.5 kHz	
25	START	NORMAL	
26	STOP	COAST	
27	ROTATION	FORWARD	
28	AUTO/MAN	BOTH	
29	MANUAL	KEYPAD	
30	CONTROL	LOCAL	
31	HZ UNITS	HERTZ	
32	HZ MULT	1.00	
33	SPEED DP	XXXXX	
34	LOAD MLT	100%	

NOTE 1: REFER TO SECTION 18.0 - DESCRIPTION OF PARAMETERS.

PARAMETER MENU: USER SETTING RECORD			
PARAM. NUMBER	**PARAMETER NAME**	**FACTORY DEFAULT**	**USER SETTING**
35	CONTRAST	HIGH	
39	TB5 MIN	.00 Hz	
40	TB5 MAX	60.00 Hz	
42	TB10A OUT	NONE	
43	@TB10A	60.00 Hz	
44	TB10B OUT	NONE	
45	@TB10B	125 %	
47	TB13A	NONE	
48	TB13B	NONE	
49	TB13C	NONE	
50	TB13D	EXT FAULT	
52	TB14 OUT	NONE	
53	TB15 OUT	NONE	
54	RELAY	NONE	
55	TB5B LOSS	FAULT	
57	SERIAL	DISABLE	
58	ADDRESS	30	

PARAMETER MENU: USER SETTING RECORD			
PARAM. NUMBER	**PARAMETER NAME**	**FACTORY DEFAULT**	**USER SETTING**
61	PASSWORD	19	
63	SOFTWARE	(N/A)	
64	MONITOR	ON	
65	PROGRAM	RESET 60	
66	HISTORY	MAINTAIN	
69	LANGUAGE	ENGLISH	
70	FAULT HISTORY	(N/A)	

Password

Prog

Select

Max Freq

enter

change

enter

Run

AC Technology Corporation

660 Douglas Street, Uxbridge MA 01569

Sales: 800 - 217 - 9100, FAX: 508 - 278 - 7873

Service: 508 - 278 - 9100 ext 125, FAX: 508 - 278 - 6620

A.P.C.S.

TYPE NO. DESIGNATION

WT227 - X X X X

Output:

- 1 = 4 - 20mA. } 2-Wire
- 2 = 10 - 50mA. } 2-Wire
- *) 3 = 0 - 1mA. } 3-Wire (+V Ref).
- *) 4 = 0 - 10mA. } 3-Wire (+V Ref).
- *) 5 = 0 - 20mA. } 3-Wire (+V Ref).
- *) 6 = 0 - 1V. } 3-Wire (+V Ref).
- *) 7 = 0 - 5V. } 3-Wire (+V Ref).
- *) 8 = 0 - 10V. } 3-Wire (+V Ref).
- *) 9 = Other (Specify).

Input:

- 1 = 0 - 5mV.
- 2 = 0 - 7.5mV.
- 3 = 0 - 10mV.
- 4 = 0 - 15mV.
- 5 = 0 - 20mV.
- 6 = 0 - 30mV.
- 7 = 0 - 50mV.
- 8 = 0 - 100mV.
- *) 9 = Other (Specify).

Excitation:

- 1 = 4.7V @ 1mA max.
- *) 2 = 1mA constant (min 5k).
- *) 3 = 3V @ 1mA max.
- *) 9 = Other (Specify).

Options:

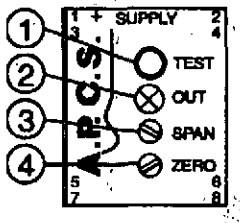
- 0 = None.
- *) 1 = SPAN, remote adjustment Incl. 1.5m cable tail (Potentiometer extra).
- *) 2 = SPAN and INPUT OFFSET remote adjustment. Incl. 2 x 1.5m cable tail (Potentiometer extra).
- *) 3 = Reverse action.
- *) 4 = 3-Wire supply for <5k bridge (10V excit).

RECOMMENDED TRANSDUCERS:

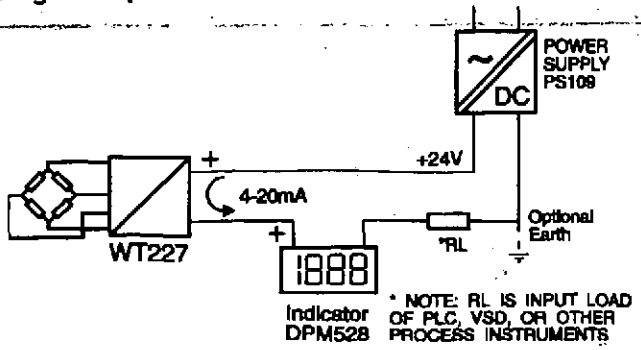
- Philips KS2153 (0.4 - 25 Bar).
- Philips KS2150 (1 - 400 Bar).
- Honeywell 234PC.
- Novasensor NPI-19A.
- Trans Instrument 2000A.

Front Control Explanation

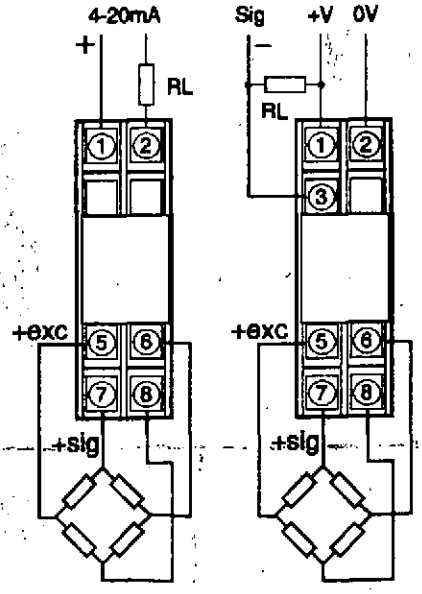
1. Test socket - output signal access with reference to terminal (1) loop integrity is maintained when digital multimeter Rin <30 Ω is used.
2. Loop indicator - dim at 4mA, bright at 20mA.
3. SPAN (full scale) adjust 15 turn.
4. ZERO (start scale) adjust 15 turn.



Wiring Example



CONNECTION DIAGRAMS



*) Price Extra.

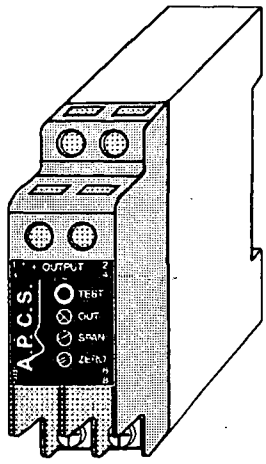
A.P.C.S. ANALOG PROCESS CONTROL SERVICES PTY. LTD.
24 FRED ST, LILYFIELD 2040 N.S.W., AUSTRALIA
Fax 02 9555 1055
Tel 02 9555 1044

STRAIN GAUGE TRANSMITTER WT227 No. **DS227015** Issue: **5** 15/08/96

A.P.C.S.

STRAIN GAUGE TRANSMITTER WT227

DESCRIPTION



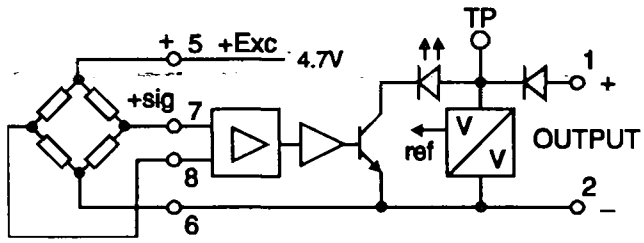
As part of the A.P.C.S. Series 200 modular range of loop powered transmitters the STRAIN GAUGE TRANSMITTER WT227 offers an economic solution combining compactness with accuracy and flexibility. Due to its total width of only 22.5mm and the 35mm DIN-Rail mounting arrangement the WT227 is ideal for "Nestmounting" in field enclosures or as a "space saver" in larger control cabinets. Standard output is 4 - 20mA with a minimum supply voltage of 6.3V. This enables the WT227 to be used in 12V battery supply systems or in automotive applications. Other factory set output configurations are 10 - 50mA loop powered and 0 - 10mA, 0 - 20mA or voltage output in 3-wire connection. Reference for 3-wire connection is the positive supply which can be as high as 40VDC. Higher voltages are permissible with the use of suitable series zener diodes. Double surge protection is standard with all Series 200 loop powered transmitters to prevent failure due to spikes induced by DC switched inductive loads.

The WT227 is primarily designed for use with strain-gauge type pressure transducers. Any other strain gauge devices can be accommodated as long as the bridge resistance is not below 5k Ω. Typical applications for separation of transducer and transmitter would be where the transducer is submersed or otherwise inaccessible, as the conveniently mounted transmitter provides non-interacting ZERO and SPAN adjustments from the front of the module. A front mounted L.E.D. and a test socket verify module function and assist in calibration checks without disconnection of output wires. (IN-PROCESS OUTPUT MONITORING).

GENERAL SPECIFICATIONS

Size:	22.5W x 68H x 109D (mm)
Mounting:	Clip for 35mm DIN-Rail.
Housing material:	Polycarbonate.
Connection:	Screw-terminals.
Weight:	88 gr.
Protection class:	IP40.
Cal. Accuracy:	<0.5% of range.
Linearity:	<0.5% all ranges.
Ambient operating temperature range:	-20...+70°C.
Temperature drift error:	0.02% / °C within operating range.
Supply voltage:	6.3 - 40V continuous (50V 30 seconds).
Load for 4 - 20mA output:	RL max = $\frac{\text{supply voltage - 6.3V}}{0.02\text{A}}$ [Ω].
Load change effect:	0.1% up to RL max.
Response time:	0.2 sec for T_{90}.
Zero adjust:	-20...+10%.
Span adjust:	-12...+100% (Gain 0.88...2.10).
Input range:	5mV up to 100mV.
Excitation output:	4.7V @ 1mA max or 1mA constant (4.7V drive).
Input/output isolation:	None - refer to SPI232 for isolation.

BLOCK DIAGRAM



For input/output combinations refer to TYPE NO. DESIGNATION overleaf.

A.P.C.S.
Analog Process Control Services

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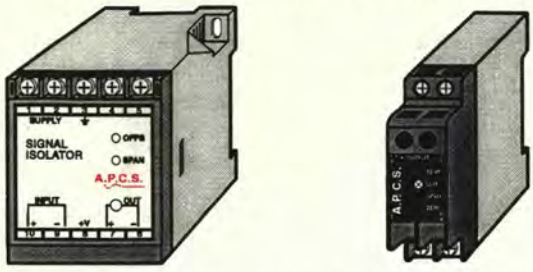
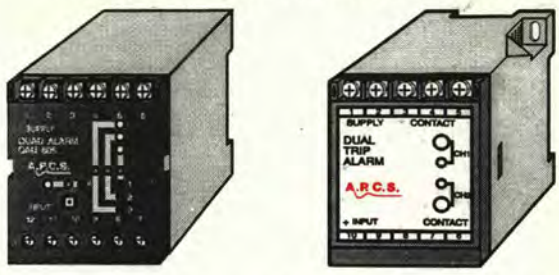
Email: sales@apcs.net.au
Tel: (02) 9555 1044
Fax: (02) 9555 1055

AUSTRALIAN MADE QUALITY PRODUCTS

PROCESS SIGNAL ISOLATORS AND TRANSMITTERS SIGNAL, LOOP OR AUXILLARY POWERED

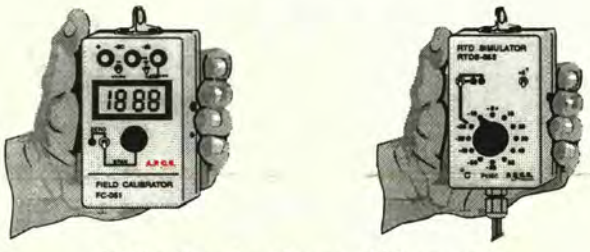


SINGLE AND MULTICHANNEL PROCESS ALARMS SIGNAL, LOOP OR AUXILLARY POWERED



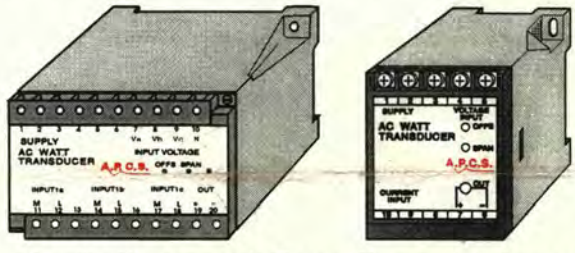
a.c and d.c Current or Voltage, Vibration (Accelerometer, Swing coil, Eddy current), Temperature (RTD, T/C), Frequency (Proximity, Encoder), Water Chemistry (pH, ORP, Conductivity), Liquid Level (Conductive, Back pressure), Pressure (Solid State), Weight (Strain Gauge, load cell) and Special sensors on request.

HAND-HELD FIELD CALIBRATORS

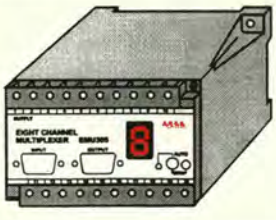


RTD, Strain Gauge, Volts and 4-20mA (Sink or Source)

SINGLE AND THREE PHASE POWER TRANSDUCERS

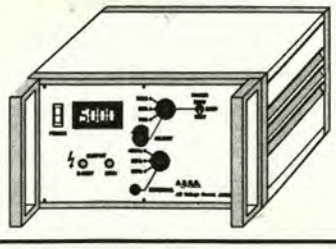


Single Phase and Three Phase Unbalanced/ Balanced (3/4 wire) Watts, Vars, VA, Phase Angle



MULTICHANNEL MULTIPLEXERS

RTD, T/C and Process Signals Upto 256 Channels



BENCH TOP CALIBRATORS

AC Voltage/Current Variable Frequency

PID CONTROLLER

IP54 protection class pH/ORP, Conductivity, Process signal inputs Pulse duration or analogue output

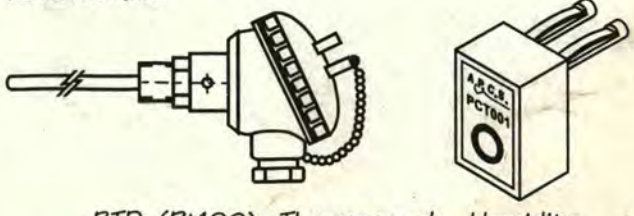
IP65 FIELD MOUNTABLE TX.

3 Wire or Loop Powered Rugged Alluminium Housing Temperature (RTD, T/C), Water Chemistry (pH, ORP, Conductivity), Weight (Strain Gauge, load cell), Frequency (Proximity, Encoder) and Special sensors on request.

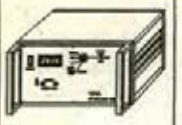
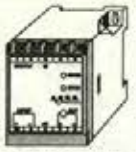
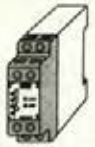
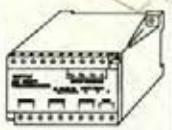
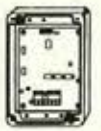
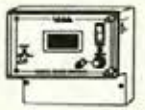
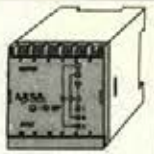
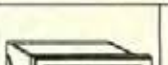
DIGITAL AND BARGRAPH INDICATORS

Imported - Microprocessor Based RTD, T/C and process signal inputs

ACCESSORIES



RTD (Pt100), Thermocouple, Humidity and pH/ORP probes. C/T's upto 20A

A.P.C.S.											
DESCRIPTION	Bench-top Calibrators	Hand-held Calibrators	Isolators, Controllers, Transmitters & Alarms	Isolators, Transmitters & Alarms	Isolators, Multiplexers Transmitters & Alarms	Bar Graph Indicators & Loading stations	Metal Housing IP65 Transmitters	IP55 Indicators & Controllers	Alarms & Monitors	Indicators & Alarms	Probes, Transmitters & Transducers
SUPPLY	IEC Mains socket	Dry cell, NCL battery or plug pack	Auxiliary or Signal	Loop, 3 Wire, Auxiliary or Signal	Auxiliary	Auxiliary	Loop, 3 Wire or Auxiliary	Auxiliary	Auxiliary	Auxiliary or Signal	Auxiliary or Signal
SERIES	30	50	100	200	300	400	500	600	800	ACD	ACE/M/P
DC current (e.g 4-20mA)		HC - FC051	TX - SC120/BSC133 IS - SI139/BSI134 CI - SI132 AL - STA138/DTA137	TX - SC220/DCT247 IS - SI239 CI - SI231 SP - SPI232 AL - PA201/PA202	AL - MCA301 MP - EMU305	LS - LOS40X BG - BGI402	TX - SC520	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPM528 IN - DPM33X IN - DPM635	
DC Volts, mV (e.g 0-10V)		HC - FC051	TX - SC120/MVT123 IS - SI139/BSI134 CI - SI132 AL - STA138/DTA137	TX - SC220 IS - SI239/MVT223 CI - SI231 AL - PA201/PA202	AL - MCA301 MP - EMU305	LS - LOS40X BG - BGI402	TX - SC520	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPM528 IN - DPM33X IN - DPM635	
AC current	BC - ACS040 BC - ACS041 BC - ACS042		TX - BSC133 IS - ACT141 AL - STA138/DTA137 AR - ACM117	IS - ACT241 AL - DPA203/CM270 AR - ACM217	AL - MCA301			AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPM5XX IN - DPM6XX IN - DPM7XX	PR - PCT001
AC volts	BC - AVS030 BC - AVS031		TX - BSC133 IS - AVT145 AL - STA138/DTA137	IS - AVT245 AL - DPA203	AL - MCA301			AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPM5XX IN - DPM6XX IN - DPM7XX	
RTD (Pt100)		HC - RTDS053	TX - RTDT125/BSC133 IS - SI130 AL - STA137/DTA137 AR - RTDA111	TX - RTDT225 AL - DPA203 AR - RTDA211	AL - MCA301 MP - EMU305		TX - RTDT525 TX - RTT508 TX - TT50X	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPMXXX	PR - PR505 PR - PR506 PR - PR507
Thermocouple (all types)		HC - FC051	TX - TCT126/BSC133 IS - SI130 AL - STA138/DTA137 AR - TCA112	IS - TCT226 AL - DPA203 AR - TCA212	AL - MCA301 MP - EMU305		TX - TCT526 TX - TCT506 TX - TT507	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPMXXX	
Frequency			TX - FRT150/PRM180 IS - SI130 AL - STA138/DTA137 AR - FRA151	TX - FRT250 AL - DPA203 AR - FRA251	AL - MCA301 MP - EMU305		TX - FRT550	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805	IN - DPM450 IN - DPM528 IN - DPM535	
Resistance			TX - RT143/BSC133 IS - SI130/BSI134 AL - STA138/DTA137	TX - RT243 AL - DPA203	AL - MCA301 MP - EMU305		TX - RT543	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805		
Potentiometer (Slidewire)			TX - SWT140/RT124 IS - SI130/BSI134 AL - STA138/DTA137	TX - SWT240 AL - DPA203			TX - SWT540	AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805		PR - 275-502
pH/redox			TX - PHT129/BSC133 IS - SI130 AL - STA138/DTA137	IS - PHT229 AL - PA203				AL - UPM60X CR - UPC61X IN - UPI61X	AL - QAM803 AL - QUA805		PR - PRM11
Loadcell (Strain)		HC - SGS054	TX - WT127 AR - WA114	TX - WT227 AR - WA214	MP - EMU305		TX - WT527	AL - UPM60X CR - UPC61X IN - UPI61X			
Vibration			TX - VBT144 AL - STA138/DTA137	TX - VBT244	MP - EMU305						PR - PR337F04
Pressure			TX - PIC146	TX - PIC246 AR - PM276/PM277							PR - PR20008
Conductivity			TX - CDT128 AL - STA138/DTA137	IS - CDT228				AL - CDC60X			PR - PR128
Position			CR - PSC170 TX - TPT194								
Watts			ET - AWT190		ET - AWT390						
VAR			ET - ART191		ET - ART391						
VA			ET - AVAT192		ET - AVAT392						
Phase angle			ET - APT193								
Mains Freq.			ET - MFT184								
Power Supplies			PS - PS108/PS109	PS - PS208/PS209 PS - PS210							

Function Index

AL - Alarm
AR - Retranmitting Alarm
BC - Bench-top Calibrator
BG - Bar Graph Indicator
CI - Configurable Isolator
CR - Controller
ET - Electrical Transducer
HC - Hand-held Calibrator
IN - Digital Indicator
IS - Isolator
MP - Multiplexer
PR - Probe
PS - Power Supply
SP - Signal Powered
TX - Transmitter (Transducer)