

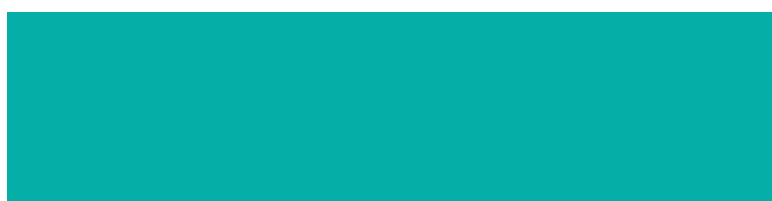
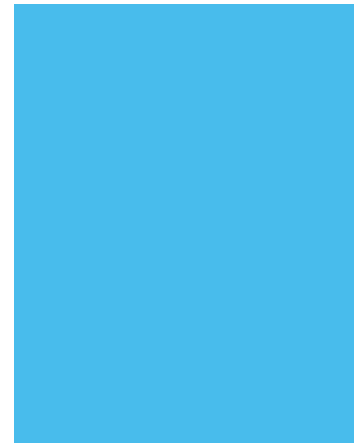
# Installation, Operation and Maintenance Manual

## Volume 1 – Functional Descriptions, Operation and Maintenance Manual

879540-84-IOM-0001

REPLACEMENT OF AERATION BLOWERS AT GIBSON ISLAND SEWAGE  
TREATMENT PLANT

C1314-011



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# 1.1 Control Systems Functional Descriptions



# **CONTROL SYSTEM**

## FUNCTIONAL SPECIFICATION

**DOCUMENT CONTROL**

**Contract No** **C1314-011**

**Title** **Control System**

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## 1 PURPOSE

The purpose of this document is to provide a detailed description of the PLC and SCADA functional design for the new Gibson Island blowers. This document describes the PLC device function block interfaces, SCADA Screens and interfaces to be developed and modified.

## 2 SCOPE

This document describes the functional operation and changes to existing operation of the main blowers for the Gibson Island WWTP blower upgrade project. The scope includes the specification for a new Blower Master PLC (PLC13) and the modification required to the existing Main Blowers PLC (PLC3).

### 3 DEFINITIONS AND ACRONYMS

Term	Explanation
HMI	<b>H</b> uman <b>M</b> achine Interface
I/O	System Inputs and <b>O</b> utputs (May apply to physical PLC, device communications or SCADA Inputs and outputs)
PLC	<b>P</b> rogrammable <b>L</b> ogic <b>C</b> ontroller
SCADA	<b>S</b> upervisory <b>C</b> ontrol <b>a</b> nd <b>D</b> ata <b>A</b> cquisition
TCP/IP	<b>T</b> ransmission <b>C</b> ontrol <b>P</b> rotocol / Internet <b>P</b> rotocol
WWTP	<b>W</b> aste <b>W</b> ater <b>T</b> reatment <b>P</b> lant

## 4 RELATED DOCUMENTS

Rev	Document No.	Title / Description
2.5	003547	QUU – PLC Software Guidelines

## 5 PROCESS AREA SCOPE

The blowers provide air to the Oxidation Tanks and Grit Channel. The blower system comprises of four individual blowers each being controlled by its own local control system. Each of the four blowers' local control systems are connected to the Blowers Master PLC (PLC13) via Ethernet. The blowers are controlled by a PID algorithm in PLC13 which uses the header pressure to determine if more or less air is required.

The main components that will be monitored and/or controlled by the PLC and SCADA are:

- 4 x Blower Systems
- 1 x Manifold Pressure

The existing SCADA is a CitectSCADA v7.0 and modification will be required as described in this document.

### 5.1 CONTROL SYSTEM

The control system consists of a Blowers Master PLC (PLC13) and a Main Blowers PLC (PLC3). Both are GE Fanuc Rx3i PLCs.

The following devices are monitored from the PLC13 via Modbus TCP/IP Communications:

- 4 Blower Systems

#### 5.1.1 FAILURE MODE

The following failure responses apply to PLC13 unless specifically specified for a particular item.

- All communications data within the PLC will revert to 0 on a communications failure to the communicating device

## 6 GRIT / BLOWER BUILDING PLC (PLC3)

### 6.1 DESCRIPTION

The Grit / Blower Building PLC controls the Grit Channel air flow, the Grit Dredger, Plant Bypass Valve and other miscellaneous utilities.

### 6.2 EQUIPMENT

The Grit / Blower Building PLC transmitters PIT03101 and FIT03100 are to be moved to PLC13. This move will require them to be renamed to PIT13101 and FIT13100 respectively.

Description	Equipment Number
PLC	PLC3
Grit Channel Air Flow Meter	FIT30202
Visy Paper Flow Meter	FIT30206
Plant Bypass Valve	FCV30205
Grit Dredger	BR92
Grit Dredger Pump	PU396
Grit Dredger Clam Actuator	ACT38
Grit Channel Air Flow Valve	FCV30201

### 6.3 ARCHITECTURE

The PLC already monitors the manifold pressure. It also receives the pressure set point from PLC4.

### 6.4 METHOD OF OPERATION

This section does not document the configuration and labelling changes required for the relocation of PIT03101 and FIT03100 to PLC13.

#### 6.4.1 DETAILED DISPLAYS

There is no detailed display modification requirement for this process area.

#### 6.4.2 EQUIPMENT CONTROL

There is no equipment control modification requirement for this process area.

#### 6.4.3 SEQUENCE CONTROL

The existing blower duty and pressure control is to be removed.

#### 6.4.4 ANALOGUE CONTROL

There is no analogue control modification requirement for this process area.

#### 6.4.5 TREND DISPLAYS

There is no modification requirement for trend displays in this process area.

#### 6.4.6 HELP

There is no requirement for modification to any help system for this process area.

#### 6.4.7 DATA LOGGING

There is no requirement for modification to data logging for this process area.

#### 6.4.8 SUB SYSTEM COMMUNICATIONS

There is no modification requirement for sub system communications in this process area.

**6.4.9 PEER TO PEER COMMUNICATIONS**

The following tables describe the peer to peer communications data for PLC3. The only modification is the removal of interfacing with PLC4 for pressure control.

**6.4.9.1 DATA RECEIVED**

Source PLC	Description	Notes
PLC1	Standby Generator Supplying Plant Flag	Staggered Startup
	Heartbeat Word	Comms Alarm
	RSP1 Flow Valid	Plant Inflow Calculation
	RSP2 Flow Valid	Plant Inflow Calculation
	RSP3 Flow Valid	Plant Inflow Calculation
	RSP1 Flow in Litres/sec	Plant Inflow Calculation
	RSP2 Flow in Litres/sec	Plant Inflow Calculation
	RSP3 Flow in Litres/sec	Plant Inflow Calculation
	Raw Sewerage Pump 1 Running	Close Plant Bypass Valve (BPV) if all RSPs stopped and BPV in Auto
	Raw Sewerage Pump 2 Running	Close PBV if all RSPs stopped and BPV in Auto
	Raw Sewerage Pump 3 Running	BPV if all RSPs stopped and BPV in Auto
PLC4	Heartbeat Word	Comms Alarm
	Floating Header Pressure Setpoint	Blower Control
	WAS 1 Flow	Plant Outflow Calculation
	WAS 1 Flow Available	Plant Outflow Calculation
	WAS 2 Flow	Plant Outflow Calculation
	WAS 2 Flow Available	Plant Outflow Calculation
PLC5	RAS 1 & 2 Flows	Plant Outflow Calculation
	RAS valid signals	Plant Outflow Calculation
	Heartbeat Word	Comms Alarm
	Oxidation Ditch 1 Flow	Plant Outflow Calculation
	Oxidation Ditch 2 Flow	Plant Outflow Calculation
	Oxidation Ditch 1 Flow Invalid	Plant Outflow Calculation
	Oxidation Ditch 2 Flow Invalid	Plant Outflow Calculation

**6.4.9.2 DATA PRODUCED**

Destination PLC	Description	Notes
PLC1	Heartbeat Word	
	Night Time Sensor	Sensors ON when it is dark
PLC2	Heartbeat Word	
	Night Time Sensor	
PLC4	Fixed Pressure Setpoint Mode ON	Fixed to Floating Bumpless Transfer
	FIT03100 Scaled Header Pressure	
	Heartbeat Word	
	Night Time Sensor	Sensors ON when it is dark
PLC5	Heartbeat Word	
	Night Time Sensor	Sensors ON when it is dark

Destination PLC	Description	Notes
PLC6	<i>Heartbeat Word</i>	
	<i>Night Time Sensor</i>	<i>Sensors ON when it is dark</i>

**6.4.10 OTHER REQUIREMENTS**

There are no other requirements for this process area.

## 7 BLOWER MASTER PLC (PLC13)

### 7.1 DESCRIPTION

The Blower Master PLC process area includes monitoring and master control of the four Blower Systems.

### 7.2 EQUIPMENT

The Blowers Master PLC devices include four Blower Systems, a pressure transmitter, a flow transmitter and the PLC.

Description	Equipment Number
PLC	PLC13
Blower 1	BLO01
Blower 2	BLO02
Blower 3	BLO03
Blower 4	BLO04
Common Manifold Pressure	PIT13101
Common Manifold Air Flow	FIT13100

### 7.3 ARCHITECTURE

The PLC will monitor and control the Blowers Systems via Ethernet communications.

### 7.4 METHOD OF OPERATION

This section does not document the configuration and labelling changes required for the relocation of PIT03101 and FIT03100 to PLC13.

### 7.4.1 DETAILED DISPLAYS

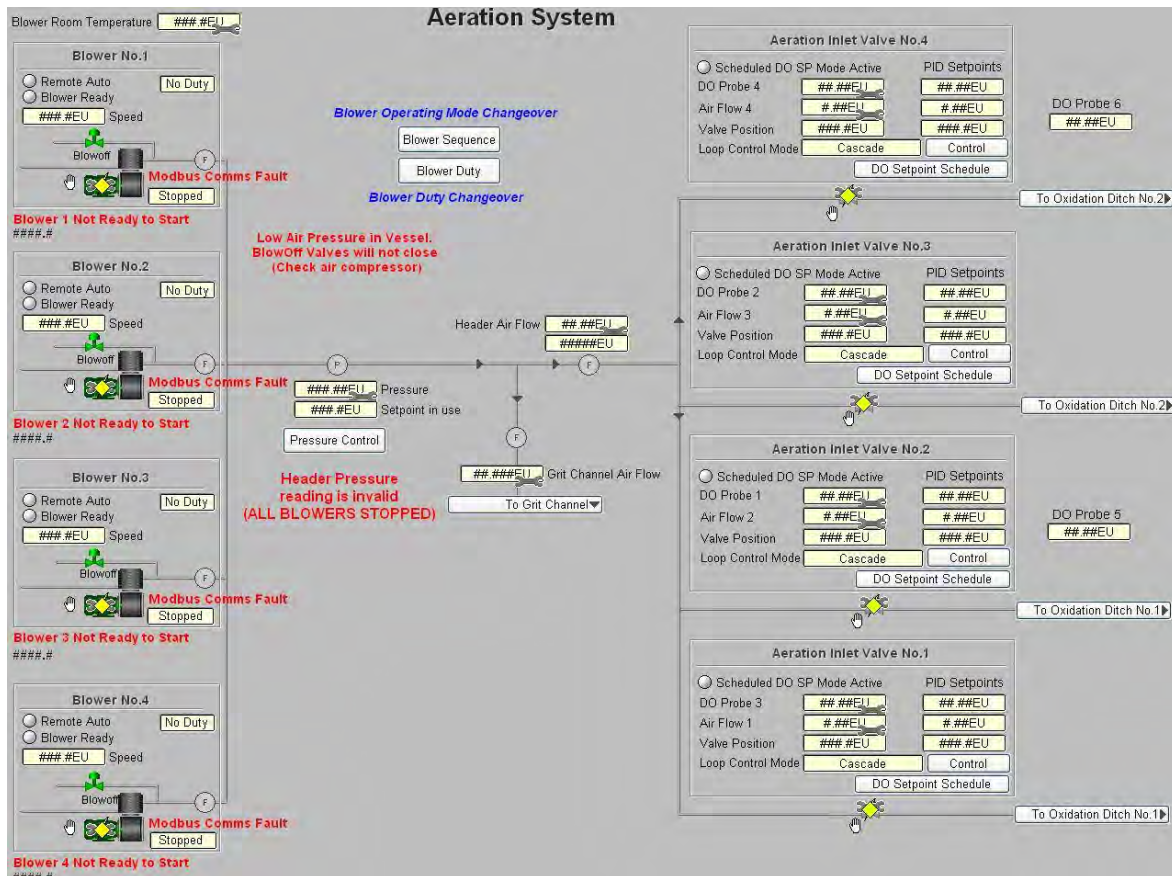
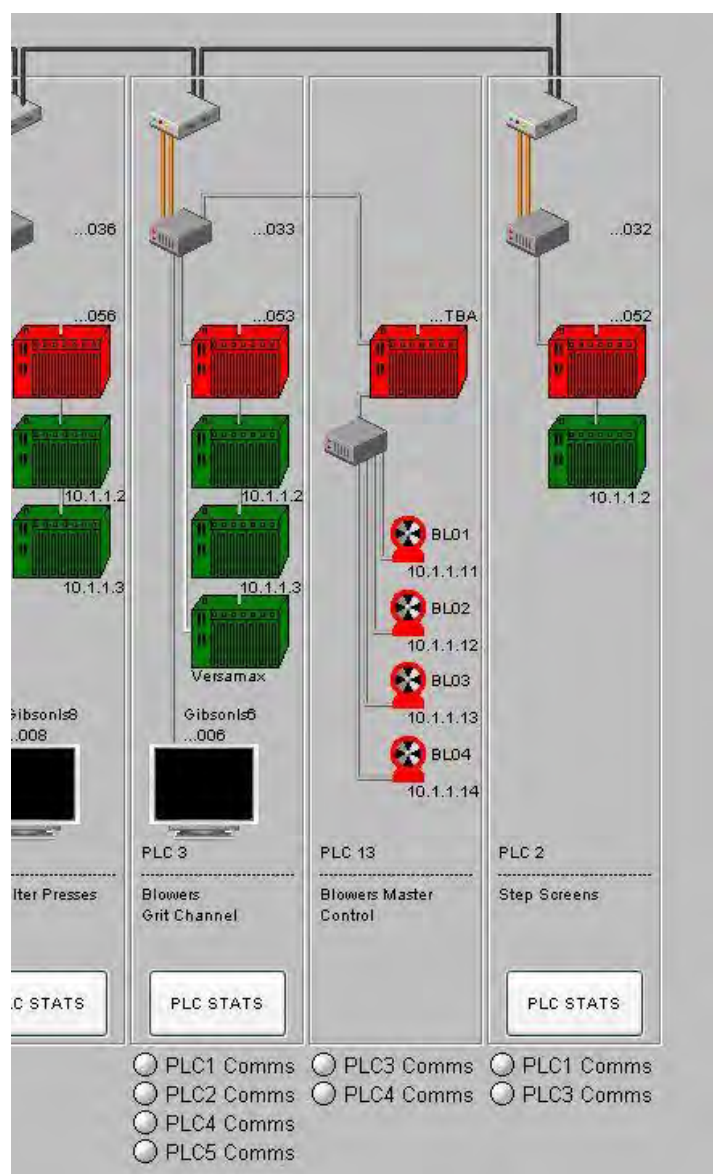


Figure 1 Modification to Aeration System Display

**Figure 2 Communications Display Section****7.4.2 EQUIPMENT CONTROL****7.4.2.1 BLOWERS CONTROL****7.4.2.1.1 START INTERFACE**

A Blower System is started by activating the load command. The Blower System will be configured for automatic load.

**7.4.2.1.2 STOP INTERFACE**

A Blower System is stopped by activating the stop command. The stop command will be active whenever the interlocks are unhealthy or the associated Blower System is not required to run by the sequence control.

**7.4.2.1.3 DEMAND INTERFACE**

The blower can operate on 4 different types of demand, where-by the internal control system will control to the demand Set Valve (known as the SV). For this application the blowers will operate in Current/Power (%) demand mode. This control mode is the most appropriate for aeration systems. It is a more or less demand regardless of the actual pressure and flow. The blowers will have a "working range" somewhere between 40% to 95% input power which will be confirmed during commissioning.

**7.4.2.1.4 DRIVE RUN INTERLOCKS**

The following drive run interlocks will inhibit the running of all Blowers and cause running blowers to stop immediately.

- Header pressure above 60kPa (Hard coded limit)
- Header pressure high high
- Header pressure invalid

Note that blowers may still operate in local if any of the above occurs.

**7.4.2.1.5 REMOTE MANUAL RUN PERMISSIVES**

There are no permissives that apply to remote manual operation only.

**7.4.2.1.6 REMOTE AUTOMATIC RUN PERMISSIVES**

There are no permissives that apply to remote automatic operation only.

**7.4.3 EQUIPMENT MONITORING****7.4.3.1 BLOWER ERROR CODES**

The following error codes are faults read from the blowers at start up.

Error Code	Error	Description
1	Pressure Sensor	DP1 > 5kPa DP2 > 5kPa P2 > 70kPa
2	Temp Sensor	T1 > 100°C or T2 > 150°C
4	DCL	DCL > 700V
16	VFD	VFD Error
32	VFD Cooling	Temp switch "ON" of VFD
64	Speed	RPM > 10000

The following error codes are alarms read from the blowers during operation. The blower continues to run when these errors occur. These alarms will remain active while the alarm condition remains. If a second alarm occurs, it will overwrite the first alarm.

Error Code	Error	Description
101	Filter Blockage	DP1 > 1.5kPa
102	High T2	T2 > 120°C
103	High T1	T1 > 45°C
104	High P2	P2 > 80kPa
105	High Speed	Speed > 98% Max Speed
106	Surge	Blower operating near surge line
110	High Magnet Temp	Magnet Temp > 280°C
111	High Duty	Duty > 90%
113	High VFD Temp	VFD Temp > 0.95 Max Temp
114	Low SV	SV < 10%
126	High Motor Temp	Motor Temp > 180°C

The following error codes are faults read from the blowers during operation. The blower will stop when these errors occur. These faults will overwrite an alarm and will remain active until operator intervention has occurred at the blower to reset the condition.

Error Code	Error	Description
201	Filter Blockage	DP1 > 2.3kPa
202	P2 Limit	P2 > 85kPa
204	Current Limit	Current > Max Allowable
205	Low DC Link	DCL < Set Value
206	High DC Link	DCL > Set Value
207	Over Speed	RPM > Max Value
210	Inverter Problem	Error signal from inverter
211	Inverter Overheat	Overheat of heat sink
214	Start	Fail on DCL rise within time
215	Start	Below 10000rpm after start
216	Start	No movement
220	Cooling Fan	No action of cooling fan or MC
221	Motor	Speed < 9000rpm
222	T1 Limit	T1 > 50°C
223	BOV	Not Closed
224	Surge	Blower was operating at surge
225	Real Time Surge	Real Time Surge Safety Trip
230	Switching Error	Manual Stop when in Remote
236	Emergency Stop	Touch screen version only
239	Loss of Power	Power has been interrupted
240	Motor Bearing	Motor not rotating within design
241	Fan Motor	< 8000rpm
242	Low DCL Fan	Fan motor inverter DCL < Set Value
243	High DCL Fan	Fan motor inverter DCL > Set Value
244	Fan Motor Fail	Fan motor failed to start
245	Fan Motor High Temp	Fan motor > 180°C
246	Fan Motor Inverter	Error from fan motor inverter
250	High VFD Intake Temp	VFD inlet temp > 50°C
255	EEPROM CPU	Cannot be read from EEPROM

If the CPU fails, all outputs are lost and the blower goes into fail-safe shutdown. In this case, no error code will be read from the blower. The error 255 occurs when the CPU memory only fails.

#### **7.4.4 SEQUENCE CONTROL**

The blower set consists of four blowers controlled in a duty arrangement. The combination of blowers selected to run is determined to give the most efficient configuration for producing the required air demand. The system is designed so that normally there will always be at least one blower running.

When the requested power of running Blower Systems is over the switching point for a time period the next Blower System is started to increase the air output. During this period the

PID output is forced to a set power for a time period in order to stabilise the system. This is achieved by setting the PID to manual mode and forcing the control variable output to the set power.

If the requested power of the running Blower Systems is below the appropriate switching point for a time period then the lowest duty running Blower System is stopped. During this period the PID controller output is forced to a set power for a time period in order to stabilise the system. This is achieved by setting the PID to manual mode and forcing the control variable output to the set power.

The following setpoints are used for starting and stopping of the blowers;

Time Delay Before Starting Next Blower	300 seconds
Time Delay Before Stopping Last Blower	300 seconds
1 Blower Maximum (Maximum Power Before Starting 2 <sup>nd</sup> Blower)	96.5%
1 Blower Minimum (Minimum Power Of 1 Blower)	5.5%
2 Blower Maximum (Maximum Power Before Starting 3 <sup>rd</sup> Blower)	96.5%
2 Blower Minimum (Minimum Power Before Stopping 2 <sup>nd</sup> Blower)	5.5%
3 Blower Maximum (Maximum Power Before Starting 4 <sup>th</sup> Blower)	96.5%
3 Blower Minimum (Minimum Power Before Stopping 3 <sup>rd</sup> Blower)	5.5%
4 Blower Maximum (Maximum Power Of 4 Blowers)	96.5%
4 Blower Minimum (Minimum Power Before Stopping 4 <sup>th</sup> Blower)	5.5%
Set Power For Addition Of Blower	75%
Set Power For Removal Of Blower	10%
Time Delay Before Releasing PID Output	15 seconds

*Note: The power percentages in the table above reflect percentages of the working range. They do not directly relate to the input power percentage of the blower.*

#### 7.4.4.1 DUTY

Duty control for the blowers will be according to duty for a continuous run system. Duty changeover will occur automatically on the 1<sup>st</sup> of each month (monthly). Duty will be able to be changed manually via the SCADA. A duty selection and status genie will be displayed on the Aeration page in Citect.

##### 7.4.4.1.1 DUTY CHANGEOVER

To avoid a period when no blower is producing process air duty changes that result in the replacement of running blowers will be controlled. The replacement blower is to be started for a time period and then the replaced blower is to stop.

If a duty change requires multiple replacements each replacement will occur in order of the replacing blower's duty.

The following setpoints are used for duty changeover of the blowers;

Time Delay Before Stopping Blower	30 seconds
-----------------------------------	------------

### 7.4.5 ANALOGUE CONTROL

A PID controller output is used to modulate the power reference to all running Blower Systems. As a result all running blowers will control their power in parallel (all modulating together). Parallel configured systems provide a courser but more aggressive control than cascaded blower configurations. The controller is reverse acting such that if the pressure is measured below the setpoint all Blower System powers are increased, and vice versa. The process variable for the controller is the manifold pressure and the setpoint is either a Fixed Pressure Setpoint (set by operator) or a Floating Pressure Setpoint.

#### 7.4.5.1 POWER INCREASE INHIBIT

The power setpoint will be inhibited from increasing if any of the following occur;

- Header pressure high alarm
- Header pressure > 1kPa above the pressure setpoint

#### 7.4.5.2 FIXED SETPOINT MODE

Fixed Mode is selected via the Pressure Control button located on the Aeration Page. When selected, the operator has to later select Floating mode when finished.

In Fixed Set Point Mode the operator enters the desired header pressure set point from the SCADA. The blower input powers are modulated to maintain the required header pressure. The header pressure must be kept within limits (44kPa → 52kPa).

This mode allows PLC13 blowers to run independently of PLC4 if required. It should be used if communications is lost between PLC13 and PLC4.

#### 7.4.5.3 FLOATING SETPOINT MODE

Floating Set Point Mode is sometimes referred to as "Optimised" Mode or "Automatic" Mode and is the normal running mode. In this mode, the Header Pressure Setpoint is received from PLC4. The Header Pressure Setpoint is clamped to a range of 44 to 52kPa.

If the system is using Floating Control Mode and PLC13 fails to communicate with PLC4, the system defaults to Fixed Mode and the setpoint will remain unchanged (bumpless). If required the operator may then change the setpoint. When communications is restored, the system goes back into Floating mode providing the Fixed Mode button was not pressed.

#### 7.4.5.4 BUMPLESS TRANSFER BETWEEN PRESSURE MODES

To ensure that there are no sudden changes in pressure setpoint when changing between Fixed and Floating SP modes bumpless transfer is used. The method of bumpless transfer varies depending on the direction of changeover.

##### 7.4.5.4.1 FLOATING TO FIXED PRESSURE MODE BUMPLESS TRANSFER

Whilst the pressure control is set to Floating Mode, the scaled header pressure value is continuously written into the Fixed Pressure SP. When the pressure control switches from Floating to Fixed Mode, the Fixed Pressure SP will already be equal to the actual pressure therefore the pressure will remain constant. The operator can then change the Fixed Pressure SP as required.

##### 7.4.5.4.2 FIXED AND FLOATING PRESSURE MODES

It should be noted that Fixed Pressure SP mode is used when there is a communications fault between PLC4 and PLC13. During a communications fault, the Header Pressure and the Pressure Control mode cannot be read by PLC4. When the communication fault is reset these values are immediately transferred to PLC4 before the Floating Pressure Mode becomes available.

### 7.4.6 TREND DISPLAYS

There is no requirement for trend displays in this process area.

**7.4.7 HELP**

There is no requirement for a help system for this process area.

**7.4.8 DATA LOGGING**

The SCADA system will set a general PLC bit 'dcEOD' at a pre-set time each day. At the end of the scan the PLC is to reset the 'dcEOD' bit. The running feedback and all analogue indications (refer to the associated Device Function Sheets for a complete list) will be logged for each blower.

**7.4.9 SUB SYSTEM COMMUNICATIONS**

The PLC contains two Ethernet cards. The second Ethernet card is used for sub system communications to each of the Blower Systems. The PLC receives communication from each of the Blower Systems via Modbus TCP/IP.

A communications failure between the PLC and the Blower System will cause the blower to stop if it is running in remote.

**7.4.10 PEER TO PEER COMMUNICATIONS**

The PLC contains two Ethernet cards. The first Ethernet card is used for peer to peer communications. The following tables describe the peer to peer communications data for this PLC.

**7.4.10.1 DATA RECEIVED**

Source PLC	Description	Notes
PLC4	Heartbeat Word	Comms Alarm
	Floating Header Pressure Setpoint	Blower Control

**7.4.10.2 DATA PRODUCED**

Destination PLC	Description	Notes
PLC4	Heartbeat Word	
	Fixed Pressure Setpoint Mode ON	Fixed to Floating Bumpless Transfer
	FIT03100 Scaled Header Pressure	

**7.4.10.3 INTER-PLC COMMUNICATIONS ALARM**

The first integer in the Integer Array is the watchdog counter. The counter is incremented every second and reset to 0 when it reaches 32767. This PLC will check to see that the PLC4 watchdogs are changing. If a watchdog does not change within 5 seconds a communications alarm is raised.

**7.4.11 OTHER REQUIREMENTS**

There are no other requirements for this process area.

## APPENDIX A      DEVICE FUNCTION SHEETS

### A.1 BLOWERS MASTER COMMON

#### A.1.1 COMMON PROPERTIES

Property	Value
N/A	

#### A.1.2 COMMON INTERLOCKS

Tag	Description	Display Description
N/A		

#### A.1.3 COMMON AUTO PERMISSIVES

Tag	Description	Display Description
N/A		

#### A.1.4 COMMON MANUAL PERMISSIVES

Tag	Description	Display Description
N/A		

#### A.1.5 COMMON DEVICE FAULTS

Tag	Data Type	Description	Alarm Type
N/A			

#### A.1.6 COMMON DEVICE STATUS

Tag	Data Type	Description
N/A		

#### A.1.7 COMMON DEVICE CONTROLS

Tag	Data Type	Description
dcEOD	BOOL	End of day flag. To be reset by PLC at the end of the scan.

#### A.1.8 COMMON DEVICE ANALOGUE INDICATIONS

Tag	Data Type	Description	Min	Max	Units
N/A					

#### A.1.9 COMMON DEVICE ANALOGUE SET-POINTS

Tag	Data Type	Description	Alarm	Min	Max	Units
N/A						

**A.2 BLOWERS MASTER PLC HARDWARE (PLC13)****A.2.1 PLC13CPUHRD PROPERTIES**

Property	Value
N/A	

**A.2.2 PLC13CPUHRD INTERLOCKS**

Tag	Description	Display Description
N/A		

**A.2.3 PLC13CPUHRD AUTO PERMISSIVES**

Tag	Description	Display Description
N/A		

**A.2.4 PLC13CPUHRD MANUAL PERMISSIVES**

Tag	Description	Display Description
N/A		

**A.2.5 PLC13CPUHRD DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
dsOffline	BOOL	PLC to SCADA Communications Failure	Category
dsBattFault	BOOL	Battery Fault	Category 0
dsBattLow	BOOL	Battery Low	Category 0
dsCPUFault	BOOL	CPU Fault	Category 1
dsCPUTemperatureHi	BOOL	CPU Temperature High	Category 0
dsIOModuleFault	BOOL	IO Module Fault	Category 3
dsIOModuleLost	BOOL	IO Module Lost	Category 3

**A.2.6 PLC13CPUHRD DEVICE STATUS**

Tag	Data Type	Description
N/A		

**A.2.7 PLC13CPUHRD DEVICE CONTROLS**

Tag	Data Type	Description
dcSyncClock	BOOL	Synchronise CPU Time and Date

**A.2.8 PLC13CPUHRD DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDay	INT	Day	0	31	N/A
asMonth	INT	Month	1	12	N/A
asYear	INT	Year	1990	2100	N/A
asDayOfWeek	INT	Day of Week	0	6	N/A
asHours	INT	Hours	0	23	Hrs

Tag	Data Type	Description	Min	Max	Units
asMinutes	INT	Minutes	0	59	Min
asSeconds	INT	Seconds	0	59	Sec

**A.2.9 PLC13CPUHRD DEVICE ANALOGUE SET-POINTS**

Tag	Data Type	Description	Alarm	Min	Max	Units
N/A						

**A.3 DUTY SYSTEM (DTY01)****A.3.1 DTY01 PROPERTIES**

Property	Value
N/A	

**A.3.2 DTY01 INTERLOCKS**

Tag	Description	Display Description
N/A		

**A.3.3 DTY01 AUTO PERMISSIVES**

Tag	Description	Display Description
N/A		

**A.3.4 DTY01 MANUAL PERMISSIVES**

Tag	Description	Display Description
N/A		

**A.3.5 DTY01 DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
N/A			

**A.3.6 DTY01 DEVICE STATUS**

Tag	Data Type	Description
dsDrive1Avail4Seq	BOOL	Drive 1 Available for Sequence
dsDrive2Avail4Seq	BOOL	Drive 2 Available for Sequence
dsDrive3Avail4Seq	BOOL	Drive 3 Available for Sequence
dsDrive4Avail4Seq	BOOL	Drive 4 Available for Sequence
dsDrive1DutyA	BOOL	Drive 1 Duty A
dsDrive1DutyB	BOOL	Drive 1 Duty B
dsDrive1DutyC	BOOL	Drive 1 Duty C
dsDrive1DutyD	BOOL	Drive 1 Duty D
dsDrive2DutyA	BOOL	Drive 2 Duty A
dsDrive2DutyB	BOOL	Drive 2 Duty B
dsDrive2DutyC	BOOL	Drive 2 Duty C
dsDrive2DutyD	BOOL	Drive 2 Duty D
dsDrive3DutyA	BOOL	Drive 3 Duty A
dsDrive3DutyB	BOOL	Drive 3 Duty B
dsDrive3DutyC	BOOL	Drive 3 Duty C
dsDrive3DutyD	BOOL	Drive 3 Duty D
dsDrive4DutyA	BOOL	Drive 4 Duty A
dsDrive4DutyB	BOOL	Drive 4 Duty B
dsDrive4DutyC	BOOL	Drive 4 Duty C

Tag	Data Type	Description
dsDrive4DutyD	BOOL	Drive 4 Duty D

**A.3.7 DTY01 DEVICE CONTROLS**

Tag	Data Type	Description
dcChangeDuty	BOOL	Automatic Duty Change Input

**A.3.8 DTY01 DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDutyStatus	INT	Duty Status	1	4	

**A.3.9 DTY01 DEVICE ANALOGUE SET-POINTS**

Tag	Data Type	Description	Alarm	Min	Max	Units
acNoOfDuties	INT	No of Drives for Duty Selection	N/A	0	4	
acDutySelect	INT	User Selected Duty Sequence	N/A	0	4	

**A.4 BLOWER 1 SYSTEM (BLO01)****A.4.1 BLO01 PROPERTIES**

Property	Value
N/A	

**A.4.2 BLO01 INTERLOCKS**

Tag	Description	Display Description
ST032_PIT13101_dsTrip	Header pressure above 60kPa	Header pressure above 60kPa
ST032_PIT13101_dsHiHi	Header pressure high high	Header pressure high high
ST032_PIT13101_dsInvalid	Header pressure invalid	Header pressure invalid

**A.4.3 BLO01 AUTO PERMISSIVES**

Tag	Description	Display Description
None		

**A.4.4 BLO01 MANUAL PERMISSIVES**

Tag	Description	Display Description
None		

**A.4.5 BLO01 DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
dsF2Start	BOOL	Fail to Start	Category 1
dsFault	BOOL	General Fault	Category 1
dsError	BOOL	Error Status	Category 1
dsWarn	BOOL	Warning Status	Category 1
dsF2Stop	BOOL	Fail to Stop	Category 1
dsCommsFault	BOOL	Modbus Comms Fault	Category 1
dsEStop	BOOL	Estop	Category 1

**A.4.6 BLO01 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Available for Operation
dsAvailRemAuto	BOOL	Available in Remote Auto
dsDuty	BOOL	Duty
dsLocal	BOOL	Local Selected
dsRemote	BOOL	Remote Selected
dsRunning	BOOL	Running Feedback
dsReady	BOOL	Ready Status
dsLAN	BOOL	LAN Selected
dsWait	BOOL	Wait Status

Tag	Data Type	Description
dsUnload	BOOL	Unload Status
dsModeCurrent	BOOL	Current Mode Status
dsModeFlow	BOOL	Flow Mode Status
dsModeRPM	BOOL	RPM Mode Status
dsModeProut	BOOL	Prout Mode Status
dsModeDO	BOOL	DO Mode Status
dsLoad	BOOL	Load Status
dsLoadShed	BOOL	Load Shed

**A.4.7 BLO01 DEVICE CONTROLS**

Tag	Data Type	Description
dcAlarmInhibit	BOOL	Alarm Inhibit
dcAuto	BOOL	Auto (Citect)
dcManual	BOOL	Manual (Citect)
dcOffline	BOOL	Offline (Citect)
dcReset	BOOL	Reset (Citect)
dcAutoRun	BOOL	Sequence Start

**A.4.8 BLO01 DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDuty	INT	Duty	1	4	
asRunHrs	INT	Run Hours	0	24	Hrs
asRunMin	INT	Run Minutes	0	59	Min
asRunHrsYD	INT	Run Hours Yesterday	0	24	Hrs
asRunMinYD	INT	Run Minutes Yesterday	0	59	Min
asStarts	INT	Starts	0	32767	
asError	INT	Error Code			
asSV	INT	Set Value	0	400	
asRunTime	INT	Run Time	0	32767	Hrs
asStartsYD	INT	Starts Yesterday	0	32767	
asDiffPressure	REAL	Filter Differential Pressure	0	100	kPa*10
asOutPressure	REAL	Outlet Pressure	0	200	kPa
asOutTemp	REAL	Outlet Temperature	-20	180	oC
asInletTemp	REAL	Inlet Temperature	-20	100	oC
asAmps	REAL	Motor Current	0	300	A
asFlow	REAL	Flow	0	8000	Nm3/hr
asPower	REAL	Power	0	300	kW
asSpeed	INT	Rotational Speed (RPM)	0	10000	RPM*10

**A.4.9 BLO01 DEVICE ANALOGUE SET-POINTS**

Tag	Data Type	Description	Alarm	Min	Max	Units
acAutoSpeed	INT	Auto Speed SP	N/A	0	100	%
acManSpeed	INT	Manual Speed SP	N/A	0	100	%
acSpeedMax	INT	Max Speed SP	N/A	0	100	%
acSpeedMin	INT	Min Speed SP	N/A	0	100	%
acLoadShed	DINT	Load Shed SP	N/A	0	100	

**A.5 BLOWER 2 SYSTEM (BLO02)****A.5.1 BLO02 PROPERTIES**

Property	Value
N/A	

**A.5.2 BLO02 INTERLOCKS**

Tag	Description	Display Description
ST032_PIT13101_dsTrip	Header pressure above 60kPa	Header pressure above 60kPa
ST032_PIT13101_dsHiHi	Header pressure high high	Header pressure high high
ST032_PIT13101_dsInvalid	Header pressure invalid	Header pressure invalid

**A.5.3 BLO02 AUTO PERMISSIVES**

Tag	Description	Display Description
None		

**A.5.4 BLO02 MANUAL PERMISSIVES**

Tag	Description	Display Description
None		

**A.5.5 BLO02 DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
dsF2Start	BOOL	Fail to Start	Category 1
dsFault	BOOL	General Fault	Category 1
dsError	BOOL	Error Status	Category 1
dsWarn	BOOL	Warning Status	Category 1
dsF2Stop	BOOL	Fail to Stop	Category 1
dsCommsFault	BOOL	Modbus Comms Fault	Category 1
dsEStop	BOOL	Estop	Category 1

**A.5.6 BLO02 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Available for Operation
dsAvailRemAuto	BOOL	Available in Remote Auto
dsDuty	BOOL	Duty
dsLocal	BOOL	Local Selected
dsRemote	BOOL	Remote Selected
dsRunning	BOOL	Running Feedback
dsReady	BOOL	Ready Status
dsLAN	BOOL	LAN Selected
dsWait	BOOL	Wait Status

Tag	Data Type	Description
dsUnload	BOOL	Unload Status
dsModeCurrent	BOOL	Current Mode Status
dsModeFlow	BOOL	Flow Mode Status
dsModeRPM	BOOL	RPM Mode Status
dsModeProut	BOOL	Prout Mode Status
dsModeDO	BOOL	DO Mode Status
dsLoad	BOOL	Load Status
dsLoadShed	BOOL	Load Shed

**A.5.7 BLO02 DEVICE CONTROLS**

Tag	Data Type	Description
dcAlarmInhibit	BOOL	Alarm Inhibit
dcAuto	BOOL	Auto (Citect)
dcManual	BOOL	Manual (Citect)
dcOffline	BOOL	Offline (Citect)
dcReset	BOOL	Reset (Citect)
dcAutoRun	BOOL	Sequence Start

**A.5.8 BLO02 DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDuty	INT	Duty	1	4	
asRunHrs	INT	Run Hours	0	24	Hrs
asRunMin	INT	Run Minutes	0	59	Min
asRunHrsYD	INT	Run Hours Yesterday	0	24	Hrs
asRunMinYD	INT	Run Minutes Yesterday	0	59	Min
asStarts	INT	Starts	0	32767	
asError	INT	Error Code			
asSV	INT	Set Value	0	400	
asRunTime	INT	Run Time	0	32767	Hrs
asStartsYD	INT	Starts Yesterday	0	32767	
asDiffPressure	REAL	Filter Differential Pressure	0	100	kPa*10
asOutPressure	REAL	Outlet Pressure	0	200	kPa
asOutTemp	REAL	Outlet Temperature	-20	180	oC
asInletTemp	REAL	Inlet Temperature	-20	100	oC
asAmps	REAL	Motor Current	0	300	A
asFlow	REAL	Flow	0	8000	Nm3/hr
asPower	REAL	Power	0	300	kW
asSpeed	INT	Rotational Speed (RPM)	0	10000	RPM*10

**A.5.9 BLO02 DEVICE ANALOGUE SET-POINTS**

Tag	Data Type	Description	Alarm	Min	Max	Units
acAutoSpeed	INT	Auto Speed SP	N/A	0	100	%
acManSpeed	INT	Manual Speed SP	N/A	0	100	%
acSpeedMax	INT	Max Speed SP	N/A	0	100	%
acSpeedMin	INT	Min Speed SP	N/A	0	100	%
acLoadShed	DINT	Load Shed SP	N/A	0	100	

**A.6 BLOWER 3 SYSTEM (BLO03)****A.6.1 BLO03 PROPERTIES**

Property	Value
N/A	

**A.6.2 BLO03 INTERLOCKS**

Tag	Description	Display Description
ST032_PIT13101_dsTrip	Header pressure above 60kPa	Header pressure above 60kPa
ST032_PIT13101_dsHiHi	Header pressure high high	Header pressure high high
ST032_PIT13101_dsInvalid	Header pressure invalid	Header pressure invalid

**A.6.3 BLO03 AUTO PERMISSIVES**

Tag	Description	Display Description
None		

**A.6.4 BLO03 MANUAL PERMISSIVES**

Tag	Description	Display Description
None		

**A.6.5 BLO03 DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
dsF2Start	BOOL	Fail to Start	Category 1
dsFault	BOOL	General Fault	Category 1
dsError	BOOL	Error Status	Category 1
dsWarn	BOOL	Warning Status	Category 1
dsF2Stop	BOOL	Fail to Stop	Category 1
dsCommsFault	BOOL	Modbus Comms Fault	Category 1
dsEStop	BOOL	Estop	Category 1

**A.6.6 BLO03 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Available for Operation
dsAvailRemAuto	BOOL	Available in Remote Auto
dsDuty	BOOL	Duty
dsLocal	BOOL	Local Selected
dsRemote	BOOL	Remote Selected
dsRunning	BOOL	Running Feedback
dsReady	BOOL	Ready Status
dsLAN	BOOL	LAN Selected
dsWait	BOOL	Wait Status

Tag	Data Type	Description
dsUnload	BOOL	Unload Status
dsModeCurrent	BOOL	Current Mode Status
dsModeFlow	BOOL	Flow Mode Status
dsModeRPM	BOOL	RPM Mode Status
dsModeProut	BOOL	Prout Mode Status
dsModeDO	BOOL	DO Mode Status
dsLoad	BOOL	Load Status
dsLoadShed	BOOL	Load Shed

**A.6.7 BLO03 DEVICE CONTROLS**

Tag	Data Type	Description
dcAlarmInhibit	BOOL	Alarm Inhibit
dcAuto	BOOL	Auto (Citect)
dcManual	BOOL	Manual (Citect)
dcOffline	BOOL	Offline (Citect)
dcReset	BOOL	Reset (Citect)
dcAutoRun	BOOL	Sequence Start

**A.6.8 BLO03 DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDuty	INT	Duty	1	4	
asRunHrs	INT	Run Hours	0	24	Hrs
asRunMin	INT	Run Minutes	0	59	Min
asRunHrsYD	INT	Run Hours Yesterday	0	24	Hrs
asRunMinYD	INT	Run Minutes Yesterday	0	59	Min
asStarts	INT	Starts	0	32767	
asError	INT	Error Code			
asSV	INT	Set Value	0	400	
asRunTime	INT	Run Time	0	32767	Hrs
asStartsYD	INT	Starts Yesterday	0	32767	
asDiffPressure	REAL	Filter Differential Pressure	0	100	kPa*10
asOutPressure	REAL	Outlet Pressure	0	200	kPa
asOutTemp	REAL	Outlet Temperature	-20	180	oC
asInletTemp	REAL	Inlet Temperature	-20	100	oC
asAmps	REAL	Motor Current	0	300	A
asFlow	REAL	Flow	0	8000	Nm3/hr
asPower	REAL	Power	0	300	kW
asSpeed	INT	Rotational Speed (RPM)	0	10000	RPM*10

**A.6.9 BLO03 DEVICE ANALOGUE SET-POINTS**

<b>Tag</b>	<b>Data Type</b>	<b>Description</b>	<b>Alarm</b>	<b>Min</b>	<b>Max</b>	<b>Units</b>
acAutoSpeed	INT	Auto Speed SP	N/A	0	100	%
acManSpeed	INT	Manual Speed SP	N/A	0	100	%
acSpeedMax	INT	Max Speed SP	N/A	0	100	%
acSpeedMin	INT	Min Speed SP	N/A	0	100	%
acLoadShed	DINT	Load Shed SP	N/A	0	100	

**A.7 BLOWER 4 SYSTEM (BLO04)****A.7.1 BLO04 PROPERTIES**

Property	Value
N/A	

**A.7.2 BLO04 INTERLOCKS**

Tag	Description	Display Description
ST032_PIT13101_dsTrip	Header pressure above 60kPa	Header pressure above 60kPa
ST032_PIT13101_dsHiHi	Header pressure high high	Header pressure high high
ST032_PIT13101_dsInvalid	Header pressure invalid	Header pressure invalid

**A.7.3 BLO04 AUTO PERMISSIVES**

Tag	Description	Display Description
None		

**A.7.4 BLO04 MANUAL PERMISSIVES**

Tag	Description	Display Description
None		

**A.7.5 BLO04 DEVICE FAULTS**

Tag	Data Type	Description	Alarm Type
dsF2Start	BOOL	Fail to Start	Category 1
dsFault	BOOL	General Fault	Category 1
dsError	BOOL	Error Status	Category 1
dsWarn	BOOL	Warning Status	Category 1
dsF2Stop	BOOL	Fail to Stop	Category 1
dsCommsFault	BOOL	Modbus Comms Fault	Category 1
dsEStop	BOOL	Estop	Category 1

**A.7.6 BLO04 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Available for Operation
dsAvailRemAuto	BOOL	Available in Remote Auto
dsDuty	BOOL	Duty
dsLocal	BOOL	Local Selected
dsRemote	BOOL	Remote Selected
dsRunning	BOOL	Running Feedback
dsReady	BOOL	Ready Status
dsLAN	BOOL	LAN Selected
dsWait	BOOL	Wait Status

Tag	Data Type	Description
dsUnload	BOOL	Unload Status
dsModeCurrent	BOOL	Current Mode Status
dsModeFlow	BOOL	Flow Mode Status
dsModeRPM	BOOL	RPM Mode Status
dsModeProut	BOOL	Prout Mode Status
dsModeDO	BOOL	DO Mode Status
dsLoad	BOOL	Load Status
dsLoadShed	BOOL	Load Shed

**A.7.7 BLO04 DEVICE CONTROLS**

Tag	Data Type	Description
dcAlarmInhibit	BOOL	Alarm Inhibit
dcAuto	BOOL	Auto (Citect)
dcManual	BOOL	Manual (Citect)
dcOffline	BOOL	Offline (Citect)
dcReset	BOOL	Reset (Citect)
dcAutoRun	BOOL	Sequence Start

**A.7.8 BLO04 DEVICE ANALOGUE INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asDuty	INT	Duty	1	4	
asRunHrs	INT	Run Hours	0	24	Hrs
asRunMin	INT	Run Minutes	0	59	Min
asRunHrsYD	INT	Run Hours Yesterday	0	24	Hrs
asRunMinYD	INT	Run Minutes Yesterday	0	59	Min
asStarts	INT	Starts	0	32767	
asError	INT	Error Code			
asSV	INT	Set Value	0	400	
asRunTime	INT	Run Time	0	32767	Hrs
asStartsYD	INT	Starts Yesterday	0	32767	
asDiffPressure	REAL	Filter Differential Pressure	0	100	kPa*10
asOutPressure	REAL	Outlet Pressure	0	200	kPa
asOutTemp	REAL	Outlet Temperature	-20	180	oC
asInletTemp	REAL	Inlet Temperature	-20	100	oC
asAmps	REAL	Motor Current	0	300	A
asFlow	REAL	Flow	0	8000	Nm3/hr
asPower	REAL	Power	0	300	kW
asSpeed	INT	Rotational Speed (RPM)	0	10000	RPM*10

**A.7.9 BLO04 DEVICE ANALOGUE SET-POINTS**

Tag	Data Type	Description	Alarm	Min	Max	Units
acAutoSpeed	INT	Auto Speed SP	N/A	0	100	%
acManSpeed	INT	Manual Speed SP	N/A	0	100	%
acSpeedMax	INT	Max Speed SP	N/A	0	100	%
acSpeedMin	INT	Min Speed SP	N/A	0	100	%
acLoadShed	DINT	Load Shed SP	N/A	0	100	

**A.8 COMMON MANIFOLD PRESSURE (PIT13101)****A.8.1 PIT13101 PROPERTIES**

Property	Value
N/A	

**A.8.2 PIT13101 DEVICE ANALOG INPUT**

Tag	Data Type	Description	Min	Max
PIT13101_aiPressure	INT	Header Pressure Input	4mA	20mA

**A.8.3 PIT13101 DEVICE ANALOG INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asValue	REAL	Scaled value	0	100	kPa

**A.8.4 PIT13101 DEVICE ALARMS**

Tag	Data Type	Description	Alarm Type
dsHiHi	BOOL	Pressure High High Alarm	
dsHi	BOOL	Pressure High Alarm	
dsLo	BOOL	Pressure Low Alarm	
dsLoLo	BOOL	Pressure Low Low Alarm	
dsInvalid	BOOL	Pressure Signal Invalid	
dsAlarm	BOOL	Pressure Alarm	
dsOverSafeLimit	BOOL	Pressure Over Max Safety Limit	

**A.8.5 PIT13101 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Pressure Transmitter Available

**A.8.6 PIT13101 DEVICE CONTROLS**

Tag	Data Type	Description
acConfig	INT	Pressure: Configuration Setup
acFilterLength	INT	Pressure: Number of Filter Samples
acLoLo	REAL	Pressure: Low Low Setpoint
acLo	REAL	Pressure: Low Setpoint
acHi	REAL	Pressure: High Setpoint
acHiHi	REAL	Pressure: High High Setpoint
acHysteresis	REAL	Pressure: Hysteresis Setpoint
dcOffline	BOOL	Pressure: Offline Command
dcReset	BOOL	Pressure: Reset Command

**A.9 COMMON MANIFOLD FLOW (FIT13100)****A.9.1 FIT13100 PROPERTIES**

Property	Value
N/A	

**A.9.2 FIT13100 DEVICE ANALOG INPUT**

Tag	Data Type	Description	Min	Max
FIT13100_aiFlow	INT	Header Flow Input	4mA	20mA

**A.9.3 FIT13100 DEVICE ANALOG INDICATIONS**

Tag	Data Type	Description	Min	Max	Units
asValue	REAL	Scaled value	0	10	m <sup>3</sup> /s
asM3PerHour	REAL	Scaled value in m <sup>3</sup> /Hr	0	35000	m <sup>3</sup> /hr
asTotal	REAL	Today's total value	0	28800	m <sup>3</sup>
asTotalYDay	REAL	Yesterday's total value	0	28800	m <sup>3</sup>

**A.9.4 FIT13100 DEVICE ALARMS**

Tag	Data Type	Description	Alarm Type
dsHiHi	BOOL	Flow High High Alarm	
dsHi	BOOL	Flow High Alarm	
dsLo	BOOL	Flow Low Alarm	
dsLoLo	BOOL	Flow Low Low Alarm	
dsInvalid	BOOL	Flow Signal Invalid	
dsAlarm	BOOL	Flow Alarm	
dsOverSafeLimit	BOOL	Flow Over Max Safety Limit	

**A.9.5 FIT13100 DEVICE STATUS**

Tag	Data Type	Description
dsAvailable	BOOL	Flow Transmitter Available

**A.9.6 FIT13100 DEVICE CONTROLS**

Tag	Data Type	Description
acConfig	INT	Flow: Configuration Setup
acFilterLength	INT	Flow: Number of Filter Samples
acLoLo	REAL	Flow: Low Low Setpoint
acLo	REAL	Flow: Low Setpoint
acHi	REAL	Flow: High Setpoint
acHiHi	REAL	Flow: High High Setpoint
acHysteresis	REAL	Flow: Hysteresis Setpoint
dcOffline	BOOL	Flow: Offline Command
dcReset	BOOL	Flow: Reset Command

## APPENDIX B PLC IO REGISTER

### B.1 PLC IO LIST

#	Type	Tag	Description	Slot	Ch
1	AI	FIT13100_aiFlow	Common Manifold Flow	5	1
2	AI	PIT13101_aiPressure	Common Manifold Pressure	5	2
3	DI	AER01BL01_diAvailable	Aeration Blower 1 Available	6	1
4	DI	AER01BL01_diEStop	Aeration Blower 1 E Stop	6	2
5	DI	AER01BL02_diAvailable	Aeration Blower 2 Available	6	3
6	DI	AER01BL02_diEStop	Aeration Blower 2 E Stop	6	4
7	DI	AER01BL03_diAvailable	Aeration Blower 3 Available	6	5
8	DI	AER01BL03_diEStop	Aeration Blower 3 E Stop	6	6
9	DI	AER01BL04_diAvailable	Aeration Blower 4 Available	6	7
10	DI	AER01BL04_diEStop	Aeration Blower 4 E Stop	6	8

### B.2 DEVICE ADDRESSING

Device	Address
PLC13 – 1 <sup>st</sup> Card – Peer To Peer	192.168.151.068
PLC13 – 2 <sup>nd</sup> Card – Subsystem	10.1.1.1
Blower 1	10.1.1.11
Blower 2	10.1.1.12
Blower 3	10.1.1.13
Blower 4	10.1.1.14

### B.3 BLOWER MODBUS TCP/IP DATA

#### B.3.1 DIGITAL INPUT STATUS

The data in the following table is read using Modbus function code 2.

Address (bit)	Name
0	LAN(Normal) Selected
1	LOCAL Selected
2	REMOTE Selected
3	Service Mode Selected
4	LAN(Auto) Selected
8	WAIT Status
9	READY Status
10	ERROR Status
11	UNLOAD Status
12	LOAD Status
13	WARN Status

Address (bit)	Name
16	Current Mode
17	Flow Mode
18	RPM Mode
19	Prout Mode
20	DO Mode

**B.3.2 DIGITAL OUTPUT STATUS**

The data in the following table is written to using Modbus function code 5.

Address (bit)	Name
0	START
1	STOP
2	LOAD
3	UNLOAD

**B.3.3 HOLDING REGISTERS READ**

The data in the following table is read using Modbus function code 3.

Address (word)	Name	Scale	Range
0	Filter diff. pressure	÷10	0 – 10 kPa
1	Outlet pressure	1	0 – 200 kPa
2	Inlet temp.	1	-20 – 100 °C
3	Outlet temp.	1	-20 – 180 °C
4	Rotational Speed	*10	0 – 10000 (RPM*10)
5	Motor Current	1	0 – 300 A
6	Power	1	0 – 300 kW
7	Flow	1	0 – 1000 Nm <sup>3</sup> /min
8	Error code	1	0 – 255
9	SV (Set Value)	1	0 – 400
10	DO sensor value	÷10	0 – 10.0 ppm
11	DCLink	1	0 – 1000
12	Run time	1	0 – 32767 Hr
13	MODBUS Set Value	1	0 – 400
14	CP Parameter No.	1	0 – 100
15	CP Parameter Value	1	0 – 32767

**B.3.4 HOLDING REGISTERS WRITE**

The data in the following table is written to using Modbus function code 6.

Address (word)	Name	Scale	Range
13	MODBUS Set Value	1	0 – 400
14	CP Parameter No.	1	0 – 100
15	CP Parameter Value	1	0 – 32767

---

## **APPENDIX C      TAG NOMENCLATURE**

Please refer to "QUU – PLC Software Guidelines" for tag nomenclature.

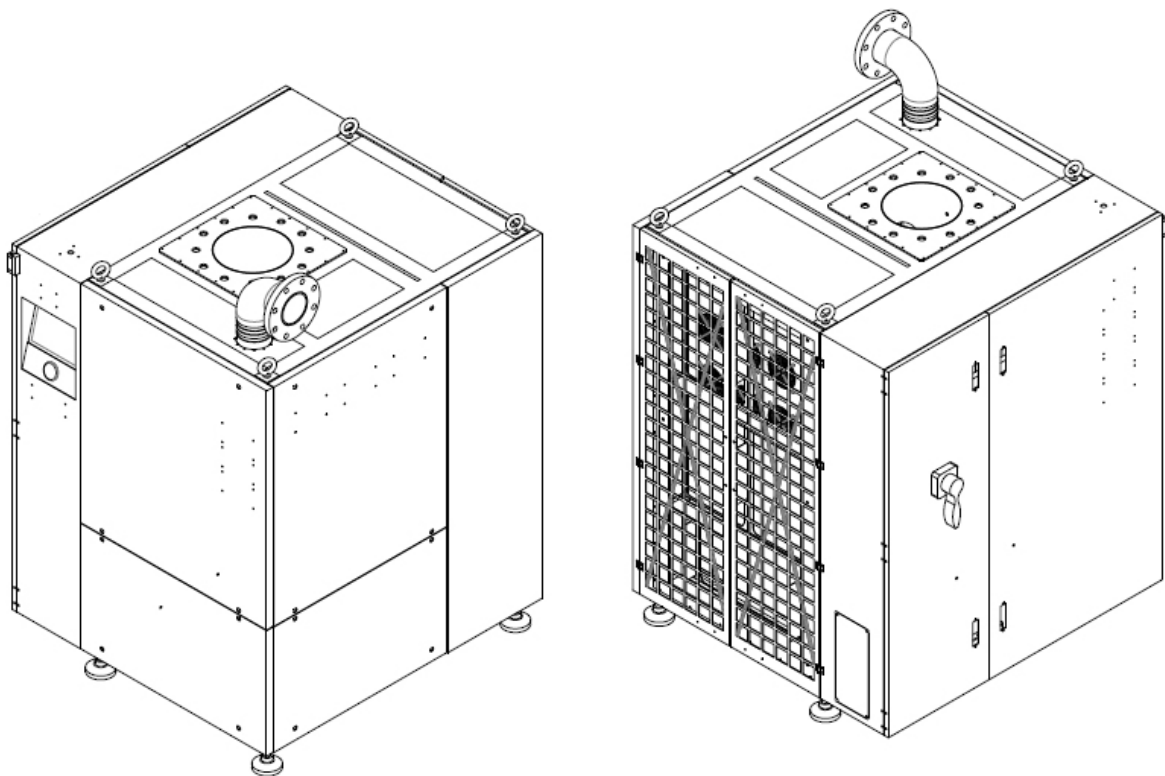
## 1.2 Operation and Maintenance Manuals

## **1.2.1 AERZON – Turbo Blower**

*Aerzen Turbo*



# ***TURBO BLOWER O&M MANUAL***



Touch screen version

**Aerzen Turbo Co., Ltd.**

Version: 20130514, Mai 14, 2013 released Revision: 002  
Originator: Hasemann

Blowers • Compressors • Gasmeters



Aerzen Turbo Co., Ltd. • 256-1 Geumho, Bugang, Sejong, 339-942 • KOREA

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***EC-Declaration of Conformity According to  
Machinery Directive 2006/42/EC  
Low Voltage directive 2006/95/EC***

*The Manufacturer:*  
AERZEN TURBO Co., Ltd.  
256-1 Geumho, Bugang, Sejong, 339-942 • KOREA

*herewith declares:*

The following products have been tested by us with the listed standards and found in compliance with the European Community Machinery Directive (MD) 2006/42/EC and Low Voltage Directive 2006/95/EC. Assessment of compliance of the product with the requirements was based on the following standards:

*Standards:*

EN ISO 12100:2010  
EN 60204-1/AC:2010  
EN 61000-6-2/AC:2005  
EN 61000-6-4/A1:2011

*Designation:* TURBO BLOWER

*Unit types:* AT25, AT30, AT50, AT75, AT100, AT150, AT200, AT250, AT300, AT400

Mr. JungMin Ko, Customer Service Manager at AERZEN TURBO Co., Ltd., has been authorized to compile the documentation / technical files. If required, he will electronically submit specific documents to the national authorities.

Sejong, 22 January 2013

Signature Representative Director

Signature Technical Director

Korea Exchange Bank (KEB) Account No. 630-007462-419 • BIC: KOEXKRSE

VAT No. 317-81-22143  
Comm. Registry No. 150114-0002640

## Basic Function and parameter description of a Turbo Blower

The Aerzen Turbo Blower is a high efficient machine that is conveying and compressing air. It's function is characterized by a certain pressure rise and a certain volume flow range. It's used to supply compressed air to waste water treatment plants and for other applications.

It consist of a turbomachinery part, an electric motor, an inverter and a controller. All this components are arranged in a closed and noise insulated package. The fresh air is sucked through a filter in the package by the rotating impeller of the turbomachine. The impeller is driven by the high speed electric PM motor. The electric power has to be connected to the package and it's converted and inverted by the vfd to supply the motor with AC current. The controller is operating the vfd and the connection to the user is done by a HMI or a connection to the central controlling unit via Internet.

The compressed air leaves the package through a flange on top of the blower that should be connected via a flexible joint and a check valve to the user piping system.

The cooling air is discharged through an elbow on top of the blower and can be used in a separate piping system as required.

The blower package should always kept closed. Opening is only allowed by special service personal after switching of the main circuit breaker. Any manipulation of the parts inside, disassembly or change of the settings is only allowed by special educated personal.

The blower and it's parts should only be used for conveying air as described in this text and in the owners manual. The use of other gases is not allowed.

The blower cannot convey liquids and solids and chaffing of parts is also impossible. This will destroy the blower and will impact persons.

If you have any problems with the blower, please call the Aerzen Turbo Service.

# Preface

This manual contains essential information related to the installation, operation, and maintenance of the turbo blowers manufactured by Aerzen Turbo Co., Ltd. This manual does not contain complete details of every variation in equipment.

Carefully read this manual before installing and operating the equipment. Following the instructions in this manual can prevent potential dangerous situations during operation and maintenance.

If you have any further questions or need additional technical assistance, please contact your nearest Aerzen Turbo Co., Ltd. representative.

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# 1. Introduction

## 1.1. General Articles

Aerzen Turbo Co., Ltd. vouches for the quality of their products and are responsible for any defects in the product that occur within 24 months of delivery. If the period of warranty specified is other than 24-months it may have priority.

### 1.1.1. Warranty

Aerzen Turbo Co., Ltd. will repair defective products at no cost to the owner within the term of the warranty. Damage or defects resulting from improper handling, storage, maintenance, operation, or damage resulting from practices that do not follow the operations and maintenance manual will be the responsibility of the owner.

### 1.1.2. Limitation of Liability

Aerzen Turbo Co., Ltd. is responsible only for defects of the products. Aerzen is not responsible for the secondary loss caused from the defects of any of the products.

### 1.1.3. Applicable Models

The content of this manual is applicable to all of Aerzen Turbo Co., Ltd. blowers G4.5.

### 1.1.4. Unacceptable Operating Practices

- ➡ Starting and stopping the blower without first operating in unloaded mode

allowing the blower motor to cool down.

- Stopping the blower by pushing the Emergency Stop button under normal operating conditions.
- Exerting static or dynamic forces onto the blower discharge flange and thus also the discharge cones.
- Operation in improperly ventilated areas.
- Operation with pressure spikes causing the blower to go into surge mode and shut down without unloading and cooling the motor off.
- Operating with unacceptable voltages, voltage fluctuations, and residual harmonics in the power supply.
- Operation with incorrect and / or improper maintained air filters
- Operation with removed sound enclosure panels (will affect or completely void the warranty)
- Operation below minimum and above maximum blower speed
- Operation with too much pressure loss on motor and / or variable speed drive cooling ducts
- Operation without that the customer pipe work is properly support under all operating conditions
- Operation with any other medium than air
- Outdoor operation without proper weather protection.
- Placing foreign objects or substances into the blower package. Do not place foreign objects or substances near the blower package or suction piping/housing where they may be pulled into the blower suction. Foreign objects and substances sucked into the high-speed impeller may cause serious damage or injury. Do not change or modify intake filters during blower operation.
- Exceeding the maximum nameplate pressure rating of the blower.
- Closing any installed main suction or discharge valves during operation. Unexpected closure of these valves may result in surge.
- Maintaining the blower during operation.

#### 1.1.5. Recommended Operating Practices

- Quick energizing and de-energizing of the DC link voltage upon longer standstill periods.
- Operation in idle mode if the blower is being shut down more than 5

times a day.

- ➡ Always switch to unload mode prior to shut down. Suggested time period 10 minutes.
- ➡ Operation with hardwired inputs and outputs.
- ➡ Operating in Current mode is preferred.

#### 1.1.6. Allowable Operating Frequency of Aerzen Turbo Blower

The two following operation modes are developed to protect the machine and the electric parts, as motors, VFD, IGBT's (Insulated-gate bipolar Transistor) as well as the safe discharge of capacitors.

##### 1.1.6.1. Operation Mode START/STOP (LOAD/OFF)

Blower-Type	Starts	Time for Restart lock ( $t_2$ )
AT150	3 Starts per hour	20 min*
AT200	3 Starts per hour	20 min*
AT300	2 Starts per hour	30 min*
AT400	2 Starts per hour	30 min*
$\leq$ AT100	3 Starts per hour	20 min*

\* Higher operating frequency only after consultation with Manufacturer.

For control and protection the restart lock is necessary and the proposed times ( $t_2$ ) of restart lock must be observed strictly.

The starts must be evenly spread over one hour.

##### 1.1.6.2. Operation Mode START/IDLE/STOP (LOAD/UNLOAD/OFF)

If the Turbo Blower is started more than 12 times per day from operating mode START/STOP (LOAD/OFF), it's mandatory necessary to select the operating mode START/IDLE/ STOP. At this in the idle phase a cool down time ( $t_3$ ) and after the STOP a restart lock of ( $t_4$ ) is mandatory.

Blower Type	Starts per day	Cool down time (t <sub>3</sub> )	Time for Restart lock (t <sub>4</sub> )
AT150	12 Starts per day	120 min engine idle*	15 min*
AT200	12 Starts per day	120 min engine idle*	15 min*
AT300	10 Starts per day	150 min engine idle*	20 min*
AT400	8 Starts per day	180 min engine idle*	20 min*
≤AT100	12 Starts per day	120 min engine idle*	15 min*

\* Higher operating frequency and shorter cool down times only after consultation with Manufacturer.

For control and protection a cool down time and a restart lock is mandatory and the recommended times (t<sub>2</sub>) and (t<sub>3</sub>) are to be strongly maintained.

The starts must be evenly spread over one day.

## 1.2. Specification

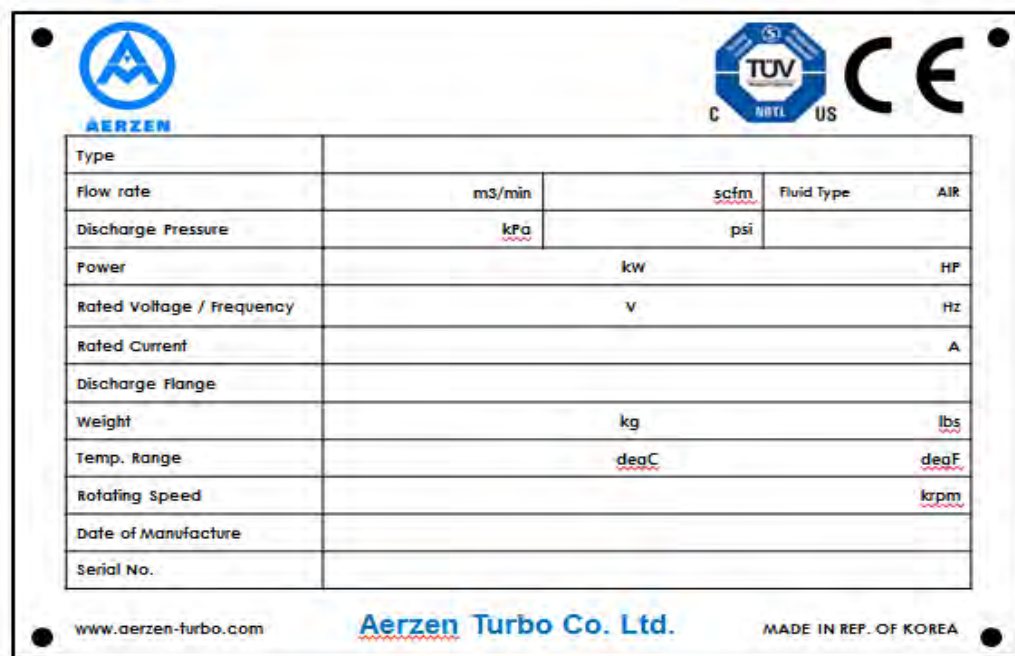


Figure1-1 Name Plate

The blower nameplate is located on the left side panel of the blower package. The nameplate contains data specific to the blower model.

Item	Specification	Comment
Type	Turbo blower with PM motor/air bearing/VFD	
Flow Control	By Speed variation	
Motor Drive	Inverter drive with VFD control	
Voltage / Frequency	440 V ~ 480 V, 60 Hz, 3 PHASE and 380 V ~ 400 V, 50/60 Hz, 3 PHASE	
Blow Off valve	Pneumatic or Solenoid	
Cooling	Air-cooled or Water-cooled(above 400HP)	
Vibration	Below 2 mm/s (0.08 inch/s)	
*Sound Noise	78 dB ~ 84 dB	@ 1 m
Temperature	-20°C ~ +40°C (-4°F ~ +104°F)	
Humidity	~ 95 %RH	
Atmosphere	~ 101.325 kPa <sub>A</sub> (14.7 psi <sub>A</sub> )	

Table 1-1 General Specification

## 1.3 Machine Description

### 1.3.1. Compressor & Impeller

Impellers are made from SUS 630 by precision die-casting using the lost-wax method. The impeller blades are designed using three dimensional computational fluid dynamics numeric analysis.

### 1.3.2. Shaft and air foil bearing

The main motor shaft is directly connected to the impeller. Hydrodynamic air foil bearings are used to provide oil-less lubrication system for the motor shaft. Hydrodynamic forces produce a pressure gradient around the shaft resulting in a bearing system with no mechanical contact between the shaft and journal bearing. The use of air foil bearings eliminates the need for oil bearings, oil seals, oil filters, oil coolers, etc.

### 1.3.3. Variable frequency driver (VFD)

The variable frequency driver and permanent magnet motor combine to control the speed of impeller, which in turn controls the flow rate and/or discharge pressure.

### 1.3.4. PM motor

The PM (permanent magnet) motor rotates due to the electromagnetic interactions between the stator coils and the rotor, which is constructed from permanent magnets. The motor can start with only 10% of the full load current. The PM motors can operate at speeds up to 48,000 rpm and with 95% efficiencies.

### 1.3.5. Touch-LCD Display

The colored Touch-LCD has various functions as listed below;

- Operating data display
- Graph of machine's operating point
- Operating history which has each second and every one hour.
- The fault summary data and its error code
- Instance graphic view of each operating value.
- Operation mode set-up
- On- off control
- Communication mode set-up

#### 1.3.6. Sensors

- Sensors for the measurement of intake/discharge temperature
- Sensor for the measurement of discharge pressure
- Sensor for the measurement of intake differential pressure
- Current sensor
- Thermal switches to protect the VFD over-heating.

#### 1.3.7. Aux. Components

- Flexible joint assemblies
- Discharge check valves
- Stop valve

#### 1.3.8. Option(s)

- Harmonic filter

## 2.1. Safety







No.	Warning and Caution Labels	Position	Comments
1	 <b>CAUTION</b> <b>PROTECTIVE EARTH.</b> Establish and maintain protective earth ground according to the operator's manual.	Left Panel: Base of blower unit near BUS BAR	PROTECTIVE EARTH Protective earth. Establish and maintain protective earth ground according to the operator's manual.
2	 <b>WARNING</b> <b>ELECTRIC SHOCK HAZARD.</b> Electric current is still alive when the machine stops. This unit is to be serviced by trained personnel only.	Left Panel: Center of power box door	ELECTRIC SHOCK HAZARD Electric shock hazard. Electric current is still alive when the machine stops. This unit is to be serviced by trained personnel only.
3	 <b>WARNING</b> <b>Noise hazard.</b> Wear approved ear protection in this area.	3 Panels: Except back panel	NOISE HAZARD Noise hazard. Wear approved ear protection in this area.
4	 <b>WARNING</b> <b>HOT SURFACE.</b> Do Not Touch. TURN OFF POWER and allow to cool before servicing.	Right Panel: Near exit of motor cooling air discharge Air collection drum (twin type)	HOT SURFACE Hot surface, Do not touch. TURN OFF POWER and allow to cool before servicing.
5	 <b>WARNING</b> <b>Avoid Injury.</b> This unit is to be serviced by trained personnel only.	Front Panel: Under LCD (or TFT)	AVOID INJURY Avoid injury. This unit is to be serviced by trained personnel only.
6	 <b>WARNING</b> <b>Read and understand operator's manual and all other safety instructions before using this equipment.</b>	Front Panel: Under LCD (or TFT)	READ OPERATORS MANUAL Read and understand operator manual and all other safety instructions before using this equipment.

Table 2-1. Warning and Caution Labels

Major warning and caution labels are shown in Table 2-1 for keeping the safety. The position of each label is shown in Figure 2-1 and Figure 2-2 for the single and twin volute blower packages respectively.

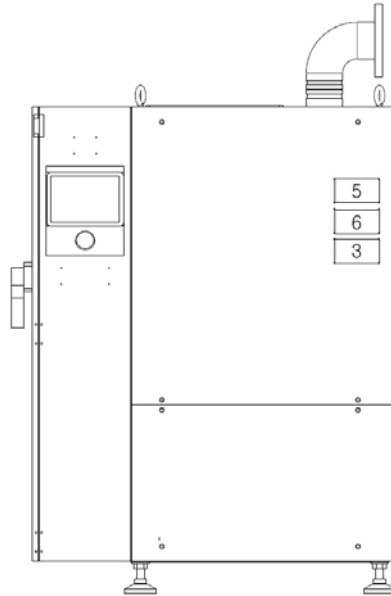


Figure 2 – 1 (a) Signs on the front side

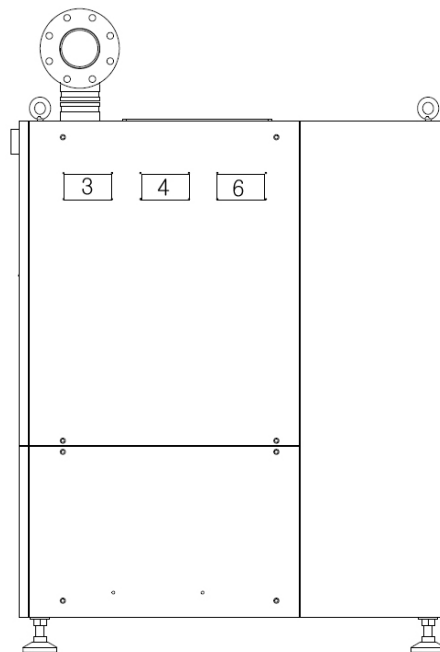


Figure 2-1 (b) Signs on the right side

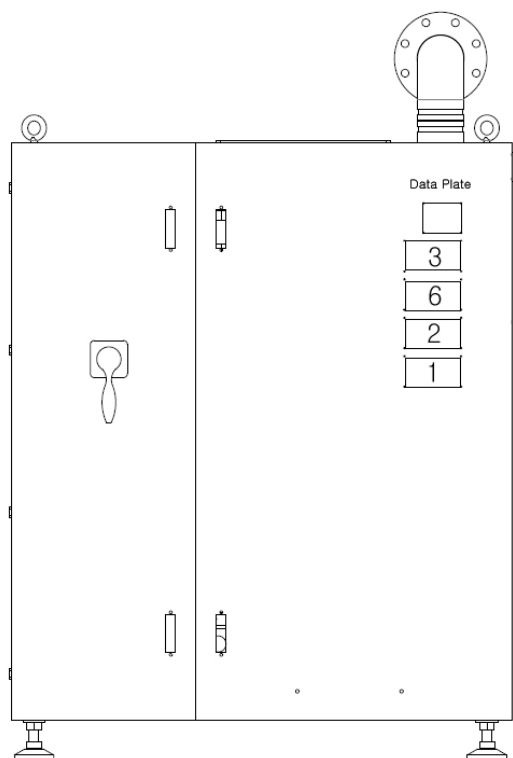


Figure 2-1 (c) Signs on the left side

	<b>Warning</b>	The equipment might be damaged or performance issue.
* Read and understand operator's manual and all other safety instructions before using this equipment.		
* Do not modify components or structures without authorization from Aerzen Turbo Co., Ltd.. Abnormal operation may cause serious injury or financial losses. Please consult with Aerzen technician for support and assistance.		
* Do not place foreign objects or substances into the blower package. Do not place foreign objects or substances near the blower package or suction piping/housing where they may be pulled into the blower suction. Foreign objects and substances sucked into the high-speed impeller may cause serious damage or injury. Do not change or modify intake filters during		

blower operation.

- \* Do not exceed the maximum nameplate pressure rating of the blower.
- \* Do not close the main suction or discharge valve during operation. Unexpected closure of these valves may result in surge.
- \* Do not perform any maintenance during blower operation.
- \* Electric current inside the inverter is still energized for approximately 10 minutes after the blower is completely shut down. Do not attempt to access any blower panels, including filters, for a minimum of 10 minutes after complete shut down.
- \* Electric power for lamps and displays at the filter panel are energized regardless of the status of the main breaker in the blower package. Risk of electric shock is present even though this breaker is in the off position.
- \* Do not add unauthorized circuits to the control panel. Please contact an Aerzen Turbo Co., Ltd. technician for support and assistance.
- \* All grounding should be completed in accordance with international electric standards. Use the special type 3 grounding method (Ground impedance : below 10Ω for 460V class).
- \* Working on or disassembling the inverter is dangerous. Please contact a Aerzen Turbo Co., Ltd. technician for support and assistance.
- \* The blower package does not meet standards for explosion proof equipment. Do not install or operate this blower in a classified space or a potentially explosive environment.
- \* Noise levels may exceed 85 dB during operation. Wear protective hearing equipment while working around the blowers. Failing to use proper protective hearing equipment may expose you to noise levels that are dangerous.

Table 2-2. Important safety regulations

## 3. Storage

It is important to store equipment and materials in accordance with the manufacturers written instructions to prevent damage to equipment and materials prior to installation.

### 3.1. Storage up to 120 days

Blowers are shipped sealed in an air-tight plastic enclosure to protect the units from excessive dust and moisture. If this seal is not compromised, special means of storage is not necessary. If the seal is compromised, the products should be stored in a dust free environment where ambient temperature and humidity are controlled. Supplemental ventilation may be necessary for the electric components if the humidity is excessive.

### 3.2. Storage longer than 120 days

Blowers are shipped sealed in an air-tight plastic enclosure to protect the units from excessive dust and moisture. If this seal is not compromised, long term storage beyond 120 days can be accomplished by placing the equipment in a dry environment with temperatures ranging between 40 and 100 degrees F. If the seal is compromised or removed, the following guidelines should be followed:

- Store equipment in a location free from excessive dust and humidity. Cover the blower package to prevent dust from migrating and settling inside the blower package.
- Maintain the storage temperature as constant as possible. Condensation due to ambient temperature variation may result in corrosion and/or damage to electrical components.
- Store with dehydrates such as silica gel to prevent condensation.
- Install space heaters or 100 watt electric light bulbs to facilitate removal of moisture.

\* Improper product storage may affect warranty durations. Please consult with your local Aerzen Turbo representatives, if you have any special storage case.

## 4. Installation

### 4.1. Inspection of the Components

Blowers and blower enclosures are shipped completely assembled, **except the clamp between scroll and diffusing cone that has to be checked and fastened after connecting the blower to the customer piping system, to make sure that there are no loads on the blower.** Components external to the blower enclosure (valves, flexible fittings, silencers, etc.) are shipped loose for installation by the contractor.

Upon receiving a shipment the owner should inspect all the components to ensure no components are missing and that no components have been damaged during shipping. If components are missing or damaged they should be noted in Table 4–1 below. Please include this table along with a brief description of the damaged or missing component and forward it to your local representative or contact the Aerzen office.

classification	Components	Missing*	Damaged**
Main body	Motor/Core Assembly, Inverter, Controller, Casing		
	Intake Filter		
	Blow-Off Valve		
	Blower-Off Valve Silencer		
Aux. element	Flexible Connection (suction and/or discharge)		
	Discharge Silencer		
	Discharge Check Valve		
	Discharge Isolation Valve		
Option	Harmonic & EMC Filter		

(\* please check “√ “)

Table 4–1. Delivery Check List

### 4.2. Installation Location

Selecting the appropriate installation environment and equipment arrangement is important and will save both installation and maintenance costs. Equipment should be installed to provide safe and easy access for operations and

maintenance personnel.

4.2.1. The ideal location to install the blower is indoors and out of the weather where adequate lighting and space exist for operation and maintenance activities. In this atmosphere the blower package is not subjected to excessive climatic changes or dust. If the blower is installed indoors but in a dusty environment, the intake filter will require more frequent cleanings and changes. Excessive humidity, even if indoors, may also contribute to electrical and electronic component problems.

4.2.2. The blowers should not be installed in locations where the blower or the suction intake of the blower will be subjected to various pollution sources such as smokestacks, cooling towers, high temperature exhaust gases, steam, etc.

4.2.3. If the blower is installed outdoors a suitable means should be provided to protect the blower enclosure and the blower suction inlet from precipitation.

4.2.4. The blower package should be installed where adequate ventilation is available to provide an adequate fresh source of air for the blower intake (if applicable) and the blower cooling system. Reject heat from the blower is estimated at 3% of total power consumption and should be accounted for in any room ventilation system.

4.2.5. Provide suitable working space around the blower for operations and maintenance activities. Activities might include inspection, repair, assembly, and disassembly. Table 4-2 shows recommended working spaces for each blower type.

Model	Between machines	Between wall	Height
Under AT100	< 1.5m (4.9ft)	< 1m (3.3ft)	< 5m (16.4ft)
AT200	< 1.5m (4.9ft)	< 1m (3.3ft)	< 5m (16.4ft)
AT300	< 2m (6.6ft)	< 1m (3.3ft)	< 5m (16.4ft)
AT400	< 2m (6.6ft)	< 1m (3.3ft)	< 5m (16.4ft)

\* Height is adjustable if the discharge piping system arranges to horizontal.

Table 4-2 Recommended ample space

4.2.6. If the blowers are to be installed above grade or on a second floor of a building appropriate access ways should be provided to get spare or replacement parts into the facility.

4.2.7. Install the blower on a flat, level, horizontal surface. The surface should be able to accommodate all static loads. The blowers do not impart a dynamic load to the installed base. Vibration from other devices should be effectively isolated so they do not impact the blower equipment base. Anchor bolts may be used to restrain blower movement due to external vibration or seismic activity.



Figure 4-1 Foundation



<Level Check in front view>



<Level Check in side view>

Figure 4-2. Level Check



Figure 4-3 Anchoring

### 4.3. Preparations for Installation

Before installation, the following items should be checked.

Place :		Date of Check :	
Model : AT		Date of Delivery :	
Classification		CHECK POINT	Results
Operating condition	Pressure	Nominal operating pressure	
	Flow rate	Nominal operating flow rate	
	Drawing	Preparation of drawings with respect to piping	
	usage	Fitness for the process	
Place	space	Enough space for inspection	
	suitability	Environmental suitability for installation	
	maintenance	Enough space for maintenance	
Electricity	power	Security for stabilized power source	
	transformer	Enough capacity for operation	
	Switching Board	Capacity of NFB(No Fuse Breaker) & power cable	
		Distance between NFB and installation place	
Piping	discharge	Status of discharge piping	
	Accessory	Status of Check valve, Flexible, silencer	
	intake	Status of intake piping (if available)	
Etc	Environmental Condition	Mechanical vibration level	
		Sound noise level	
		Amount of dust	
		Flatness of ground	
	CCR operation	REMOTE/local operation	
		Application for MCP	
	Picture	Pictures at the installation place	
	etc	The other items	

Table 4-3. Check sheet for installation.

## 4.4. Transportation

Products should be transported or moved using the following procedures.

4.4.1. Ensure that there are no obstacles around the installation location.

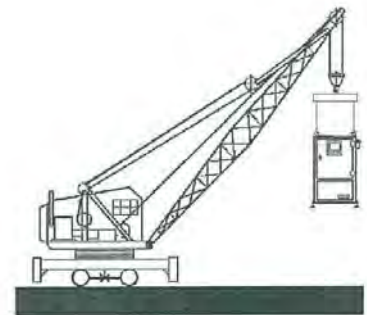
4.4.2. Lift and move the blower from underneath using either a hand palette jack or a forklift. Take precautions to avoid mechanical shocks while moving the equipment. If using the eyebolts please make sure that there are only tractive forces and no bending forces.



Hand Palette Jack



Fork Lift



Truck Crane

Figure 4-4. Transportation

## 4.5. Piping

4.5.1. Line up the centerline of the discharge piping with the centerline of the blower discharge on the enclosure as shown in Figure 4-5. Verify that the height shown on the drawing agrees with the actual measured height at installation.

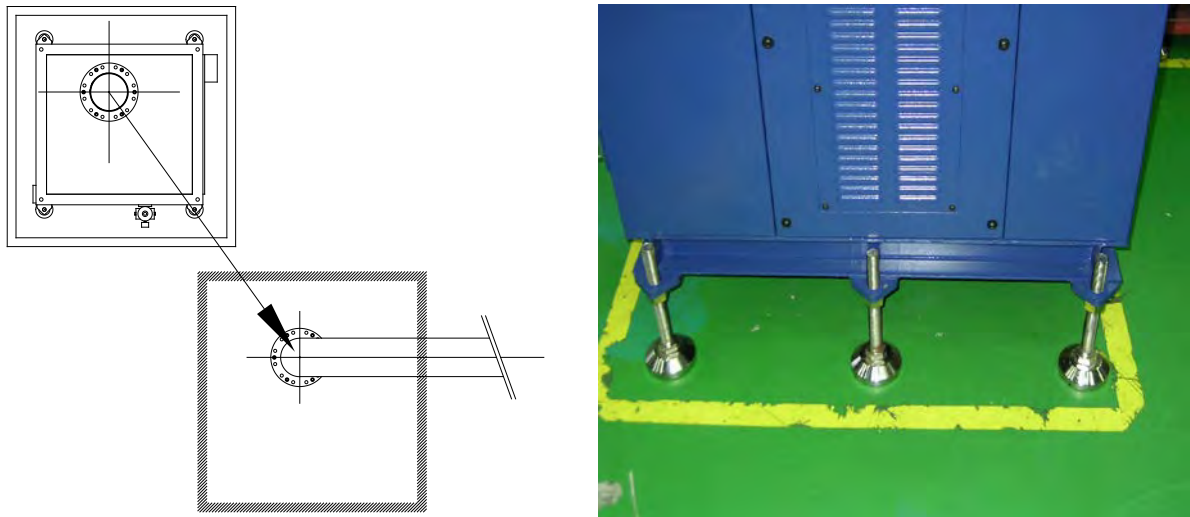


Figure 4-5. Aligning the Blower and Marking the Position

4.5.2. Rotate the blower about the discharge pipe center so as to get accurate position of the blower feet. Then adjust horizontal level by adjusting the leveling feet beneath the blower as shown in Figure 4-6.

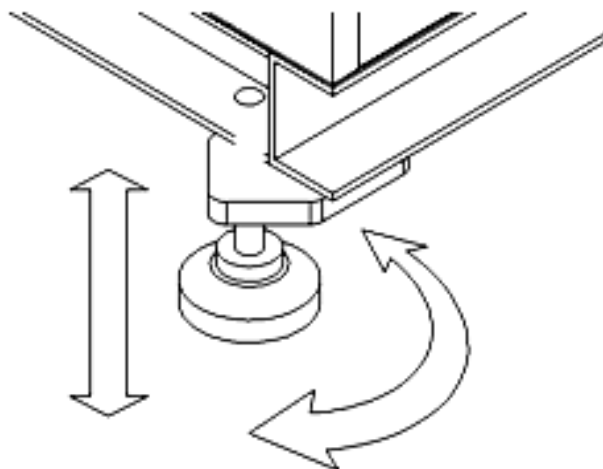


Figure 4-6. Leveling Feet

### 4.5.3. Discharge Piping & Motor cooling Piping

4.5.3.1. Install discharge accessories in accordance with Figure 4–7. Discharge components may include expansion joint, check valve and isolation valve. Verify gaskets are properly inserted at this time.

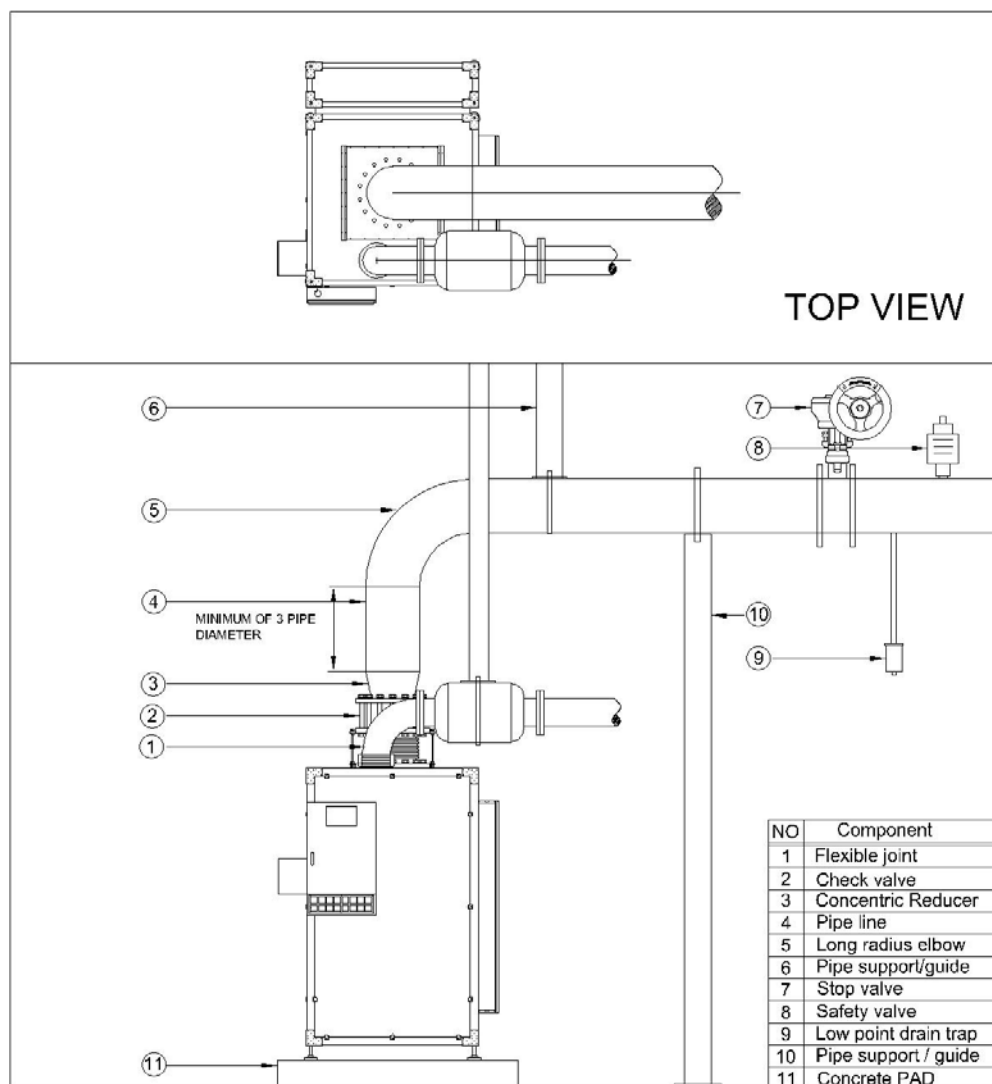


Figure 4–7. Discharge Piping Example

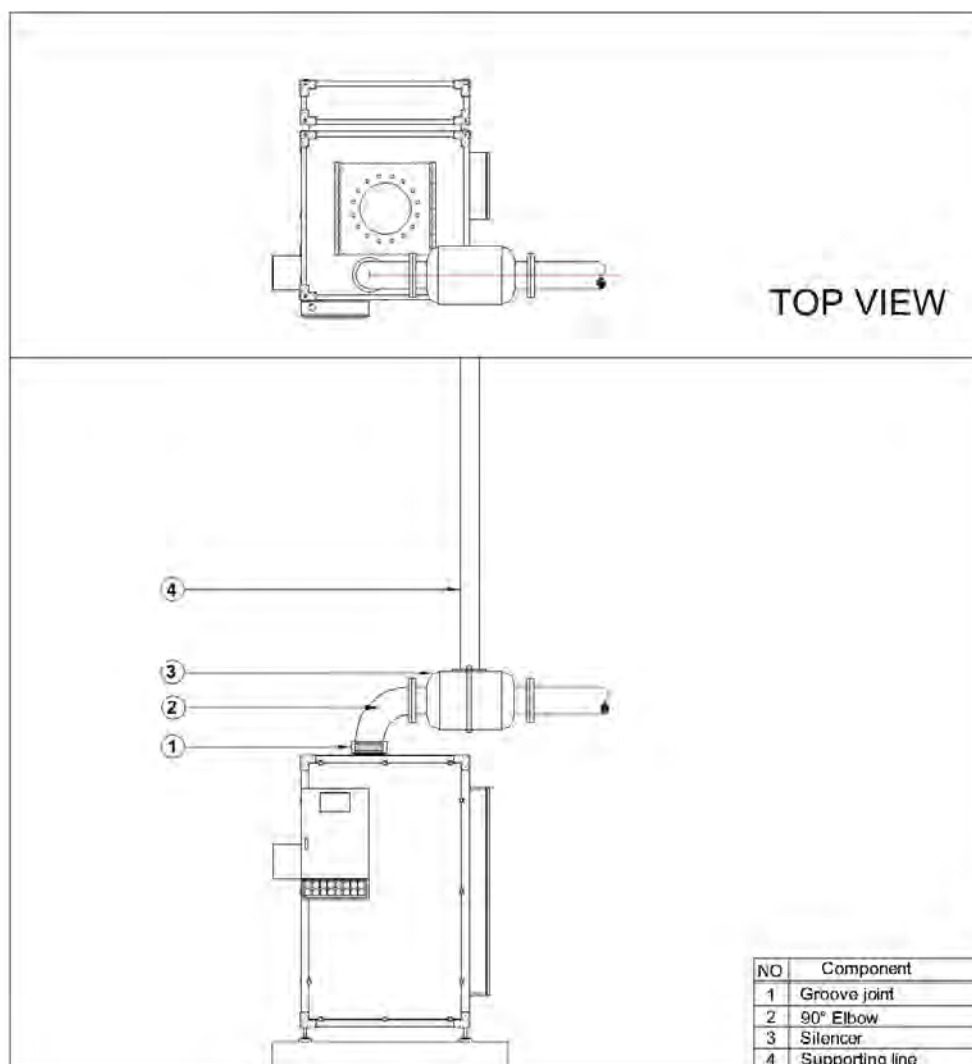


Figure 4-8. BOV & Motor cooling Piping configuration Example

4.5.3.2. Install the flexible joint directly to the blower discharge flange. **Support all piping and accessories independently from the blower.** The weight of piping and accessories should not be transmitted to the blower package. After piping work is finished, check gap between Scroll and Diffusing Cone (3.5 to 5mm) and mount clamp! Don't start Blower without this clamp (clamp not pre-installed)!

4.5.3.3. If possible, maintain at least 3 straight pipe diameters after the discharge check valve.

4.5.3.4. Verify the flow direction is consistent with the check valve operation. The check valve should be installed near the machine.

4.5.3.5. Install the isolation valves (stop valve) after the check valve for future maintenance.

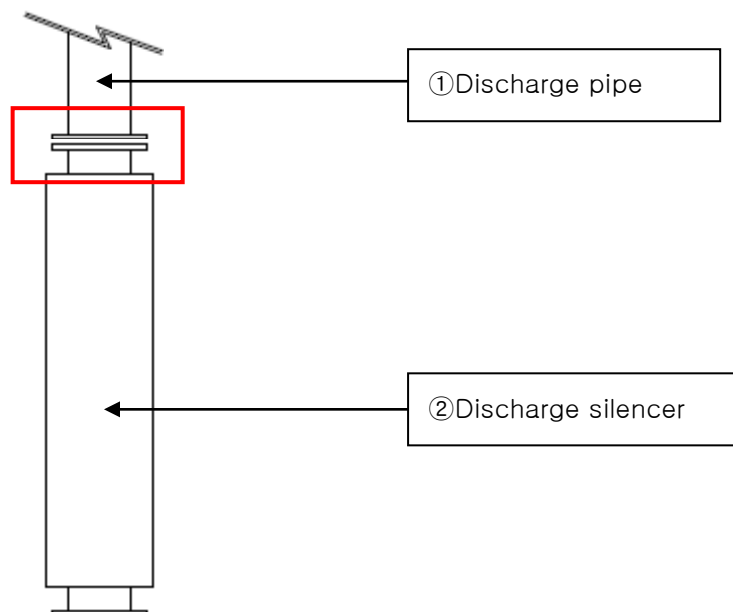


Figure 4–9. Isolation(Butterfly) Valve

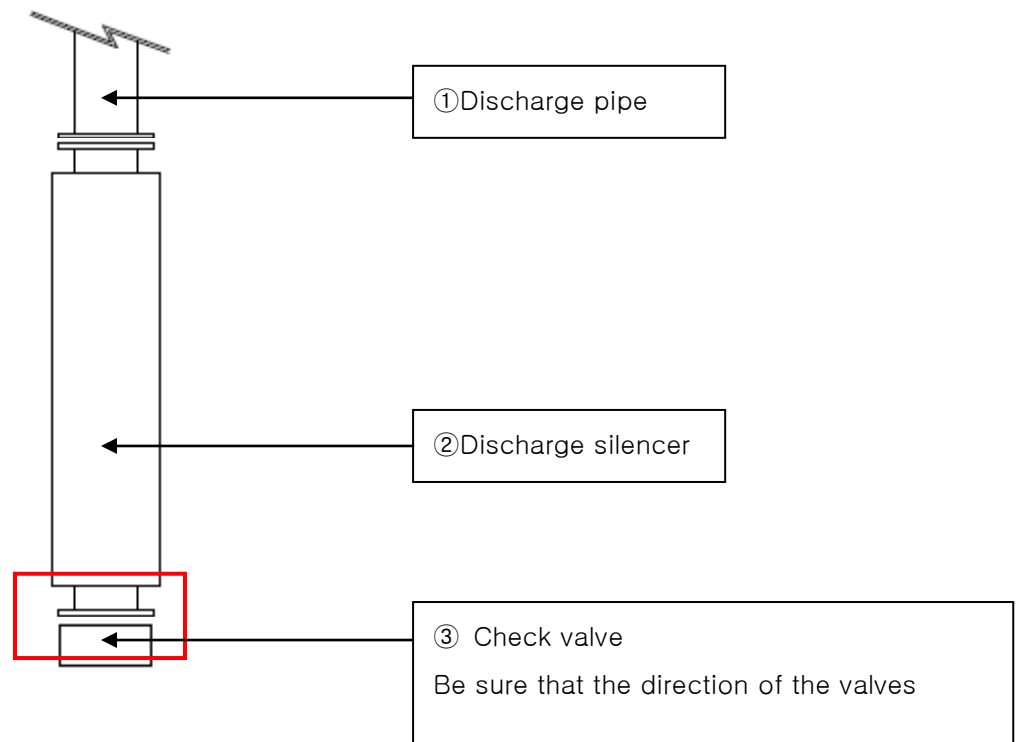
#### 4.5.4. Piping connection

##### ◇ Piping connection order on vertical arrangement

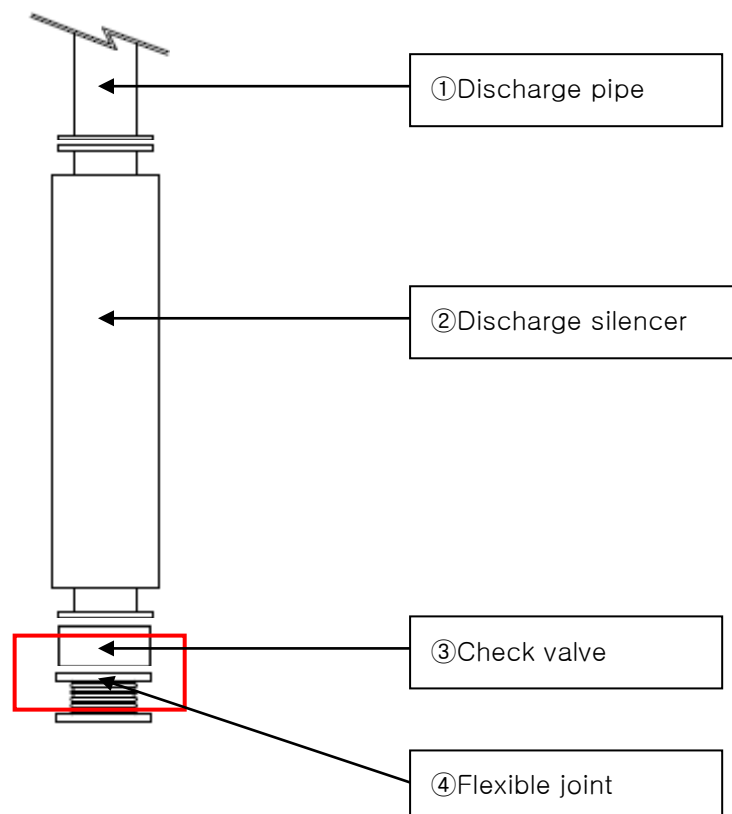
1) Connect the discharge silencer to the customer piping system.(① + ②)



2) Connect the Silencer and Check valve.(① + ② + ③)

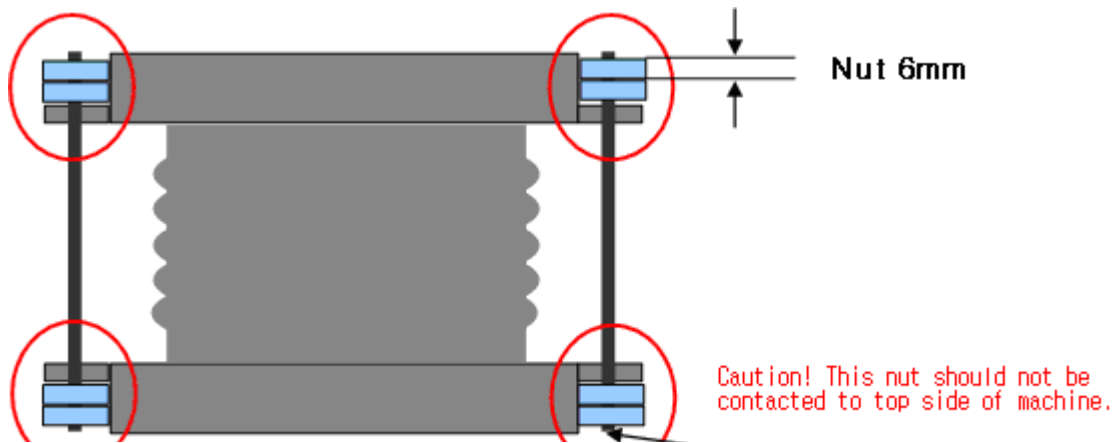


3) Connect the Check valve and Flexible joint.(① + ② + ③ + ④)



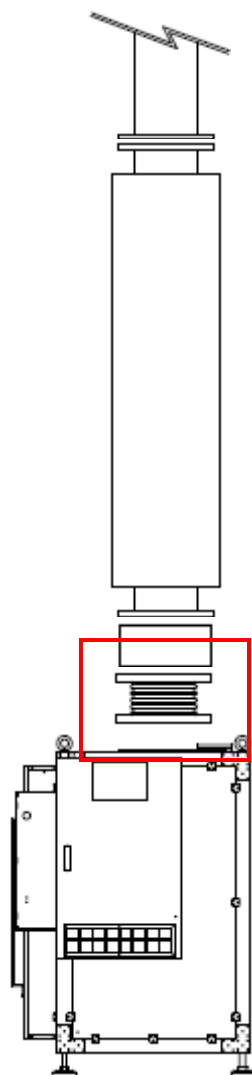
### ■ Flexible joint

; To prevent over expansion, please put the Limiter bar every 120 degrees on the flexible joint and tight it with a six (6) mm double nut.

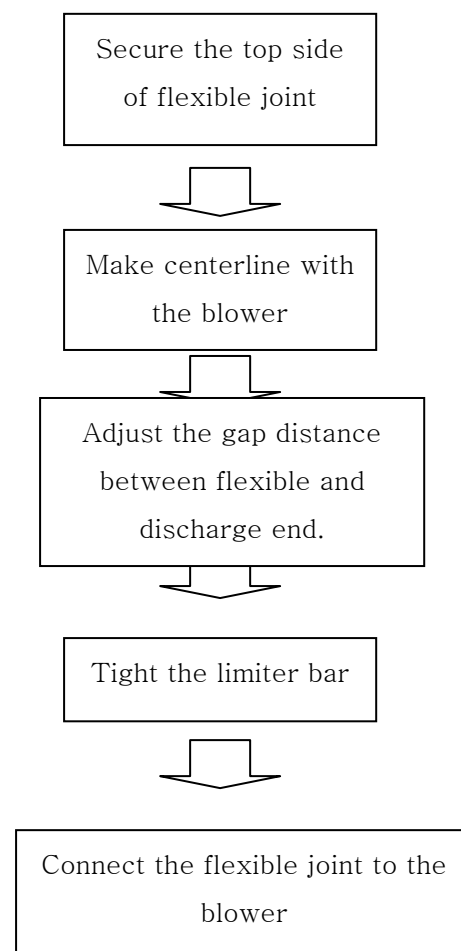


5) Connect the flexible joint to the Aerzen high speed turbo blower discharge end.

- ① First thing is to make sure the top side of flexible joint is firmly connected with the discharge check valve and its centerline should be aligned with blower's discharge end center.
- ② The gap between the bottom of flexible joint and the top discharge end of the blower is adjustable with the limiter.
- ③ Adjust this gap within 1mm on every direction between the bottom of the flexible joint and gasket placed on the discharge end of the blower. The adjustment is made by loosening the limiter nuts on the flexible joint or adjusting the blower level feet.
- ④ After adjusting the gap properly, tight the limiter bat nut and put it on double nut to prevent loosening the securing nut.  
Put on the marking point to check its status.
- ⑤ Connect the bottom side of the flexible joint to the blower's discharge end.

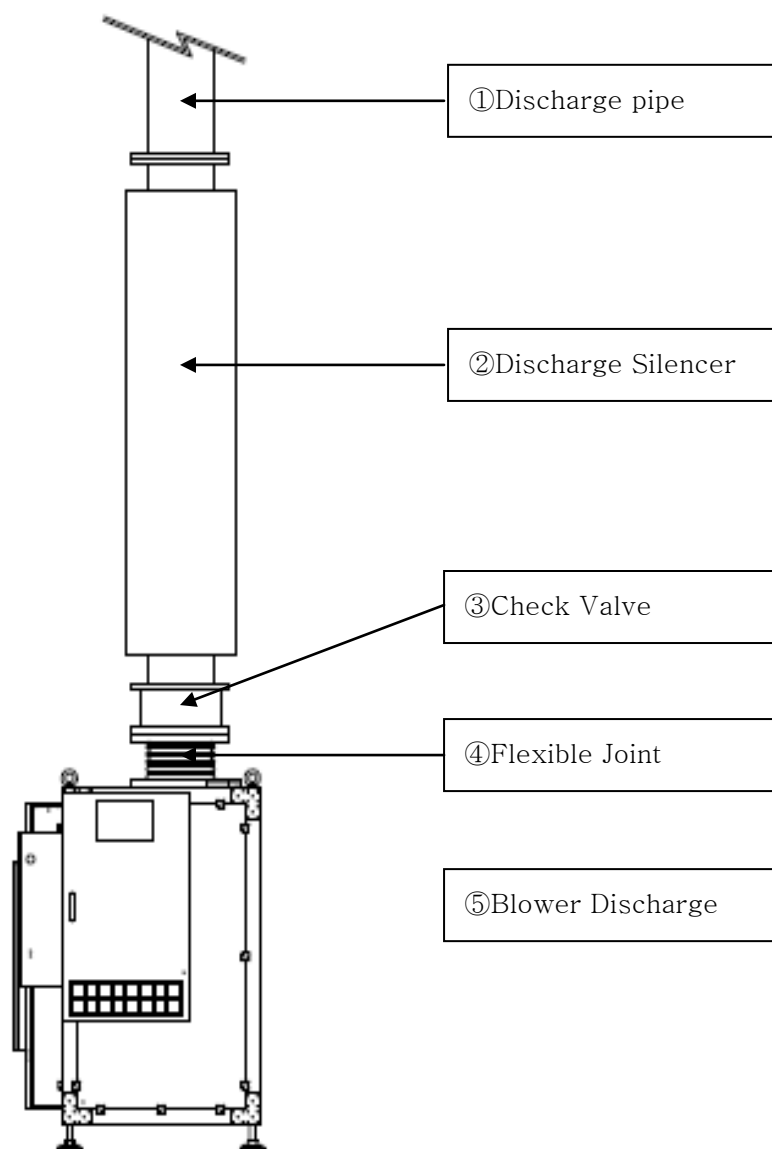


#### ■ Flexible joint connection order



■ Make sure its connection order is as listed below;

- ① Customer's piping system -> ② Check valve -> ③ Elbow -> ④ Flexible joint ->
- ⑤ Aerzen Turbo blower discharge end.

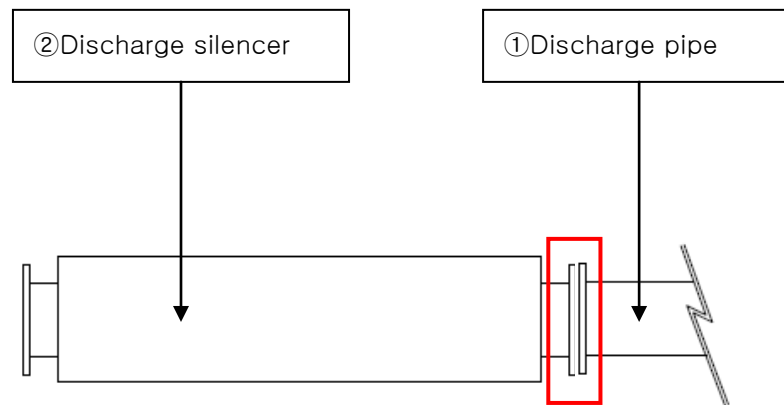


#### ■ Caution

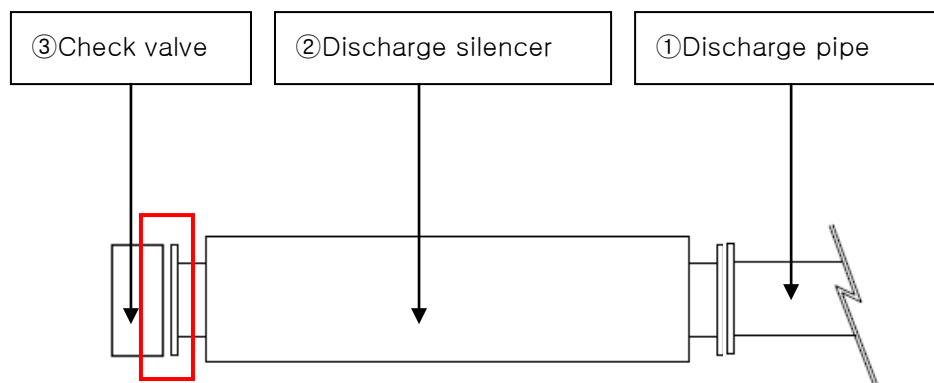
1. Make sure the piping support system is properly installed. Every discharge piping material's weights are free from the top side of the blower package including the discharge flexible joint.
2. If you have a more than 12 PSI (1 bar) machine, please do not forget to install the anchoring device.
3. A gasket is required at every flanged connection.

### ◇ Piping connection order on horizontal arrangement

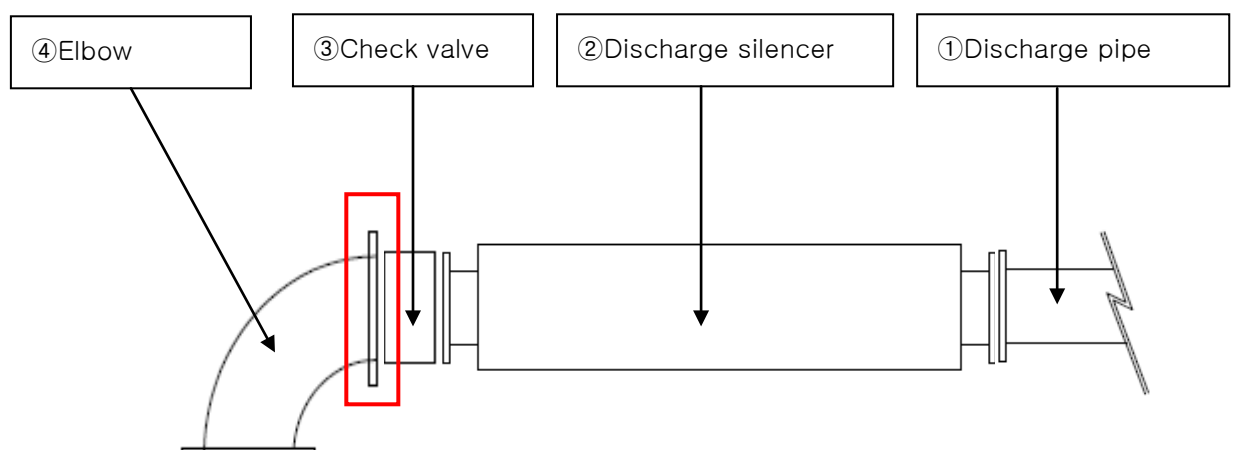
1) Connect the discharge check valve to the customer piping system. (① + ②)



2) Connect the elbow to the discharge check valve. (① + ② + ③)



3) Connect the Check valve to the Elbow. (① + ② + ③ + ④)

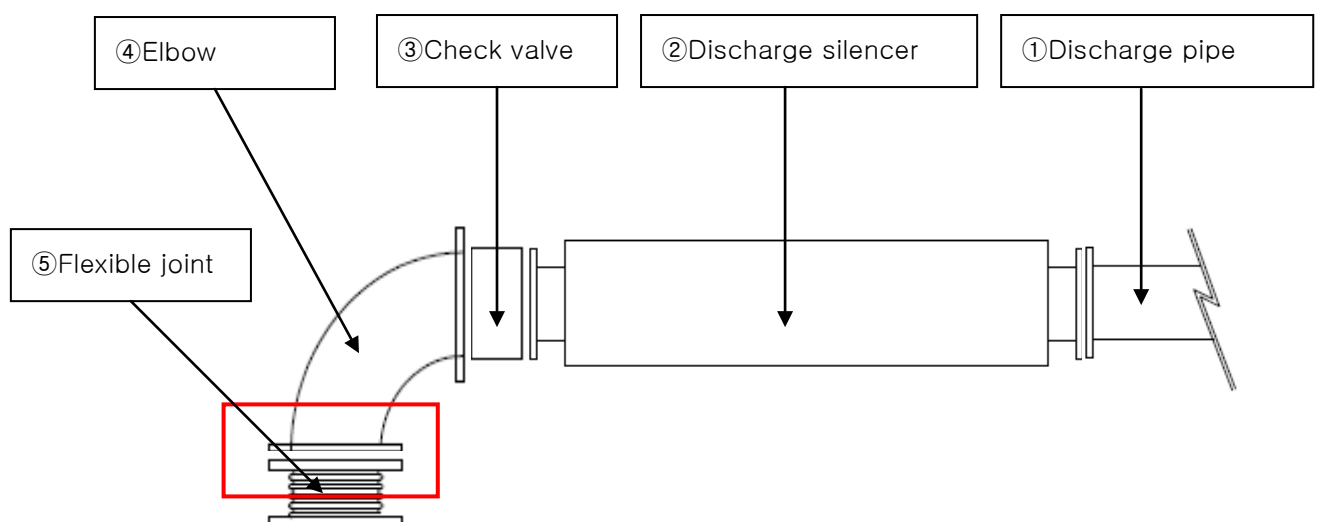


■ Caution to connect the discharge check valve with vertical direction.

- 1) You have to check its arrow mark on the surface of valve.
- 2) Additionally, Its shaft should be located to the top side. (Refer to the attached photo.)

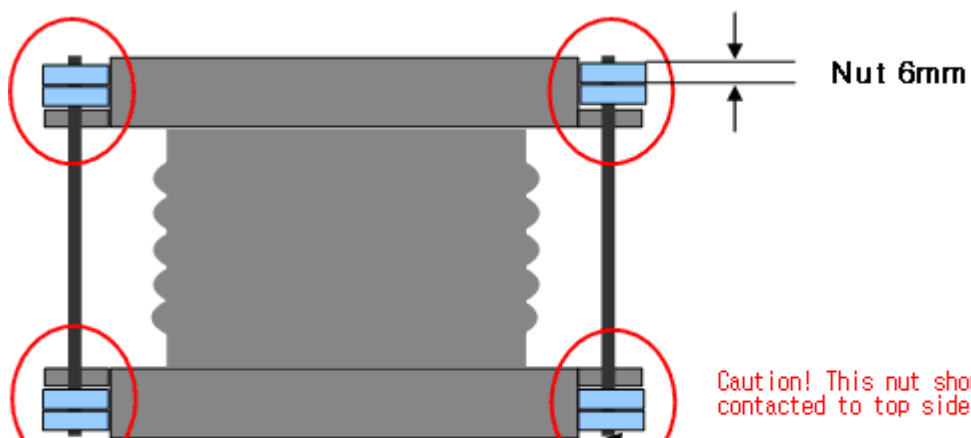


4) Join the flexible joint to the elbow. (① + ② + ③ + ④)



■ Flexible joint

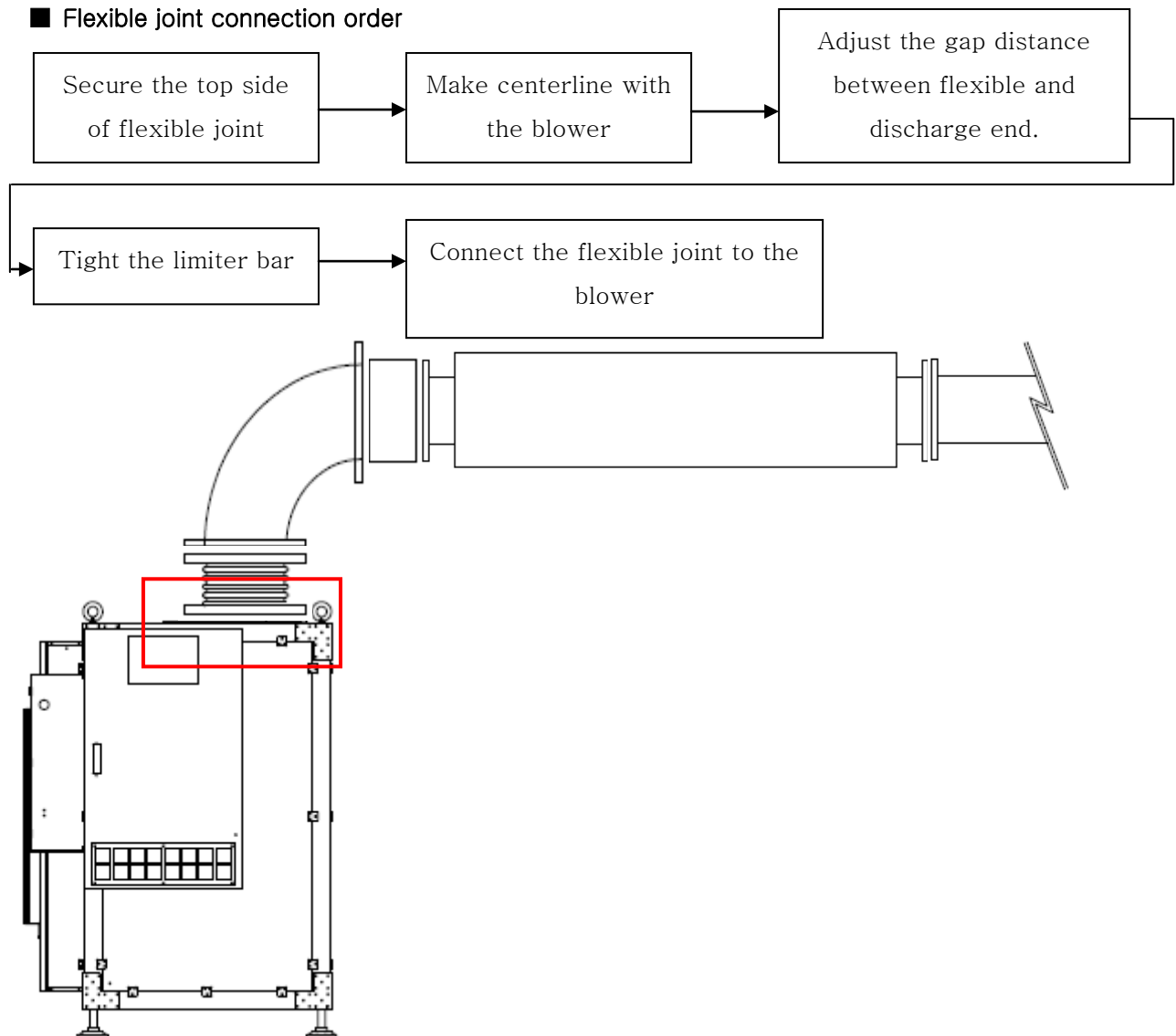
; To prevent over expansion, please put the Limiter bar every 120 degrees on the flexible joint and tight it with a six (6) mm double nut.



5) Connect the flexible joint to the Aerzen Turbo high speed turbo blower discharge end.

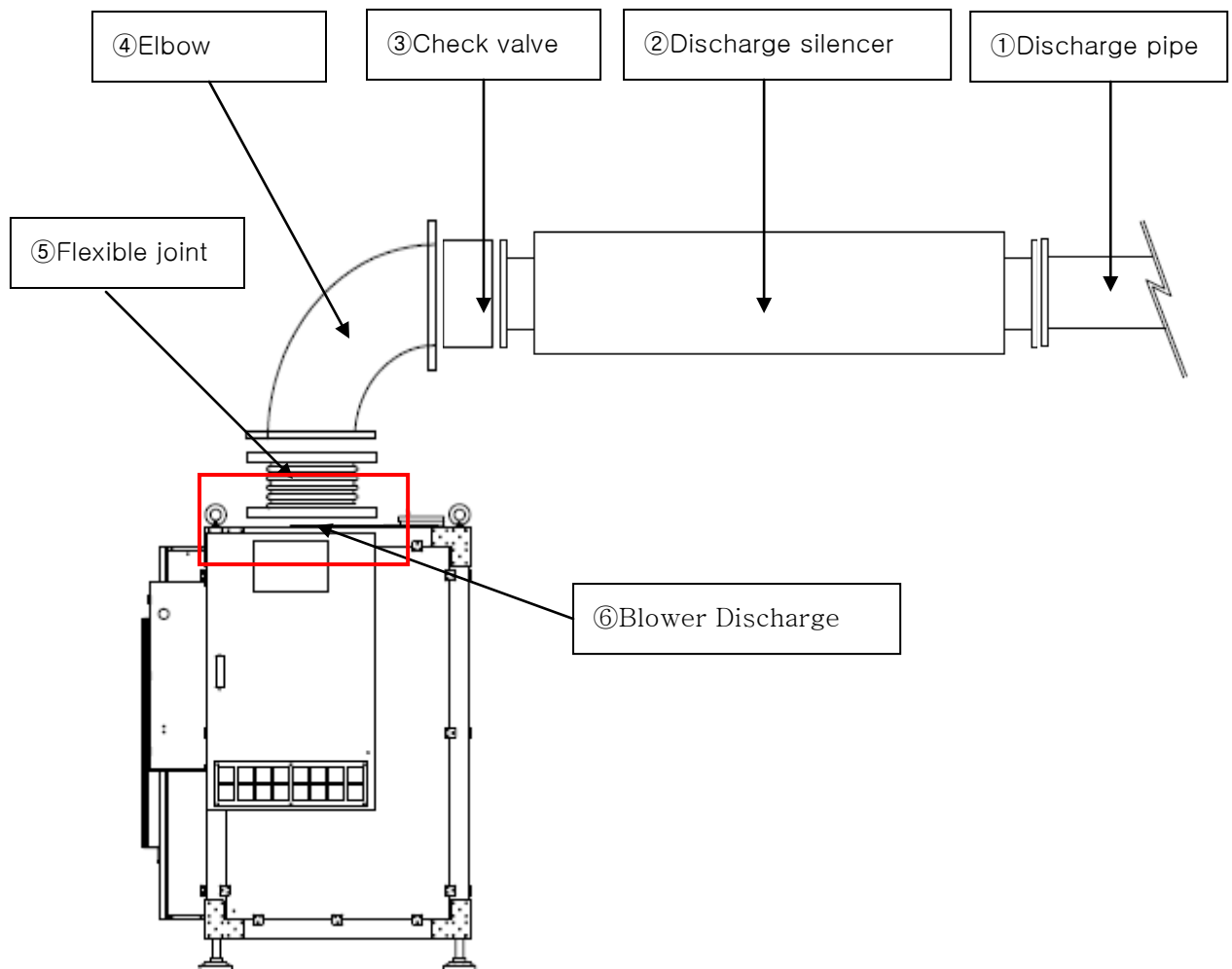
- ① First thing is to make sure the top side of flexible joint is firmly connected with the discharge check valve and its centerline should be aligned with blower's discharge end center.
- ② The gap between the bottom of flexible joint and the top discharge end of the blower is adjustable with the limiter.
- ③ Adjust this gap within 1mm on every direction between the bottom of the flexible joint and gasket placed on the discharge end of the blower. The adjustment is made by loosening the limiter nuts on the flexible joint or adjusting the blower level feet.
- ④ After adjusting the gap properly, tight the limiter bar nut and put it on double nut to prevent loosening the securing nut.  
Put on the marking point to check its status.
- ⑤ Connect the bottom side of the flexible joint to the blower's discharge end.

#### ■ Flexible joint connection order



■ Make sure its connection order is as listed below;

① Discharge pipe -> ② Silencer -> ③ Check valve -> ④ Elbow -> ⑤ Flexible joint ->  
⑥ Blower Discharge



#### ■ Caution

1. Make sure the piping support system is properly installed. Every discharge piping material's weights are free from the top side of the blower package including the discharge flexible joint.
2. If you have a more than 12 PSI (1 bar) machine, please do not forget to install the anchoring device.
3. A gasket is required at every flanged connection.

#### 4.5.5. Intake Systems

4.5.5.1. Verify that the fine intake filters are attached to the back of the unit.

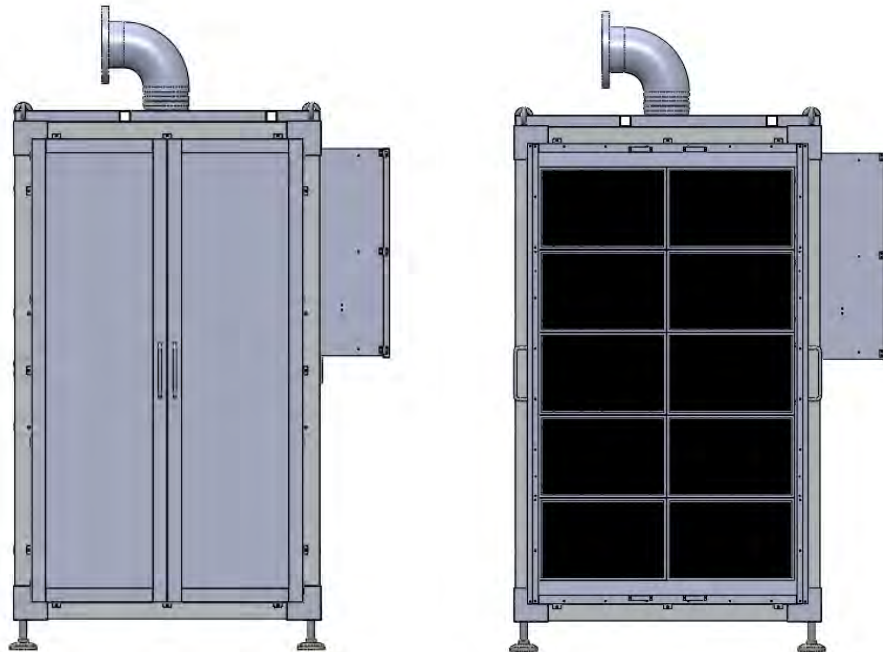


Figure 4-10. Main intake filter Assembly

4.5.5.2. If external intake filtering system is selected, the filter specifications should be designed to remove 98% of 4  $\mu\text{m}$  particles. The differential pressure through the filter should never exceed 2 kPa (0.3 psi) during operation.

#### 4.5.6. Other Precautions

##### 4.5.6.1. Particle Transportation

- Install a pressure relief valve off of the discharge piping.
- Consider installing a surge tank if pressure fluctuations are high.
- Construct pipelines with smooth curves for the good particle transport.

##### 4.5.6.2. Connecting in Parallel with Positive Displace Blowers

- Do not directly connect a turbo blower with a positive displacement blower.
- Install 5 $\text{m}^3$  (1300 gallon) surge tank between the blower discharges.
- Install a drain valve under the surge tank.

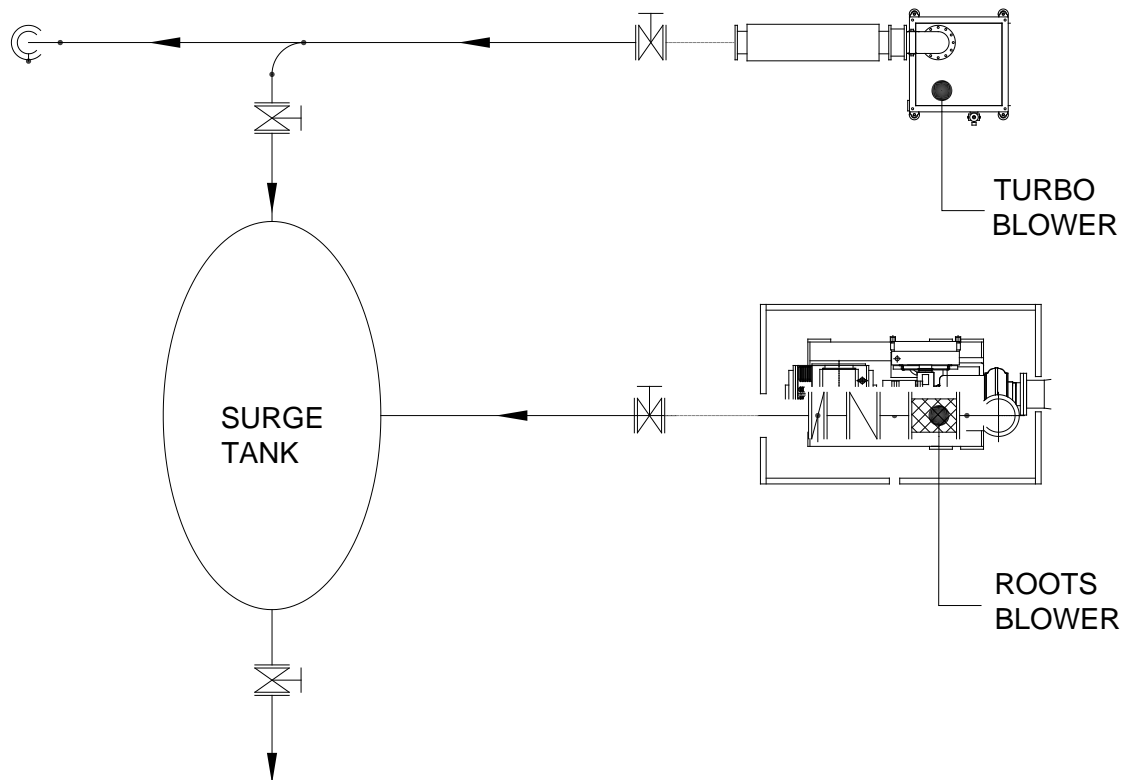


Figure 4-11. Recommended parallel Connection with Positive Displacement Blowers

## 4.6. Power cable & Ground

4.6.1. Table 4-4 shows the specification for main power and ground cable as determined by “KS C IEC 60364-5-52:2004”. Cables should be connected as shown in Figure 4-11(Please follow local regulations.)

4.6.2. R/L1-S/L2-T/L3 sequence is not applicable for models of 200 HP or less. For models 300 hp and larger the phase should be adjusted.

4.6.3. Ground cable color should be Green/Yellow. These color cables should not be used for any other purpose. Use the special type 3 grounding method (Ground impedance: below 10Ω above 400 V).

rated (HP)	kW	Input voltage = 480 V				Input voltage = 575 V			
		Amp(In)	cable(mm <sup>2</sup> )	GND(mm <sup>2</sup> )	ELCB	Amp(In)	cable(mm <sup>2</sup> )	GND(mm <sup>2</sup> )	ELCB
25	21	27	6	6	40AT	23	6	6	30AT
50	42	55	16	16	80AT	46	10	10	60AT
75	63	82	25	16	150AT	69	16	16	100AT
100	84	110	25	16	175AT	92	25	16	150AT
150	126	164	70	35	300AT	137	50	25	200AT
200	168	219	120	70	350AT	183	70	35	300AT
250	210	274	120	70	400AT	229	120	70	350AT
300	252	329	150	95	500AT	275	120	70	400AT
400	336	439	240	120	700AT	366	150	95	600AT
500	420	548	185 x 2	185	800AT	458	240	120	700AT
600	504	658	240 x 2	240	1000AT	549	185 x 2	185	800AT

★ Applicable for 600V CV cable

Table 4-4. size of Power & Ground wire(Reference only)

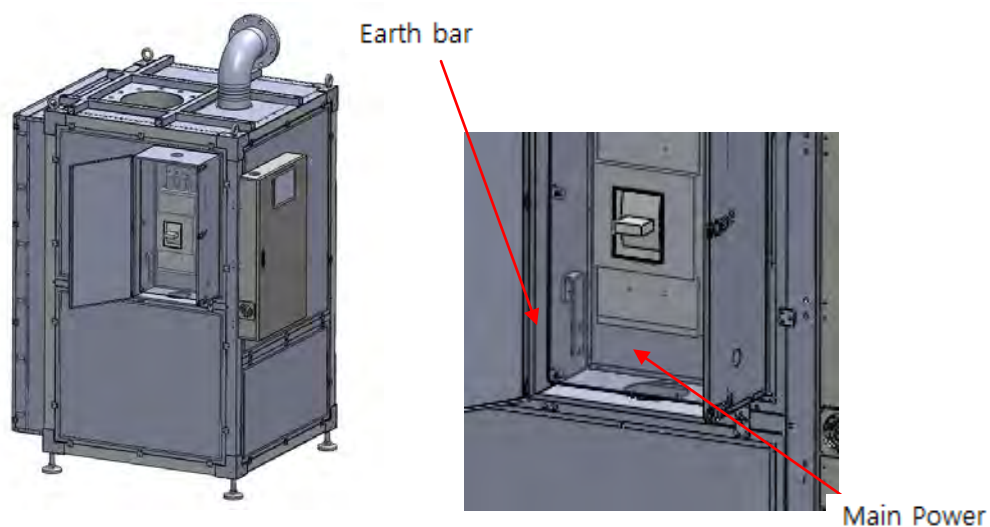


Figure 4-12. Connection point of AC inlet and ground

#### 4.6.4. Insulation Resistance

If the blower is located in high humidity conditions the insulation resistance should be measured. With 1000V between main power and ground the resistance should be above 2000 M $\Omega$ .

## 4.7. Customer connection wiring

This is just for case of remote operation selection which is generally called hard wiring control connection.

TB1			
1	R3	15	LOAD-
2	S3	16	ALARM+
3	R33	17	ALARM-
4	S33	18	ERROR+
5	S33	19	ERROR-
6	P	20	POWER+
7	N	21	POWER-
8	N	22	R/START+
9	N	23	N
10	READY+	24	SVI+
11	READY-	25	SVI-
12	RUN+	26	PVI+
13	RUN-	27	PVI-
14	LOAD+	28	SP1+
15	LOAD-	29	SP1-
		30	

Figure 4-13. Terminal Block

## 4.8. Preparations for start-up

The following items should be checked prior to initial startup.

Pre-startup check list				
Date				Serial no.
Blower no.				In charge
Division	Items	Details	Pass or Fail	Remarks
Before Operating	Motor room	The assembly state of the temperature sensor(T1, T2), $\Delta P1$ , $\Delta P2$ , P3 is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Impeller rotation is OK during operation.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		There is no substance on the surface and inside of the motor.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The motor cooling-arm and BOV piping are fixed well.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The space between motor scroll and con-pipe is suitable. (3-5mm)	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Motor connection is fixed well.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The assembly of bus-bar(U,V,W) on motor power supply is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	VFD (Inverter) room	Floor surface of the package and inverter are fixed strongly.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The bus-bar connection between input(R, S, T) and output(U, V, W) is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The circuit breaker is selected and assembled well.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The 220V transformer tab is connected well to fit on input power.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Fixed state and connection of boards (K1B, DRV3K, DRV U etc.) is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Fixed state and connection of the bus-bar of DC Choke and DC Reactor are OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Control panel	Fixed state of the I/O board and CPU board is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Insulated state of the I/O board connector is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Fixed state of the pressure sensor of I/O board is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Insulated state and fixed state of the relay is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Fixed state and connection of the isolator is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Exterior	The package storage is suitable.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The pipe size of discharge is suitable.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		There is no obstacle in the discharging pipe.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Pipe installation of the motor cooling air discharge is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
Installation State	Installation	The package is horizontal. (front and side)	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Fixing state of the flexible pipe is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Space control bolt of the flexible pipe is released.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The check valve is the dual type. (attention direction)	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		The support beam of the discharge pipe is installed.	Y <input type="checkbox"/> / N <input type="checkbox"/>	

		Fixing state of the floor surface of the blower's level foot is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		Main header size is suitable when blowers are operating multiple.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
		direction of discharge is suitable.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
Power & Controller	Power supply voltage	Power among each phase is OK and matched with necessary power.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Power cable loss	Connection tightness and R,S,T phase connection are OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	External controller loss	All terminal connection are correct.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Using UPS	Power connection is correct.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Cable size	Capacity of the power cable is enough.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Using communication line	All connection are OK between UTP cable and terminal.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
	Protocol converter	Each terminal connection is OK.	Y <input type="checkbox"/> / N <input type="checkbox"/>	
Remarks				

Table 4-5. CHECK LIST for Initial Startup

5. Operation

Aerzen Turbo blower can be controlled with any of the following methods:

- LOCAL – Using with LCD or TFT display
- REMOTE – Using with hard wiring through the customer connection terminal block
- LAN – Using with Ether-Net connection

5.1. Local Operation

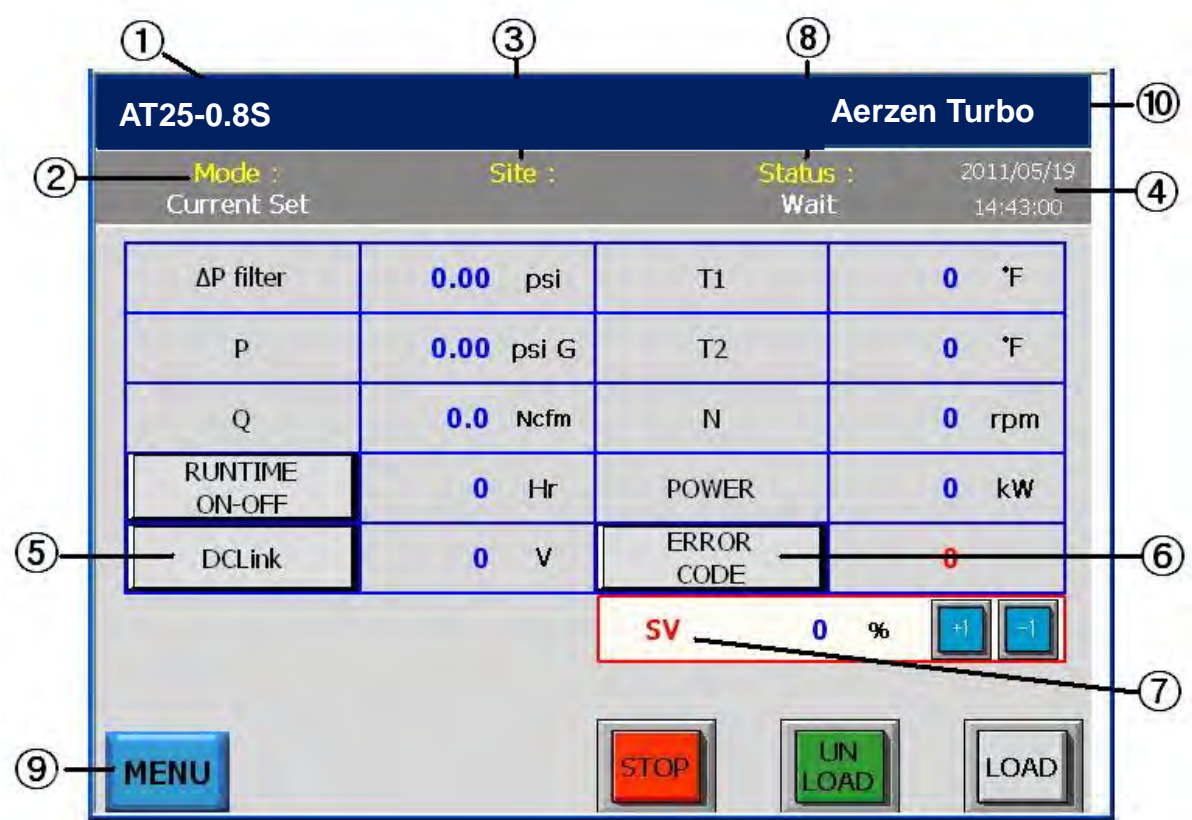


Fig.5-1. Touch Screen Display

① Model	⑥ ERROR CODE
② Operation Mode	⑦ Current SV
③ LAN/ LOCAL/ REMOTE	⑧ Operation Status
④ YEAR / MONTH/ DAY, HH: MM: SS	⑨ SUB MENU
⑤ DISPLAY By CP [17]	⑩ HMI Shutdown

Item	Explanation	Item	Explanation
$\Delta P$	Differential pressure across intake filter (kPa)	T1	Intake air temperature (°C)
P	Discharge pressure (bar)	T2	Discharge air temperature (°C)
VOLUME FLOWRATE	Flow rate of air (m <sup>3</sup> /min)	SPEED	Rotating speed of motor (RPM)
RUN TIME ON-OFF	Accumulated run time (hours)	INPUT POWER	Input power (kW)
DCLink	DC voltage (V)	ERROR CODE	Information for error code

Table 5-1. Details for the Display Screen

## 5.1.2. Operating mode SETUP

The Operating MODE is usually set up to perform the initial startup.

## Constant Current Set

In this operating mode the electric current is maintained constant. This mode is primarily used for aeration process.

## Constant Flow Set

In this operating mode the electric current is adjusted to maintain a constant flow rate. This mode is primarily used for particle transport.

## POUT

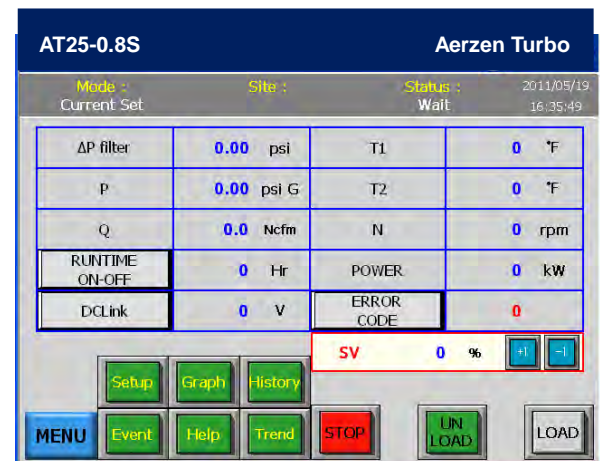
This operating mode is used to maintain constant blower pressure.

## DO control

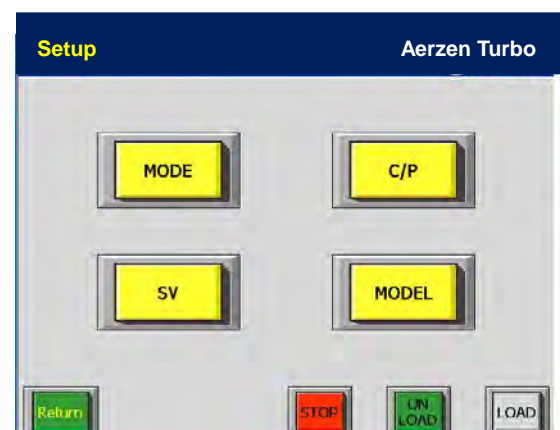
This operating mode is used to maintain constant dissolved oxygen.

Press **MENU** at the base screen.

Then you see six green sub-menus.

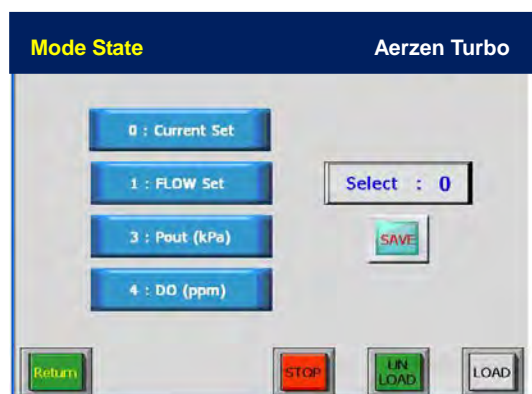
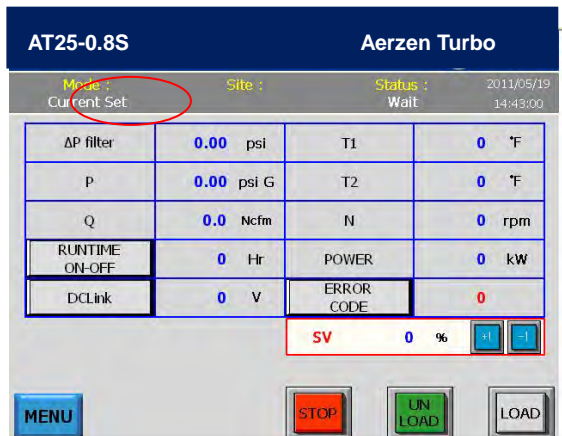


Press **Setup** to go to Setup menu.



Press **MODE** to see mode selection screen.

(cf) Pressing **0** in the below figure will get you the same result.



Press **0:Current Set** to select (electric) current mode and verify select=0.

Press **SAVE** and **Return** to go to the home screen.

### 5.1.3. SETUP SV

The following units are used for the SV (Set Value) according to the selected operating MODE.

MODE	INPUT	unit
CURRENT	% of max. current	%

FLOW	Volume flow rate	m <sup>3</sup> /min
RPM	% of max. speed	%
Pout	Discharge pressure	bar
DO	Dissolve oxygen	ppm

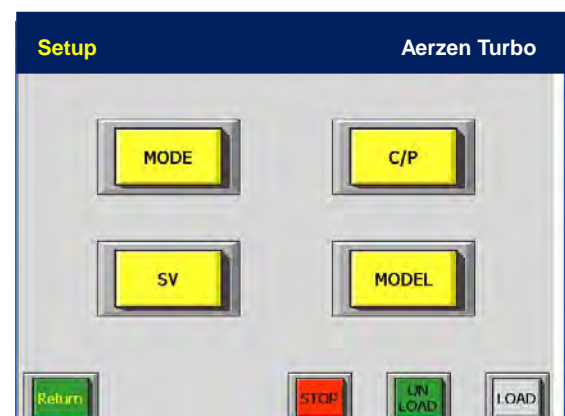
Table 5-2. Input Units for SV

SV can be adjusted at any time using the below procedure.

Press **MENU** at the base screen to bring up the six green sub-menus.



Press **Setup** to go to Setup menu.

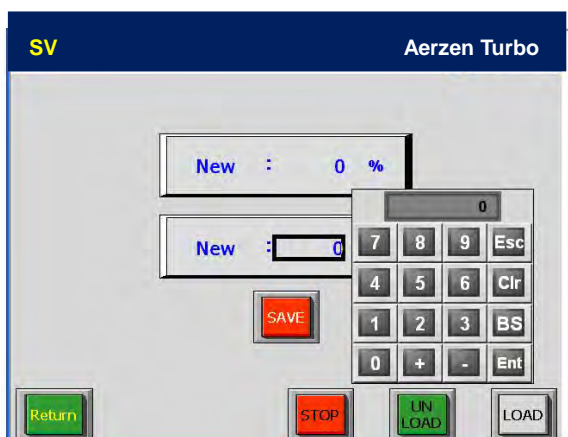


Press **SV** to adjust SV.

(cf) Pressing **0** in the next figure will get you the same result.



Press **0** in the above figure to see next screen.



Enter a new SV using the numeric keypad.

Press **Ent**, **SAVE**, and **Return** to go back to the home screen.

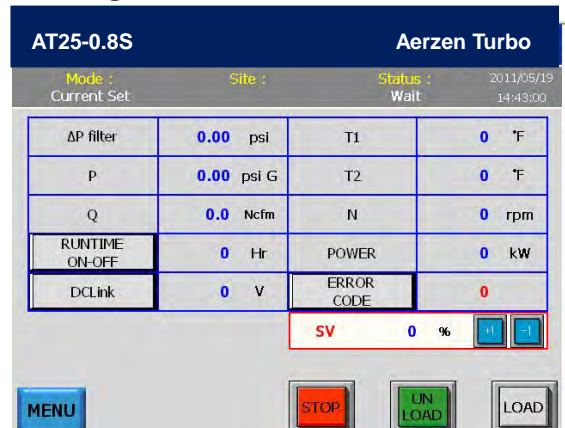
#### 5.1.4. SETUP Control Parameters



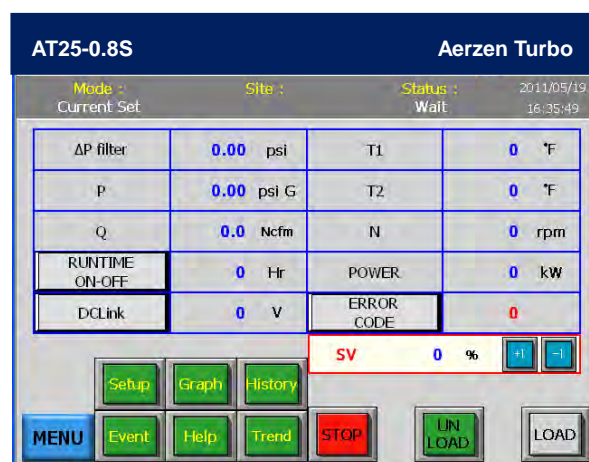
(Warning)

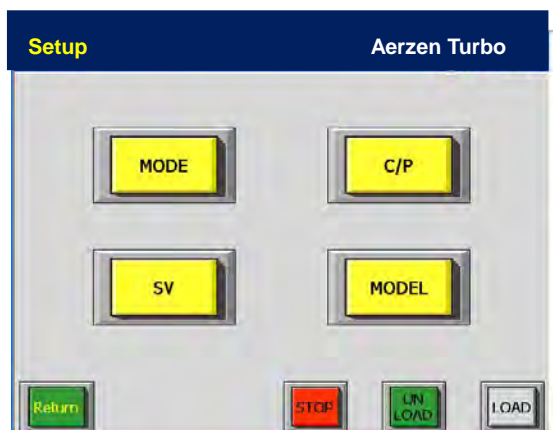
Change of control parameters (C/P) may cause serious damage to the machine. It should be done only under permission of trained personnel.

Press **MENU** at the base screen to display the six green sub-menus.



Press **Setup** to go to Setup menu.





Press **C/P** to change C/P.



Two screens can be toggled by **Next** and **Previous**.



Press **O** in the above figure to see new window.



Enter new value using numeric keypad.

Press **Ent**, **SAVE**, and **Return** to go to the home screen.

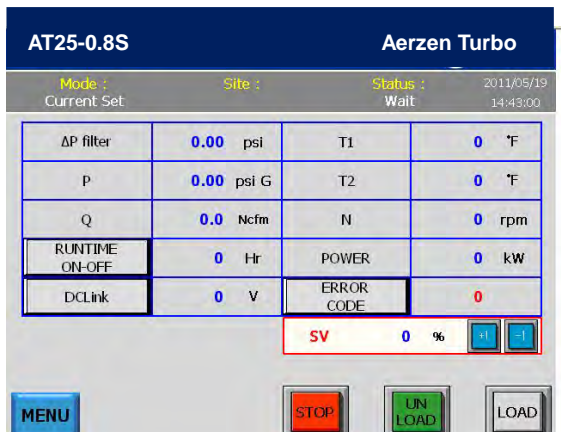
Press **Target** to remove the window.

#### 5.1.5. SETUP CLOCK

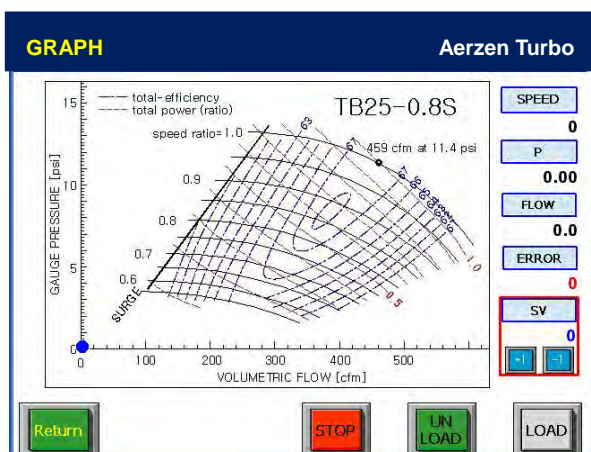
The touch screen program is based on Windows CE. The system clock can only be changed in the operating system and cannot be changed at the LCD screen.

#### 5.1.6. Graph Menu

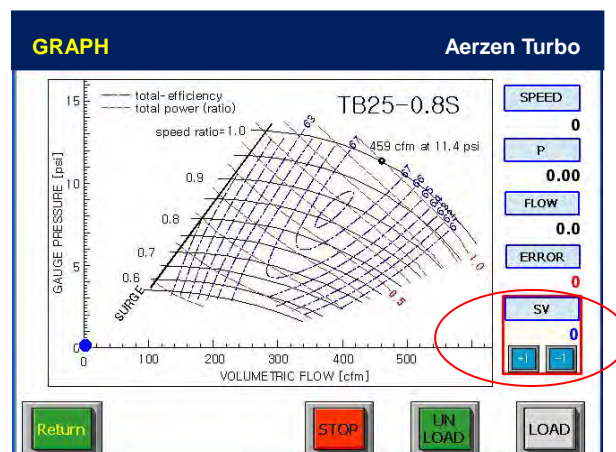
Press **MENU** at the base screen to display the six green sub-menus.



Press **Graph** to see the operating point on the performance curve.



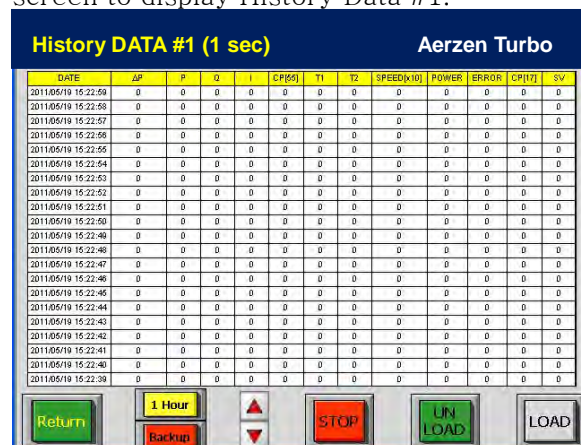
Press **+1** or **-1** in **SV** by incremental steps.



Press **Return** to go to the home screen.

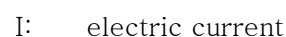
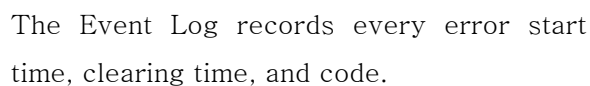
#### 5.1.7. History #1

Press **MENU** and **History** from the home screen to display History Data #1.



Data are logged once a second for the past 5 minutes and recorded in the non-volatile stack memory.

Press **Return** to go to the home screen.



I/P: input power

R/T: Run Time

D/L: DC Link

Use the following method to select the trend parameter.

Select item to see ( $\Delta P \sim D/L$ ).

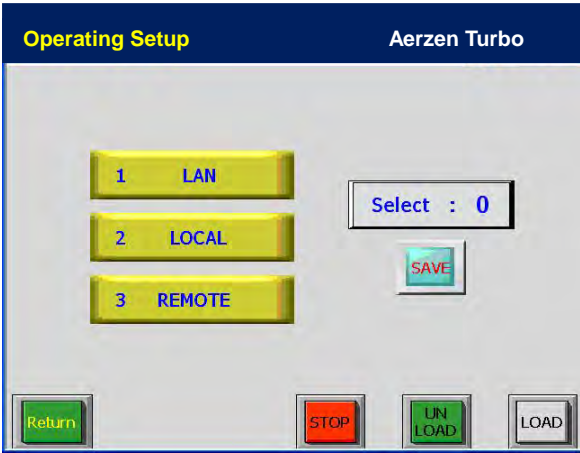


Input the maximum Y-value.

Press **O** in the above figure. Use numeric keypad to input the maximum Y value for the selected item, and press **Ent**.

#### 5.1.11 Setup of Control Method

Press **O** at the home screen to go to the operating setup screen.



Press **2 LOCAL** to change the current control location to LOCAL.

Verify “select” value becomes **Select 2** and press **SAVE**.

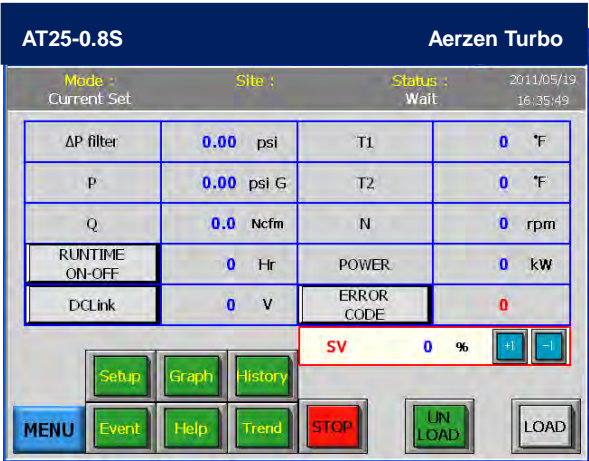
Press **Return** to go to the home screen.

#### 5.1.12. Model Selection

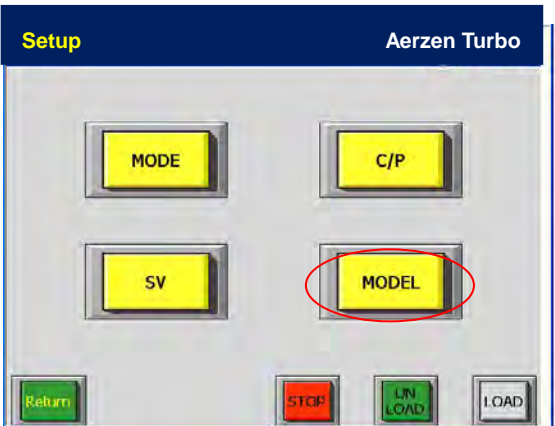
This is the part of control parameter area. No change is recommended.



Press menu at the home screen to go to the model selection screen.



There are 6 sub menus. Press Setup for model selection.

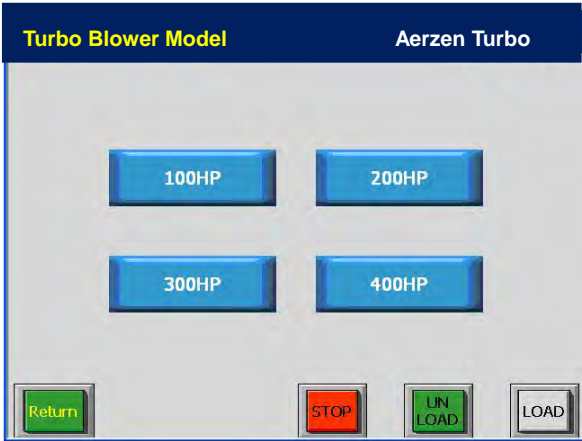


Press **O** for model selection.

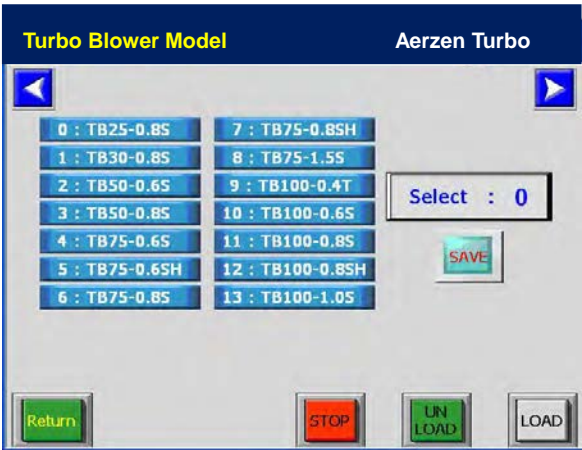


Pop-up screen for PIN.  
Press appropriate PIN for proceed.

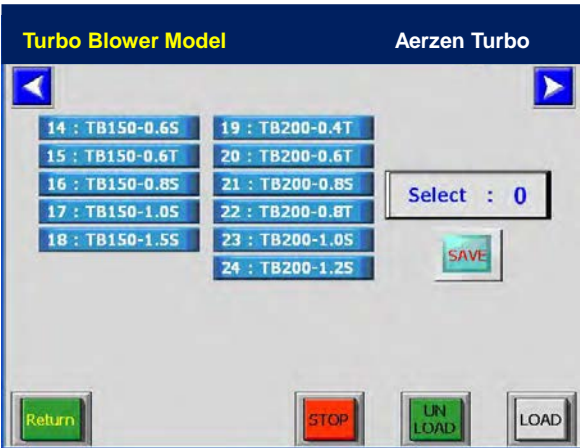
- Model selection screen 1 -



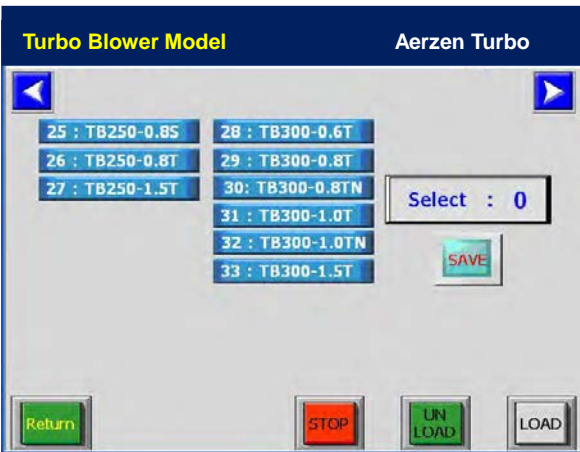
- Model selection screen 2 -



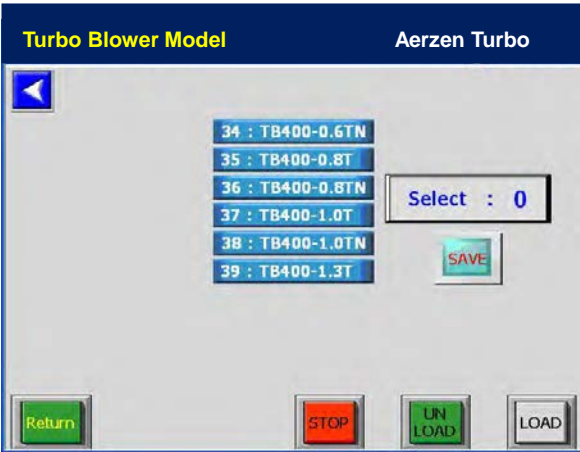
- Model selection screen 3 -



- Model selection screen 4 -



- Model selection screen 5 -



Select the appropriate value, and press **SAVE** **Return**

### 5.1.13. Error Code Table

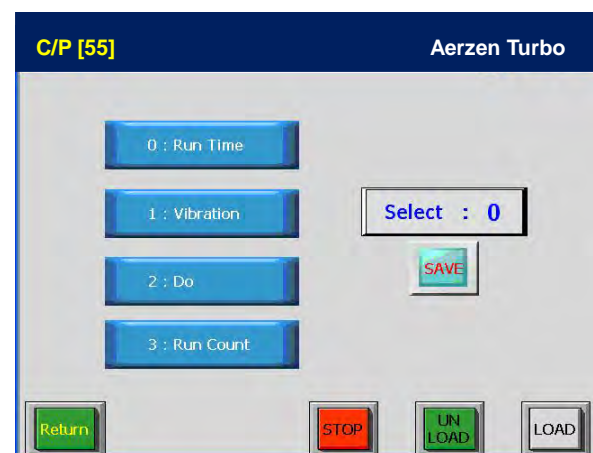
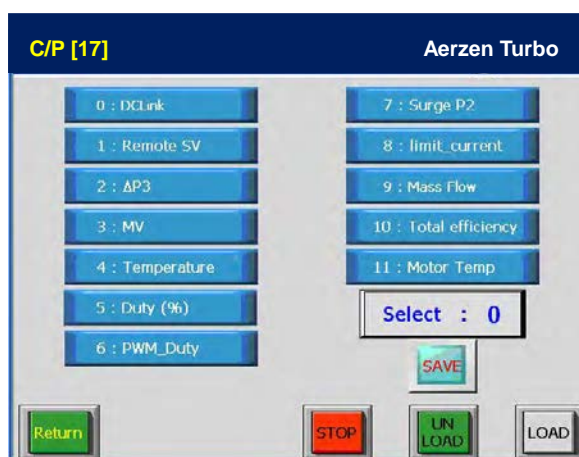
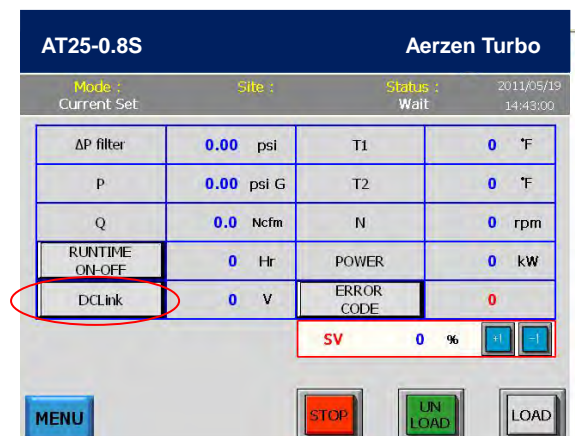
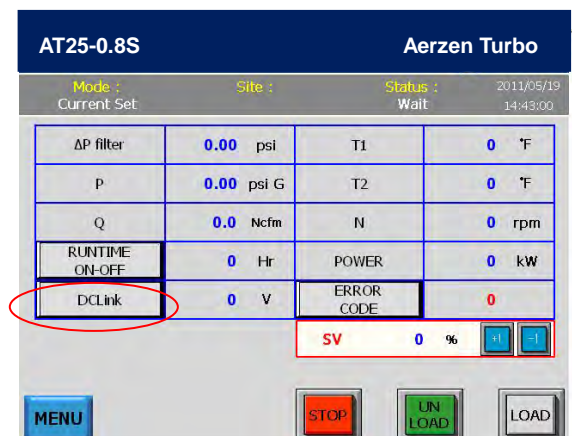
Press **O** in the next figure to display ERROR TABLE. See Chapter 7 for error details.



Press **O** to remove the ERROR TABLE.

### 5.1.14. About C/P[17]

Press **O** in the next figure to display items related to C/P[17].



- 0 : DC Link voltage (V)
- 1 : Remote SV (0-100%)
- 2 : differential pressure (Pa)
- 3 : motor input voltage (V)
- 4 : magnet temperature (°C)
- 5 : Duty\_ratio(%)
- 6 : pwm\_duty
- 7 : surge discharge pressure (kPa)
- 8 : limit current
- 9 : maximum ppm on DO control

#### 5.1.15. About C/P[55]

Press **O** in the next figure to display items related to C/P[55].

- 0 : Run Time(Hr)
- 1 : Vibration(0-100%)
- 2 : DO values (ppm)
- 3 : Run count (times)

#### 5.1.16. HELP


The HELP screen shows the contact information of Aerzen Turbo Co., Ltd.

5.1.17. START and STOP the machine.

5.1.17.1. Turn on the electric power and verify the LCD displays.


5.1.17.2. Make sure that the selected operating MODE is suitable for your plant.

5.1.17.3. The status displays “READY” means that the system is ready for normal operation. But if the status displays “wait” means that the system is still working for ready of operation thus, wait until status indicates “READY”.

5.1.17.4. After the status display “READY”, You can touch the  button once means that the system start to charging the capacitor and after several second the machine shall start to rotate.


5.1.17.5. Check the machine’s status which is any abnormal sound or vibration.

5.1.17.6. The blower will perform unloading operations at 10,000~15,000 rpm. At the moment, the machine exhausted the compressed air to atmosphere through the blow off valve (BOV).

5.1.17.7. After get the stable operation around 1 minute, the system is ready to put the load, therefore you can touch the  button in the case of LOCAL operation mode. When in the REMOTE or LAN control mode the “LOAD” and “UNLOAD” commands are follow through the SCADA system.

5.1.17.8. After the blower has been loaded the speed and power are increased to meet the Pre-set SV. After the machine ramps-up to SV amount (determined at startup) the BOV will be closed automatically. Check the system status and record the operating status for your future reference.

5.1.17.9. See Section 5.1.3. to modify the SV.

5.1.17.10. If you want to stop the machine, simply touch the  sign on the screen to stop the blower. The blower will immediately open the BOV valve and ramp-down the speed until preset amount which is the 10,000~15,000.

The blower will keep running for an additional 3~5 minutes to cool-down the system.

5.1.17.11. After complete shut down the blower should not be restarted until the DC link voltage drops below 70V. This takes approximately 2~10 minutes.

## 5.2. Remote Operation

Aerzen Turbo Co., Ltd. blowers can be operated remotely with a relay CONTACT and analog signals.

### 5.2.1. Signals

Remote control is achieved through terminal block (TB4) located in the control Panel. Figure 5-3 shows the inputs and outputs available at TB4.

Signal	Contact	Comment
READY	#10, #11	“ON” when READY (2A)
RUN	#12, #13	“ON” when RUN (2A)
LOAD	#14, #15	“ON” during load operation (2A)
ALARM	#16, #17	“ON” when ALARM takes place (2A)
ERROR	#18, #19	“ON” when ERROR takes place (2A)
POWER	#17, #18	“ON” when control power is “ON” (2A)
START/STOP	#20, #21	INPUT, RELAY open (ON), close (OFF)
SV (set value)	#24, #25	INPUT, Set mode of operation 4~20mA input
PV (present value)	#26, #27	OUTPUT, present flow/current/rpm 4~20mA output
Load/Unload	#28, #29	Open (Unload), Close(Load)

Table 5-3 Customer connection point descriptions

#### 5.2.1.1. Remote Ready

If the operational mode is set to "REMOTE" at the LCD panel and there are no error signals at the blower, then the Remote Ready relay contact will be “CLOSED”. If there is an error or fault in the blower or the blower has a “STOP” status, the Remote Ready relay will be “OPEN”.

#### 5.2.1.2. Unload

Unload signal is "ON" if the blower is in operation.

#### 5.2.1.3. START/STOP



The relay status is "CLOSED (ON)" for run and "OPEN (OFF)" for stop.

#### 5.2.1.4. SV (set-point value)

An analog input signal from MCP or equivalent unit which is 4~20mA can be control the operating amount of air volume or % of amperage.

#### 5.2.1.5. PV (present value)

An Analog output signal from the blower (4~20mA) is available to use the SCADA system as present value of the machine which is flow, current, pressure, or DO.

#### 5.2.1.6. ALARM

Whenever the blower's operating condition reaches to warning level, then the coil energize and throw the signal to the circuit.

#### 5.2.1.7. ERROR

The relay status is closed (ON) when an error occurs and the unit will shut down the machine.

#### 5.2.1.8. POWER

The relay status is "OPEN" when power is disconnected and "CLOSED" when power is connected.

#### 5.2.1.9. LOAD

The relay status is "OPEN" during unload operations and "CLOSED" during load operations.

#### 5.2.2. Procedures for remote control

The signal for "Start" can be enabled only if the signal for "Remote Ready" is ON. The blower normally stops if the start signal is OFF, and emergency stops if an error occurs. When the blower stops, signals for "Remote Ready" and "Normal Operation" are all OFF. Restart is possible after the unit has been stopped for at least 20.

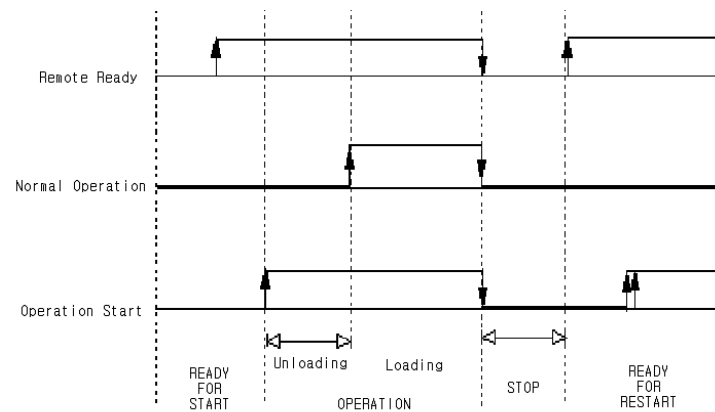


Figure 5-4. Procedures for Remote Control

5.2.2.1. Set operating mode to "REMOTE" using the LCD display on the blower front panel.

5.2.2.2. Verify that the signal for "Remote Ready" is ON (relay "CLOSED").

5.2.2.3. Turn on the blower by making the signal for "Operational Start" ON. (See chapter 4)

5.2.2.4. Verify that the signal for "Normal Operation" is ON (relay CLOSED).

5.2.2.5. Shut down the blower by making the signal for "Operation start" OFF.

5.2.2.6. More than 2 minutes may be necessary before restarting the blower after it has been shut down. The required time delay varies from model to model. During this time all signals are OFF (relays "OPEN").

## 5.3. LAN Operation

Aerzen Turbo Co., Ltd. blower equipped COMMUNICATION module which is capable to communicate with plant PLC or SCADA system.

### 5.3.1. MODBUS Communication protocol

MODBUS protocol that is commonly used as universal MODBUS protocol supports traditional and recently developed RS232/RS485/RS422 device also supports Ethernet devices. Therefore, most industrial devices (PLC, DCS, HMI, instrumentation, etc.) using MODBUS communications as standard and is the situation. Our equipment also RS422 (4 wire) or RS485 (2 wire) using the MODBUS RTU protocol and also to use the Ethernet link to support the MODBUS TCP protocol.

### 5.3.2. Communication module set-up

Run “ezConfig.exe”, and click the “PROBE” button. If there is no problem with the network you will see a dialog box named “ezConfig – exTCP” displaying “LOCAL IP ADDRESS” at the top. If you do not receive this dialog box the procedure failed and you will need to repair the LAN problem and rerun the file.



Figure 5-6. ezConfig.exe

5.3.2.1 Input communication data into the dialog box. Make sure do not write the same address into the clients and the server column.

LOCAL IP ADDRESS	IP address of the client (blower)
------------------	-----------------------------------

SUBNET MASK	Subnet address of host computer
GATEWAY	Gateway of host computer
NAME SERVER	Inactive dialog box (0.0.0.0)
NAT IP ADDRESS	Inactive dialog box (0.0.0.0)
PEER IP ADDRESS	IP address of host computer
BAUD RATE	19200
PARITY	NONE
MUX TYPE	Inactive dialog box, COD(2)
LOCAL PORT	Inactive dialog box (0)
WATER MARK	Inactive dialog box (1)
PASSWORD	Inactive dialog box
DATA BITS	8
FLOW CTRL	NONE
TIME OUT	50
PEER PORT	Connection key number(10000 ~ 10007) (connect client NO. 1 ~ NO. 8, each)

Table 5-4. Communication Data



Figure 5-7. Connection of LAN Cable to Our Blower

## 6. Preventative Maintenance

### 6.1. Matters which should be always reminded

6.1.1. Check regularly to ensure cooling fans are operating normally.

6.1.2. Do not disassemble or reassemble blowers without permission from Aerzen Turbo technicians. Repair costs as a result of unauthorized assembly or disassembly will not be covered under warranty.

6.1.3. If abnormal operation is observed shut the blower down and contact the Aerzen Turbo technician for assistance. In the event of a blower failure and automatic shut down, record the three digits Error Code and contact a Aerzen Turbo technician prior to restarting the blower.

### 6.2. Maintenance Schedule

Maintenance schedule may differ depending on blower room condition. Under the severely dirty condition, make sure the maintenance schedule.

#### 6.2.1. Inverter

No.	Part name	Period of inspection	Check point	Recommended Replacement period
1	CON./INV. Drive board	Once a year	Damage for heat	3 years
2	CON./INV. IGBT	Once a year	Resistance, function	1 decade
3	Diode (SCR)	Once a year	Resistance, function	1 decade
4	Cooling fan	Twice a year	Cleaning Blade	2 years
5	DC reactor	Once a year	Measure L value	1 decade
6	Motor control board	Once a year	Inspect the function	5 years
7	Soft starter board	Once a year	Inspect the function	5 years
8	Power capacitor	3 times a year	Inspect the capacity	5 years
9	Film capacitor	3 times a year	Inspect the capacity	5 years
10	Control power transformer	Once a year	Measure the output current	10 years

## 6.2.2. Motor

No.	Part name	Check point	Recommended overhaul cycle	Remark
1	Motor Overhaul	insulation resistance	Once a year	Since 2 years after operation
		Stator re-winding	3 to 5 years	Determine after the inspection for the insulation resistance and withstanding voltage
		Impellor and airo cleaning	3 to 5 years	
		Rust removal on the frame, re-plating	3 to 5 years	
		Thrust bearing	3 to 5 years	Determine after the disassemble
		Radial bearing	3 to 5 years	Determine after the disassemble

※ Major overhaul for Motor is recommended between 3 to 5 years.

## 6.2.3. Control panel

No.	Part name	Period of inspection	Check point	Recommended replacement cycle
1	I/O Board	Once a year	IO testing and correction	5 years
2	VT Board	Once a year	IO testing	5 years
3	TEMP. Sensor	Once a year	Testing and correction	1 decade
4	Pressure Sensor	Once a year	Testing and correction	1 decade
5	CPU Board	Once a year	Operation test	5 years
6	Communication card	Once a year	Operation test	5 years
7	Signal isolator	Once a year	IO testing	1 decade
8	Touch Display unit	Once a year	Operation test	1 decade
9	LCD Display unit	Once a year	Operation test	5 years
10	Control panel	Once a year	Operation test	1 decade



## 6.2.4. Filter replacement

No.	Part name	Period of inspection	Check point	Recommended replacement cycle
1	Filter for compressor	Once a month	Depending on the condition	In case if severely dirty /3 to 6 months
2	Check valve	Once a year	Depending of leakage	In case if leakage occurred/3 years

## 7. Error Code

### 7.1. Fail before operation

NO.	FAULT	CAUSE	INSPECTION/MAINTENANCE
1	Pressure sensor	DP1 > 5 kPa DP2 > 5 kPa P2 > 70 kPa	Change sensor / controller
2	Temp sensor	T1 > 100 °C or T2 > 150 °C	Change sensor / controller
4	DCL	DCL > 700V	Check VFD, change controller
16	VFD	VFD error	Check VFD, change controller
17	Fan VFD fault	Fan VFD error	Check Fan VFD, change controller
32	VFD cooling	Temp switch "ON" of VFD	Check VFD, controller
64	speed	RPM > 10000	Change VFD driver, CPU

### 7.2. Warning during operation

NO.	WARNING	CAUSE	INSPECTION/MAINTENANCE	C/P
101	Filter blockage	DP1 > CP value	Clean/change filter Check controller and CP value	28
102	high T2	T2 > CP value	Check temp sensor, controller, operating condition	29
103	high T1	T1 > CP value	Check temp sensor, controller, operating condition	30
104	high P2	P2 > CP value * 0.98	Check operating condition	9
105	High speed	Speed > CP value * 0.98	Check operating condition	14
106	Surge	flow < surge flow + CP	Check operating condition, CP value	18
110	High magnet temp.	Magnet temp > 280°C	Check motor, CP value	75 83
111	High duty	Duty > 90%	Check motor voltage, CP value	83
113	High VFD temp	VFD temp > cp[11]*0.95	Check ambient & VFD temperature	11
114	Low SV	SV > 10%	Check SV value and corresponding wiring	
126	High motor temp	Motor temperature > 180 °C	Check motor cooling	

### 7.3. Fail during operation

NO.	FAULT	CAUSE	INSPECTION/MAINTENANCE	C/P	tripping pattern
201	Filter blockage	$\Delta p$ at filter > CP Value	Clean/change filter Check controller and CP value	8	Idling stop
202	P2 Limit	$P2 > CP$ Value	Check operating condition	9	stop
204	Current Limit	Current > CP Value	Check operating condition, CP value	15	Idling stop
205	Low DC Link	$DCL < CP$ Value	Check VFD, controller, CP value	12	stop
206	High DC Link	$DCL > CP$ Value	Check VFD, controller, CP value	13	stop
207	Over speed	$RPM > CP$ Value	Check operating condition, out of synchronization, CP value	14	stop
210	Inverter problem	Error signal from inverter	Check inverter		stop
211	Inverter Overheat	Overheat of heat sink	Check job site, fan motion, operating condition		stop
214	Start	Fail on DCL rise within time	Check charging status, controller, wiring		stop
215	Start	Below 10000 rpm after start	Check motor, VFD, CP value	1	stop
216	Start	No movement	Check motor, VFD		stop
220	Cooling Fan	No action of cooling fan or MC	Check MC2, wiring		stop
221	Motor	Speed < 9000 rpm	Check motor and CP value	1	stop
222	T1 Limit	$T1 > CP$ Value	Check job site, operating condition, controller, T1 sensor, and CP value	10	Idling stop
223	BOV	Not closed	Check job site and CP value	44, 45	
224	surge	Surge	Check job site, operating condition, and CP value	64 ~67	stop
225	Real time surge	Real time surge	Check job site and CP value	44	Stop
230	Switching error	Manual stop at remote control	Check job site and controller		Idling Stop
236	Emergency stop	Touch screen version only	Press emergency stop button		Stop
238	Motor winding temp. high	Motor temp > 200°C	Checking cooling system		Stop
239	AC power fail	Utility power interrupted	Check utility power		Stop
240	Bearing fault	Failed motor bearing	Check bearing		Stop
250	High VFD intake temperature	VFD inlet temp > cp[11]	Check ambient & VFD temperature	11	Idling Stop
255	EEPROM	Cannot be read from EEPROM	Change CPU		Stop

## 7.4. Fan VFD & Motor Error

NO.	WARNING	CAUSE	INSPECTION/MAINTENANCE	C/P
127	Motor Temo High Warning	Over 180℃	Check cooling status	
241	Motor Fail Trip	After starting, RPM<8,000	Check motor status	
242	VFD DCL Low trip	DCL < C/P 12	Check input voltage or CP12	12
243	VFD DCL High Trip	DCL > C/P13	Check input voltage or CP13	13
244	Motor starting Fail Trip	In 3 Min, RPM < 5,000	Check motor status	
245	Motor Temp high Trip	Over 200℃	Fix cooling part	
246	VFD Fault Trip	Fan VFD trip	Check VFD	

## **1.2.2 iPower Solutions - Main Blower Switchboard - MBSB**

# i.Power Solutions Moducell IOM Manual

Maximum Safety  
High Reliability Low Voltage Modular Switchgear  
Power Distribution and Motor Control



  
**Lend Lease**

## i.Power Solutions Moducell v2.2 IOM Manual

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## i.Power Solutions Moducell v2.2 IOM Manual

### 1 INTRODUCTION



The **MODUCELL v2.2** is a fully metal clad low voltage switchgear solution incorporating a modular construction for electrical distribution and motor control applications.

The **MODUCELL v2.2** is modelled on its predecessor, the popular and widely accepted MODUCELL V2, with many new features and options being designed into the new **v2.2** to enhance flexibility, improve quality and offer additional value for money to end users.

i.Power Solutions has markedly improved the flexibility of selection with a wide range of module and tier configurations. The range and size of the various plug-in, de-mountable modules offers an infinite selection ensuring customising comes with flexibility to meet specific customer requirements.

The adaptability of the switchboard in offering either a top, centre or bottom horizontal busbar chamber and the rigidity of the 2.0mm sheet steel structural frame allowing the options for both bottom and/or top cable entry, sets an industry benchmark in low voltage switchgear design. This is offered in both single-sided and double-sided tier configurations.

Equipment interfacing is performed with compartment doors closed which eliminates the possibility of electric shock from live exposed conductors. Optional features available provide safety to operators in the event of an internal arcing fault. Arc baffles prevent door mounted equipment becoming dislodged potentially causing injury to operators. This feature is a unique development which enhances the safety of the LV switchgear above and beyond the requirements of Australian and international Standards.

In-built arc fault chimneys are designed into the tiers to ensure ionised gases are vented out through a pressure relief vent and safely away from operators in the unlikely event of an internal arc fault occurring within a particular drive / feeder functional unit during operation.

The **MODUCELL v2.2** is designed and manufactured by i.Power solutions to Australian and international standards.

## i.Power Solutions Moducell v2.2 IOM Manual

### 2 Warnings

#### Isolation



Always disconnect all electricity supplies prior to working on electrical plant. Safeguard the plant from being started accidentally. Otherwise, there will be danger to life

#### Caution



The equipment covered in this manual must be installed, operated and maintained by qualified persons who are thoroughly trained and who understand any hazards that may be involved.

## i.Power Solutions Moducell v2.2 IOM Manual

### 3 TECHNICAL SPECIFICATIONS (MODUCELL V2.2 SERIES SWITCHBOARD AND MOTOR CONTROL CENTRE)

MODUCELL v2.2 Series has been type tested in accordance with the requirements of AS/NZS 3439.1:2002 "Low Voltage Switchgear and Controlgear Assemblies – Part 1: Type-tested and Partially Type-tested Assemblies"

Type Tests have been conducted at:

- Testing & Certification Australia (TCA), Sydney Australia.
- Safety in Mines Testing & Research Station (SIMTARS), Brisbane Australia. (IP Testing only)
- Institut Prüffeld für elektrische Hochleistungstechnik GmbH (IPH), Berlin Germany.

Type tests conducted in Australia are NATA Certified, and Type tests conducted in Germany are ASTA Certified

#### 3.1 Fault rating

The MODUCELL v2.2 Series is rated for the following fault capacities:

- 50kA for 1 second on vertical busbar system
- 63kA for 1 second on vertical busbar systems
- 80kA for 1 second on both horizontal and vertical busbar systems
- 100kA for 1 second on both horizontal and vertical busbar systems

#### 3.2 Rated operational voltage ( $U_e$ )

The MODUCELL v2.2 Series is tested for connection to and operation at a Rated Operational Voltage ( $U_e$ ) of 1000V +10%/-6% three phase 50Hz.

#### 3.3 Rated insulation voltage ( $U_i$ )

The MODUCELL v2.2 Series is tested for operation at a Rated Insulation Voltage ( $U_i$ ) of 1000V +10%/-6%.

#### 3.4 Rated impulse withstand voltage ( $U_{imp}$ )

The MODUCELL v2.2 Series has a Rated Impulse Withstand Voltage ( $U_{imp}$ ) of 12kV.

#### 3.5 Rated operational current

The following standard busbars arrangements and ratings are based upon an ambient temperature of 35°C with an allowable temperature rise of 60°C. These ratings have been developed either by test or by extrapolation of test results.

##### Main Horizontal Busbar System

- |         |  |
|---------|--|
| • 1250A | 1 x 80 x 10mm HDHC natural copper busbar                     |
| • 1600A | 1 x 120 x 10mm HDHC natural copper busbar                    |
| • 2000A | 2 x 80 x 10mm HDHC natural copper busbar                     |
| • 2275A | 2 x 100 x 10mm HDHC natural copper busbar                    |
| • 2750A | 2 x 120 x 10mm HDHC natural copper busbar                    |
| • 3000A | 3 x 100 x 10mm HDHC natural copper busbar                    |
| • 3500A | 3 x 120 x 10mm HDHC natural copper busbar                    |
| • 4000A | 2 parallel sets of 2 x 100 x 10mm HDHC natural copper busbar |
| • 5000A | 2 parallel sets of 2 x 120 x 10mm HDHC natural copper busbar |

##### Vertical Dropper Busbar System

- |         |  |
|---------|--|
| • 625A  | 1 x 50 x 6.3mm HDHC tinned copper busbar |
| • 750A  | 1 x 63 x 6.3mm HDHC tinned copper busbar |
| • 950A  | 1 x 80 x 6.3mm HDHC tinned copper busbar |
| • 1150A | 1 x 80 x 10mm HDHC tinned copper busbar  |

## i.Power Solutions Moducell v2.2 IOM Manual

### 3.6 Form of internal separation

The standard Form of Separation for the MODUCCELL v2.2 in accordance with AS/NZS 3439.1:2002 is Form 4a. Panels can however be configured for other Forms of Separation as required.

### 3.7 Degree of protection

The MODUCCELL v2.2 Series has been tested for operation at IP54 and IP66. IP42 is also available as an option.

### 3.8 Creepage and clearance distances

The MODUCCELL v2.2 Series has been tested for compliance for Creepage and Clearance distances at  $U_i=1000V$  &  $U_{imp}=1000V$  for a Material Group of II and a Pollution Degree of 3.

### 3.9 Effectiveness of protective circuit

The effective connection between exposed conductive parts and the protective circuit have been verified to comply.

### 3.10 Increased Security against the occurrence or the effects of internal arcing faults

When required, the MODUCCELL v2.2 Series can be manufactured to ensure increased operator safety in the event of an internal arcing fault.

The MODUCCELL v2.2 Series has undergone extensive testing of outgoing functional units in accordance with Annex ZD of AS/NZS 3439.1:2002. In addition, further testing has been completed on the main busbar and incoming air circuit breaker assemblies to verify them as a Fault Free Zone.

Note: These features are optional and must be specified by the customer at time of quote.

## i.Power Solutions Moducell v2.2 IOM Manual

### 4 TYPE TESTING

Exhaustive type testing has and is being completed in accordance with AS/NZS 3439.1:2002 to ensure that the MODUCELL v2.2 Series of Switchboard & Motor Control Centres remains at the forefront of the Low Voltage marketplace. A detailed Summary of Type Testing can be found below along with copies of relevant certificates.

		A	B	C1	C2	C3	C4	D	E	F	G	H1	H2	H3	H4	I
Type Test Reports	<a href="#">TR 102630</a>	✓														
	<a href="#">TR 103014</a>	✓														
	<a href="#">TR 103012</a>	✓														
	<a href="#">TR 102087</a>		✓						✓							
	<a href="#">TR 102578</a>		✓	✓	✓			✓								✓
	<a href="#">TR 102652</a>		✓			✓		✓	✓	✓						
	<a href="#">TR 102943</a>		✓				✓	✓								
	<a href="#">TR 102087</a>			✓	✓	✓	✓	✓								
	<a href="#">TR 102820</a>					✓		✓								
	<a href="#">TR 102918</a>			✓	✓		✓	✓								
	<a href="#">TR 103273</a>						✓									
	<a href="#">TR NE05-0038</a>										✓					
	<a href="#">TR NE06-0048</a>										✓					
	<a href="#">TR 103014</a>										✓					
	<a href="#">TR 102224</a>											✓	✓			
	<a href="#">TR 2767.0007.7.400</a>													✓		
	<a href="#">TR 2767.0007.7.620</a>													✓		
	<a href="#">TR 103019</a>												✓		✓	
	<a href="#">TR 103111</a>												✓		✓	
	<a href="#">TR 103157</a>												✓		✓	

Column	AS3439.1-2002	Type Test Description
A	8.2.1	Temperature-rise limits
B	8.2.2	Dielectric properties
C1	8.2.3	50kA Short-circuit withstand strength
C2	8.2.3	63kA Short-circuit withstand strength
C3	8.2.3	80kA Short-circuit withstand strength
C4	8.2.3	100kA Short-circuit withstand strength
D	8.2.4	Effectiveness of the protective circuit
E	8.2.5	Clearances and creepage distances
F	8.2.6	Mechanical operation
G	8.2.7	Degree of protection and internal separation
H1	Annex ZC/ZD	Standard 50kA Increased security against the effects of internal arcing
H2	Annex ZC/ZD	Standard 63kA Increased security against the effects of internal arcing
H3	Annex ZC/ZD	Standard 80kA Increased security against the effects of internal arcing
H4	Annex ZC/ZD	Special Tests 60kA/0.1/0.3s Increased security against the effects of internal arcing
I	IEC 60439.1 - 2004	Resistance of Insulating Materials to Abnormal Heat and Fire (Glow Wire Test)

## i.Power Solutions Moducell v2.2 IOM Manual

 <b>Testing &amp; Certification Australia</b>	
<h1 style="text-align: center;">Certificate</h1>	
<b>of Short-circuit Rating</b>	<b>Number 102087</b>
<b>Apparatus</b>	The main horizontal phase-to-phase system, three vertical phase-to-phase systems, one vertical phase-to-line, neutral-to-phase system and two horizontal mutual line arrangements of 0-1000 V / 1000 V / 10 kV / (U <sub>0</sub> -U <sub>1</sub> -U <sub>2</sub> ) 50 Hz low-voltage assembly
<b>Designation</b>	M3JUCILL 72
<b>Manufacturer</b>	1 Power Solutions Pty Ltd 55 Gosport Street, Hermon QLD 4774 Australia
<b>Client</b>	1 Power Solutions Pty Ltd 55 Gosport Street, Hermon QLD 4774 Australia
<b>Dates of Tests</b>	20 December 2002 to 22 February 2003
<p>The apparatus, constructed to AS/MAS standards, has been developed to photographically reproduce in this Certificate, the test results achieved by the apparatus in accordance with AS/NZS 3438:1-2002, Clauses 8.2.2, 4.2.3 and 8.2.6.</p> <p>The results are shown in the test reports and test summary, in limited details. The full unexpedited and full expedited test reports are available on request and may be obtained by e-mail or by direct telephone contact. The full report is being supplied by electronic means only.</p>	
<p>For ratings assigned by the manufacturer and printed by the test report page 1.</p>	
<p>The apparatus reproduced the following test results which, for short-circuit rating assessment, have been accepted as valid test results for the purpose of this Certificate. The test results are valid for the purpose of this Certificate for the period of validity of this Certificate. The test results are valid for the purpose of this Certificate for the period of validity of this Certificate.</p>	
<p>The Certificate comprises 25 pages, 2 appendices, 16 photographs, 23 photographs and 1 drawing.</p>	
<div style="display: flex; justify-content: space-between;"> <div>   M. A. Carroll  Test Engineer </div> <div>   M. A. Carroll  Test Engineer </div> </div>	
<div style="display: flex; justify-content: space-between;"> <div>   M. A. Carroll  Test Engineer </div> <div>   M. A. Carroll  Test Engineer </div> </div>	
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<div style="display: flex; justify-content: space-between;"> <div>   M. A. Carroll  Test Engineer </div> <div>   M. A. Carroll  Test Engineer </div> </div>	
<div style="display: flex; justify-content: space-between;"> <div>   M. A. Carroll  Test Engineer </div> <div>   M. A</div></div>	

## Test Record

Laboratory Reference No.: 162087

Testing &  
Certification  
Australia

### RAIINGS ASSIGNED BY THE MANUFACTURER AND PROVED BY THE TESTS

#### Dielectric properties (Clause 8.2.2)

Rated operating voltage (V <sub>0</sub> )	1100 V
Rated insulation voltage (kV)	1200 V
Rated impulse withstand voltage	12 kV

#### Short-circuit withstand strength (Clause 8.2.3)

##### Rated peak and short-time withstand current (Clause 8.2.3.2.1b)

###### Horizontal phase busbars

1) - 80 mm x 12 mm solid copper bar	120 kA rms for 1 s, 120 kA peak 90 kA rms for 1 s, 170 kA peak 100 kA rms for 1 s, 220 kA peak
-------------------------------------	--

###### Vertical phase busbars

T or T1) - 45 mm x 6.3 mm lined copper bar	60 kA rms for 1 s, 120 kA peak
T or T1) - 60 mm x 6.3 mm lined copper bar	80 kA rms for 1 s, 170 kA peak

###### Ter 2) - 80 mm x 6.3 mm lined copper bar

60 kA rms for 1 s, 120 kA peak 80 kA rms for 1 s, 170 kA peak
--

###### Ter 3) - 80 mm x 6.3 mm lined copper bar

60 kA rms for 1 s, 105 kA peak
--------------------------------

##### Rated peak and short time withstand current (Clause 8.2.3.2.3 d)

###### Horizontal neutral busbar (1 universal solid vertical bar)

1) - 80 mm x 10 mm solid copper bar	50 kA rms for 1 s, 105 kA peak 60 kA rms for 1 s, 132 kA peak
-------------------------------------	--

###### Vertical neutral busbar

Ter 2) - 40 mm x 6.3 mm lined copper bar	50 kA rms for 1 s, 105 kA peak
--	--------------------------------

##### Clearence and creepage distances (Clause 8.2.5)

Verified

M. A. Carroodi  
NATA Signatory

Page 1 of 29

[illegible]

<b>Simlars</b> <b>Engineering, Testing and Certification Centre</b>		Phone: +61 7 3510 6000 Fax: +61 7 3510 6006
2 South Street, PTMWAY, CA 17 0001, AUSTRALIA Postal Address: PO Box 452, Glenvale, QLD, 4300 Australia		
<b>Test Report</b>		
<b>AS 60529 - 2004</b> <b>IEC 60529 - Ed 2.1:2004</b>	<b>Degrees of Protection provided by enclosures (IP Code)</b>	
Report No.:	MEG0009	
Date of Issue:	01 May 2006	
Job No.:	053071	
Applicant/Customer Name:	U-Tower Solutions Pty Ltd 55 Glasgow Street NORMANT QLD 4174	
Equipment Details:	Zinc coated mild steel enclosure types STD-016 and STD-019	
Ambient Temperature:	+27°C to +30°C	
Degree of Protection:	IP54 for enclosure type STD-016 IP55 for enclosure type STD-019	
<div style="display: flex; justify-content: space-between; align-items: flex-end;"> <div style="width: 45%;"> <p>Checked: <u><i>[Signature]</i></u> S. Pitt</p> </div> <div style="width: 45%; text-align: right;"> <p>Approved/Signatory: <u><i>[Signature]</i></u> J. Farmer</p> </div> </div>		
<div style="display: flex; align-items: center;"> <p style="font-size: small;">             This document is controlled by the National Association of Testing Authorities, Australia. This document has been              once performed in accordance with a scope of accreditation. This document is available for access, receipt and              use by the public for non-commercial purposes.           </p> </div>		
<div style="display: flex; justify-content: space-between;"> <span>EE0001 (Rev 04/04) 01/2005 06</span> <span>Page 1 of 2</span> </div>		

## i.Power Solutions Moducell v2.2 IOM Manual

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# ASTA TEST REPORT

Laboratory Ref. No. 2767.1244.7.620

Test Report No. 2798

**APPARATUS:**

Low-voltage switching assembly consisting of:  
 1 three-phase three-pole switch  
 1 three-phase circuit-breaker system  
 1 horizontal protective breaker  
 3 fusing modules

**DESIGNATION:**

Model: 92.2

**MANUFACTURER:**

Power Solutions Pty Ltd.  
 185 Glenroy Road  
 Kingsley Marine Parade  
 Marston Queensland 4170  
 AUSTRALIA

**TESTED BY:**

Ingolf A. Griebner, [ingolf.griebner@asta-ungarheim.at](mailto:ingolf.griebner@asta-ungarheim.at), GmbH  
 Sandberger Allee 373A  
 10807 Berlin, GERMANY

**DATE(S) OF TESTS:**

1 November 2007

The apparatus, submitted in accordance with the description, drawings and photographs incorporated in the test report, was tested in accordance with IEC 61812-1 and -2.

The test procedure and test parameters were stated as

ASTA 3433.1-2002.

During testing, test results were observed on-screen. Location of test was at rated operational voltage of 250 V AC and a prospective current of substantially > 250 mA.

**This is not a certificate of testing.**

A certificate of testing was not issued as this test is not a type test or a compulsory test.

The documents forming this Test Report are:

**Names of Drawing Types:**

Page 1 to 44

Diagram No.

101 8267, 102 8268, 103 5497, 104 6497, 105 6498

Diagram Ref. No.

1 to 16

Diagram Ref.

RM00012-1, 250V, RM0002-2-16, 0101, RM0002-16, 0102, RM0002-16, 0103, RM0002-16, 0104, RM0002-16, 0105, RM0002-16, 0106, RM0002-16, 0107, RM0002-16, 0108, RM0002-16, 0109, RM0002-16, 0110, RM0002-16, 0111, RM0002-16, 0112, RM0002-16, 0113, RM0002-16, 0114, RM0002-16, 0115, RM0002-16, 0116, RM0002-16, 0117, RM0002-16, 0118, RM0002-16, 0119, RM0002-16, 0120, RM0002-16, 0121, RM0002-16, 0122, RM0002-16, 0123, RM0002-16, 0124, RM0002-16, 0125, RM0002-16, 0126, RM0002-16, 0127, RM0002-16, 0128, RM0002-16, 0129, RM0002-16, 0130, RM0002-16, 0131, RM0002-16, 0132, RM0002-16, 0133, RM0002-16, 0134, RM0002-16, 0135, RM0002-16, 0136, RM0002-16, 0137, RM0002-16, 0138, RM0002-16, 0139, RM0002-16, 0140, RM0002-16, 0141, RM0002-16, 0142, RM0002-16, 0143, RM0002-16, 0144, RM0002-16, 0145, RM0002-16, 0146, RM0002-16, 0147, RM0002-16, 0148, RM0002-16, 0149, RM0002-16, 0150, RM0002-16, 0151, RM0002-16, 0152, RM0002-16, 0153, RM0002-16, 0154, RM0002-16, 0155, RM0002-16, 0156, RM0002-16, 0157, RM0002-16, 0158, RM0002-16, 0159, RM0002-16, 0160, RM0002-16, 0161, RM0002-16, 0162, RM0002-16, 0163, RM0002-16, 0164, RM0002-16, 0165, RM0002-16, 0166, RM0002-16, 0167, RM0002-16, 0168, RM0002-16, 0169, RM0002-16, 0170, RM0002-16, 0171, RM0002-16, 0172, RM0002-16, 0173, RM0002-16, 0174, RM0002-16, 0175, RM0002-16, 0176, RM0002-16, 0177, RM0002-16, 0178, RM0002-16, 0179, RM0002-16, 0180, RM0002-16, 0181, RM0002-16, 0182, RM0002-16, 0183, RM0002-16, 0184, RM0002-16, 0185, RM0002-16, 0186, RM0002-16, 0187, RM0002-16, 0188, RM0002-16, 0189, RM0002-16, 0190, RM0002-16, 0191, RM0002-16, 0192, RM0002-16, 0193, RM0002-16, 0194, RM0002-16, 0195, RM0002-16, 0196, RM0002-16, 0197, RM0002-16, 0198, RM0002-16, 0199, RM0002-16, 0200, RM0002-16, 0201, RM0002-16, 0202, RM0002-16, 0203, RM0002-16, 0204, RM0002-16, 0205, RM0002-16, 0206, RM0002-16, 0207, RM0002-16, 0208, RM0002-16, 0209, RM0002-16, 0210, RM0002-16, 0211, RM0002-16, 0212, RM0002-16, 0213, RM0002-16, 0214, RM0002-16, 0215, RM0002-16, 0216, RM0002-16, 0217, RM0002-16, 0218, RM0002-16, 0219, RM0002-16, 0220, RM0002-16, 0221, RM0002-16, 0222, RM0002-16, 0223, RM0002-16, 0224, RM0002-16, 0225, RM0002-16, 0226, RM0002-16, 0227, RM0002-16, 0228, RM0002-16, 0229, RM0002-16, 0230, RM0002-16, 0231, RM0002-16, 0232, RM0002-16, 0233, RM0002-16, 0234, RM0002-16, 0235, RM0002-16, 0236, RM0002-16, 0237, RM0002-16, 0238, RM0002-16, 0239, RM0002-16, 0240, RM0002-16, 0241, RM0002-16, 0242, RM0002-16, 0243, RM0002-16, 0244, RM0002-16, 0245, RM0002-16, 0246, RM0002-16, 0247, RM0002-16, 0248, RM0002-16, 0249, RM0002-16, 0250, RM0002-16, 0251, RM0002-16, 0252, RM0002-16, 0253, RM0002-16, 0254, RM0002-16, 0255, RM0002-16, 0256, RM0002-16, 0257, RM0002-16, 0258, RM0002-16, 0259, RM0002-16, 0260, RM0002-16, 0261, RM0002-16, 0262, RM0002-16, 0263, RM0002-16, 0264, RM0002-16, 0265, RM0002-16, 0266, RM0002-16, 0267, RM0002-16, 0268, RM0002-16, 0269, RM0002-16, 0270, RM0002-16, 0271, RM0002-16

[illegible]

## i.Power Solutions Moducell v2.2 IOM Manual

### 5 CONSTRUCTION & APPEARANCE

#### 5.1 Incoming functional units

Incoming Functional Units are designed to provide the operator with maximum safety during operation and maintenance. The standard design has 4 main sections that are segregated from each other.

- ✓ Functional Unit Main Switching Device
- ✓ Functional unit Instrumentation Section
- ✓ Busbar Zone
- ✓ Incoming Cable Connection Zone

The sectionalising of the panel allows the low voltage control terminals of the main switching device to be safely accessed without exposing operators to live busbars or connections.

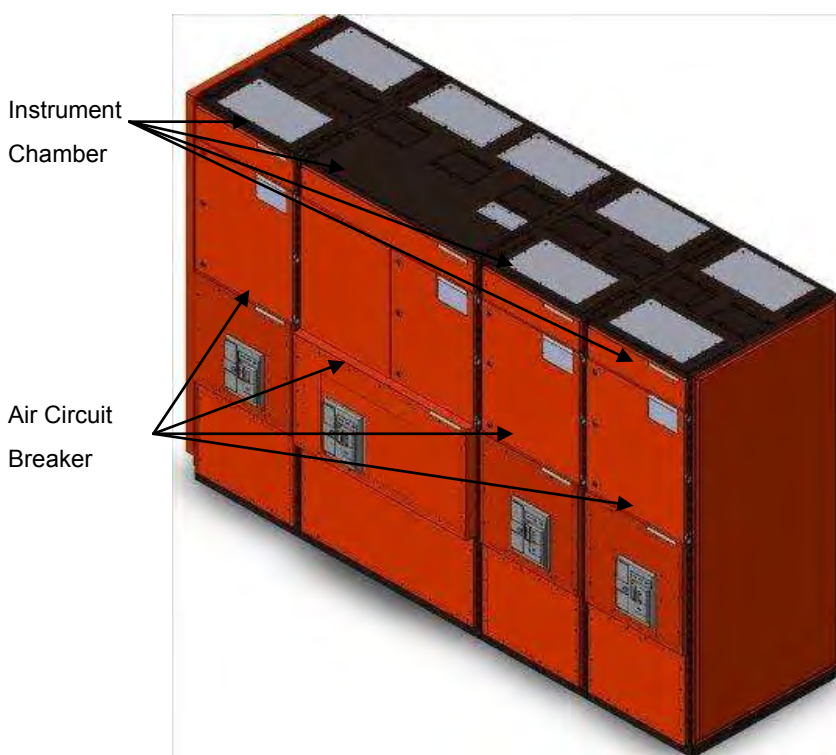
Incoming connections can be via gland plates situated in the top or bottom of the unit and can also be configured for direct connection onto propriety busduct systems to meet the project specific requirements.

Supply Authority metering sections can also be incorporated for connection to local or remote metering panels.

The modular design of the Incoming Functional Unit also allows it to be used effectively as an outgoing feeder for larger sub circuit supplies or larger motor start applications. The variations of available switch type, cable entry location and segregation make the design extremely flexible to suit any specific project requirements.

In addition to the typically used Air Circuit Breaker (ACB), a wide variety of other apparatus can be accommodated for incoming function units to suit the project application.

- ✓ Moulded Case Circuit Breaker (MCCB)
- ✓ Automatic Transfer Switch (ATS) applications
- ✓ Load Break Switch (LBS)
- ✓ Combination Fuse Switch (CFS)



This drawing depicts a typical suite of ACB panels. In these panels the incoming cable connection zone is at the bottom of the panel, the functional unit main switching device is in the middle and the instrumentation section is towards the top of the panel, the doors of which are secured closed using quarter turn locks with an 8mm square insert as standard. The uppermost cover provides access to a control wireway running through each panel.

## i.Power Solutions Moducell v2.2 IOM Manual

### 5.2 Outgoing functional units

The construction of the MODUCELL v2.2 is based on a plug in demountable technique. This technique ensures quality power and control connections are maintained throughout the service life of the switchgear.

Withdrawable techniques require special attention with respect to power and control connections that if unattended to can lead to potential hot spots within the switchgear and control assembly.

To ensure segregation between functional units and the dropper can assembly, metal cover plates are fitted at the front of the can assembly at every point except where the main circuit connections are located.

At these points a spring loaded safety shutter assembly is available as an option to provide additional safety during removal/replacement of a module while the arrangement is still live.

All operations and equipment interfacing are performed with the module door closed and interlocked with the switching device.

The modules can be designed for distribution and/or motor control in either a 3 pole or 4 pole arrangement and can be designed using conventional technology or intelligent type microprocessor based relay systems.

A wide variety of apparatus can be installed into the modules which can be designed to suit any specific project requirements.

- ✓ Distribution
- ✓ Motor Control
- ✓ MCCB
- ✓ CFS
- ✓ Conventional TOL
- ✓ Intelligent Systems
- ✓ VSD Systems
- ✓ Soft Starter
- ✓ Automatic Transfer Switch
- ✓ Live Line Indicator modules for easy and safe verification of isolation of all phases



This drawing depicts a typical suite of standard functional unit tiers. A variety of combinations and permutations are available to suit the specific requirements of the customer.

## i.Power Solutions Moducell v2.2 IOM Manual

Module sizes range from 02 to 18 inclusive with a height increment of 60mm. All functional units are provided with a door, module, module divider, carrier plate and vertical busbar blanking plate. All spare space modules are provided with a full un-punched door and vertical busbar blanking plate. All doors are secured closed using quarter turn locks with an 8mm square insert as standard.

### Flexible module configuration

The modules are of the demountable configuration and provided with a suitably rated 3 or 4 pole busbar plug which plugs onto the vertical busbar dropper assembly for the power connections, whilst control connections are normally wired to terminals within the adjacent cable zone. Pluggable connections for the control wiring from within the modules to the cable zone terminals can be also be provided as an option to facilitate changeover of modules without having to disconnect control wiring.

### Easy access cable entry

For standard form 4a segregated assemblies, the outgoing power cable terminations are made within the functional unit with the cables entering either directly into the functional unit via the top or bottom module gland plate. (For those modules located at the very top or bottom of the tier) For units located throughout the middle of the tier assembly, cable entry to the functional unit is via the vertical cable zone through a 65mm diameter nylon dome plug fitted to the side of the module. This plug is drilled to suit the diameter of the power cable. Cable entry to the cable zone is via gland plates located at the top and bottom of the tier.

### Module earthing

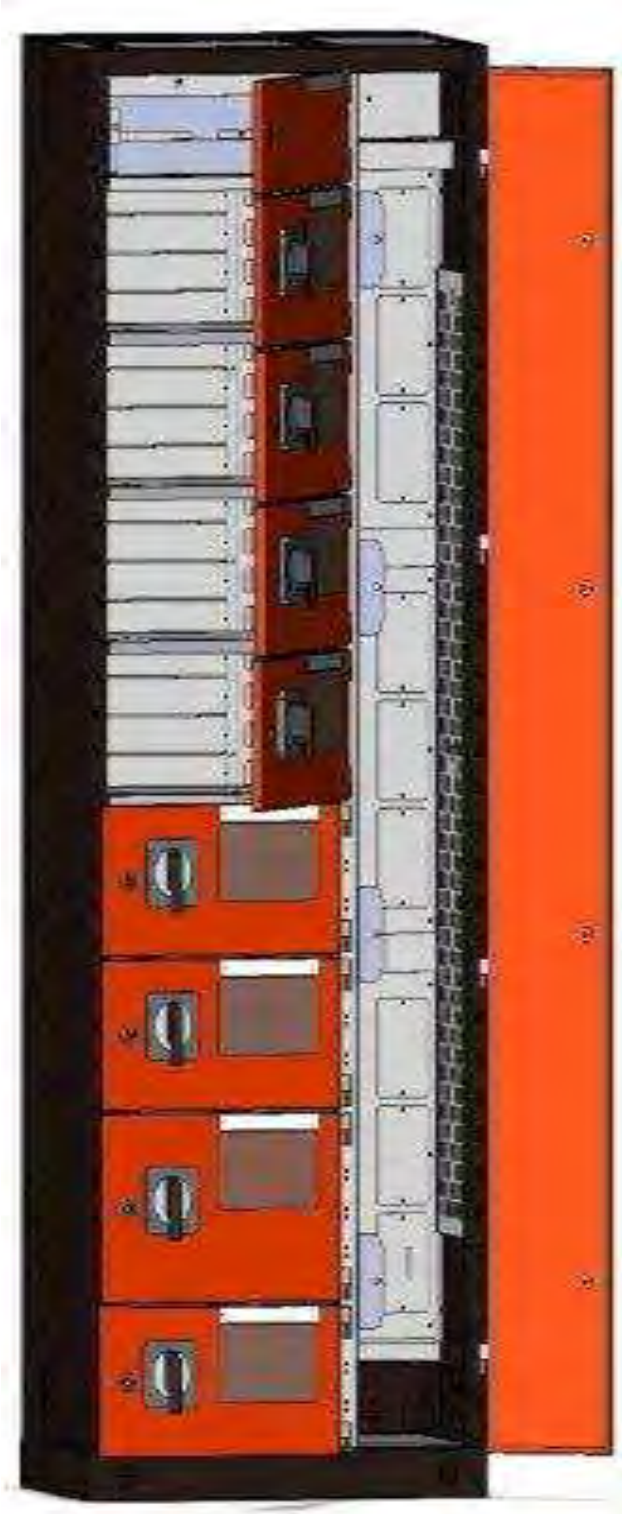
All modules are fitted with an earth wipe assembly which earths the module to the main earth bar. This connection point is also used to provide dedicated earth connections to the module door and equipment earthing within the module. The earth wipe assembly makes contact with the earth bar prior to the power connections engaging the dropper connection bars.

### Panel widths

In addition to the typical modular type outgoing functional units, a range of full tier starter designs are also available in panel widths from 400mm up to 800mm in increments of 100mm. These panels offer additional space for auxiliary interface equipment or additional cable terminating space for unusually large cables.

## i.Power Solutions Moducell v2.2 IOM Manual

### 5.3 Structural Frame (IP54 Version)



#### Construction

The IP54 version of the **MODUCELL v2.2** tier assembly is fully metal clad and consists of an 80mm high 3mm thick galvabond plinth for added durability with all other parts manufactured from 2mm sheet steel. All sheet metal components are laser cut, CNC punched and folded for exacting tolerances.

The sheet metal components are all fastened into assemblies using M6 trilobial screws providing a standard M6 threaded hole when removed, all fixings except for those into 3mm steel sheet are formed into punched holes giving a minimum of 4mm thread depth.

#### Paint specification

All sheet metal components are epoxy polyester powder coated to a minimum DFT of 70 microns. Both the frame and the plinth are coated to a standard colour Metallic Charcoal Gloss Finish, whilst all modules and internal sheet metal are Pearl White Gloss Finish. All external doors and covers are coated a standard colour X15 Electrical Orange Gloss Finish.

Other colours are available as an option on request.

#### Configuration

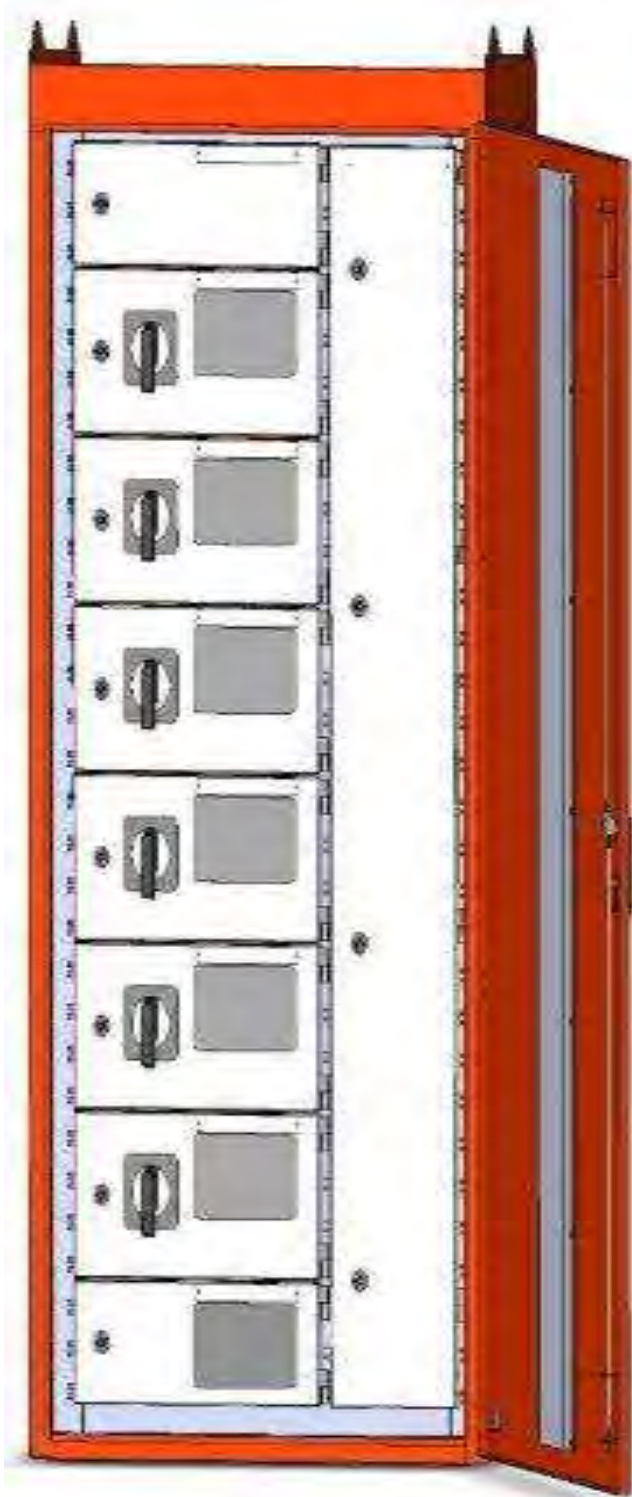
The IP54 **MODUCELL v2.2** is available in two basic arrangements, single-sided front connect which is suitable for mounting against a switch room wall, or the double-sided arrangement which requires access from both front and rear of the switchboard.

Various standard tier configurations are available for both arrangements and there are 8 different widths of panels depending upon the performance and space requirements.

The standard IP54 configuration allows for a maximum of 36 modules to be installed in any one tier. This includes a size 03 wireway (if required) and can be made up of any combination of available module sizes. There is one limiting factor namely a minimum size 04 drive/feeder module located at the top and bottom of a tier.

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### 5.4 Structural frame (IP66 Version)



#### Construction

The IP66 version of the **MODUCELL v2.2** tier assembly is fully metal clad and consists of an 76mm x 38mm parallel flanged channel iron plinth for durability with all other parts manufactured from 2mm sheet steel. All sheet metal components are laser cut, CNC punched and folded for exacting tolerances. NOTE - External sheetmetal components can be manufactured from various grades of stainless steel as an option.

The sheet metal components are all fastened into assemblies using M6 trilobial screws providing a standard M6 threaded hole when removed, all fixings except for those into 3mm steel sheet are formed into punched holes giving a minimum of 4mm thread depth.

#### Paint specification

All sheet metal components are epoxy polyester powder coated to a minimum DFT of 70 microns. Modules, module doors and internal sheet metal components are Pearl White Gloss Finish. To reduce the effects of solar radiation, we recommend all external doors, covers and sheetmetal components be powder coated in a light colour (eg Pearl White Gloss or similar). A natural unpainted finish is also available if external sheetmetal components are manufactured from stainless steel. The channel iron plinth is hot dipped galvanised with a natural finish.

Other colours are available as an option on request.

#### Configuration

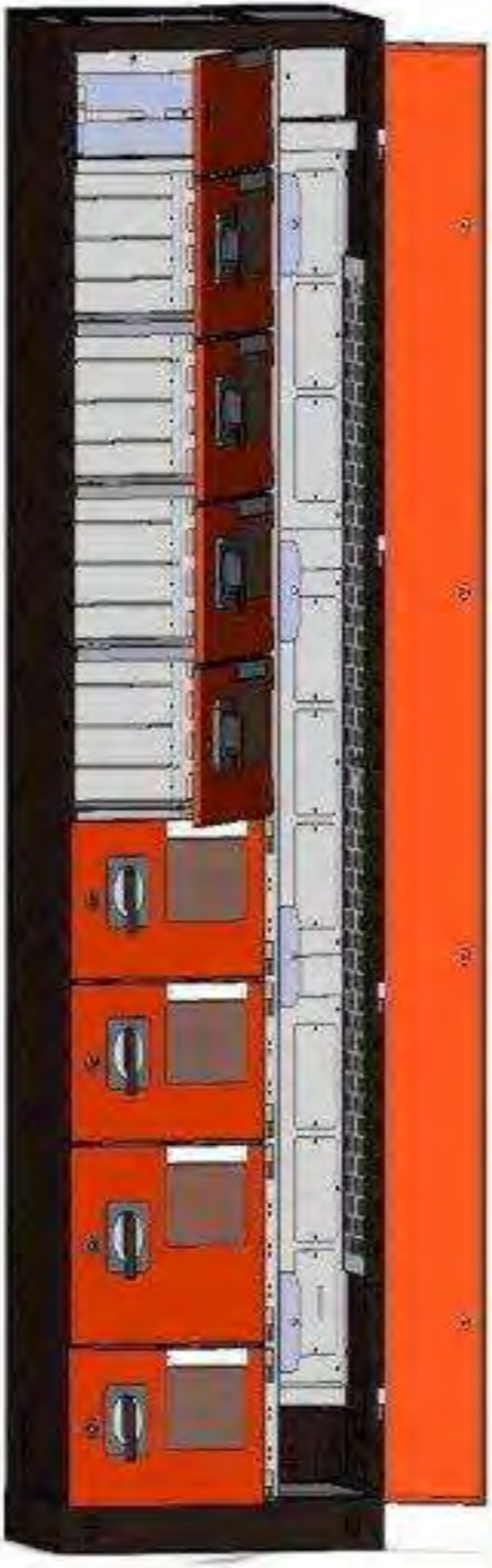
The IP66 **MODUCELL v2.2** comes in one basic arrangement, single-sided front connect.

Various standard tier configurations are available for this arrangement and there are 7 different widths of panels depending upon the performance and space requirements.

The standard IP66 configuration allows for a maximum of 30 modules to be installed in any one tier. This includes a size 03 wireway (if required) and can be made up of any combination of available module sizes. There is one limiting factor namely a minimum size 04 drive/feeder module located at the top and bottom of a tier.

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### 5.5 Cable zones



#### Cable zones

In standard drive tiers, a generous sized full height cable zone is provided on the right hand side of all functional units. These cable zones are 300mm wide as standard (with a 400mm wide model as an option) and are fitted with a full height hinged front door and gland plates allowing either top or bottom cable access. Cable zone doors are secured closed using quarter turn locks with an 8mm square insert as standard.

#### Control cables

Control cables are terminated into terminals fitted to a vertical din rail located adjacent to the starter / feeder modules.

#### Power cables

Power cables are terminated on the power components within the functional unit for form 4a applications. For form 4b application, cables are terminated in dedicated enclosures within the cable zone.

A section of pre-punched cable ladder is provided on the right side of the cable zone for the support of power and control cables.

#### Earthing

A frame earth connection busbar is provided within all cable zones, a neutral busbar is also provided when required.

#### Gland plates

Each tier is provided with four gland plates, two at the top and two at the bottom. One of each of these gland plates provides direct cabling into either the top most module or bottom most module depending upon cable entry requirements, whilst the others provide cabling access into the full height cable zone.

As standard two of these four gland plates are manufactured from 4mm thick aluminium with the other two being manufactured from 2mm thick powder coated mild steel. Optional 4mm thick brass gland plates are available.

#### Wireways

An Inter-tier wireway can be provided at either the top or bottom of each tier depending upon cable entry requirements. These wireways are located behind a size 3 module door located at either the top or the bottom of the tier.

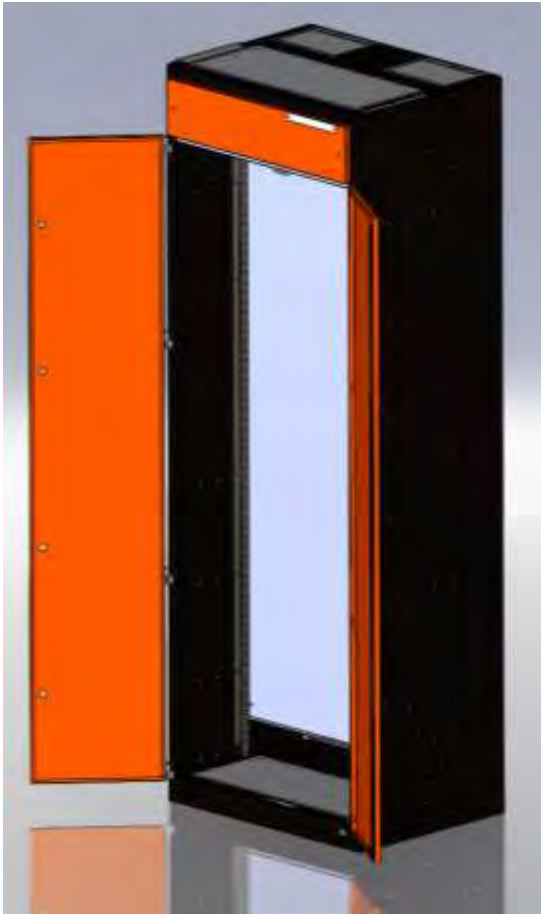
#### Doors

All doors are hinged on the right hand side and provided with quarter turn locks with an 8mm square insert as standard.

All holes for the later addition and or changing of the tier module arrangement are provided and pre punched, so no site drilling is required.

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### 5.6 General purpose tiers



#### Applications

General Purpose Tiers can be used for numerous applications such as PLC / DCS panels, power factor correction equipment and form 1 starter panels.

#### Configuration

General purpose tiers are available in 8 widths – 400mm to 1000mm in increments of 100mm, and 1200mm.

They can be provided with or without main busbars fitted to allow for future extension of the switchboard even if utilised as a PLC panel. Where a connection to the main bus is required in the tier, a vertical dropper assembly is installed to provide a demountable connection up to 1150 Amps.

All tiers are fitted with full height interlocked double doors. The right hand door is secured closed using 2 spring loaded internal latches. The left hand door is secured closed using quarter turn locks with 8mm square inserts as standard. Three point locking mechanisms are available as an option.

A typical general purpose tier fitted with a programmable logic controller and associated control equipment.



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### 5.7 Main horizontal busbar system – phase busbars

The main busbar zone is located in the rear (or middle for double-sided arrangements) of the switchgear assembly with three possible vertical busbar positions.

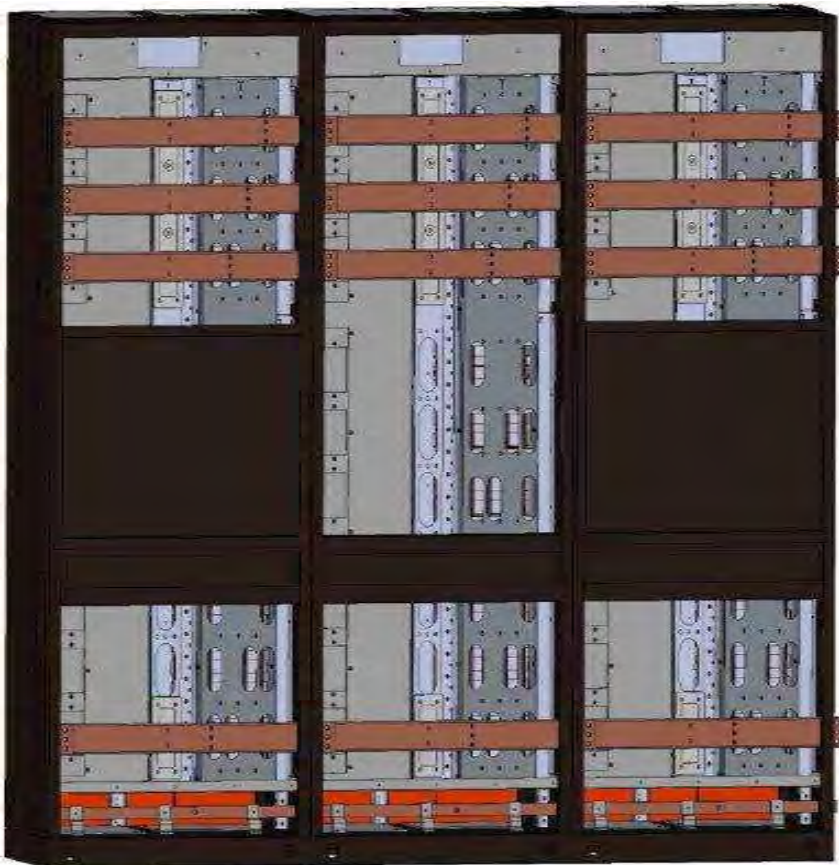
- ✓ Top
- ✓ Centre
- ✓ Bottom

This variety provides excellent flexibility for busbar systems allowing normal supply bus, Generator bus or VVVF bus system to be employed within the one switchgear assembly.

The following phase busbar arrangements and ratings are based upon an ambient temperature of 35°C with an allowable temperature rise of 60°C which satisfy the requirements of AS/NZS 3000:2007 & AS/NZS 3439.1:2002.

#### Available Main Phase Busbar Configurations

- 1250A - 1 x 80 x 10mm HDHC natural copper busbar
- 1600A - 1 x 120 x 10mm HDHC natural copper busbar
- 2000A - 2 x 80 x 10mm HDHC natural copper busbar
- 2275A - 2 x 100 x 10mm HDHC natural copper busbar
- 2750A - 2 x 120 x 10mm HDHC natural copper busbar
- 3000A - 3 x 100 x 10mm HDHC natural copper busbar
- 3500A - 3 x 120 x 10mm HDHC natural copper busbar
- 4000A - 2 parallel sets of 2 x 100 x 10mm HDHC natural copper busbar
- 5000A - 2 parallel sets of 2 x 120 x 10mm HDHC natural copper busbar



This drawing depicts the typical arrangement of the main bus at the top of the switchboard.

The main neutral in this case is positioned in the 'C' phase main busbar position in the bottom busbar location.

The main earth bar can also be seen running through the bottom of the switchboard.

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### 5.8 Main horizontal busbar system – neutral busbars

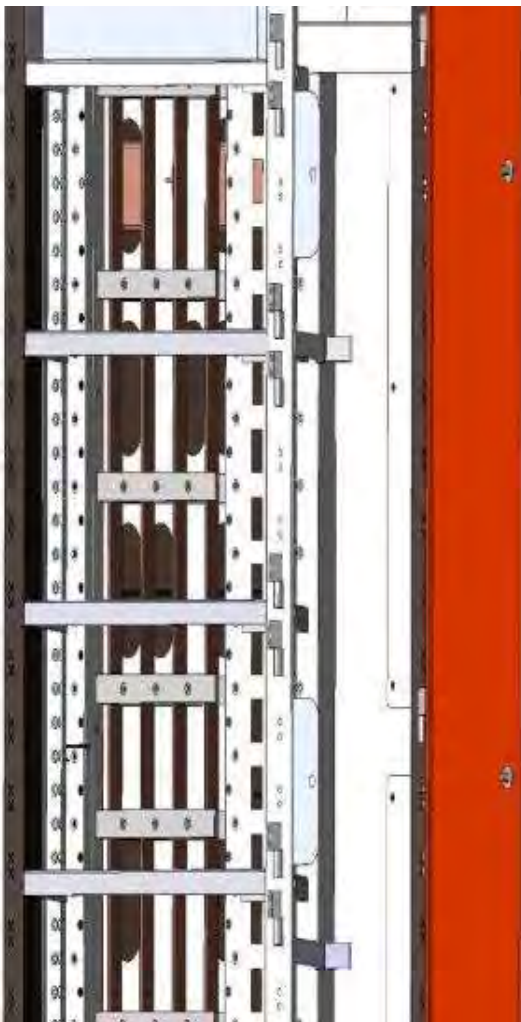
The position of the main neutral within the switchgear assembly is usually in the 'C' phase main busbar position in the bottom busbar location as shown on the previous diagram; however the 'A' phase main bus position in the top busbar location is also an option.

The following neutral busbar arrangements and ratings are based upon an ambient temperature of 35°C with an allowable temperature rise of 60°C which satisfy the requirements of AS/NZS 3000:2007 & AS/NZS 3439.1:2002.

#### Available Main Neutral Busbar Configurations

- 1250A - 1 x 80 x 10mm HDHC natural copper busbar
- 2000A - 2 x 80 x 10mm HDHC natural copper busbar
- 2500A - 3 x 80 x 10mm HDHC natural copper busbar

### 5.9 Vertical dropper busbar system



The vertical Busbar (or dropper) system is enclosed in an assembly referred to as the Dropper Can assembly.

The Dropper Can assembly can have bus systems rated up to 1150A for tier distribution in either 3 or 4 pole arrangements for both distribution and/or motor control systems.

#### Features

- ✓ Electro tinned plated busbars
- ✓ Up to 1150A 80kA 1 second
- ✓ 3 or 4 pole construction

The following standard busbars arrangements and ratings are based upon an ambient temperature of 35°C with an allowable temperature rise of 60°C

- 625A - 1 x 50 x 6.3mm HDHC tinned copper busbar
- 750A - 1 x 63 x 6.3mm HDHC tinned copper busbar
- 950A - 1 x 80 x 6.3mm HDHC tinned copper busbar
- 1150A - 1 x 80 x 10mm HDHC tinned copper busbar

NOTE : Size restrictions apply depending upon the required rated short circuit level of the arrangement:

- 50x6.3mm – Maximum rated short circuit level - 50kA
- 63x6.3mm – Maximum rated short circuit level - 65kA
- 80x6.3mm – Maximum rated short circuit level - 80kA
- 80x10mm – Maximum rated short circuit level - 100kA

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### 5.10 Distributed control neutral

A unique option for the MODUCELL v2.2 is the ability to incorporate a distributed control neutral connection into a three phase dropper system. A 25x6.3mm copper bar with spacers is installed in lieu of the full sized neutral dropper bar. The control neutral can be fitted to a dropper assembly with any of the busbar sizes listed above.

This provides a convenient neutral connection point within each functional unit and allows the connections for control supplies to remain completely inside the functional unit.

### 5.11 Earth bar & MEN links

A continuous main earth bar runs the entire length of the switchboard assembly. The main earth bar is manufactured from 32x6.3mm HDHC copper with a natural finish.

This cross sectional area has been verified by type test for systems with a prospective three phase short circuit level up to 80kA. The cross sectional area has also been verified for systems with a prospective three phase short circuit level up to 100kA in accordance with Annex B of AS/NZS 3439.1:2002. In this case the expected temperature rise of the earth bar under fault has also been calculated to be approximately 200°C, well under the accepted allowable limit of 300°C for earth bars.

Under normal circumstances, the sizing of an MEN link is to be in accordance with clause 5.3.5.2 of AS/NZS 3000:2007 which requires the current carrying capacity of the MEN link to be the same as the main incoming neutral conductor. This is neither desirable nor in some cases possible within the confines of a standard switchboard assembly.

Clause 1.9.4 of AS/NZS 3000:2007 makes provisions for situations where compliance to standard requirements is neither possible nor desirable. With respect to MEN links, the standard size offered is the same as the standard earth bar - 32x6.3mm. This is allowable as an alternative arrangement and is verified as suitable as per the details above for earth bar sizing.

This arrangement must be acknowledged in writing by the end user and records kept on site

### 5.12 Equipotential bonding

In accordance with AS/NZS 3000:2007 clause 5.4.6.1, all parts of structural metalwork, including conductive building materials shall be earthed where the risk of contact with live parts exists. In accordance with clause 5.4.6.3, the resistance between any part of the structural metalwork and the switchboard earth bar shall not exceed 0.5Ω.

Switchboard gland plates (either ferrous or non ferrous) are classed as part of the structural metalwork of the switchboard and not part of the PE conductor. Furthermore, all cabling entering a switchboard via a gland plate shall be double insulated to eliminate the possibility of the cable coming into contact with external conductive parts.

Based upon these requirements, equipotential bonding between gland plates and the switchboard earth bar is required and a resistance of no more than 0.5Ω is achieved via the gland plate fixing screws. No further earthing measures are therefore required.

The only exception to this may be in situations where armoured cables are used and the cable armour forms part of the return earthing circuit. In these cases the installation of a separate 6mm<sup>2</sup> earth conductor may be necessary between the gland plate and the switchboard earth bar.

Where the hinged parts of the conductive frame (such as doors) are used for the mounting of electrical equipment, these doors must be connected to the structural framework by means of a 2.5mm<sup>2</sup> flexible earthing conductor in accordance with AS/NZS 3000:2007 clause 5.5.3.4.

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### 6 OPTIONAL FEATURES

#### 6.1 Increased Security Against The Occurrence Or The Effects Of Internal Arcing Faults

As an option to the standard configuration, the **MODUCELL v2.2** can be supplied to comply with the requirements of Annex ZD of AS/NZS 3439.1:2002. This involves changing the module door locks from quick release quarter turn style locks to a screw type locking mechanism which bolts the door of the outgoing functional unit shut. In addition, an arc proof baffle is fitted to the module door equipment plate to act as a barrier between the pressure wave generated by the arc and the door mounted equipment. This ensures that devices are not dislodged from the door in the event of an internal arcing fault. Larger propriety items that do not fit onto the door equipment plate (eg larger protection relays), are fixed to module doors with a frame that bolts over the front of the device to again ensure it is not dislodged from the door in the event of an internal arcing fault.

##### Air Circuit Breaker (ACB)

Double sided Air Circuit Breaker (ACB) feeders are provided with internal partitions to safely vent any gases generated by an arcing fault out through the top of the panel. To maintain form separation for single sided applications, an additional full height 200mm deep pressure relief chamber is fitted to the rear of the panel venting any gasses generated by an arcing fault at the outgoing terminals of the panel. Additionally for some ACB types and sizes, a full fixed cover is supplied and fitted over the front of the ACB. The design of the cover still allows mechanical racking, closing and tripping operations whilst providing maximum operator safety during switching and racking operations.

Please consult your nearest factory for applicable ACB types and sizes.

##### Human Machine interface (HMI)

An optional HMI can also be supplied to allow on line interrogation of more sophisticated trip units. This HMI option has been specifically developed by i.power to enable full operation and interrogation of devices where access to trip units is not possible.

##### Insulated Busbars

Where increased security measures are required for incoming ACB areas and busbar zones, these are classed as special requirements. Busbars in these areas can be coated with an insulating thermoplastic co-polymer powder coat which provides a fault free zone within these areas.

##### Isolation of Dropper Busbars

The busbar coating is also required on the vertical dropper busbars where connections are made to the individual starter modules. Due to the flexibility of the arrangement of starter modules in standard drive tiers, the vertical dropper busbars require an unpainted section of busbar every 60mm to allow connection at any point along their length. Where a starter module engages the dropper busbar, the casing of the module busplug provides adequate insulation between phases to prevent the occurrence of an arcing fault. For all other uncovered locations on the dropper busbar, a moulded insulating dummy plug is fitted across all three phases. The dummy plug provides the same insulation that the standard module busplug provides and ensures that the dropper busbars are completed insulated from each other along the entire length maintaining the fault free zone.

Where dummy plugs are supplied fitted to a switchboard arrangement, an extraction handle is also supplied to enable easy and safe removal of the dummy plug when new starter modules are added to the arrangement.

#### 6.2 Safety Shutters

Where shrouding of the dropper busbars is required when a starter module is removed, safety shutters can be supplied and fitted. The safety shutter is spring loaded and operates via 2 angled arms fitted to the rear of the starter module. As the module is being withdrawn the shutter closes reducing any possibility of contact with live busbars. As the module is re-inserted, the angled arms open the shutter allowing the module busplug to engage the dropper busbars. **NOTE** : In most situations, safety shutters and dummy plugs cannot be fitted to the same arrangement. Please consult the factory should this be required.

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### 6.3 Low voltage control plug

Low voltage plug and socket arrangements, for all low voltage power and control cabling entering/exiting the starter module, allows for quick and simple changeover of modules without having to disconnect control wiring. The following configurations are available:

- Size 02 module - 1 - 24 pin control plug
- Size 03 – 06 module - 2 - 24 pin control plugs
- Size 07 – 18 module - 4 - 24 pin control plugs

The standard wiring configuration of these plugs is detailed below.

MODUCCELL v2.2 MODULE LV PLUG STANDARD CONNECTIONS		
Pin Number	Plug A Pin Designation	Plug B Pin Designation
1	DC Positive Control Supply	AC Active Control Supply (max 13A)
2	DC Negative Control Supply	AC Neutral Control Supply (max 13A)
3	Local Control Station Start Pushbutton	Motor Heater Active Supply (max 13A)
4	Local Control Station Start Pushbutton	Motor Heater Neutral Supply (max 13A)
5	Local Control Station Stop Pushbutton	Spare
6	Local Control Station Stop Pushbutton	Spare
7	Local Control Station Emergency Stop Pushbutton	Spare
8	Local Control Station Emergency Stop Pushbutton	Spare
9	PLC/DCS Output Run Speed 1 / Forward	Spare
10	PLC/DCS Output Run Speed 1 / Forward	Spare
11	PLC/DCS Output Run Speed 2 / Reverse	RTD 1 A - Motor Winding A Phase
12	PLC/DCS Output Run Speed 2 / Reverse	RTD 1 B - Motor Winding A Phase
13	PLC/DCS Output Stop	RTD 1 C - Motor Winding A Phase
14	PLC/DCS Output Stop	RTD 2 A - Motor Winding B Phase
15	PLC/DCS Input Drive Main Switch Status	RTD 2 B - Motor Winding B Phase
16	PLC/DCS Input Drive Main Switch Status	RTD 2 C - Motor Winding B Phase
17	PLC/DCS Input Local Isolator Switch Status	RTD 3 A - Motor Winding C Phase
18	PLC/DCS Input Local Isolator Switch Status	RTD 3 B - Motor Winding C Phase
19	PLC/DCS Input Drive Running Speed 1 / Forward	RTD 3 C - Motor Winding C Phase
20	PLC/DCS Input Drive Running Speed 1 / Forward	RTD 4 A - Ambient
21	PLC/DCS Input Drive Running Speed 2 / Reverse	RTD 4 B - Ambient
22	PLC/DCS Input Drive Running Speed 2 / Reverse	RTD 4 C - Ambient
23	PLC/DCS Input Drive Fault	Thermistor +
24	PLC/DCS Input Drive Fault	Thermistor -

Note : For size 02 modules, only plug A is available.

### 6.4 Thermographic monitoring

As part of an ongoing maintenance program, regular thermographic monitoring may be required whilst switchboard assemblies are in operation. To facilitate this, an infrared sight glass can be provided and fitted to enable monitoring of the bolted connections in the main busbar.

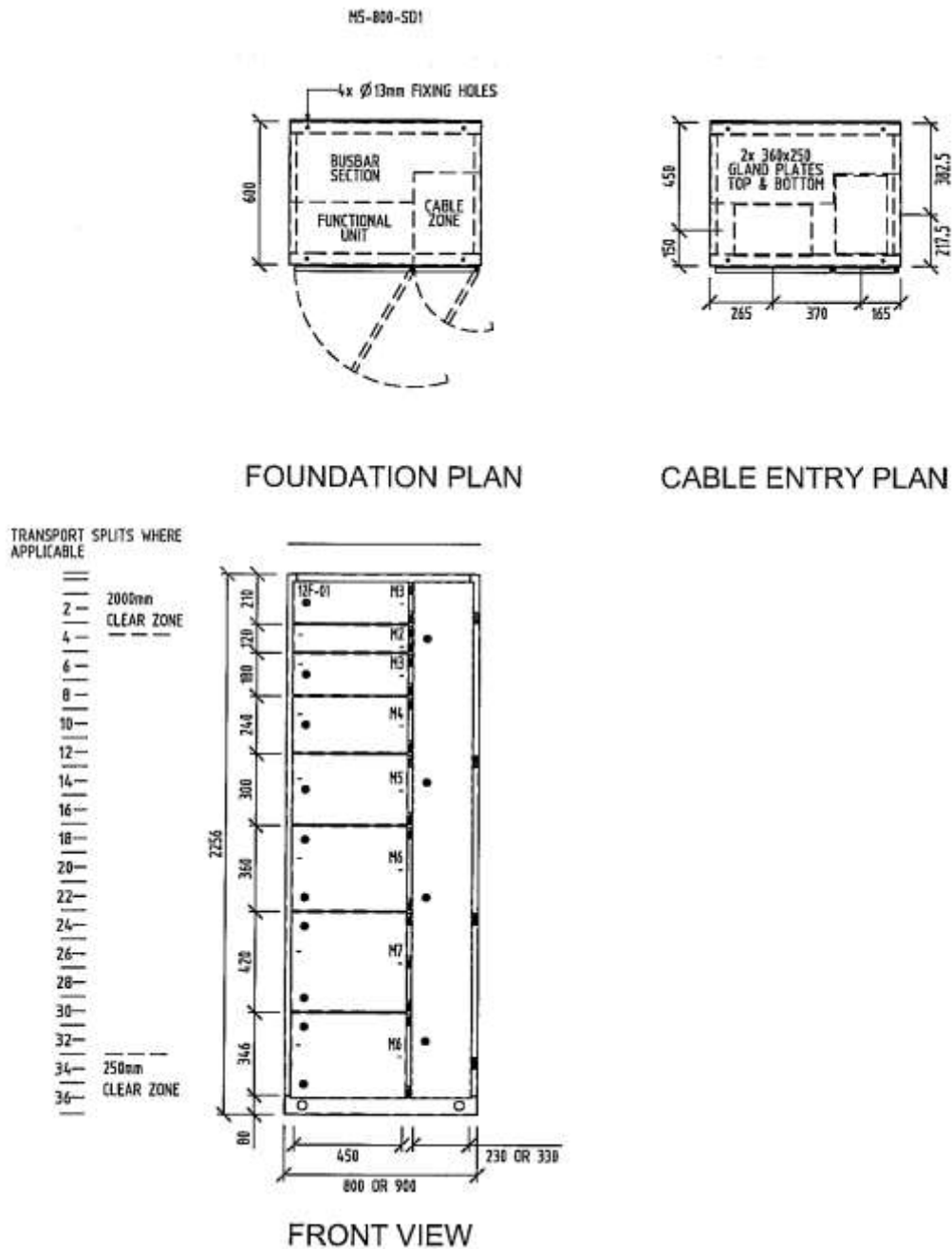
Please consult the factory for suitable applications.

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### 7 Cubicle Dimensions

#### 7.1 IP54 Single Sided Tiers

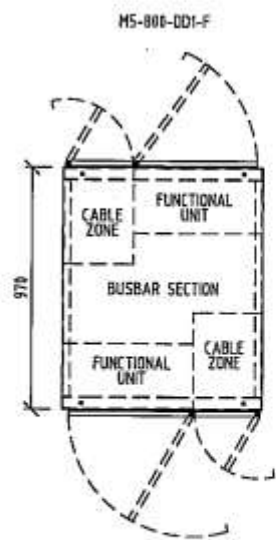
Description	Width	Depth	Weight	Heat Losses	Model No
Standard Tier 300 Wide Cable Zone	800	600	400 kg's	500 Watts	<b>M5A-800-SD1</b>
Standard Tier 400 Wide Cable Zone	900	600	420 kg's	500 Watts	<b>M5A-900-SD1</b>



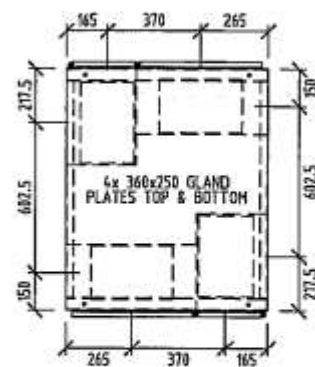
## i.Power Solutions Moducell v2.2 IOM Manual

### 7.2 IP54 Double Sided Tiers

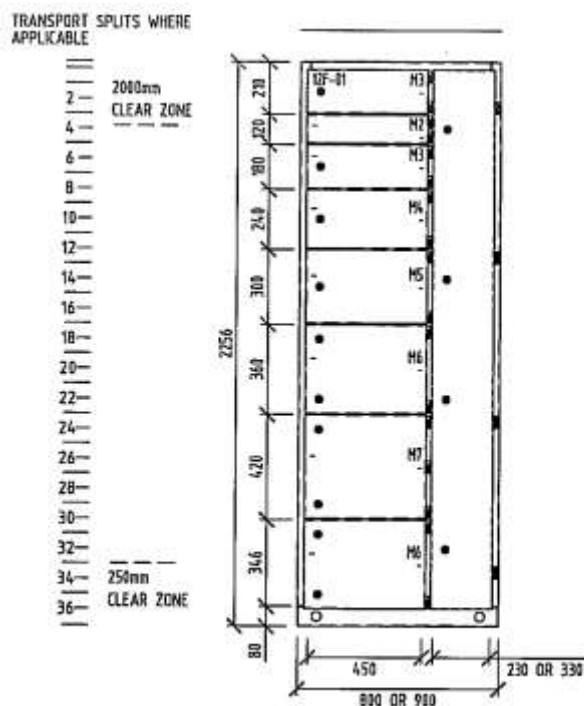
Description	Width	Depth	Weight	Heat Losses	Model No
Standard Tier 300 Wide Cable Zone	800	990	520 kg's	800 Watts	<b>M5A-800-DD1</b>
Standard Tier 400 Wide Cable Zone	900	990	550 kg's	800 Watts	<b>M5A-900-DD1</b>



FOUNDATION PLAN



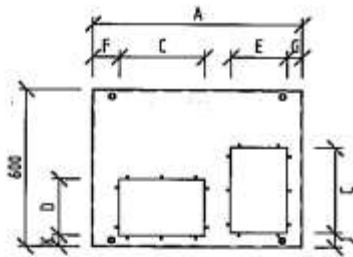
CABLE ENTRY PLAN



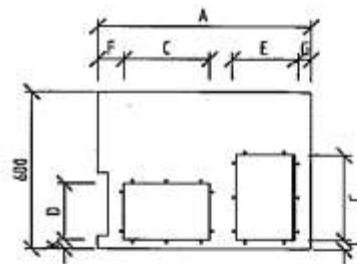
## i.Power Solutions Moducell v2.2 IOM Manual

### 8 CABLE ENTRY DETAIL

#### 8.1 IP54 Single & Double Sided Standard Tiers

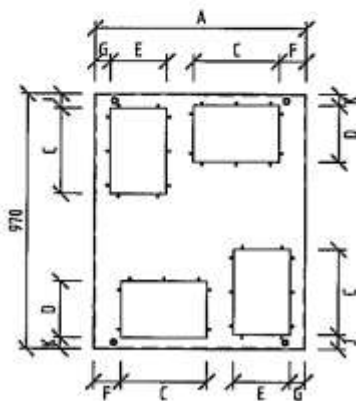


**SINGLE SIDED  
STANDARD MCC  
BOTTOM ENTRY**

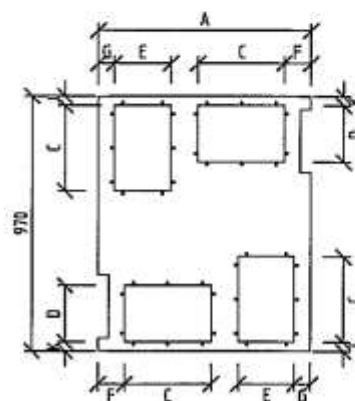


**SINGLE SIDED  
STANDARD MCC  
TOP ENTRY**

	A	C	D	E	F	G	J	K
SS PLINTH	800	325	215	215	102.5	57.5	55	42.5
DS PLINTH	800	325	215	215	102.5	57.5	55	42.5
SS PLINTH	900	325	215	315	102.5	57.5	55	42.5
DS PLINTH	900	325	215	315	102.5	57.5	55	42.5
SS ROOF	800	325	215	215	99	59	35	35
DS ROOF	800	325	215	215	99	59	35	35
SS ROOF	900	325	215	315	99	59	35	35
DS ROOF	900	325	215	315	99	59	35	35



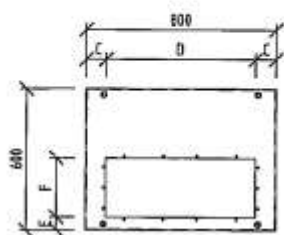
**DOUBLE SIDED  
STANDARD MCC  
BOTTOM ENTRY**



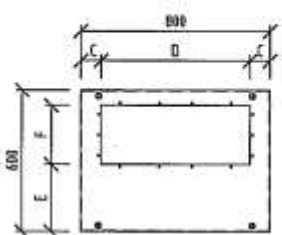
**DOUBLE SIDED  
STANDARD MCC  
TOP ENTRY**

## i.Power Solutions Moducell v2.2 IOM Manual

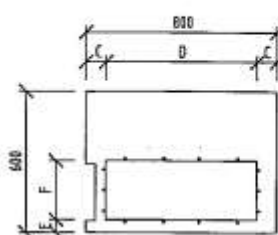
### 8.2 IP54 800W Single & Double Sided Starter/PLC & PLC Tiers



**A SINGLE SIDED  
STANDARD STARTER/ PLC  
BOTTOM ENTRY**

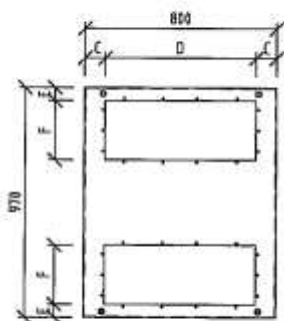


**B SINGLE SIDED  
STANDARD PLC  
BOTTOM ENTRY**

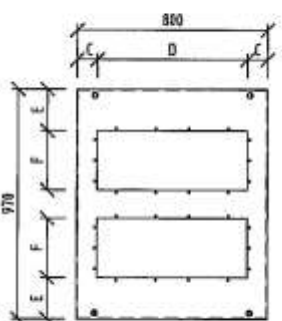


**SINGLE SIDED  
STANDARD STARTER/ PLC  
AND STANDARD PLC  
TOP ENTRY**

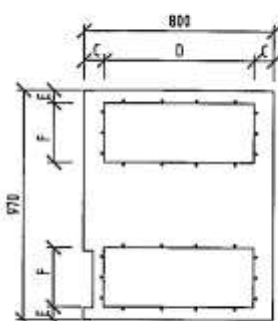
	C	D	E	F
A SS PLINTH	85	630	55	250
B SS PLINTH	85	630	205	250
A DS PLINTH	85	630	55	250
B DS PLINTH	85	630	175	250
SS ROOF	85	630	55	250
DS ROOF	85	630	55	250



**A DOUBLE SIDED  
STANDARD STARTER/ PLC  
BOTTOM ENTRY**



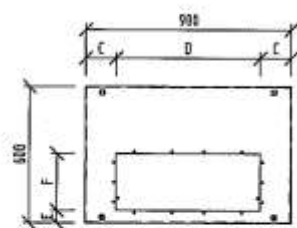
**B DOUBLE SIDED  
STANDARD PLC  
BOTTOM ENTRY**



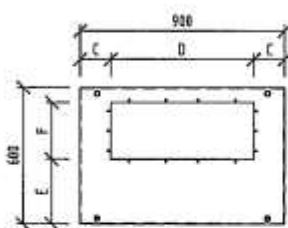
**DOUBLE SIDED  
STANDARD STARTER/ PLC  
AND STANDARD PLC  
TOP ENTRY**

## i.Power Solutions Moducell v2.2 IOM Manual

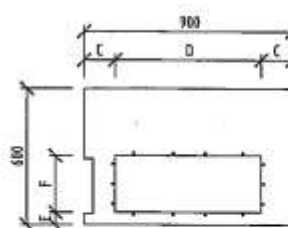
### 8.3 IP54 900W Single & Double Sided Starter/PLC & PLC Tiers



**A SINGLE SIDED  
STANDARD STARTER/ PLC  
BOTTOM ENTRY**

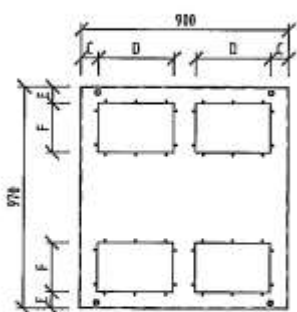


**B SINGLE SIDED  
STANDARD PLC  
BOTTOM ENTRY**

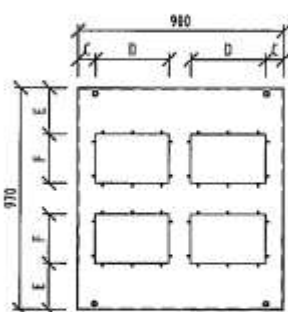


**SINGLE SIDED  
STANDARD STARTER/ PLC  
AND STANDARD PLC  
TOP ENTRY**

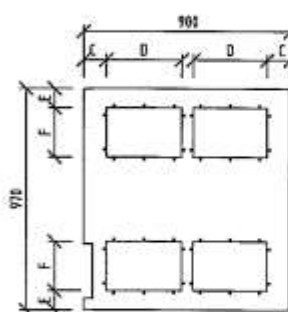
	C	D	E	F
A SS PLINTH	135	630	55	250
B SS PLINTH	135	630	285	250
A DS PLINTH	77.5	325	72.5	215
B DS PLINTH	77.5	325	202.5	215
SS ROOF	135	630	55	250
DS ROOF	99	325	85	215



**A DOUBLE SIDED  
STANDARD STARTER/ PLC  
BOTTOM ENTRY**



**B DOUBLE SIDED  
STANDARD PLC  
BOTTOM ENTRY**



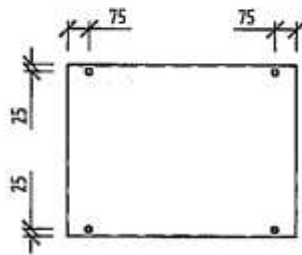
**DOUBLE SIDED  
STANDARD STARTER/ PLC  
AND STANDARD PLC  
TOP ENTRY**

## i.Power Solutions Moducell v2.2 IOM Manual

### 9 HOLD DOWN POINTS

#### 9.1 IP54 Single & Double Sided Tiers

For all size tiers both single and double sided, the 4 x 13mm diameter hold down points are the same dimensions from the external corners of the base. This allows easy installation of in floor bolting systems and location of fixing bolts.



STANDARD GROUND FASTENING DETAIL  
FOR ALL SINGLE SIDED & DOUBLE SIDED  
PANELS TOP & BOTTOM ENTRY

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### 10 STORAGE & INSTALLATION

#### 10.1 Storage

Ideally, installation should occur immediately after delivery. If this cannot occur, the switchgear shall be stored in a clean, dry environment free from condensation, harmful gases and physical damage. Panels are supplied with silica gel however this should not be relied on when storage is to occur over extended periods of time.

#### 10.2 Placement

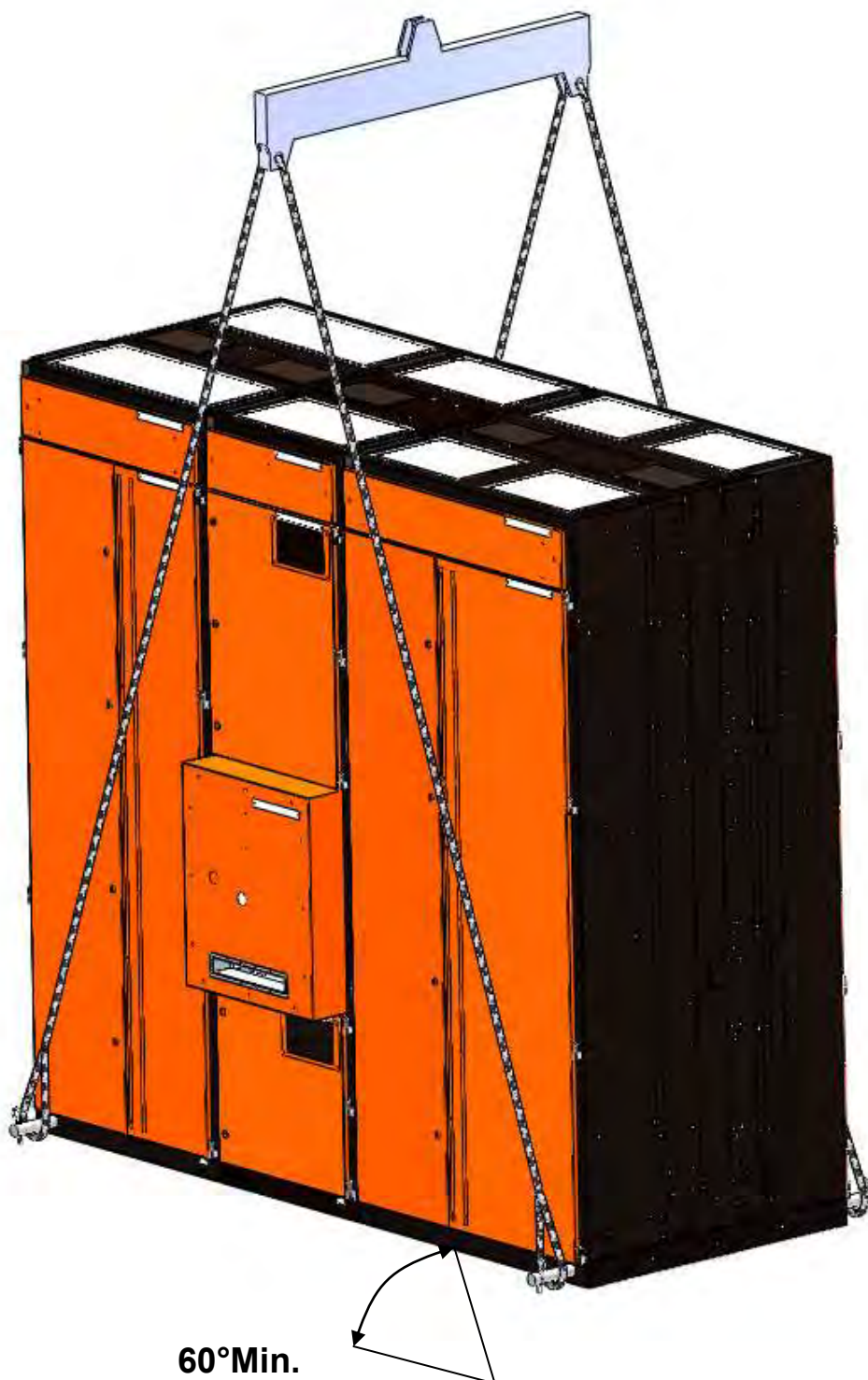
The switchgear is to be positioned on a level surface. A tolerance of no more than 2mm in every 1m is recommended to ensure trouble free assembly of the switchboard. Misalignment of multiple tier assemblies may result in improper operation of the switchgear. Care is to be taken during transport of switchgear.

#### 10.3 Lifting & Installation Into Switchroom

- Unpack new MCC section after delivery as close as practical to the switchroom door.
- MCC sections are designed to be lifted by the holes located in the plinth, using a 35mm diameter 300 grade solid steel bar. The length of the bar shall not extend more than 175mm beyond the base frame of the MCC. 6mm retainer spring clips shall be fitted to each end of the bar to prevent lifting slings from slipping off the bar.
- Lifting of MCC sections should be completed using suitably rated spreader bar and lifting slings and not chains to prevent damage to paintwork and door mounted equipment. Care should be taken to position slings so that there is no pressure from the slings onto door mounted equipment.
- Arrangement of the lifting bars is as per the MCC sections.
- The initial lift should be attempted with caution, as panels are typically top heavy and not evenly balanced.
- **It is important to ensure that the angle of the lifting slings to ground is a minimum of 60°.**
- Before lifting panel into room, floor protection where necessary should be placed on the area where the panel is to be rolled on. Flat colourbond sheets or MDF sheeting is suitable. It is also advisable to protect door jams and disconnect door closing mechanisms to prevent damage.
- Place pipe rollers on floor inside doorway approx 500mm apart. 25mm diameter steel water pipe is ideal.
- Carefully lift panel into room or external landing and place on rollers.

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It is important to ensure that the angle of the lifting slings to ground is a minimum of 60°.



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### 10.4 Positioning Of New Panels

- It is assumed at this stage floor cut outs exist under new panel position and any existing floor cover plates have been removed.
- Using pipe rollers (minimum of 3 rollers under panel at all times) move the new panel to a position approximately 1 meter from first position.
- **NOTE:** It is very important to always have pipe rollers at 90deg. to supporting floor joists, as rollers will damage floor sheets if they do not span at least 2 floor joists at all times.

### 10.5 Preparing To Join Panels

- All necessary high tensile bolting hardware, main busbars and earth busbar fish plates will be supplied loose to be installed on site.
- To access main busbar connections remove the applicable bus zone access cover. This allows access to the main busbars for joining. Also remove the bus zone access cover for joining the neutral bar where applicable.
- Before installing busbar joining fish plates, prepare copper by wiping the area to be joined with thinners and apply a light smearing of petroleum jelly.
- Installation of the fish plates should be completed as soon as possible after applying the petroleum jelly to prevent oxidation on the newly prepared surfaces.
- Install and bolt joining fish plates to either new or existing bus, using M10 HT bolts provided. All phases are to have the same configuration and care is to be taken to observe the clearance between phases and the frame. Bolts should only be finger tight to allow movement of the fish plates.

### 10.6 Joining Panels

- Roll new panel to approx. 500mm from existing panel, as closely aligned as possible. If panels are brought too close the bus bars will clash when removing rollers.
- Remove pipe rollers from under panel. This can be done using two crowbars and blocks of wood (lever & fulcrum method) with two operators, to lift one end at a time. **Note.** Again to avoid damage to floor sheets, it is very important to place fulcrum blocks directly above the supporting floor joist. These are generally located under the switchboard plinth when the switchboard is in position.
- From a suitable anchor point either inside the room or under the building, slowly jack the two sections together with observers to guide the main bus together so all bars mesh uniformly. A hydraulic porta-power is ideal for this.
- Continue jacking until panel sides are in contact both front and rear, check alignment of panel joining bolt holes on end mullions. Also check alignment of main bus joining bolt holes, a small podgy bar will assist in alignment.
- Install & tighten the 16 x M8 panel joining bolts through the side sheets of adjoining tiers. (8 front & 8 rear). Install & tighten 3 x M8 panel joining bolts through the bases of adjoining tiers. These bolts tighten into M8 nutserts mounted into the opposite side sheet or base of the adjoining tier.
- Install the remaining M10 high tensile bus joining bolts. When all bolts are installed, they must now be tightened as detailed in section 10.7 and marked with a marker pen.
- The earth bar fish plates can now be installed. The earth bar is located at the bottom or top of the board. Again these are joined using M10 high tensile bolts tightened as detailed below and marked with a marker pen.

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### 10.7 Torque Settings

The torque settings detailed in the table below are to be used for any bolted connections within the MODUCELL v2.2 arrangement.

Bolting Arrangement	Bolt Size	Bolting Configuration	Mounting Hole	Tightening Torque
BUSBAR - BUSBAR (NUT & BOLT)	M10 HIGH TENSILE	DIN 6796 Belleville Washer	11mm	30nm
BUSBAR - BUSBAR (COPPERSTERT & BOLT)	M10 HIGH TENSILE	DIN 6796 Belleville Washer	11mm	30nm
BUSBAR - CLEAT	M10 HIGH TENSILE	DIN 6796 Belleville Washer	11mm	30nm
BUSBAR - BOBBIN INSULATOR	M8 HIGH TENSILE	DIN 6796 Belleville Washer	9mm	10nm
BUSBAR - EARTH BAR BRACKET	M10 HIGH TENSILE	DIN 6796 Belleville Washer	11mm	30nm
BUSBAR - CABLE	M10 HIGH TENSILE	DIN 6796 Belleville Washer	11mm	30nm
BUSBAR - CABLE	M16 HIGH TENSILE	DIN 6796 Belleville Washer	18mm	100nm
CLEAT - SHEETMETAL	M10 HIGH TENSILE	Flat & Spring washer	11mm	20nm
BOBBIN INSULATOR - SHEETMETAL	M8x20 Eng. Stud	N/A	M8 Insert	10nm

### 10.8 Securing Panels To Floor

- Using detailed drawings from the previous sections, holes should be located as shown for securing, using 4 off M10 bolts as detailed. It is not necessary on multi-panel switchboards to install 4 bolts in every tier and the quantity and location of securing bolts should be left to the discretion of the installation subcontractor.
- Removal of the gland plates may be necessary dependent upon room access and capability of accessing the underside of tiers.

### 10.9 Testing & Finishing

- The resistance of all new joints must be tested using a micro-ohm meter and results recorded. The results should be no more than the resistance of a similar section of solid bar.
- All access covers can now be re-installed after a final visual inspection
- All interconnecting control wiring and control supply bus wiring is to be connected as per relevant wiring schematics. This wiring is contained in wiring ducts in the top or bottom wire ways and in the vertical cable zones.
- An insulation resistance test of the main bus should now be completed and results recorded. It is recommended this is done at 2.5kV DC. (This test should be conducted with the main circuit breaker open, all feeder circuit breakers open, line side connected fuses disconnected and any communication bus wiring unplugged from intelligent devices ).
- After all above points have been completed and all covers fitted, the switchboard is ready for energisation and commissioning, pending any further site specific requirements.

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### 10.10 Removal & Replacement Of Drive Starter / Feeder Module

It is recommended that any electrical work should be completed with all sources of energy isolated. Some processes do not allow complete isolation for the purposes of repair/replacement work and as such additional precautions must be adopted when conducting this work.

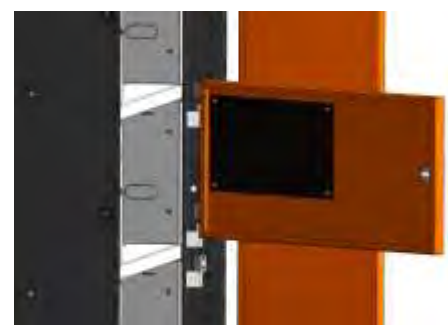
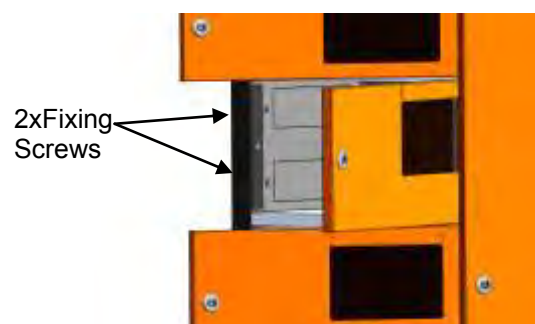
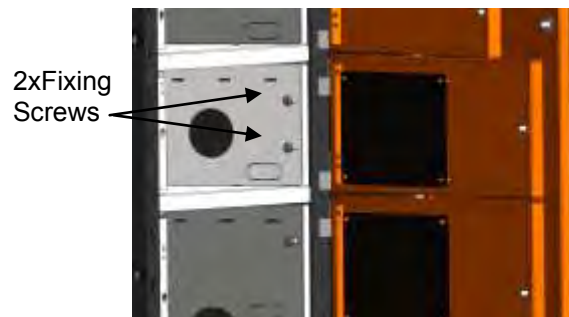
The process detailed below assumes that all sources of energy have been isolated. It does not take into account any site specific requirements or additional precautions that may be required due to the nature of the actual task.

The removal and replacement of a drive starter or feeder module can be completed in four steps as shown in the diagrams below.

1. Isolate and disconnect control cabling. After the module has been isolated from the main supply and any auxiliary supplies, the control wiring connecting the module to its terminal strip in the adjacent cable zone should be disconnected in readiness for the removal of the module. Also remove the 65mm nylon dome plug from the right hand side wall of the module.
2. Remove the four fixing screws as shown. These screws will be re-used to fix the replacement module in place.
3. With the aid of an assistant, lift the module door approximately 12mm up to disengage the hinges and allow the door to be removed from the panel. At this stage the door should be supported to ensure that there is no stress placed upon any control wiring terminating on door mounted equipment.
4. With a firm hold of the front return on both sides of the module, pull the module forward by at least 100mm to ensure that the primary connection busplug is completely disengaged from the dropper connection busbars located behind. If busbar safety shutters are fitted, the extraction of the module by this distance will allow the shutters to close. Remove the entire assembly including the door from the switchboard ensuring that any low voltage control cabling is guided out as the module is extracted.

The installation of the replacement module is in essence the reverse of the removal instructions with the following instructions being followed instead of those detailed in step 4 above.

- Prior to inserting the replacement module, any low voltage control cabling which is to be terminated into the terminal strip in the adjacent cable zone must be fed through the module opening and into the cable zone ready for re-connection.
- Insert the module approximately 200mm and ensure that the rear of the module sits squarely to the side of the panel. If busbar safety shutters are fitted, the insertion of the module by this amount will be sufficient to initiate the opening of the shutter. This will be obvious by a definite increase in the force required to insert the module. With one hand on each of the 2 front returns of the module, one firm continuous push is required to completely insert the module.
- Steps 3,2 and 1 can now be followed to complete the installation of the replacement module.



Door Removal



Module Removal

## i.Power Solutions Moducell v2.2 IOM Manual

### 11 COMMISSIONING

#### 11.1 Commissioning instructions

Testing and commissioning should only be completed by suitably competent authorised persons. It should be conducted in accordance with the relevant Australian Standards and site specific requirements.

#### Isolation



Always disconnect all electricity supplies prior to working on electrical plant. Safeguard the plant from being started accidentally. Otherwise, there will be danger to life

#### Caution



The equipment covered in this manual must be installed, operated and maintained by qualified persons who are thoroughly trained and who understand any hazards that may be involved.

## i.Power Solutions Moducell v2.2 IOM Manual

### 12 ROUTINE MAINTENANCE

Detailed below is a matrix of recommended regular maintenance for switchgear and equipment. To ensure correct operation and longevity it is vitally important to correctly maintain the switchgear. Loose busbar joints or even a blocked ventilation filter can have a catastrophic effect on the operation of a switchboard.

It is recommended that full maintenance of the switchboard be conducted during shut down periods. Based on your local maintenance schedule the shut down period intervals may differ accordingly, but the frequency of inspections depends on the continuous usage of the equipment and the environment.

Busbar inspections while the switchboard is in service must to be conducted as per your local safety procedure.

Type of service	Start-up	Monthly	Annually	Shutdown
Inspect general condition (exterior)	X	X		X
Inspect and clean interior	X			X
Inspect and clean ventilation filters	X	X		X
Inspect barriers and minimum air clearances	X			X
Air circuit breaker routine inspection (according to manufacturer)	X		X	X
Inspect internal cable terminations	X		X	X
Inspect mechanical and key interlocks	X			X
Busbar inspection	X			X
Busbar joint inspection	X			X

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### 13 PERIODIC MAINTENANCE

#### 13.1 General

All electrical equipment utilised throughout the switchboard is virtually maintenance free for the period of its service life. The maintenance listed in the following sub sections is the minimum requirement and should be carried out at the intervals recommended by competent personnel experienced with this type of equipment. Specific equipment manufacturers may also have other maintenance requirements for their particular equipment and this should also be adhered to.

#### 13.2 Electrical equipment

- Check for signs of over temperature of equipment.
- Check for signs of over temperature of cable terminations.
- Check tightness of all cable terminations.
- Carry out earth leakage test on all earth leakage devices at intervals determined as per statutory requirements.

#### 13.3 Inspection of the electric cables

All plant power cabling should be visually inspected at 12 month intervals for the following:

- Mechanical damage such as cracks and bubbling.
- Chemical damage such as cracks and bubbling.
- Overheating damage such as bubbling and discolouration.

If any of the above is evident the cable should be tested by disconnecting it at both ends and performing an insulation test, using a 1000V megger. Check all conductors to earth and between each conductor.

If a reading of  $> 1 \text{ M}\Omega^*$  is observed, an assessment should be made if the cable is suitable for service.

If the reading of  $< 1 \text{ M}\Omega^*$  is observed, the cable should be replaced immediately.

Note -  $*$  This value is based upon the requirements of AS/NZS3000:2007 Clause 8.3.6

#### 13.4 Inspection of the electric cable terminations

All plant power cabling terminations should be visually inspected at 12 month intervals for the following.

- Tightness of terminations.
- Signs of overheating damage.

Any loose terminations should be tightened immediately to the recommended torque setting.

Should the termination be a special insert which forms part of the equipment, the manufacturers' recommendations should be followed.

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### 14 INSPECTION & TEST SCHEDULE

#### 14.1 General inspections

General inspections of the MCC and associated control equipment should be performed according to your local maintenance schedule. These inspections should be performed by a competent electrician who is able to identify early indicators of a potential component failure. These inspections should include, but may not be limited to, the following items:

- Contact status (check for evidence of burning or pitting of the main contacts in accordance with manufacturers recommendations)
- Loose wires (either power or control)
- Blown indicator lamps (use the test facility on indicator if available)
- Any evidence of venting of gas from the arc chutes of any circuit breakers (starter circuit breakers)
- Excessive heating of any component which could indicate hot or loose joints.
- Excessive build up of dust or ingress of water.
- Condition of door and cover seals to ensure IP rating is maintained.
- Update electrical drawings with any temporary or permanent wiring changes that have been performed.
- Ensure that doors and cover plates are in place and securely fastened.
- Condition of sealing gaskets, signs of corrosion, any smell which may indicate overheating and any noisy components should be investigated.

#### 14.2 Periodic tests

Testing of the electrical operation and protection functions of the MCC and associated control equipment should be performed according to your local maintenance schedule. These tests should be performed by a competent electrician who fully understands the arrangement and operation of the MCC. These tests should include, but may not be limited to, the following items:

- Manual trip of all starter circuit breakers to ensure correct operation of output contacts.
- Correct operation of all circuit breakers including three phase and single phase circuits.
- Armature pole faces should be cleaned to prevent or stop chatter. Where accessible the contacts should be inspected for condition and replaced if necessary.

#### 14.3 Start Up And Shut Down Tests

This frequency may vary according to site requirements. These tests should be performed by a competent electrician who fully understands the arrangement and operation of the MCC. These tests should include, but may not be limited to, the following items:

- Inspection of all busbar joints for any evidence of localised heating due to a high resistance joint.
- Tensions of all motor cable termination bolts.
- Resistance tests of the MCC main busbars.
- Thermographic scan of bolted joints; may be conducted more frequently if necessary.
- All results should be compared with previous results to ensure that gradual deterioration is not occurring.
- Insulation resistance test should be conducted & results recorded.
- 2.5kV insulation test of main bus. (This test should be conducted with the main circuit breaker open, all feeder circuit breakers open, line side connected fuses disconnected and any communication bus wiring unplugged from intelligent devices ).

## i.Power Solutions Moducell v2.2 IOM Manual

### 15 MODULARITY CHARTS

The following tables give approximate module sizing for various type 2 co-ordinated electrical starter situations for the major suppliers of motor control equipment. These sizes are for the minimum of control equipment such as interposing relays and terminals. Consult your applicable factory for more exact sizing to meet your specific requirements.

#### 15.1 Merlin Gerin / Telemecanique

MODUCELL v2.2 MODULARITY CHARTS MERLIN GERIN / TELEMECANIQUE <sup>1</sup>			
Drive/Module Rating	Module Size <sup>2</sup>		
	DOL Starter Non Reversing	DOL Starter Reversing	VSD <sup>3</sup>
0-30kW MCCB / Contactor / TOL	02	03	02
0-11kW MCCB / Contactor / MPR	02	03	02
15-30kW MCCB / Contactor / MPR	03	04	03
37kW MCCB / Contactor / TOL (or MPR)	03	04	03
45-75kW MCCB / Contactor / TOL (OR MPR)	05	08	05
90-110kW MCCB / Contactor / TOL (OR MPR)	13	13	13
132-160kW MCCB / Contactor / TOL (OR MPR)	16	Full Tier <sup>4</sup>	16
>160kW MCCB / Contactor / TOL (OR MPR)	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>
Feeder Rating	MCCB Feeder	CFS Feeder	Contactor Controlled Feeder
0-125A 3 Pole Feeder	03	04	Refer Factory
126-160A 3 Pole Feeder	03	06	Refer Factory
161-250A 3 Pole Feeder	03	08	Refer Factory
251-400A 3/4 Pole Feeder	09	10	Refer Factory
>400A 3/4 Pole Feeder	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>
Distribution Board	Without Main Switch	With 3 Pole Main Switch	
18 Pole 250A	06	N/A	
30 Pole 250A	N/A	10	
42 Pole 250A	10	12	
48 Pole 250A	12	N/A	
60 Pole 250A	N/A	16	
72 Pole 250A	16	N/A	

<sup>1</sup> These tables provide a guideline for module sizing for various type 2 co-ordinated electrical starter situations based upon an operating voltage of 415V with a prospective fault level of 70kA.

<sup>2</sup> These arrangements allow for a minimum of control equipment such as interposing relays and control terminals. Control miniature circuit breakers are mounted with the control terminal strip either in the adjacent full height cable zone for modular starters or in the top wireway for full tier arrangements.

<sup>3</sup> Module sizes based upon the VSD being mounted remote to the module due to ventilation requirements of VSD negating internal arc protection measures. For soft starter arrangements please consult the original equipment manufacturer.

<sup>4</sup> The width of this starter should be determined by referring to standard drive layout drawings.

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## 15.2 Terasaki / Sprecher &amp; Schuh / Socomec

MODUCELL v2.2 MODULARITY CHARTS TERASAKI / SPRECHER & SCHUH <sup>1</sup>			
Drive/Module Rating	Module Size <sup>2</sup>		
	DOL Starter Non Reversing	DOL Starter Reversing	VSD <sup>3</sup>
0-22kW MCCB / Contactor / TOL	02	03	02
0-22kW MCCB / Contactor / MPR	03	04	03
30-45kW MCCB / Contactor / TOL (or MPR)	04	05	04
55-75kW MCCB / Contactor / TOL (or MPR)	06	08	06
90-110kW MCCB / Contactor / TOL (OR MPR)	14	14	14
132-160kW MCCB / Contactor / TOL (OR MPR)	16	16	16
>160kW MCCB / Contactor / TOL (OR MPR)	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>
Feeder Rating	MCCB Feeder	CFS Feeder	Contactor Controlled Feeder
0-125A 3 Pole Feeder	02	04	Refer Factory
126-160A 3 Pole Feeder	03	06	Refer Factory
161-250A 3 Pole Feeder	03	08	Refer Factory
251-400A 3/4 Pole Feeder	09	10	Refer Factory
>400A 3/4 Pole Feeder	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>	Full Tier <sup>4</sup>
Distribution Board	Without Main Switch	With 3 Pole Main Switch	
18 Pole 250A	06	N/A	
30 Pole 250A	N/A	10	
42 Pole 250A	10	12	
54 Pole 250A	12	N/A	
60 Pole 250A	N/A	16	
72 Pole 250A	16	N/A	

<sup>1</sup> These tables provide a guideline for module sizing for various type 2 co-ordinated electrical starter situations based upon an operating voltage of 415V with a prospective fault level of 65kA.

<sup>2</sup> These arrangements allow for a minimum of control equipment such as interposing relays and control terminals. Control miniature circuit breakers are mounted with the control terminal strip either in the adjacent full height cable zone for modular starters or in the top wireway for full tier arrangements.

<sup>3</sup> Module sizes based upon the VSD being mounted remote to the module due to ventilation requirements of VSD negating internal arc protection measures. For soft starter arrangements please consult the original equipment manufacturer.

<sup>4</sup> The width of this starter should be determined by referring to standard drive layout drawings.

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### 16 CABLING & TERMINATION CHARTS

The following tables provide details of the maximum allowable outgoing cable sizes that can be terminated into a particular standard arrangement module or ACB tier. If a larger cable (or combination of cables) is required to be terminated, a special design must be considered.

MODUCCELL v2.2 CABLING & TERMINATION CHARTS			
Module Size	Maximum Allowable Outgoing Power Cable Size		Maximum number of Single Layer WDU4 4mm <sup>2</sup> Terminals <sup>1</sup>
	Starter	Feeder	
02	25mm <sup>2</sup>	35mm <sup>2</sup>	10
03	25mm <sup>2</sup>	120mm <sup>2</sup> **	20
04	35mm <sup>2</sup>	120mm <sup>2</sup> **	30
05	70mm <sup>2</sup>	120mm <sup>2</sup> **	40
06	70mm <sup>2</sup>	120mm <sup>2</sup> **	49
07	70mm <sup>2</sup>	120mm <sup>2</sup> **	59
08	70mm <sup>2</sup>	120mm <sup>2</sup> **	69
09	70mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	79
10	70mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	89
11	70mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	99
12	70mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	108
13	120mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	118
14	120mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	128
15	120mm <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	138
16	185mm <sup>2</sup> <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	148
17	185mm <sup>2</sup> <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	158
18	185mm <sup>2</sup> <sup>2</sup>	185mm <sup>2</sup> <sup>2</sup>	167
Full Tier <sup>3</sup>	630mm <sup>2</sup>	630mm <sup>2</sup>	55

<sup>1</sup> Number of terminals based on standard Weidmuller WDU 4 terminals (part number 1020100000). The following items are included in the terminal strip in addition to the terminals:

- 1 x 2 Pole Miniature Circuit Breaker (18mm high)
- 1 x 0292460000 SCHAT 5 Large Group Tag Marker (19.5mm high)
- 1 x 1050000000 WAP 2.5-10 Terminal End Plate (1.5mm high)
- 2 x 0383560000 EW 35 DIN Rail End Bracket (8.5mm high each)

<sup>2</sup> 185mm<sup>2</sup> power cable only possible in a bottom/top entry situation. If power cables are entering module through the side a maximum of 120mm<sup>2</sup> is possible.

<sup>3</sup> The maximum number of terminals listed is based upon the terminal strip being located in the wireway at the top of the tier. More terminals are available should the terminal strip be located within the module.

\*\* Conditions Apply for maximum cable size - Refer to standard drive layout drawings

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MODUCELL v2.2 CABLING & TERMINATION CHARTS		
ACB Size / Current rating	Maximum Allowable Outgoing Power Cable Size	
	Single Sided Tier	Double Sided Tier
800 - 800A	2 x 500mm <sup>2</sup>	2 x 630mm <sup>2</sup>
1000 - 1000A	2 x 500mm <sup>2</sup>	2 x 630mm <sup>2</sup>
1200 - 1250A	2 x 500mm <sup>2</sup>	2 x 630mm <sup>2</sup>
1600 - 1550A	2 x 500mm <sup>2</sup>	2 x 630mm <sup>2</sup>
2000 - 2000A	4 x 500mm <sup>2</sup>	4 x 630mm <sup>2</sup>
2500 - 2275A	4 x 500mm <sup>2</sup>	4 x 630mm <sup>2</sup>
3200 - 2750A	4 x 630mm <sup>2</sup>	6 x 630mm <sup>2</sup>
4000 - 3350A	4 x 630mm <sup>2</sup>	6 x 630mm <sup>2</sup>
4000 - 4000A	Not Available	6 x 630mm <sup>2</sup>
5000 - 4650A	Not Available	6 x 630mm <sup>2</sup>
6300 - 5000A	Not Available	6 x 630mm <sup>2</sup>

Maximum outgoing cable arrangements based upon the following information:

- Cable route length 30 metres
- Conductor material - copper
- Design load - as per current rating detailed above
- Efficiency - 100%
- Voltage - 415V / 3 Phase
- Maximum voltage drop 3%
- Design ambient - 40°C
- Cables installed 3 x 1 core trefoil X-90 (XLPE) in 1 layer on ladder, touching
- Standard single core 0.6/1kV unarmoured XLPE insulated HR PVC sheathed cables with circular conductors
- Standard metal glands - unarmoured

All other arrangements please refer to factory

## **1.2.3 Control System – SCADA Operation**



# CONTROL SYSTEM

## USER MANUAL

**DOCUMENT CONTROL**

**Contract No** C1314-011

**Title** Control System

**Document Number** 879540-84-IOM-0002

**Document Control** This Document is Uncontrolled When Printed

Revision Details	Revision	Date	Reason
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	Name	Position	Date
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<b>Authorised by</b>			

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## 1 PURPOSE

The purpose of this document is to provide a description of the PLC and SCADA design and functionality of the blower system at Gibson Island WWTP. This document assumes prior operational understanding of the Gibson Island WWTP SCADA including operation of drives, duty, and PID control loops.

## 2 SCOPE

This document describes SCADA operation of the installed system.

This document does not cover the operation of the function blocks and user interface contained in the Gibson Island SCADA standard library.

### 3 DEFINITIONS AND ACRONYMS

Term	Explanation
HMI	<b>H</b> uman <b>M</b> achine Interface
I/O	System Inputs and <b>O</b> utputs (May apply to physical PLC, device communications or SCADA Inputs and outputs)
PID	<b>P</b> roportional, Integral and <b>D</b> erivative
PLC	<b>P</b> rogrammable Logic <b>C</b> ontroller
SCADA	<b>S</b> upervisory <b>C</b> ontrol <b>a</b> nd <b>D</b> ata <b>A</b> cquisition
TCP/IP	<b>T</b> ransmission <b>C</b> ontrol <b>P</b> rotocol / <b>I</b> nternet <b>P</b> rotocol
WWTP	<b>W</b> aste <b>W</b> ater <b>T</b> reatment <b>P</b> lant

## 4 RELATED DOCUMENTS

Rev	Document No.	Title / Description
2.5	003547	QUU – PLC Software Guidelines
C	879540-84-SP-0001	Control System Functional Specification
0	486/5/5-0205-108	Grit/Blower Building PLC13 Control System Network Topology
0	486/5/5-0205-116	PLC13 Rack 0 Schematic Diagram
-	-	Aerzen Turbo Blower O&M Manual

## 5 BLOWER SYSTEM OVERVIEW

The blower system includes a GE Fanuc PLC (PLC13) for monitoring and master control of 4 Blower Systems. The blowers are connected to the PLC via an Ethernet connection. The PLC is connected to the main site network via a separate Ethernet connection through which it communicates with PLC3 and PLC4.

As well as the 4 blower systems, the process area includes a pressure transmitter and a flow transmitter. The pressure transmitter is utilised to control the main header pressure via a control loop.

### 5.1 PROCESS OVERVIEW

The blower system is controlled via a pressure control PID "control loop". The PID output is used to regulate the power reference to all running blower systems. As a result, all running blowers will control their power together. This type of system provides a coarser but more aggressive level of control than other configurations. The controller is reverse acting so that if the pressure is measured below the setpoint, all blower systems increase their power and if it is measured above the setpoint, all blower systems reduce their power. The process variable can be set by either the operator (Fixed Pressure Setpoint) or by the system (Floating Pressure Setpoint).

The four blowers are controlled in a duty arrangement. The combination of blowers selected to run is determined to give the most efficient configuration for producing the required air demand. The system is designed so that normally there will always be at least one blower running.

When the requested power of the running blower systems is over the switching point for a specified time period, the next blower in the duty sequence is started to increase the air output. During this period the PID output is forced to a set power for a certain amount of time in order to stabilise the system.

If the requested power of the running blower systems is below the appropriate switching point for a specified time period, then the lowest duty running blower is stopped. During this period the PID controller output is forced to a set power for a certain amount of time in order to stabilise the system.

#### 5.1.1 FIXED SETPOINT MODE

Fixed Mode is selected via the Pressure Control Popup (refer to 6.1.5). When selected, the operator has to later select Floating Mode when finished.

In Fixed Set Point Mode the operator enters the desired header pressure set point. The blower input powers are modulated to maintain the required header pressure. The fixed pressure setpoint must be kept within limits (44kPa → 52kPa).

This mode allows PLC13 blowers to run independently of PLC4 if required. It should be used if communications is lost between PLC13 and PLC4.

#### 5.1.2 FLOATING SETPOINT MODE

Floating Set Point Mode is sometimes referred to as "Optimised" Mode or "Automatic" Mode and is the normal running mode. In this mode, the Header Pressure Setpoint is received from PLC4. The Header Pressure Setpoint is clamped to a range of 44 to 52kPa.

If the system is using Floating Control Mode and PLC13 fails to communicate with PLC4, the system defaults to Fixed Mode and the setpoint will remain unchanged (bumpless). If required, the operator may then change the setpoint from the pressure control popup

(refer to 6.1.5). When communications is restored, the system automatically returns to Floating Mode, providing the Fixed Mode button was not pressed.

### **5.1.3 DUTY CONTROL**

Duty control for the blowers will be according to standard duty for a continuously run system. Duty changeover will occur automatically on the 1<sup>st</sup> of each month (monthly). Duty can be changed manually via the Duty Control Popup (refer to 6.1.4).

#### **5.1.3.1 DUTY CHANGEOVER**

To avoid a period when no blower is producing process air, duty changes that result in the replacement of running blowers will be automatically controlled. The replacing blower is started for a time period before the replaced blower is stopped.

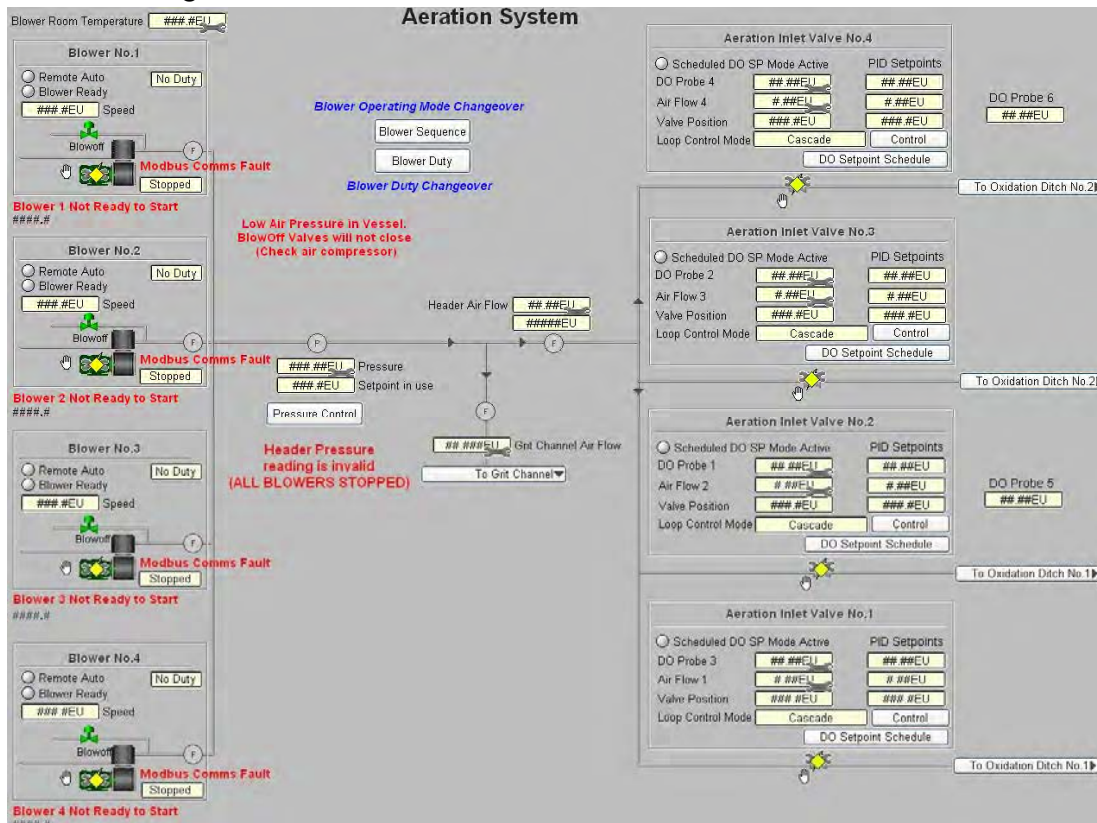
If a duty change requires multiple replacements each replacement will occur in order of the replacing blower's duty.

## 6 OPERATION

Operator monitoring and control of the blower system is accessed via the aeration system SCADA display.

### 6.1 AERATION SYSTEM SCADA DISPLAY

The aeration system SCADA display shows a P&ID like representation of the blower system as shown in the figure below.



**Figure 1: Aeration System Display**

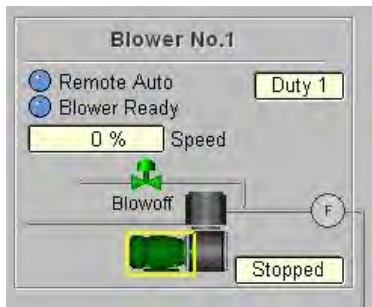
This display provides access to the following popups:

1. Each blower's control
2. Each blower's information
3. Sequence control
4. Duty control
5. Pressure control

Please refer to the following sections for more information regarding operation and access to the above popups.

#### 6.1.1 BLOWER CONTROL

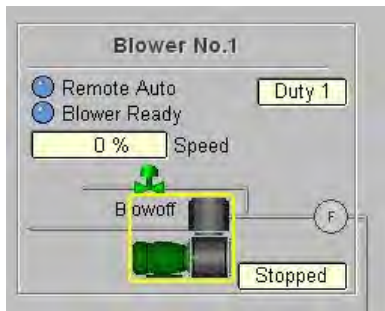
A Blower's Control Popup can be opened by clicking on the associated blower motor on the Aeration System page, shown in Figure 2 inside the yellow selection box.

**Figure 2: Opening the Blower Control Popup****Figure 3: Blower Control Popup**

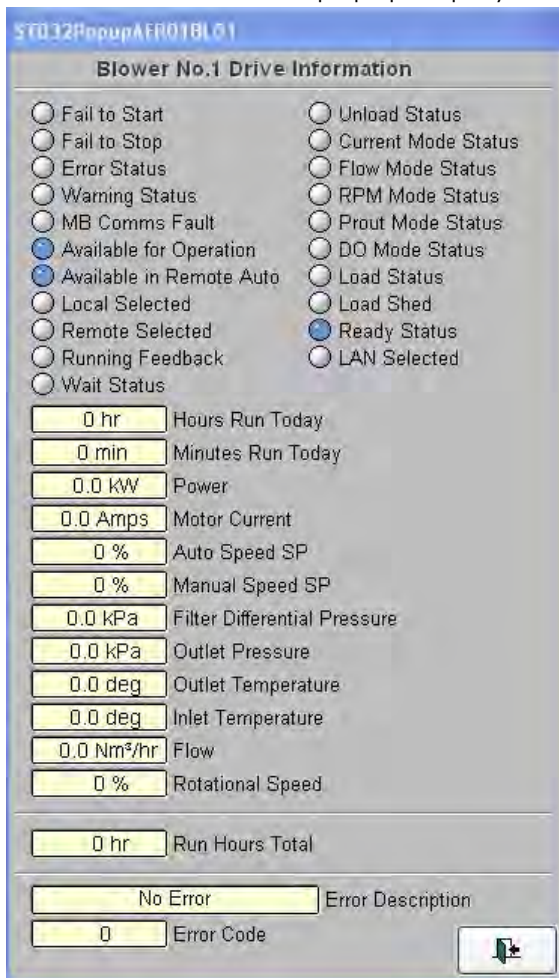
The Blower Control Popup utilises the standard StartStop1 popup of the Gibson Island standard library. Please refer to the operation of this popup for more information.

### 6.1.2 BLOWER INFORMATION

A Blower's Information Popup can be opened from the Aeration System page by clicking on the associated blower drive, shown by the yellow selection box in Figure 4.

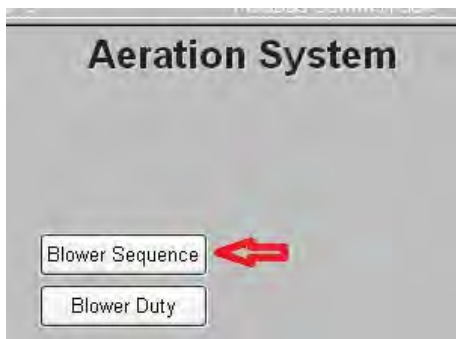
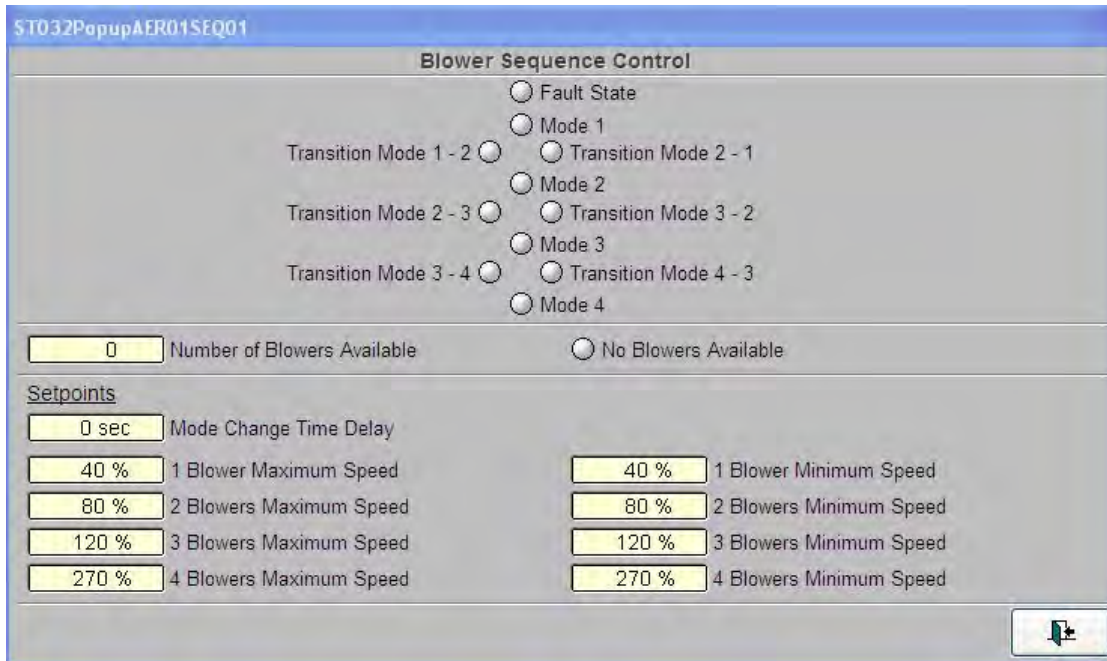
**Figure 4: Opening the Blower Information Popup**

The Blower Information popup displays status and drive information, as shown in Figure 5.

**Figure 5: Blower Information**

### 6.1.3 SEQUENCE CONTROL

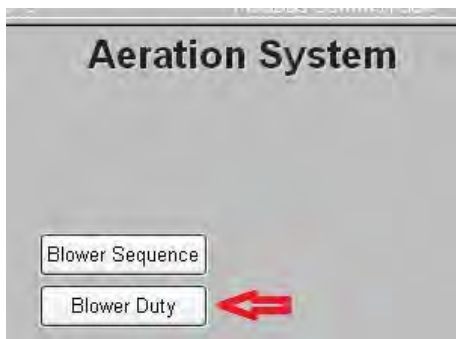
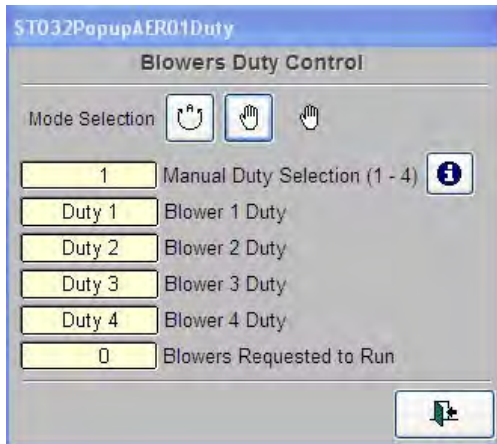
The Blower Sequence Control popup can be opened by clicking on the Blower Sequence button on the Aeration System page, refer to Figure 6. This popup, shown in Figure 7, shows the current running mode of the blower system or the transition currently underway if switching between system modes. This popup also provides the facility to configure the sequence control setpoints.

**Figure 6: Opening the Blower Sequence Popup****Figure 7: Blower Sequence Control**

The setpoints shown in Figure 7 are used for starting and stopping the blowers as part of automatic sequence transitions. The power percentages reflect percentages of the working range. They do not directly relate to the input power percentages of the blower. Please refer to 5.1: Process Overview for a description of the sequence transition process.

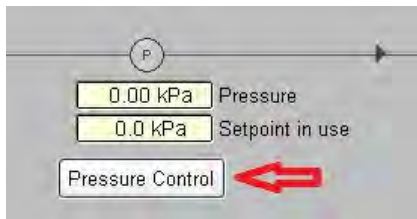
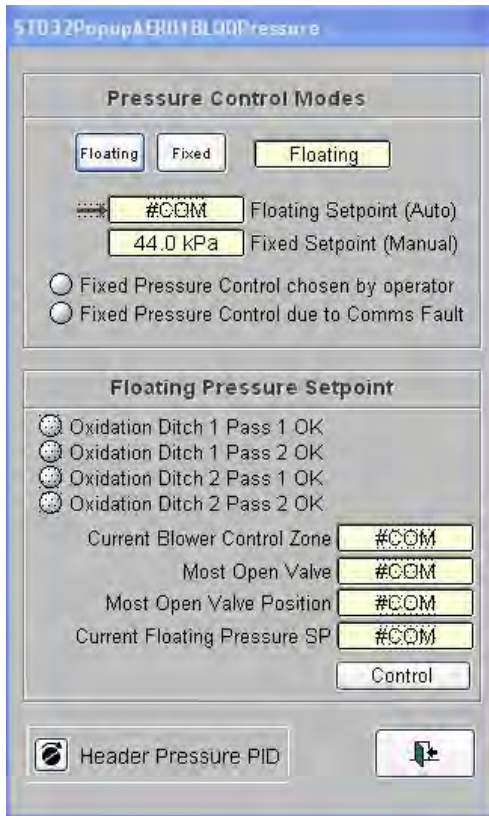
#### 6.1.4 DUTY CONTROL

The duty selection and status popup can be opened by clicking on the Blower Duty button on the Aeration System page as shown in Figure 8. The Duty Control popup is shown in Figure 9. The information icon next to the Manual Duty Selection input on this popup opens the Blowers Duty Control Selection, shown in Figure 10, which displays the duty roles assigned to each blower under the available duty selections.

**Figure 8: Opening the Blowers Duty Control Popup****Figure 9: Blowers Duty Control****Figure 10: Blowers Duty Control Selection**

### 6.1.5 PRESSURE CONTROL

The pressure control popup is accessed via the Pressure Control button on the Aeration System page, as shown in Figure 11.

**Figure 11: Opening the Pressure Control Popup****Figure 12: Pressure Control**

#### 6.1.5.1 FIXED AND FLOATING SETPOINT MODES

Fixed Mode is selected via the Pressure Control Popup, as shown in Figure 13. When selected, the operator has to later select Floating Mode when finished. Please refer to 5.1.1: Fixed Setpoint Mode for more information.

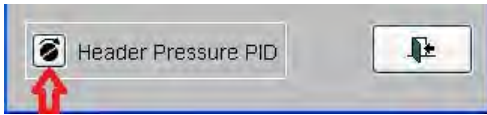
**Figure 13: Selecting Fixed Setpoint Mode**

Floating Mode is also selected via the Pressure Control Popup, as shown in Figure 14. Please refer to 5.1.2: Floating Setpoint Mode for more information.

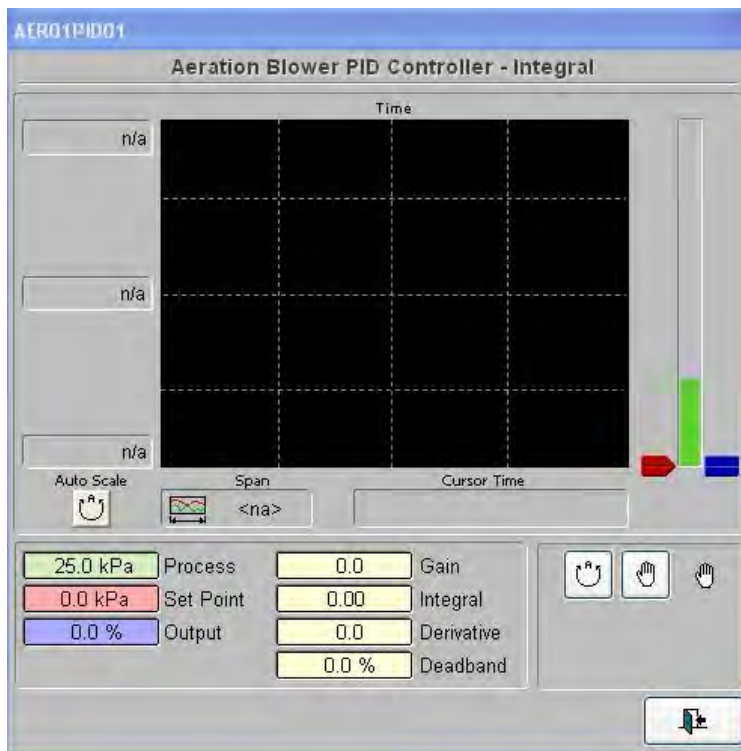
**Figure 14: Selecting Floating Setpoint Mode**

### 6.1.5.2 PRESSURE CONTROL PID

The controls for the PID controller are accessible via the Header Pressure PID button (refer to Figure 15) on the Pressure Control popup, shown in Figure 12, with the PID controller popup displayed in Figure 16.



**Figure 15: Opening the Header Pressure PID**



**Figure 16: Aeration Blower PID Controller**

## 7 TROUBLESHOOTING

Item	Symptom	Possible Causes	Further Actions
1	PLC13 tags are displayed as "#Com" on the SCADA	PLC13 communications fault to SCADA	Confirm if communications fault by checking PLC13 status on Communications page. If communications fault, refer to item 2: PLC13 Communications Fault.
2	PLC13 Communications Fault	Ethernet cable unplugged or faulty	Check Ethernet cable plugged into Ethernet card slot 4 Of PLC13.
		Ethernet Switch Fault	Check Ethernet switch at PLC3
		PLC hardware fault	Check PLC13
3	Blower showing an Error Code / Fault status	Blower Fault	Refer to the associated code in Appendix A
4	All values on Blower Drive Information Popup are zero	Blower communications fault	Refer to item 5: Blower Modbus Comms Fault.
5	Blower Modbus Comms Fault	Blower powered off	Check blower is powered on
		Blower system network switch faulty	Check Ethernet Switch ENS13
		Ethernet cable fault	Check Ethernet cable plugged into associated port (PLC = port 1; Blower 1 = port 2; Blower 2 = port 3; Blower 3 = Port 4; Blower 4 = Port 5) of blower system Ethernet switch.
6	Blower unable to be started with available status	Header pressure above 60kPa	Check Header Pressure
		Header pressure above high setpoint	Check Header Pressure & high setpoint
		Header pressure transmitter fault	Check header pressure transmitter
7	Blower system not increasing in power	Pressure not below pressure setpoint	Check header pressure & pressure setpoint
		PID Power Setpoint inhibited from increasing	Check pressure not more than 1kPa above setpoint
			Check Comms to PLC4

## APPENDIX A BLOWER ERROR CODES

The following error codes are faults and warnings read from the blowers.

Error Code	Error	Description	Inspection/Maintenance
1	Pressure Sensor	DP1 > 5kPa DP2 > 5kPa P2 > 70kPa	Change sensor / controller
2	Temp Sensor	T1 > 100°C or T2 > 150°C	Change sensor / controller
4	DCL	DCL > 700V	Check VFD, change controller
16	VFD	VFD Error	Check VFD, change controller
32	VFD Cooling	Temp switch "ON" of VFD	Check VFD, controller
64	Speed	RPM > 10000	Change VFD driver, CPU
101	Filter Blockage	DP1 > 1.5kPa	Clean or change filter
102	High T2	T2 > 120°C	Check temp sensor, controller, operating condition
103	High T1	T1 > 45°C	Check temp sensor, controller, operating condition
104	High P2	P2 > 80kPa	Check operating condition
105	High Speed	Speed > 98% Max Speed	Check operating condition
106	Surge	Blower operating near surge line	Check operating condition
110	High Magnet Temp	Magnet Temp > 280°C	Check motor
111	High Duty	Duty > 90%	Check motor voltage, CP value
113	High VFD Temp	VFD Temp > 0.95 Max Temp	Check ambient & VFD temperature
114	Low SV	SV < 10%	Check SV value and corresponding wiring
126	High Motor Temp	Motor Temp > 180°C	Check motor cooling & filters
201	Filter Blockage	DP1 > 2.3kPa	Clean or change filter
202	P2 Limit	P2 > 85kPa	Check operating condition
204	Current Limit	Current > Max Allowable	Check operating condition, CP value
205	Low DC Link	DCL < Set Value	Check VFD, controller,

			lightning
206	High DC Link	DCL > Set Value	Check VFD, controller, lightning
207	Over Speed	RPM > Max Value	Check operating condition
210	Inverter Problem	Error signal from inverter	Check inverter
211	Inverter Overheat	Overheat of heat sink	Check job site, fan motion, operating condition
214	Start	Fail on DCL rise within time	Check charging status, controller, wiring
215	Start	Below 10000rpm after start	Check motor, VFD
216	Start	No movement	Check motor, VFD
220	Cooling Fan	No action of cooling fan or MC	Check MC2, wiring
221	Motor	Speed < 9000rpm	Check motor
222	T1 Limit	T1 > 50°C	Check cooling air ducting, controller, T1 sensor
223	BOV	Not Closed	Check BOV valve and CP value
224	Surge	Blower was operating at surge	Check job site, operating conditions
225	Real Time Surge	Real Time Surge Safety Trip	Check job site, operating conditions
230	Switching Error	Manual Stop when in Remote	Check job site and controller
236	Emergency Stop	Touch screen version only	Press emergency stop button
239	Loss of Power	Power has been interrupted	Check power supply
240	Motor Bearing	Motor not rotating within design	Check motor rotation
241	Fan Motor	< 8000rpm	Check fan motor rotation
242	Low DCL Fan	Fan motor inverter DCL < Set Value	Check VFD, controller, lightning
243	High DCL Fan	Fan motor inverter DCL > Set Value	Check VFD, controller, lightning
244	Fan Motor Fail	Fan motor failed to start	Check fan motor rotation, fan motor CB
245	Fan Motor High Temp	Fan motor > 180°C	Check fan motor, ambient temp

246	Fan Motor Inverter	Error from fan motor inverter	Check fan motor VFD
250	High VFD Intake Temp	VFD inlet temp > 50°C	Check ambient & VFD temperature
255	EEPROM CPU	Cannot be read from EEPROM	Change CPU