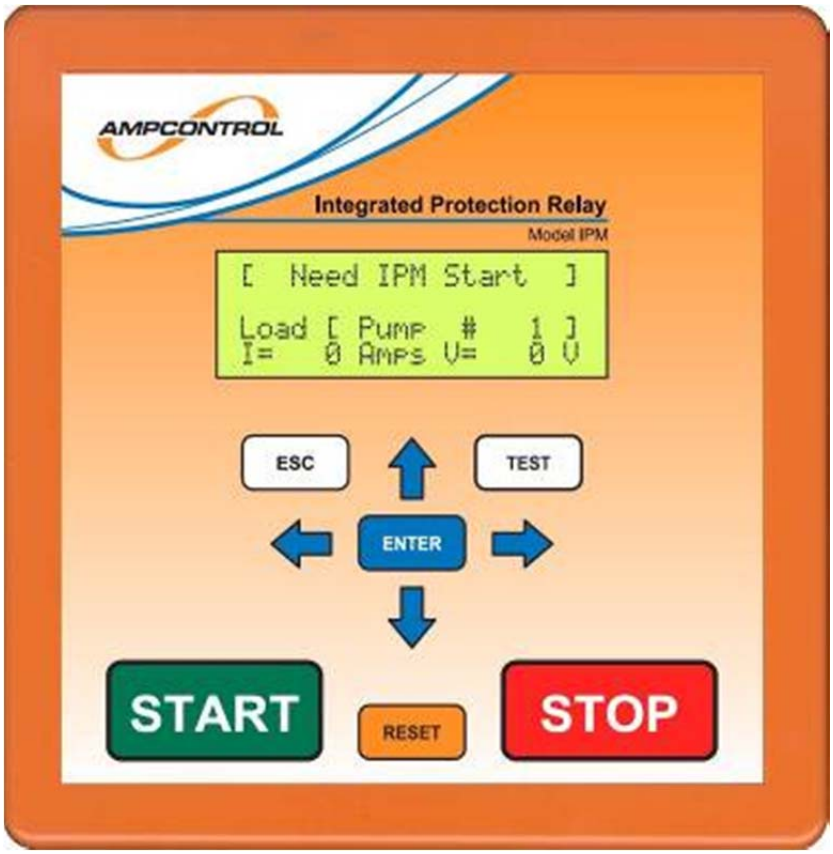
IPM V2
Integrated Protection Relay
User Manual



IPM2B003 121549 Issue 9 05/07/12

Designed and Manufactured in Australia by Ampcontrol Pty Limited ACN 000 915 542
Ampcontrol Electronics Phone: (02) 4903 4800 Fax: (02) 4903 4888

AMPCONTROL
POWER THROUGH INNOVATION

Copyright Notice

Disclaimer

Ampcontrol Pty Ltd will make no warranties as to the contents of this documentation and specifically disclaims any implied warranties or fitness for any particular purpose.

Ampcontrol further reserves the right to alter the specification of the system and/or manual without obligation to notify any person or organisation of these changes.

Before You Begin

We would like to take a moment to thank you for purchasing the IPM Integrated Protection Relay. To become completely familiar with this advanced protection and control relay system and to ensure correct operation, we recommend that you take the time to read this user manual thoroughly.

CRN: 9657

IPM Software

Version IPM V03 Initial Release

Version IPM V04

Version IPM V05 Prototype only. (Not for use)

Version IPM V06 Snore Function Added

Version IPM V07 Modified Under Current Trip

Version IPM V08 No Functional Changes

Version IPM V09 Added 100:1 Current Transformer

Increase relays current range by adding the ability to select either the 100:1 or the 1000:1 CT's

Version IPM V10 Added Remote IPM Control

1 Overview 1
- 1.1 Introduction 1
- 1.2 Protection Functions 1
- 1.3 Basic Display Operation 1
- 1.4 Trip / Status Messages: 2
- 1.5 Last Trip Status Messages: 3

2 Machine Data Transfer 3
- 2.1 Remote Termination Module 3
- 2.2 Machine Type Codes 3
- 2.3 Machine Type Number 3

3 Earth Protection Functions 3
- 3.1 Earth Leakage 3
- 3.2 Insulation Test 4
- 3.2.1 Automatic Insulation Test 4
- 3.2.2 Manual Insulation Test 4
- 3.3 Earth Continuity 4

4 Current Related Functions 5
- 4.1 Overload Protection 5
- 4.2 Short Circuit Protection 6
- 4.3 Phase Current Balance 6
- 4.4 Residual Current Signal 7
- 4.5 Under Current Trip 7

5 Voltage Related Functions 7
- 5.1 Main Contactor Fail Protection 7
- 5.2 Undervoltage Trip 7
- 5.3 Voltage Metering 7

6 Analogue Output 7

7 Communications 8
- 7.1 Modbus Commands 8
- 7.2 Modbus Status 8

8 IPM Alarm Functions 8

9 Fan Control 8
- 9.1 Burp Function 8

10 The IPM Snore Function 9
- 10.1 Basic Operation 9
- 10.2 Setup procedure for Snore Function: 9

11 Remote IPM Control Function 10
- 11.1 Function Overview 10
- 11.2 Operation Modes 11
- 11.3 IPM/ RTM Software Compatibility 11

12 Adjustable Settings 11
- 12.1 Parameter Groups 11
- 12.2 Changing Settings 12

13 System Control 12
- 13.1 Digital Inputs 12
- 13.2 Output Relays 12
- 13.3 Outlet Control 13
- 13.4 Start Mode 13
- 13.5 Operational Sequence (insulation test and Burp Function selected) 13

14 Event Log 13

15 Time & Date 14

16 IPM Equipment Parts List 15

17 General Notes: 15

18 IPM Specifications 16

19 Menu Structure: 17

20 IPM Modbus Address Table 18

Drawings Related to Manual.

IPM2E002
Connection Diagram 22

IPM2A013
IPM Display Map 23

IPM2E008
Motor Overload and
Short Circuit Curves 24

IPM2A004
Case Dimensions 25

IPM2A001
IPM Terminal Block 26

IPM2A002
415V ITM Module 27

IPM2A003
1kV ITM Module 28

IPM2A005
RTM Module Details 29

IPM2A018
Current Transformer 87mm
& 45mm Profiles.....30

1 Overview

1.1 Introduction

The Ampcontrol IPM Integrated Protection Relay (Version IPM V10.0) is an intelligent protection relay based on microprocessor technology.

The IPM Integrated Relay provides the necessary functions required for protecting electrical outlets supplying underground mining machinery, powered by reeling or trailing cables, in the metalliferous industry. The relay can also be used to provide optimum overload protection of motors used on conveyors, pumps, fans and compressors. All of the protection functions are combined into a compact, plug-in unit, which can be easily changed out to minimise down time in the event of a problem with the relay.

The IPM Integrated Protection Relay can provide Machine Data Transfer through the use of a Remote Termination Module (RTM) connected between the pilot and earth at the machine end of the trailing cable. Through the use of the RTM Remote Termination Module the relay parameters are automatically up loaded from a remote machine when a cable is inserted into a power outlet. The RTM also allows for remote control (starting) of the IPM output.

A RS485 Modbus communication port is available that can be connected to Motor Starter PLC's or a central monitoring system for continuous monitoring and fault-finding.

The IPM Relay provides an isolated 4-20mA analogue output to continuously monitor Average Current, Overload, Earth Leakage and the Insulation level of the relay (see Section 6, Page 7 for details).

An automatic Insulation Test can be initiated once all starting conditions are met. A high voltage DC “Insulation Test” to earth of the cable is carried out. If the result of the Insulation Test is above the preset resistance level, the IPM’s MCR relay energises, which in turn closes the main contactor. A manual “Insulation Test” is provided as a maintenance/fault finding tool. (When this test is performed the MCR relay does not close at completion of a healthy test).

The Insulation Test allows cable insulation levels to be trended as an aid to preventative maintenance.

A Burp Function allows for the progressive inflation of ventilation bags (tubes) by pulsing the motor contactor controlling a ventilation fan, several times at start up.

A Snore Function is available for controlling pumps; the Snore function automatically stops the output on detection of low current and restarts the outlet after a fixed or automatically-adjustable time delay.

The IPM Integration Protection Relay has 6 digital inputs, which feed into a microprocessor unit. The microprocessor has been programmed to control three output relays. The relays are MCR (Main Contactor Relay), CBR (Circuit Breaker Relay) and ALM (Alarm Relay).

All of the tripping logic and outlet control is performed by the microprocessor, so that virtually no external control is required (See Typical Connection Diagram IPM2-E-002).

A four-line 20 character backlit LCD display combining with a keypad provides an easy to operate user interface. The display provides easy access to all available information. A simple procedure allows adjustment of the relay’s settings.

1.2 Protection Functions

The Ampcontrol IPM Integrated Protection Relay provides protection functions for:

Earth Leakage - Section 3.1
Earth Continuity - Section 3.3
Overcurrent - Section 4.1
Short Circuit - Section 4.2
Under Current - Section 4.5
Contactor Fail - Section 5.1
Under Voltage - Section 5.2

Protection trips are stored in a non-volatile memory requiring a reset function before power can be restored to the load. This remains the case even if a power down occurs following a trip condition.

1.3 Basic Display Operation

The facia of the IPM Integrated Protection Relay has a four line 20 character backlit Liquid Crystal Display (LCD), Status LED and a tactile keypad.

The layout of the display structure is shown on the ‘IPM Display Map’. The display **level** is changed with the Up/Down arrow keys and the Left/Right arrow keys control the various display screens. See drawing ‘IPM Display Map’ Drawing IPM2-A-013.

The ENT and ESC keys are used to modify settings and provide hyper jump access to the display structure.

The Reset key allows a reset following a trip condition.

The Test key is used to activate a manual insulation test.

Start and Stop keys are provided for closing and opening the main contactor supplying power to a machine.

The Status LED is a single bi-coloured LED that can be viewed some distance from the relay. Status indication is as follows:

IPM Status	LED Colour	LED Flash
OK (Run)	Green	4Hz
OK (Stopped)	Green	1Hz
Alarm	Red	4Hz
Trip	Red	1Hz

The IPM status display is one of the most useful features of the relay’s display system and should be viewed as the first step in fault finding. The ‘Relay Status Page’ is the default screen on power up and shows the current status of the IPM Protection Relay.

Status Messages are listed in Table 1.1.

Line 1: A one-line status message is displayed and if

```
[   Need IPM Start          ]

Load     [Pump #   1        ]
I= 0     Amps V=   0         V
```

more than one message is active the display cycles through all active messages at 1 second intervals.

Line 2: IPM Software version appears here while ↑ key held.

Line 3: Shows the Load Type and Number (from the connected RTM unit).

Line 4: Shows the Load Current (3 ϕ average) and Load Voltage (Average ϕ - ϕ.)

Through the use of the Modbus communications port, PLC's and SCADA Systems can be configured to display the same messages that appear on the display. This helps to provide consistent information to operators.

1.4 Trip / Status Messages:

The following table shows a list of the forty (40) status messages and the category (type) of the messages. Messages are cleared according to their message category.
Type 1: Messages are latched for display and are cleared by either pressing the <ENT> key while on the Status Display Page or by starting a new starting sequence.
Type 2: Messages are enabled and cleared automatically.
Type 3: Messages are triggered by the respective trip functions and are cleared by resetting the trip function.

Message and Type		Comment
Tripped No Volts	1	Voltage on load side of contactor is too low
MC Close Fail	1	MCI input did not close within 5 Sec of MCR relay closing
External MC Open	1	IPM detected (via MCI input) that MC was opened – not initiated by the IPM relay
Burp MCI Fail	1	MCI Input fails to follow MCR relay output during burp phase
Under Current Trip	1	Under Current Function Tripped
Last T: --------	1	Shows 'Last Trip' record
Outlet Paused	2	IPM waits 5 Sec between running (or testing) and re-testing
Need IPM Start	2	Awaiting IPM start digital input
Testing Insulation	2	In process of Insulation Test (2 seconds)
Closing Main Cont.	2	MCR closed, waiting for MCI feedback (5 Sec max)
Burp: MCR Closed	2	Burp Phase is on MCR closed
Burp: MCR Open	2	Burp phase is active –MCR is open
Running:	2	Outlet Closed
Snore	2	Snore Function Active
Snore – Close Aux	2	Aux Digital input must be closed for Snore to function
High Current Alarm	2	High Current Alarm Triggered
Thermal Trip Alarm	2	Thermal Trip Alarm Triggered
Cur. Balance Alarm	2	Current Balance Alarm Triggered
Under Cur. Alarm	2	Under Current Alarm Triggered
Earth Leakage Alarm	2	Earth Leakage Alarm Triggered
UnderVoltage Alarm	2	Under Voltage Alarm Triggered
Insulat.Test Alarm	2	Insulation Test Alarm Triggered
Earth Leakage Trip	3	Earth leakage Function Tripped
Earth Cont. Trip	3	Earth Continuity Function Tripped
Insulat. Fail Trip	3	Insulation Test Function Tripped
Over Current Trip	3	Over Current Function Tripped
Short Circuit Trip	3	Short Circuit Function Tripped
I Balance Trip	3	Phase Current Balance Function Tripped
Residual Cur. Trip	3	Residual Current Function Tripped
Main Contactor Fail	3	Main Contactor Fail Function Tripped
RTM-Offline Trip	3	IPM can't communicate with RTM
IPM Memory Error (See Note1)	3	Corrupted memory in relay's stored settings
RTM Memory Error (See Note 1)	3	IPM detected errors in set up data received from RTM
Stopped - IPM	3	IPM Stop Digital input activated (closed)
RTM CT Ratio Error	3	the attached RTM was set up using a different CT Ratio than that of the IPM in use

Message and Type		Comment
RTM Version Error	3	the attached RTM does not support 100:1 CT operation
Need RTM Start	2	Shown when the digital input is closed but the IPM is stopped.
Remote Stop	3	Shown whenever RTM's digital input is open.
Configuration Error	2	Present when: Start is set to Modbus. In snore mode; the delay or undercurrent trip level is not set. Also if the remote start is set to 'yes' or 'aux' whilst in snore mode.
Stopped – Ext Stop	3	IPM Stop Digital input externally activated (closed)

Table 1.1

Note1:
It is normal to see the IPM Memory Error Message when switching between Diode/RTM Mode or when the RTM is first connected to the pilot.

1.5 Last Trip Status Messages:

The IPM Relay has several functions, which can stop/trip the outlet and then self-clear. The IPM Relay therefore saves the non-latched trip codes in a register and displays the 'Last Trip' messages in the Status Message Page. (Note that the stop/trip function also appears in the Event Log).

Messages that are displayed **at Last T: ---------**

Message	Comment
EC Leak T	E/C Leakage Trip that provides additional information for E/C Trip
EC Ω Trip	E/C Ohms Trip that provides additional information for E/C Trip
MC Opened	Main contactor opened – opening not initiated by the IPM Relay
RTM Off L	RTM Off Line – IPM can't communicate with RTM
Und.I Trp	Under Current trip caused outlet to stop
Stopped	IPM Stop Input Tripped Locally
Ext. Stop	IPM Stop Input Tripped Externally

Table 1.2

2 Machine Data Transfer

2.1 Remote Termination Module

The Remote Termination Module is a microprocessor based fully encapsulated module that replaces the diode at the end of the pilot conductor of the trailing cable. It is powered by and communicates via the pilot line. Its non-volatile memory stores the parameters to configure the outlet as appropriate for that machine.

Machine type and machine number are displayed on the Default and Earth Continuity Screens (Levels 1 and 3).

2.2 Machine Type Codes

There are 14 selectable machine type codes available for use in the Remote Termination Module. The descriptive code is transmitted to the IPM Relay to identify the type of machine connected to the outlet. The codes are programmed at the **'RTM Mach. Type'** page (Level 6, Screen 1).

J-bo	Face Boring Machine
Fan	Ventilation Fan
Drill	Drill
Pump	Pump
Hpmp	Hydraulic Pump
Wpmp	Water Pump
DCB	Distribution Control Box
Bolt	Bolter
HRMr	Hard Rock Miner
Belt	Conveyor Belt
Winc	Winch
Crsh	Crusher
Dplg	Dummy plug
	Spare

2.3 Machine Type Number

Machine numbers 1 to 40 can be assigned to machines. These numbers are programmed at the **'RTM Mach. Num.'** page (Level 6, Screen 2).

3 Earth Protection Functions

3.1 Earth Leakage

The earth leakage protection function uses a 1000:1 core balance toroid to measure the earth fault current. A Residual Current Device (RCD) operating characteristic is provided with adjustable trip sensitivity and time delay. If the earth leakage signal exceeds the trip level for the selected trip time, a trip occurs, tripping the MCR relay. The fault is latched.

The % leakage current is displayed on the **'Current and Voltage Information'** page (Level 2, Screen 2) as **'Ie'** shown as a % of the selected trip level. When the leakage reaches 100% for the selected time delay a trip occurs.

To reset the relay following an earth leakage trip, operate the reset key/digital input.

The trip level is selected via the **'RCD Trp. Level'** setting (Level 6, Screen 13) and is adjustable between 25 mA and 500 mA and off.

The time delay is selected via the **'RCD Trp. Time'** setting (Level 6, Screen 14). Settings are Instantaneous and adjustable settings between 50 ms and 150 ms.

For alarm functions see **'IPM Alarms'**, Section 8, Page 8.

3.2 Insulation Test

The IPM Relay can provide an automatic High Voltage 'Insulation Test'. A manual 'Insulation Test' is also provided.

An insulation test module, which is a resistive isolation device, is used to interface the power conductors to the IPM Relay. Modules are selected in the Group 1 Settings **'ITM Module'** (Level 5, Screen 2) for rated line voltages of 415V and 1000V.

IPM Insulation Test Modules (ITM) are the preferred modules and must be used when the 'Insulation Test' function is required.

When "None" is selected the IPM Relay does not provide 'Insulation Test', or voltage functions.

3.2.1 Automatic Insulation Test

If a **ITM Module** has been selected, in the Adjustable Group 1 Settings (Section 11) and a trip level has been set in the Adjustable Group 2 settings, then an automatic High Voltage DC 'Insulation Test' is initiated by operation of the start button once all starting conditions are met (See Section 12.5).

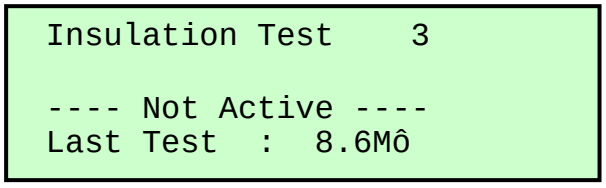
The HV DC 'Insulation Test' commences when the IPM Relay applies voltage to the V Test terminal of the relay for a period of 2 seconds. This applies 30 VDC to the ITM Module. A HV DC voltage is generated in the ITM Module, which applies a voltage of 500 V for 415 V operation and 820 V for 1000 V systems, between each phase and earth.

The IPM Relay measures the voltage on the line and calculates the resistance to earth for all phases. At the end of the test the result is stored in the Event Log as **'It:X.XMΩ'** If the resistance value is above the preset threshold the MCR Relay picks up allowing the outlet to be energised. Additionally, if the result is equal to or below an Alarm Level (typically 1.5 times the selected trip level, see Table 3-1) the status message **'Insulat.Test Alarm'** is displayed on the Status Page (Level 1, Screen 1).

Ins.Tst.Level: Selection MΩ	Alarm Level MΩ
1.0	1.5
2.0	3.0
5.0	7.5
10	15
20	30
None	None

Table 3-1

If the value is less than the preset trip level a trip occurs and is latched and saved in a non-volatile memory. To reset the relay following an insulation test fail trip, operate the reset button.



L3: Indicates the status of the insulation test.

L4: Displays the insulation resistance as a result of the test and is retained in memory until the next test is carried out.

The trip level is set at **'Ins.Tst.Level'** page **(**Level 6, Screen 18) and is selectable as per Table 3-1.

If the 'Insulation Test' is not selected by setting the **'ITM Module'** value to 'None' then the MCR Relay closes by operation of the start button.

3.2.2 Manual Insulation Test

A manual "Insulation Test" is provided as a maintenance/fault finding tool. The manual test can only be carried out when the load is not energized. A manual insulation test is also prevented when operating in snore mode.

Before a manual Insulation Test can be performed the following conditions must apply:

1. The Insulation Test page being displayed. This is located on the **'Insulation Test'** screen (Level 3, Screen 2).
2. Pilot must be healthy (and any previous trips reset).
3. Insulation Test function must not be tripped.
4. Outlet must not be running.
5. Outlet must not be in the process of 'closing'.
6. Outlet must not be 'Paused'

When the above conditions are met the **<TEST>** key must be pressed and held (for the duration of the test). After 3 seconds the manual insulation test is initiated. The test voltage is applied to the outgoing feeder while ever the above conditions are held (including holding the **<TEST>** key). The test results are continuously calculated and displayed. The operator should maintain the test at least long enough for the readings to stabilize, this being a function of the cable length. Once the test is completed (usually by releasing the **<TEST>** key) the results are held in memory until another insulation test is commenced either manually or as part of the starting sequence, or IPM control power is lost.

If the **'ITM Module'** has been set to 'None' then the manual test will not function.

The status of the manual insulation test is shown on the Insulation Test Screen (Level 3, Screen 2.

The three functions shown on the screen are:

'Not Active', 'Arming Man.Ins.Test' and 'Manual Insulat. Test'.

The display will show the last measured value.

3.3 Earth Continuity

The earth continuity function tests for the continuity of the earthing between the outlet and the machine, via the pilot core in the trailing cable. The pilot core is also used to transfer data when a Remote Termination Module is used to achieve Machine Data Transfer.

The IPM relay can be configured to operate in either diode or RTM mode. The mode is selected in **'EC Pilot Mode'** (Level 5, Screen 1) and determines what terminating device the relay is looking for on the pilot.

Note: The Remote Termination Module will only be recognised by an IPM Relay and will not be seen as a diode by other earth continuity devices.

The relay measures the resistance of the pilot - earth loop and the leakage between the pilot and earth conductors. The leakage measurement ensures that pilot to earth faults is detected. If the pilot - earth loop resistance exceeds 45 Ω a trip occurs which in turn opens the main contactor control circuit. The fault can be configured as latching or non-latching. This allows the user to determine if the fault is manually or automatically reset once the pilot - earth loop resistance is less than 45 Ω. The selection is either **'EC Trip Latch: On'** or **'Off"** (Level 6, Screen 17). To manually reset the relay, operate the reset button.

```
Earth Continuity              3

R:  27% L:  0%              V#10
Load    [WPump #              1]
```

L3: Shows the earth continuity resistance (**R**) of the pilot – earth loop and the leakage (**L**) between the pilot and earth conductors as a % of the trip levels. When either value reaches 100% a trip occurs. The version of the software is also indicated.

L4: Shows the Load Type and Number (from the connected RTM unit).

Pilot Trip Time is adjustable to allow for operation in noisy electrical environments. The trip times can be selected at **'Pilot Trip t'** (Level 6, Screen 15) and can be set to 80, 120, 160, 200, 300, 400 and 500 ms.

A setting of 120 ms should be suitable for most installations. Long time delays (>200 ms) should only be used where necessary. Consequence of long trip times should be thoroughly assessed from a safety point of view before using the higher values.

The leakage trip setting is fixed at 1850 Ω.

4 Current Related Functions

4.1 Overload Protection

The motor overload function is based on a thermal model of the motor. The three phase currents are squared to provide the I^2R heating input to the motor model. The selected 'Stopped Cooling Ratio' determines the cooling output for the model.

The state of the thermal model is shown by the 'Thermal Accumulator', which can be viewed on the 'Current/Volts Information' level on the display. The thermal accumulator represents the motor temperature. When it reaches 100%, a Motor Overload Trip Occurs.

The full load current is selected via the **'100% Current'** setting (Level 6, Screen 2) and can be set between 0.5125A and 640A in 448 steps. When the 100:1 CT is selected, use Table 4-1. When the 1000:1 CT is selected, use Table 4-2.

IPM Full Load Current Selection Table – Amps (100:1 CT)						
0.5125	1.025	2.05	4.1	8.2	16.4	32.8
0.5250	1.050	2.10	4.2	8.4	16.8	33.6
0.5375	1.075	2.15	4.3	8.6	17.2	34.4
0.5500	1.100	2.20	4.4	8.8	17.6	35.2
0.5625	1.125	2.25	4.5	9.0	18.0	36.0
0.5750	1.150	2.30	4.6	9.2	18.4	36.8
0.5875	1.175	2.35	4.7	9.4	18.8	37.6
0.6000	1.200	2.40	4.8	9.6	19.2	38.4
0.6125	1.225	2.45	4.9	9.8	19.6	39.2
0.6250	1.250	2.50	5.0	10.0	20.0	40.0
0.6375	1.275	2.55	5.1	10.2	20.4	40.8
0.6500	1.300	2.60	5.2	10.4	20.8	41.6
0.6625	1.325	2.65	5.3	10.6	21.2	42.4
0.6750	1.350	2.70	5.4	10.8	21.6	43.2
0.6875	1.375	2.75	5.5	11.0	22.0	44.0
0.7000	1.400	2.80	5.6	11.2	22.4	44.8
0.7125	1.425	2.85	5.7	11.4	22.8	45.6
0.7250	1.450	2.90	5.8	11.6	23.2	46.4
0.7375	1.475	2.95	5.9	11.8	23.6	47.2
0.7500	1.500	3.00	6.0	12.0	24.0	48.0
0.7625	1.525	3.05	6.1	12.2	24.4	48.8
0.7750	1.550	3.10	6.2	12.4	24.8	49.6
0.7875	1.575	3.15	6.3	12.6	25.2	50.4
0.8000	1.600	3.20	6.4	12.8	25.6	51.2
0.8500	1.700	3.40	6.8	13.6	27.2	54.4
0.8750	1.750	3.50	7.0	14.0	28.0	56.0
0.9000	1.800	3.60	7.2	14.4	28.8	57.6
0.9250	1.850	3.70	7.4	14.8	29.6	59.2
0.9500	1.900	3.80	7.6	15.2	30.4	60.8
0.9750	1.950	3.90	7.8	15.6	31.2	62.4
1.0000	2.000	4.00	8.0	16.0	32.0	64.0

Table 4-1 Current Settings

IPM Full Load Current Selection Table – Amps (1000:1 CT)						
5.125	10.25	20.5	41	82	164	328
5.250	10.50	21.0	42	84	168	336
5.375	10.75	21.5	43	86	172	344
5.500	11.00	22.0	44	88	176	352
5.625	11.25	22.5	45	90	180	360
5.750	11.50	23.0	46	92	184	368
5.875	11.75	23.5	47	94	188	376
6.000	12.00	24.0	48	96	192	384
6.125	12.25	24.5	49	98	196	392
6.250	12.50	25.0	50	100	200	400
6.375	12.75	25.5	51	102	204	408
6.500	13.00	26.0	52	104	208	416
6.625	13.25	26.5	53	106	212	424
6.750	13.50	27.0	54	108	216	432
6.875	13.75	27.5	55	110	220	440
7.000	14.00	28.0	56	112	224	448
7.125	14.25	28.5	57	114	228	456
7.250	14.50	29.0	58	116	232	464
7.375	14.75	29.5	59	118	236	472
7.500	15.00	30.0	60	120	240	480
7.625	15.25	30.5	61	122	244	488

7.750	15.50	31.0	62	124	248	496
7.875	15.75	31.5	63	126	252	504
8.000	16.00	32.0	64	128	256	512
8.250	16.50	33.0	66	132	264	528
8.500	17.00	34.0	68	136	272	544
8.750	17.50	35.0	70	140	280	560
9.000	18.00	36.0	72	144	288	576
9.250	18.50	37.0	74	148	296	592
9.500	19.00	38.0	76	152	304	608
9.750	19.50	39.0	78	156	312	624
10.000	20.00	40.0	80	160	320	640

Table 4-2 Current Settings

The trip time is selected via the **'O/L Trp t @ 6x'** setting (Level 6, Screen 6). It is a function of the current and the selected trip time curve. Drawing IPM2-E-008, 'IPM Motor Overload and Short Circuit Trip Times', shows the trip time curves.

The fifteen (15) motor overload curves allow trip settings from 3 to 40 seconds at six (6) times FLC and are shown for both cold and hot conditions. The hot curve corresponds to the trip time after the motor has been running at the selected full load current indefinitely.

The trip time can be calculated as follows:

$$Trip\ Time = C\ x\ 31.53 \times \ln\left[\frac{I^2 - \frac{1.1238A\%}{100}}{I^2 - 1.1238}\right]$$

Where:

C = Curve Selected

I = Current (FLC = 1)

A% = Initial Thermal Accumulator Value

Note: Cold Start A = 0% and on Hot Start, A = 89%.

The motor manufacturer's data should always be consulted to select the appropriate settings for the motor being protected. Typically, the capacity of a cold motor is given at six times its rated current.

The IPM Relay's trip curves can then be used to select the trip time curve, which best suits the motors overload capacity.

The motor overload trip latches once the thermal accumulator reaches 100% and can only be reset once the thermal accumulator falls below a preset value. The preset value is selected via the **'O/L Rst Level'** setting (Level 6, Screen 8) and can be set to 30%, 40%, 50%, 60%, 70%, 80%, 90%, A-30%, A-40%, A-50%, A-60%, A-70%, A-80%, A-90%. The A- settings automatically reset a motor overload trip once the thermal accumulator falls below the set value. Otherwise the trip has to be reset manually by pressing the keypad 'RESET' button or activating the 'RESET' digital input once the thermal accumulator has fallen below the set value.

An emergency restart on a hot motor can be achieved by zeroing the thermal accumulator memory. This is done by closing the **Lock** input and **Reset** key/digital input simultaneously for 1.5 seconds.

Caution: Repeated restart attempts in this condition may damage the motor.

The 'Stopped Cooling Ratio' modifies the cooling output of the thermal model when the motor is stopped. This can be used to account for reduced cooling capacity of the motor when it is not running (motor run status monitored via MCI digital input).

The ratio is selected via the **'O/L cool mult'** setting (Level 6, Screen 7) and is adjustable from 1.0 to 5.0. A cooling multiplier of 1 means the cooling is independent of whether the motor is running or not - eg a water-cooled motor. Protection for a fan-cooled motor is based on a setting of 2.5, however, for the best protection consult the motor manufacturer.

4.2 Short Circuit Protection

The short circuit function has a definite time characteristic. If the current exceeds the selected level for the pre-set time then a trip occurs. The short circuit function trips the CBR relay. (The CBR relay is normally energised, and drops out when tripped).

The short circuit trip level is selected via the **'Short Cct.Trip'** setting (Level 6, Screen 4) and is a multiple of the selected full load current, from 3.0 to 10 times FLC, in steps of 0.5. The trip time is selected via the **'Short Cct. t'** setting (Level 6, Screen 5) and is adjustable from 20 to 160 ms. See Drawing IPM2-E-008 for details.

To reset the relay following a short circuit trip it is necessary operate the reset key/digital input.

4.3 Phase Current Balance

The current balance measurement **'Ib'** is displayed on the **'Voltage and Current Information'** page, Level 2, Screen 2.

If Iave is <100% the difference between the average current and each phase current is calculated. The maximum difference is used as the current balance percentage.

If Iave is >= 100% then the current balance is calculated as:

$$I_{bal} = \frac{MAX\ \Delta\ I \times 100\%}{I_{ave}}$$

I_{ave} = Average of the 3 phase currents

MAX Δ I = The maximum deviation of a phase current from the average

Phase current balance protection is selected via the **'Cur.Bal.trip'** setting (Level 6, Screen 9).

The trip level is selectable at 5%, 10%, 20%, 50% and off.

The phase current balance protection is inhibited until the average current exceeds both 20% of the selected full load current and the selected balance trip level.

If any phase drops below the selected trip setting for a period of 2 seconds then the outlet is stopped. To reset the relay following a current balance trip, operate the reset key/digital input.

4.4 Residual Current Signal

The three phase current signals are summed electronically in the IPM to produce a residual current signal that can be used to detect earth fault currents. If the residual current signal exceeds the trip level for the selected trip time, a trip occurs, tripping the MCR relay. The fault is latched.

To reset the relay following a residual current trip, operate the reset key/digital input.

L2: Displays the 3 phase currents as a % of the FLC

L3: Displays the average current and the % residual current as **'Ir'**

```
I      A    B    C 2
Cur:    0%   0%   0%
Ave:   0 Amp Ir:  0%
Ibal:  0%   Iel:  0%
```

L4: Displays the current balance and the % of leakage current

The trip level is selected via the **'Residual iTrp'** setting (Level 6, Screen 11) and is adjustable from 10% to 250% FLC and 'off'. The trip time is selected via the **'Res.trip time'** setting (Level 6, Screen 12) and is adjustable from 100 ms to 5 seconds. Setting the trip level to 'off' disables this function.

Note that the residual current function can be used even if a core balance toroid is used for earth leakage protection. It can be used to provide some detection of wiring/CT/internal relay faults.

4.5 Under Current Trip

Under current protection is enabled as soon as the main contactor is closed (indicated by closing the MCI input). Selecting a Value of 'none' will inhibit this function. If any phase drops below the selected trip setting for a period of 4 seconds then the outlet is stopped. This raises the "Under Current Trip" alarm and is recorded in the event log as "Und.I Trp". To reset the relay, operate the reset button.

The trip level is selected via the **'Under I Level'** setting (Level 6, Screen 10). The trip level is selectable at 32%, 40%, 48%, 56%, 64%, 72%, 80%, 88% and 96%. Setting the trip level to 'None' disables this function.

This function is used when in snore mode and must be set to an appropriate level – note that there is a 4 second delay before a trip.

5 Voltage Related Functions

5.1 Main Contactor Fail Protection

The Main Contactor Fail (MCF) protection operates if the Main Contactor (MC) fails to function by either:

1. Failing to open when required. This is achieved by comparing the state of the main contactor (via the Main Contactor Input MCI) against the state of the MCR relay output. This test provides "Frozen Contactor Protection".
2. Failing to maintain insulation across the contacts when the contactor is open. The Insulation Test Module (ITM) is used to measure the voltage on the load side of the contactor. If this exceeds 10% of the rated line voltage, a trip will occur.

This test provides "Loss of Vacuum Protection". This function is inhibited immediately after the main contactor opens to allow for back EMF voltages generated by some motors to dissipate. The inbuilt time is selected via the **'back emf time'** setting (Level 6, Screen 20). The settings are adjustable from 2 to 20 seconds.

A main contactor fail trip operates the CBR relay, which trips the circuit breaker.

To reset the relay following a main contact failure trip, operate the reset key/digital input.

The status of the MCI input can be viewed on the **'IPM Relay and Keys'** Screen, (Level 4, Screen 2).

5.2 Undervoltage Trip

The Undervoltage protection is enabled as soon as the main contactor is closed (indicated by closing the MCI input). If any of the phase voltages drop below the selected trip setting of the nominal line voltage for 800ms then the MCR relay is de-energised.

```
I&V    A    B    C 2
Cur:    0%   0%   0%
Volts   0%   0%   0%
O/L:  0%  MCF-t 100%
```

To reset the relay following an undervoltage trip, operate the reset key/digital input.

The trip level is selected via the **'U/V Trp level'** setting (Level 6, Screen 19) and is adjustable from 40% to 95% in 10% increments. Setting the trip level to 'off' disables this function.

5.3 Voltage Metering

The Insulation Test Module (ITM) is also used to provide line voltage metering.

L2: Displays the line current for each of the 3 phases.

L3: Displays the line voltages for each of the 3 phases.

L4: Displays the thermal accumulator and main contactor fail timer that counts down when a main contactor fault is detected (see section 5.1).

Line voltages of 415V and 1000V are configured when the appropriate Insulation Test Module is selected in the **'Group 1 Settings'** (Level 5, Screen 2).

6 Analogue Output

IPM Relay provides an isolated 4-20 mA analogue output. The output continuously monitors Average Current, Overload, Earth Leakage and the Insulation Level of the relay. The Monitor Output settings can be

selected at **'4-20mA Output'** (Level 6, Screen 28). Settings available are O/L (0-100%), Iave (0-250%), E/L (0-100%) and MΩ (0-40MΩ). The analogue output status in milliamps is shown on the **'IPM Relay and Keys'** Screen, (Level 4, Screen 2).

7 Communications

The IPM Relay provides an industry standard RS485 Slave Modbus communication port. This allows connection to a PLC or a SCADA system. See Section 20, 'IPM Modbus Address Table', for accessible data.

The baud rate is selected via the **'Modbus:Baud /P'** setting (Level 5, Screen 4) and is selectable between 1200 and 19200 Baud, with even, odd, or no parity. One stop bit is used in conjunction with parity, while two stop bits are used with no parity.

The half-duplex 3-wire RS485 communications interface allows up to 31 devices to be multi-dropped onto a single master communication line. The IPM's Modbus Slave address is selected via the '**ModBus Addr**:' setting (Level 5, Screen 3) and is adjustable between 1 and 31.

7.1 Modbus Commands

The following Modbus commands are supported:

Modbus CMD	Comment
03	Read Holding Registers
06	Store Single Register

Table 7-1

Valid read registers are in the range from 1 to 96. An attempt to read a register outside this range will result in an exception scan. Currently, only the first 78 registers

contain valid data. Supported Modbus exception responses are:

Modbus Exception	Comment
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value

Table 7-2

7.2 Modbus Status

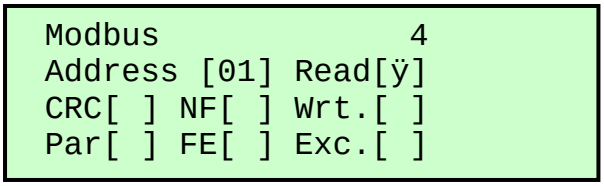
Status	Comment
Address	The Modbus slave address the IPM is set to
Read	A solid block when a READ command is received
Wrt	A solid block when a WRITE command is received
Exc	A solid block when an unsupported Modbus command is received
CRC	A solid block when a checksum error is detected
Par	A solid block when a parity error is detected
NE	A solid block when noise is detected
FE	A solid block when a framing error is detected

The Modbus Status can be viewed on Level 4, Screen 4

8 IPM Alarm Functions

The IPM has several standard alarm functions. If any are triggered, the Alarm Relay (ALM) picks up. Each has a selectable alarm level, and can be disabled. Generally the alarms are self-resetting once the alarm condition is removed.

High Current Alarm: Is activated by the phase currents exceeding the selected threshold. It is selected via the



'High I alarm' setting (Level 6, Screen 21) and is adjustable from 100% to 600% FLC and 'off'. The highest of the three phase currents is used. Time delay = 1 s. Setting the alarm level to 'off' disables this function.

Overload Alarm: Is activated by the thermal accumulator exceeding the selected threshold. It is selected via the **'O/L Alarm Lev'** setting (Level 6, Level 22) and is adjustable from 50% to 95% and 'off'. Time delay = 2 s. A motor overload trip overrides this alarm. Setting the alarm level to 'off' disables this function.

Under Cur. Alarm: Is activated by the phase current falling below the selected threshold. It is selected via the **'Under I Alarm'** setting (Level 7, Screen 10) and is adjustable from 32% to 96% and 'off'. This alarm is only activated when the motor is running (MCI input closed). Time delay = 2 s. Setting the alarm level to 'off' disables this function.

Earth Leakage Alarm: Is activated when the earth leakage current exceeds a set level. The alarm level is selected via the **'E/L Alarm Lev'** setting (Level 6, Screen 24) and can be set to 20%, 50%, 80% and 'off'. The earth leakage alarm has a time delay of 1 second and auto resets when the earth leakage current falls below the selected level. Setting the alarm level to 'Off' disables this function.

Insulat. Test Alarm: Is activated when the meg-ohm resistance of each phase to earth, as a result of an insulation test, equals or falls below the alarm level. The alarm level is set at 1.5 times the trip setting.

The alarm message is displayed until a new test is initiated or the **<ENT>** key is pressed while displaying the alarm message. **'Insulat.Test Alarm'** is also recorded in the Event Log.

9 Fan Control

9.1 Burp Function

The Burp Function of the IPM relay allows the progressive inflation of ventilation bags (tubes) by pulsing the motor contactor, controlling the ventilation fan, several times at start up (See Section 12.5 for operational sequence).

There are three configurable parameters that control the Burp Function at start up, 'Burp Number of Pulses', 'Burp Pulse On Time' and 'Burp Pulse Off Time'.

Selectable Settings:

'# Burp Pulses' (Level 6, Screen 25) Selectable at 'none' and 1 to 6 (selection of none disables the Burp Function).

'Burp On Time' (Level 6, Screen 26) and '**Burp Off Time'** (Level 6, Screen 27) are selectable at 0.6, 0.8, 1.0, 1.2, 1.5, 2.0, 2.5 and 3.0 seconds

10 The IPM Snore Function

The purpose of the IPM Snore Function is to, optionally; add a timed re-start the IPM Relay after an undercurrent trip has been detected. Please refer to the section above for information on the operation of the undercurrent trip function.

10.1 Basic Operation

The basic operation of the function is shown by the following scenario:
Assume a pump is the load device of the relay, which pumps a dam. When the pump has emptied the dam, its load current will drop significantly enough to be detected as an undercurrent trip (this level is set in the settings level (6) in Section 18) by the IPM.

The Snore Function (snore-Process) will operate only after configuration and activation via the IPM menus. The snore function will operate after undercurrent is detected and will permit the pump to restart after a time delay (tSnoreDelay). After this off period the pump will restart. During the first 4 second ON period (tSnoreOn), the pump will run: and only if the pump remains in an undercurrent state, the IPM will extend tSnoreDelay by 1.5 times and switch off the output relay for the new setting of tSnoreDelay. This process will continue until the time reaches a maximum of tSnoreDelay x 8.

The initial setting for tSnoreDelay is obtained from a menu configuration setting (tSnoreSet). The available initial settings are OFF, 5, 10,15, 20, 8F, 15F, 20F, 30F, 60F minutes (the "F" represents a fixed delay that does not extend tSnoreDelay as described above. If a load is detected during tSnoreOn (i.e. no undercurrent is detected), the pump will remain on, but tSnoreDelay will be reduced to ¾ its present setting; but not below tSnoreSet (this does not apply to the "F" settings). In the case where the new tSnoreDelay is less than tSnoreSet, then tSnoreDelay shall be set to tSnoreSet.

When in tSnoreDelay mode, and if a 'Start' stimulus from:

- The 'Start' key (on the relay), or,
- A pulse from the External Start

is detected, then, the relay will immediately abort the running tSnoreDelay and proceed through a power-on sequence.

If a power failure occurs when the IPM is operating in Snore Mode, it will resume operating in Snore Mode when power is restored. If Aux is open, or there is an EL fault on Power Up, the snore function will wait for up to 15 s to start.

10.2 Setup procedure for Snore Function:

Setup of the Snore Function is done by settings throughout the menu structure. The two additional settings that are required to enable the Snore Function to become active:

- Start Mode must be set to 'Snore'.
- The Snore Delay parameter must not be set to none.
- The 'under current' trip level must not be set to none.
- The AUX External Digital input must be active.

Relay Snore Mode starting procedure:

When 'Snore' start mode is selected (see above), the relay can be initially started from different sources:

- Key button ('Start' button on the relay), if and only if Digital-input switch is ON,
- External start button if and only if the Digital-input switch is ON.

The behaviour of each start stimulus is below:

Key Button Start

Regardless of the status of the Snore Function, but with the Digital-input switch on, operation of the 'Start' key will cause the relay to proceed through a power-on sequence.

External-Start switch

When this switch is closed the relay will start a power-on sequence on cold boot. The Digital-input switch must be on if it is open, then the relay **can't be started in Snore Mode.**

Relay Stop procedure:

- The relay will be stopped whenever the Stop key or the external Stop is actioned – regardless of the Snore process. This will reset the delay.
- If the AUX input opens at any time during operation in Snore more, then a start is required to restart the snore function. The Message 'Snore – Need Aux' will be displayed on the screen when in Snore mode with the AUX open. This will reset the delay.

11 Remote IPM Control

The IPM and RTM software have been changed to allow for the RTM digital input to be used to control the IPM. This functionality is similar to that of the IPB/C/D.

The remote start can be set in two modes. In one mode it is always active and in the other mode it is active only when the auxiliary digital input is closed. Remote start can also be disabled.

11.1 Function Overview

There was an existing parameter called 'remote start'. This parameter was previously unused, but was originally intended to implement the remote start functionality. This existing parameter has been used to enable the remote start function. Setting it to 'yes' enables remote start. Setting it to 'no' will disable remote start. Setting it to 'Aux' enables remote start only when the auxiliary digital input is closed.

The remote input (on the RTM) is edge sensitive. This ensures that if there is an upstream trip, the IPM won't restart automatically once the power is restored. It also allows the keypad and external digital input stops to work sensibly so that if the IPM is stopped locally, it won't restart immediately after any of the stop are released.

When remote start is active, the remote input is closed to start the IPM and must remain closed while the IPM is running. The remote input is opened to stop the IPM.

11.2 Operating Modes

Note that the external digital stop input and the keypad stop will always stop the IPM regardless of the start mode.

Diode Mode:
The remote start parameter has no effect when the IPM is set to diode mode.

RTM Mode:
The Remote start parameter has three possible options; 'no', 'yes' and 'aux'.

Remote start - 'no'
The remote input will be ignored. Starting the relay will depend on whatever start mode is selected as per the existing operation.

Remote start - 'yes'

Start mode - 'K/Ext' (Keypad or External)
Keypad and External start inputs are ignored. Remote input controls the IPM. Local stop input will still stop the IPM. Local stop inputs will override the remote start if they are held closed while a remote start is signalled.

Start mode - 'Ext' (External only)
As per 'K/Ext'

Start mode - 'K&Ext' (Keypad and External)
As per 'K/Ext'

Start mode - 'Modbs' and 'Snore'
These modes will not operate when remote start is set to 'yes'. The status display will show "Configuration Err".

Remote start - 'Aux'
When an appropriate start mode is selected, changing the Auxiliary digital input will switch between local (keypad or external digital start input) or remote (RTM digital input). It is allowable to change the state of the Auxiliary input while the IPM is running.

If the RTM input is open and the IPM is running while the Auxiliary input is closed, the IPM will immediately stop. If the RTM input is closed and the IPM is running while the Auxiliary input is closed, the IPM will continue to run.

Start mode - 'K/Ext', 'Ext' and 'K&Ext'
The IPM will change between remote start mode and local start mode depending on the
state of the 'Aux' digital input. When the input is close the IPM will be controlled via the RTM as described in the section above (remote start set to 'yes').
When the 'Aux' digital input is open the control will revert to local mode. The start signal required will depend on the Start mode parameter.

Start mode - 'Modbs' and 'Snore'
These modes will not operate when remote start is set to 'yes'. The status display will show "Configuration Err".

11.3 IPM/ RTM Software Compatibility

Note: An Old IPM is version 9 or earlier; An Old RTM is version 2 or earlier (reported as '20' on the IPM display).

New RTM and New IPM
Nothing to consider

New RTM and Old IPM
The Old IPM will ignore the remote start setting.

Old RTM and New IPM
The new IPM will check the version of the RTM (this is transmitted in the pilot protocol). If the RTM has the 'remote start' parameter set, but the RTM version is too old, the IPM will display "RTM Version Error".

Old RTM and Old IPM
Nothing to consider

11.4 Status Messages

There are two new status messages. “Need RTM Start” and “Remote Stop”.

When in remote start mode, whenever the RTM’s digital input is open, the display will show “Remote Stop”. If the digital input is closed but the IPM is stopped the display will show “Need RTM Start” to indicate that the RTM’s digital input needs to be opened and then closed to generate a new edge.

Note: This is most likely to happen if the RTM’s digital input is closed to allow the IPM to run and then a local stop is used to stop the IPM. Because of the edged triggered nature of the RTM digital input, the IPM will not automatically restart.

12 Adjustable Settings

12.1 Parameter Groups

There are two groups of adjustable settings contained in the IPM Relay’s non-volatile memory. Both groups can be viewed and modified via the display and the up/down and left/right keys.

The first group of settings is always stored in the relay and relates to parameters, which are linked to the system rather than the particular load connected to the outlet.

Group 1 Settings:

EC Pilot Mode:	Determines if the pilot is to be terminated with a diode or Remote Termination Module
ITM Module:	Selects the Insulation Test Module to be used with the IPM Relay
Start Mode:	Selects the inputs required to initiate a start condition
ModBus Address:	Selects the Modbus Slave Address
ModBus Baud/P:	Sets the Modbus baud rate
ModBus Timeout:	Sets ModBus Error timing
CT RATIO:	Selects between 100:1 and 1000:1 toroids

The second group of settings consists of parameters that are related to the load connected to the protected outlet. These settings are stored, retrieved to/from the memory in the IPM Relay or the memory in the Remote Termination Module, depending on the “Pilot Mode” setting. Figure 1, Page 9 shows how the memory is “switched”. If a diode pilot mode is selected the IPM Relay reads and writes to and from the relay’s internal memory for the group 2 settings.

If a RTM Mode is selected the settings are sent to and retrieved from the memory in the Remote Termination Module.

Group 2 Settings:

RTM Mach. Type:	Selects the RTM descriptive code transmitted to identify the machine connected to the outlet.
RTM Mach. Num:	Selects the assigned machine number to be transmitted by the Remote Termination Module
100% Current:	Sets the full load current
OC I mul:	Combines with OC range to define the full load current
Short Cct. Trp:	Sets the short circuit trip level
Short Cct. t:	Sets the trip time for the short circuit function
O/L trp t @6x :	Modifies the basic overcurrent time curves to achieve the desired trip times
O/L cool mult:	Allows the cooling rate of the thermal model to be modified
O/L Rst. Level:	Sets the preset level to allow a reset of an O/L trip
Cur. Bal. trp:	Adjusts current phase balance trip
Under I level:	Sets the under current threshold
Residual i Trp:	Selects the residual current trip threshold as a % of FLC
Res. Trip time:	Sets the trip time for the residual current function
RCD Trp. Level:	Sets the sensitivity trip level for the earth leakage protection
RCD Trp. Time:	Sets the trip time for the earth leakage protection
Pilot Trip t:	Sets the trip time for the earth continuity protection
Remote Start:	When “Yes” is selected the IPM Relay ignores the local start input. When “No” is selected the local start/stop inputs control the relay
EC Trip Latch:	Determines whether earth continuity trips are self-resetting or not
Ins. Tst. Level:	Sets the trip threshold or disables the insulation test function
U/V Trp. Level:	Sets the under voltage threshold
Back emf time:	Adjustable time delay to inhibit main contactor failure following opening of main contactor
High I alarm:	Selects the high current alarm threshold as a % of FLC
O/L Alarm Lev:	Selects the overload alarm threshold as a % of the thermal accumulator

Under I Alarm:	Selects the under current alarm threshold as a % of FLC
E/L Alarm Lev:	Selects the alarm trip level for the earth leakage protection
# Burp Pulses:	Sets the burp number of pulses and off
Burp on Time:	Sets the burp pulse on time
Burp Off Time:	Sets the burp pulse off time
4-20mA Output:	Sets the value to be transmitted
Snore Delay:	Sets the Snore Delay Value

12.2 Changing Settings

The procedure for adjusting the settings is independent of where the values are stored. The EC Pilot Mode should be checked prior to making any other adjustments to be certain the changes are made to the desired memory.

1. Ensure the outlet is stopped.
2. For Group 2 Settings in RTM Mode, ensure RTM is on line.
3. Display the parameter that has to be changed.
4. Close the lock input.
5. Press the enter button to change the current parameter.
6. Use the left and right arrows to step through the allowable values until the desired new setting is displayed.
7. Press the enter button to indicate that the value is the required setting.
8. Open the lock push input.

If the **ESC** key is operated at any stage during the procedure, the modifying sequence is aborted and the

```
IPM Dig Inputs     4
ExtRst¡/¡    Lock¡_¡
ExtStp¡/¡     Aux¡/¡
ExtStr¡/¡ A/O 20.0mA
```

setting reverts to its previously stored value.

When changes have been made to the stored values, the old value and the new value are stored in the event log.

A separate log immediately proceeds this recording the time and date that the change was made.

13 System Control

13.1 Digital Inputs

The IPM provides six (6) voltage free digital inputs for correct operation. To activate an input a connection needs to be made from '+DiPwr' terminal to the respective digital input's terminal.

L2: Displays the status of the external reset and the lock inputs.

L3: Displays the status of the external stop and the auxiliary inputs.

L4: Displays the external start input and the analogue output in mA.

The function of each input is as follows:

Lock: The lock input needs to be closed while ever changes to the relay settings are being made. If the lock input is not closed then the settings cannot be changed.

The lock input must also be closed to reset the thermal memory to allow an emergency re-start. To perform a reset, the motor must be stopped (MCI open) and both the reset key and the lock input must be held closed for 1.5 seconds. This will reset the 'Thermal Accumulator' and allow the motor to be started immediately

Reset: The reset digital input performs the same function as the keyboard reset allowing for external/remote resetting of trips. To reset a trip an open-to-close transition on the reset input (or reset key) is required.

MCI: The Motor Contactor Interlock input provides the IPM Relay with the status of the motor contactor. Its status is used by the thermal modelling to activate the 'Cooling Multiplier' and also provides the basis for Motor Contactor Fail (MCF) monitoring.

Digital: This is an auxiliary digital input.

Ex-Start: This input allows the installation of an external start button (See Section 11.3.1).

Ex-Stop: This input allows the installation of an external stop button (See Section 11.3.1).

13.2 Output Relays

The IPM provides three relay outputs for correct operation. All relay contacts are rated at 5A/190VAC.

MCR: (Main Trip Relay). This relay energizes when there are no trips, and drops out whenever a trip occurs. A normally open and a change over set of contacts are provided.

ALM: (Alarm Relay). This relay energizes whenever there are alarms active and drops out when all alarms are clear. One changeover set of contacts is provided.

CBR: (CBR Relay). This relay is normally energized and drops out if there is a short circuit trip or a motor contactor fail trip. One changeover set of contacts is provided.

L2: Displays the status of the CBR and MCR Relays.

L3: Displays the status of Alarm Relay, the Test key and the Main Contactor input.

L4: Displays the status of the Start, Reset and Stop Keys

```
IPM Relay & Keys   4
CBR:In. Tst  MCR:out
ALM:out ¡/¡  MCI ¡/¡
Str¡/¡ Rst¡/¡ Stp¡/¡
```

13.3 Outlet Control

The outlet can be energised by local or remote operation depending on the '**Remote Start'** option. The selection is "Yes" or "No" (Level 6, Screen 16).
If "Yes" is selected the relay ignores the local start input thus allowing operation of the outlet from the remote machine. Both the external and local stop buttons will turn off the outlet.

If "No" is selected the local start/stop buttons control the outlet.

13.4 Start Mode

The Start Mode is selected at (Level 5, Screen 3). The possible settings are K/Ext, Ext, K&Ext, Modbus and Snore The start/stop logic operates as follows:

- The external stop digital input and the front keypad stop button will always stop the relay, regardless of the settings for 'Start Mode'. In all cases only one of the stop inputs needs to be active to stop the relay.
- K/Ext mode – Relay can be started with either an external start or the keypad
- Ext mode – Only the external start is used. The keypad start is disabled
- K&Ext mode – Both the external start and the front panel keypad start button needs to be active to start the relay.
- Modbus mode – Not yet implemented
- Snore mode – The parameters for Under Current Trip, Start Mode and the Snore time delay need to be set for your application. Extra protection against accidentally selecting this mode is provided by requiring the external digital input to be closed before this mode will start.

13.5 Operational Sequence (Insulation Test and Burp Function selected)

Before an outlet can be energised there should be no protection faults present.

Once the start button is operated an insulation test is performed. If the result of this test is satisfactory the Burp Phase is initiated. When the Burp Phase is completed the IPM Relay goes into the run mode.

A time delay of 5 seconds is allowed for the Main Contactor Interlock (MCI) to close. If it does not close within this time, then the run mode is exited.

If a stop input is closed while the relay is in run mode, the run is cleared, and the MCR relay de-energises. The event log reads "Stopped".

While the main contactor is closed, the MCI input is continuously monitored. If it opens, the run is cleared and the MCR relay de-energises. In this case the event log records "MC Opened" which indicates that the outlet was turned off by something other than the IPM Relay, eg open circuited main contactor coil or control supply.

It should be noted that if the main contactor does not close when the MCR relay closes and the start/stop conditions are maintained, then the IPM will cycle through the following start sequence: testing, run, stopped, pause then repeat the sequence while ever the start input is closed.

14 Event Log

A real time clock/calendar is included in the IPM Relay. This combines with the non-volatile memory to provide a data-logging feature. This log sequentially records the time, date and details of the most recent event. A chronological list of the previous 50 events is stored.

```
Event Log          1
Record#01:  Power Up
We 26/07 14:57:13.64
We 26/07 14:58:21
```

The event log can be viewed by using the "Right or Left" arrow keys to scroll the log.

A typical display shows:

L2: Displays the event

L3: Indicates the time that the relay powered up on Wednesday, 26 July.

L4: Indicates the present time.

Log 1 is always the most recent event**.** Each time a new log is recorded, the 50th log is removed from the list.

The following events are logged:

Power Up	The instant that power is applied to the relay
Pwr Down	Removal of power from the relay
MCR Close	Closure of the Main Contactor Relay
Stopped	Stopping of the outlet by operation of the local stop button
Ext. Stop	Stopping of the outlet by operation of the external stop button
MC Opened	Main Contactor has opened but not initiated by the IPM Relay
MC Fail	Main Contactor Fail Function Trip
CloseFail	Indicates that the MCI Input did not close within 5 seconds of MCR closing

EC Ω Trip	Pilot/Earth continuity loop exceeds 45 Ohms
EC Leak T	Leakage resistance between the pilot and earth is less than 1500 Ohms
EL Trip	Earth leakage protection tripped
Burp Done	Burp sequence completed
Burp Fail	Burp sequence failed to complete
SC Trip	Trip condition of short circuit protection
OC Trip	Trip condition of overload protection
I bal-Trp	Current balance trip condition
RESET	Records resetting of a protection trip function
Setup Mod	Records that set up data has been modified
Und.I Trp	Under Current Trip caused outlet to stop
uvolt trp	Records that voltage was not present on at least one outgoing phase when the main contactor was closed
Ires.trip	Residual E/L Trip condition
Tmem Loss	The thermal memory data has been corrupted
T-mem Rst	Thermal memory has been manually reset to zero
Mem.ERROR	Records that the relay's non-volatile parameter memory has been corrupted
μ- P reset	Internal microprocessor reset
RTM mem. E	Records that the Remote Termination Module's non-volatile memory has been corrupted or Remote Termination Module has gone off line while the outlet is running.
Feeder On	Records RTM machine code and number when main contactor is closed (proceeded by MCR closed). This log only appears when in RTM mode.
RTM Off L	Indicates a loss of communications with the RTM.
Meg Ω Trp	Insulation Test failed
IT: -- . -MΩ	Records the result of the Insulation Test
Insul.Alm	Result of Insulation Test is equal to or less than the alarm level
o/l alarm	Thermal accumulator has exceeded the selected threshold
L-cur alm	Phase current has dropped below the selected threshold
H-cur.alm	Phase current has exceeded the selected threshold
e/l alarm	Earth leakage current exceeded the selected threshold
RTM Stop	In any of the remote start modes; the event log will record when the IPM is stopped via the remote digital input.

15 Time & Date

```
        Clock Setup


 We 26/07 14:58:21
```

If there is a need to adjust the real time clock, carry out the following procedure:

1. Using the Display's keys select the time and date information page (Level 4, Screen 5) to display the Day, Month, Year, Hours and Minutes.
2. Press the enter key. A "v" will appear in the top line above the minute section. This indicates the number to be changed.
3. Use the left and right arrow keys to move the "v" to the desired position.
4. Press the enter key. The "v" now changes to a "?" The right arrow key is used to increment the allowable values, once the desired value is obtained, press the enter key again. The "?" returns to a "v".
5. Repeat steps 3 and 4 until the correct time and date are displayed.
6. With the "v" showing press the reset push button. The "v" then changes to "E". (This is a prompt to press the enter key).
7. Press the enter key. At that instant, the seconds are zeroed and the selected time/date information is transferred to the internal clock.

If the battery voltage is low the time will zero and the date will reset to 1st January on power up.

Note: The date and time are used only to time stamp the events in the log (which are recorded sequentially regardless of the date/time). Date and time data is not used for any control functions.

16 IPM Equipment Parts List

143794 IPM 24VAC IPM Integrated Protection Relay

121504 ITM-415V Insulation Test Module

121505 ITM-1000V Insulation Test Module

143315 RTM Remote Termination Module Ver.2

101272 Current Transformers 45mm (1000:1CT)

101703 Current Transformers 75mm (1000:1CT)

141548 Current Transformers 45mm (500:5 CT)

17 General Notes:

Torque Setting for Relative Mounting Screws for the Facia assembly – 0.8Nm

18 IPM Specifications

Auxiliary Supply Volts:	24VAC /DC ± 20%, Power Consumption <10W
Earth Leakage Protection:	Trip Setting: 25-500mA and off Time Delay: Instantaneous (<80ms), 50ms to 150ms Alarm Setting: 10%, 20%, 30%, 40%, 50%, 60%, 80% and off
Earth Continuity Protection:	Reset if resistance < 45 Ohms Trip if resistance > 45 Ohms Shunt Leakage Trip if < 1850 Ohms Operating Time: 80, 120, 160, 200, 300, 400, 500ms
Insulation Test:	Lockout Resistance: 1, 2, 5, 10, 20 Meg-ohm and none (Test time 2s) Alarm Setting: Insulation Test Trip setting x 1.5
Overload Protection:	Current Range: 0.5125 to 64 Amps (224 steps) 100:1CT Current Range: 5.125 to 640 Amps (224 steps) 1000:1 CT Trip Time @6xFLC: 3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20, 24, 28, 32, 40s Cooling Multiplier: 1, 1.5, 2, 2.5, 3, 4, 5 times Overload Reset Level: 30%, 40%, 50%, 60%, 70%, 80%, 90%, A-30%, A-40%, A-50%, A-60%, A-70%, A-80%, A-90% Alarm Setting: 50%, 60%, 70%, 75%, 80%, 85%, 90%, 95% and off
Current Balance:	Trip Setting: 5%, 10%, 20%, 50% and off Trip Time: 2s
Under Current:	Trip Setting: 32%, 40%, 48%, 56%, 64%, 72%, 80%, 88%, 96% and none. Alarm Setting: 32%, 40%, 48%, 56%, 64% and 72% and off
High Current Alarm:	100%, 108%, 120%, 140%, 160%, 200%, 240%, 280%, 320%, 360%, 400%, 500%, 600% and off
Residual Current:	Trip Setting: 10%, 20%, 30%, 40%, 50%, 60%, 80%, 100%, 120%, 150%, 200%, 250% and off Trip Time: 100ms, 200ms, 500ms, 1s, 2s, 3s, 5s and off
Short Circuit Protection:	Trip Setting: 3.0 to 10.0 times in 0.5 increments (times full load current) Trip Time: 20, 40, 60, 80, 100, 120, 160ms
Back EMF Timer:	Delay Settings: 2, 5, 10, 15, 20s
Machine Numbers:	Can be allocated from 1 to 40
Burp Function:	Number of Pulses: None and 1 to 6 (selection of none disables the Burp Function) Time On/Off Setting: 0.6, 0.8, 1.0, 1.2, 1.5, 2.0, 2.5 and 3.0s
Snore Mode:	None, 5,10,15, 20, 8F,15F,20F, 30F, 60F Time in Minutes F= Fixed delay
Undervoltage Protection:	Selectable from 20% to 80% in 10% increments Trip delay 800ms
Communications:	RS485 Slave Modbus - Baud Rate: 1200 to 19200
Monitoring:	4-20mA Analogue Output – Iave, O/L, E/L, MΩ
Relay Contacts:	MCR (1/NO, 1 C/O), CBR and ALM (1 C/O) 5A/190VAC 100VA max

19 Menu Structure:

Level	Menu	Level - Screen	Menu Message / Function	Sub Menu Display	Default
1	**Need IPM Start**	1.1	Start / Status / Error Messages	See Trip / Status Messages;	
				Type 1 – Latched for Display	
				Type 2 – Enabled & Cleared Automatically	
				Type 3 – Triggered by Trip Function	
		1.2-1.50	Event Log : (last 50 events) L2: Event, L3: Time - Event, L4 :Present Time	Pwr Up, Pwr Down, MCR Close, Stopped, Ext. Stop, MC Fail, Close Fail, EC Ω Trip, EC Leak Trip, EL trip, Burp Done, Burp Fail, SC Trip, OC Trip,I bal-Trp, RESET, Set up Mod,	
2	**Earth Leakage**	2.1	Current / Voltage / Overload		
		2.2	All Currents; E/L, E/L, IB	% Trip Level to 100% Trip, Current Balance	
3	**Earth Continuity**	3.1	Earth Continuity	When either EC Res or Earth Loop Leakage reaches 100% a trip occurs	
		3.2	Insulation Test Level	1MΩ, 2MΩ, 5MΩ, 10MΩ, 20MΩ (Alarm - 1.5 x Set Value) Display shows last measured value	
		3.3	Status Indicator Remote Input		
4	**IPM Relays & Keys**	4.1	IPM Relay & Keys	CBR, MCR, ALM, MCI, Str, Rst, Stp	
		4.2	IPM Dig Inputs	ExtRst, ExtStp, ExtStr, Lock, Aux, A/O 4.0mA	
		4.3	Modbus Status	[Address, Read, Wrt, Exc, CRC, Par, NE, FE]	
		4.4	Clock Setup	[Day, Mth, Yr, Hrs, Mins & Sec] (Time Stamp – Events Log)	
5	**Settings :Grp1-IPM**	5.1	EC Pilot Mode	[Diode, RTM] –Earth Loop Resist. < 45Ω	
		5.2	ITM Module	[415v / 1000v]	
		5.3	Start Mode	[Selects Inputs Reqd. For Start Mode]	
		5.4	Modbus Addr	[1 -31]	
		5.5	Modbus : Baud /P	[12000,E,N, 24000,E,N, 48000,E,N, 96000,E,N, 192000,E,N]	96000
		5.6	Modbus T-out	0.5, 1.0, 2.0, 5.0, None	0.5 Sec
		5.7	CT Ratio	100:1 and 1000:1	
6	**Settings :Grp2-RTM**	6.1	RTM Machine Type	[J-bo, Fan, Dril, Pump, Hpmp, Wpmp, DCB, Bolt, HRMr, Belt, Winc, Crsh, Dplg, Spare]	
		6.2	RTM Mach. Num.	[1 to 40]	
		6.3	100% Current	[5.125A – 625A]	5.125A
		6.4	Short Cct.Trp	[Selectable; 3.0 to 10 Times FLC]	3.0 x
		6.5	Short Cct.t	[20, 40, 60,80,100, 120, 160 mSec]	20 mSec
		6.6	O/L trp t @ 6x	3, 4, 5, 6, 7, 8, 10, 12, 14, 16, 20, 24, 28, 32, 40 Sec	3 Sec
		6.7	O/L cool mult	[1.0 to 5.0] (ie 2.5 – Fan Cooled Mtr)	1.0
		6.8	O/L Rst Level	[30% - 90%, A30% - A 90%] "A- Auto Reset	30%
		6.9	Cur.Bal Trip	[5%, 10%, 20%, 50%, off]	5%
		6.10	Under I Level	[32%, 40%,48%, 56%,64%, 72%, 80%, 88%, 96%, None]	32%
		6.11	Residual i Trip	[10, 20, 30, 40, 50, 60, 80, 100, 120, 150, 200, 250%]	10%
		6.12	Res. trip time	[100mS, 1, 2, 3, 5 Sec]	100 mS
		6.13	RCD Trp. Level	[25, 50 , 100, 200, 500mA]	25 mA
		6.14	RCD Trp. Time	[50, 100, 150mSec]	50mSec
		6.15	Pilot Trip t	[80, 120, 160, 200, 300, 400, 500mSec] (120mSec)	80mSec
		6.16	Remote Start	No, Yes,	No
		6.17	EC Trip Latch	[On / Off] For Reset – Operate Reset Button	On
		6.18	Ins.Tst Level	1, 2, 5, 10, 20MΩ, None	1.0MΩ
		6.19	U/V Trip level	[40, 50, 60, 70, 75, 80, 85, 90, 95%, Off]	40%
		6.20	back emf time	[2 , 5, 10, 15, 20 Sec]	2 Sec
		6.21	High I alarm (Delay – 1s)	[100 – 600% FLC & Off]	100%
		6.22	O/L Alarm Lev (Delay – 2s)	50%, 60%, 70%, 75%, 80%, 85%, 90%, 95%, Alarm Off	50%
		6.23	Under I Alarm (Delay – 2s)	32%, 40%, 48%, 56%, 64%, 72%,80%, 88%, 96%, Off	32%
		6.24	E/L Alarm Lev (Delay – 1s)	10%, 20%, 30%, 40%, 50%,60%, 80%, Off	10%
		6.25	Burp Pulses	[None, 1 to 6]	None
		6.26	Burp On Time	[0.6, 0.8, 1.0, 1.2, 1.5, 2.0. 2.5. 3.0Sec]	0.6 Sec
		6.27	Burp Off Time	[0.6, 0.8, 1.0, 1.2, 1.5, 2.0. 2.5. 3.0Sec]	0.6 Sec
		6.28	4-20 Ma Output	[O/L : 0 – 100%, lave: 0-250%, E/L: 0 -100%, MΩ 0- 40MΩ	O/L
		6.29	Snore Delay	Off, 5, 10, 15, 20, 8F, 15F, 20F, 30F, 60F (F= Fixed Delay)	Off

Type 1	
Tripped No Volts	EC Leak T
MC Close Fail	EC Ω Trip
External MC Open	MC Opened
Burp MCI Fail	RTM Off L
Under Current Trip	Und.I.Trp
Last Trip Message	Stopped
	Ext.Stop

Type 2	
Outlet Paused	Snore-Close Aux
Need IPM Start	High Current Alarm
Testing Insulation	Thermal Trip Alarm
Closing Main Cont.	Cur. Balance Alarm
Burp: MCR - Closed	Under Cur. Alarm
Burp: MCR - Open	Earth Leakage Alarm
Running	UnderVoltage Alarm
Snore	Insulat.Test Alarm

Type 3	
Earth Leakage Trip	RTM –Off Line Trip
Earth Cont. Trip	IPM Memory Error
Insulat. Fail Trip	RTM Memory Error
Over Current Trip	Stopped – IPM
Short Circuit Trip	
I Balance Trip	
Residual Cur. Trip	
Main Contactor Fail	

20 IPM Modbus Address Table

Modbus Addr	Description
0 -3	Unused Address
4 Note: Bit set when tripped.	Trip Status 1 and 2 Bit8 = Earth Leakage Trip Bit9 = Earth Continuity Trip Bit10 = Insulat. Fail trip Bit11 = Overcurrent Trip Bit12 = Short Circuit Trip Bit13 = I Balance trip Bit14 = Residual Cur. Trip Bit15 = Main Contactor Fail Bit 0 = External Stop Bit 1 = RTM Offline Trip Bit2 = IPM Memory Error Bit3 = RTM Memory Error Bit4 = Stopped - IPM Bit5 = Unused Bit Bit6 = Unused Bit Bit7 = RTM CT Ratio Error
5 Note: Bit set when tripped.	Soft Trip Status and Alarms Bit8 = Tripped No Volts Bit9 = MC Close Fail Bit10 = External MC Open Bit11 = Burp MCI Fail Bit12 = Under Current Trip Bit13 = Unused Bit Bit14 = Unused Bit Bit15 = Last T: Bit 0 = High Current Alarm Bit 1 = Thermal Trip Alarm Bit2 = Unused Bit Bit3 = Under Cur. Alarm Bit4 = Earth Leakage Alarm Bit5 = Unused Bit Bit6 = Insulation Test Alarm Bit7 = Unused Bit
6 Note: Bits set when active	Status Bit0 = Outlet Paused Bit1 = Need IPM Start Bit2 = Testing Insulation Bit3 = Closing Main Cont. Bit4 = Burp: MC Closed Bit5 = Burp: MC Open Bit6 = Running Bit7 = Manual Insulation Test Bit8 = Snore Bit9 = Snore – Close Aux Bit10 = RTM Version Error
7 Bits 0-7 clr when key pressed	Digital Inputs and Keys Bit10 = Lock Input Bit11 = Reset Input Bit12 = Aux Input Bit13 = Start Input Bit14 = Stop Input Bit15 = MCI Input

Modbus Addr	Description
7 cont.	Bit0 = Stop Key Bit1 = Start Key Bit2 = Reset Key Bit3 = Test Key
8	N/A
9	E/C Forward Resistance
10	E/C Reverse Resistance
11	Insulat. Test Result (MOhms)
12	Control Keys Bit0 = Up Key Bit1 = Down Key Bit2 = Left key Bit3 = Right key Bit4 = Enter key Bit5 = Esc Key
13	E/L Current (0..110%)
14	A Phase Current (0..1000%)
15	B Phase Current (0..1000%)
16	C Phase Current (0..1000%)
17	Current Balance (0..100%)
18	Residual Current (0..1000%)
19	OC Thermal Accum (0..120%)
20	A Phase Voltage (0..120%)
21	B Phase Voltage (0..120%)
22	C Phase Voltage (0..120%)
23	Phase Voltage Average (BCD format)
24	Current Average (0..250%)
25	Unused
26	Unused
27	Unused
28	Unused
29	Unused
30	Unused
31	Unused
32	IPM Software Version – where x = Top 3 bits (Hardware Ver.) y = Bot 5 bits (Software Ver.)
33	Time Sub -Second
34	Time - Second
35	Time - Minute
36	Time - Hour
37	Date
38	Month
39	Year
40	Day
41	EC Pilot-mode 0 = Invalid Data 1 = RTM 2 = Diode
42	ITM Module 0 = Invalid Data 1 = 415V 2 = 1000V 3 = None

Modbus Addr	Description
43	Modbus Address 0 = Invalid Data 1……31
44	Modbus Baud Rate 0 = Invalid Data 1 = 1200E 2 = 1200O 3 = 1200N 4 = 2400E 5 = 2400O 6 = 2400N 7 = 4800E 8 = 4800O 9 = 4800N 10 = 9600E 11 = 9600O 12 = 9600N 13 = 19k2E 14 = 19k2O 15 = 19K2N
45	Machine Type 0 = - - - - 1 = J-bo - Jumbo 2 = Fan 3 = Drill 4 = Pump 5 = Hpmp - Hydraulic Pump 6 = Wpmp - Water Pump 7 = DCB 8 = Bolt - Bolter 9 = HRMr - Hard Rock Miner 10 = Belt 11 = Winc - Winch 12 = Crush - Crusher 13 = DPlug – Dummy Plug 14 = Spare
46	Machine Number 0 = Invalid Data 1 …. 40
47	FLC Setting (See OC section): 1..32 = 5.125..10.000A 33..64 = 10.25..20.00A 65..96 = 20.5..40.0A 97..128 = 41..80A 129..160 = 82..160A 161..192 = 164..320A 193..224 = 328..640A

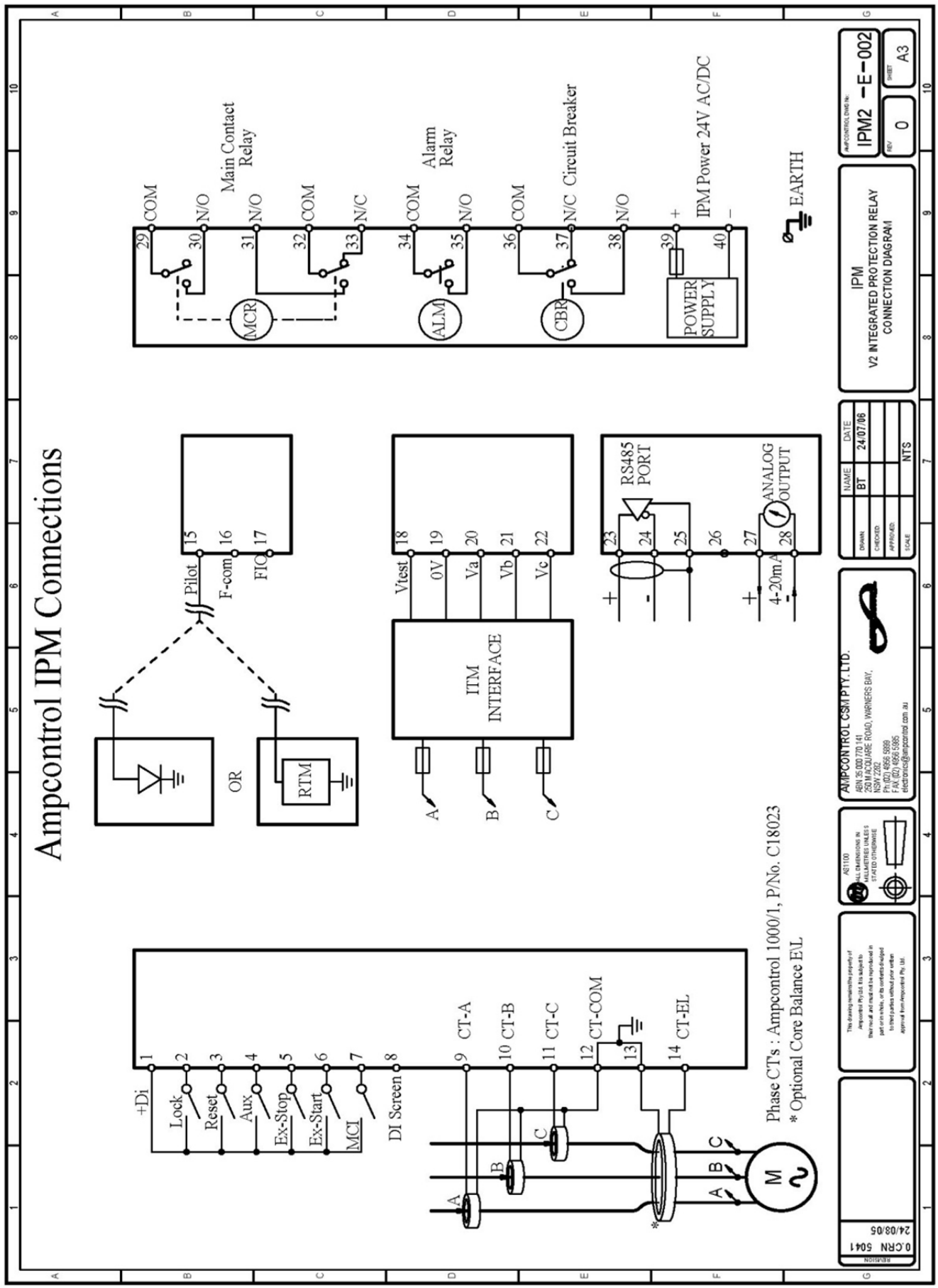
Modbus Addr	Description
48	SC Trip Level (xFLC): 0 = Invalid Data 1 = 3x 2 = 3.5x 3 = 4x 4 = 4.5x 5 = 5x 6 = 5.5x 7 = 6x 8 = 6.5x 9 = 7x 10 = 7.5x 11 = 8x 12 = 8.5x 13 = 9x 14 = 9.5x 15 = 10x
49	SC Trip Time: 0 = Invalid Data 1 = 20 ms 2 = 40 ms 3 = 60 ms 4 = 80 ms 5 = 100 ms 6 = 120 ms 7 = 160 ms
50	O/L Trip Time @ 6x FLC: 0 = Invalid Data 1 = 3s 2 = 4s 3 = 5s 4 = 6s 5 = 7s 6 = 8s 7 = 10s 8 = 12s 9 = 14s 10 = 16s 11 = 20s 12 = 24s 13 = 28s 14 = 32s 15 = 40s
51	S-Cool Ratio: 0 = Invalid Data 1 = 1.0 2 = 1.5 3 = 2.0 4 = 2.5 5 = 3.0 6 =4.0 7 =5.0

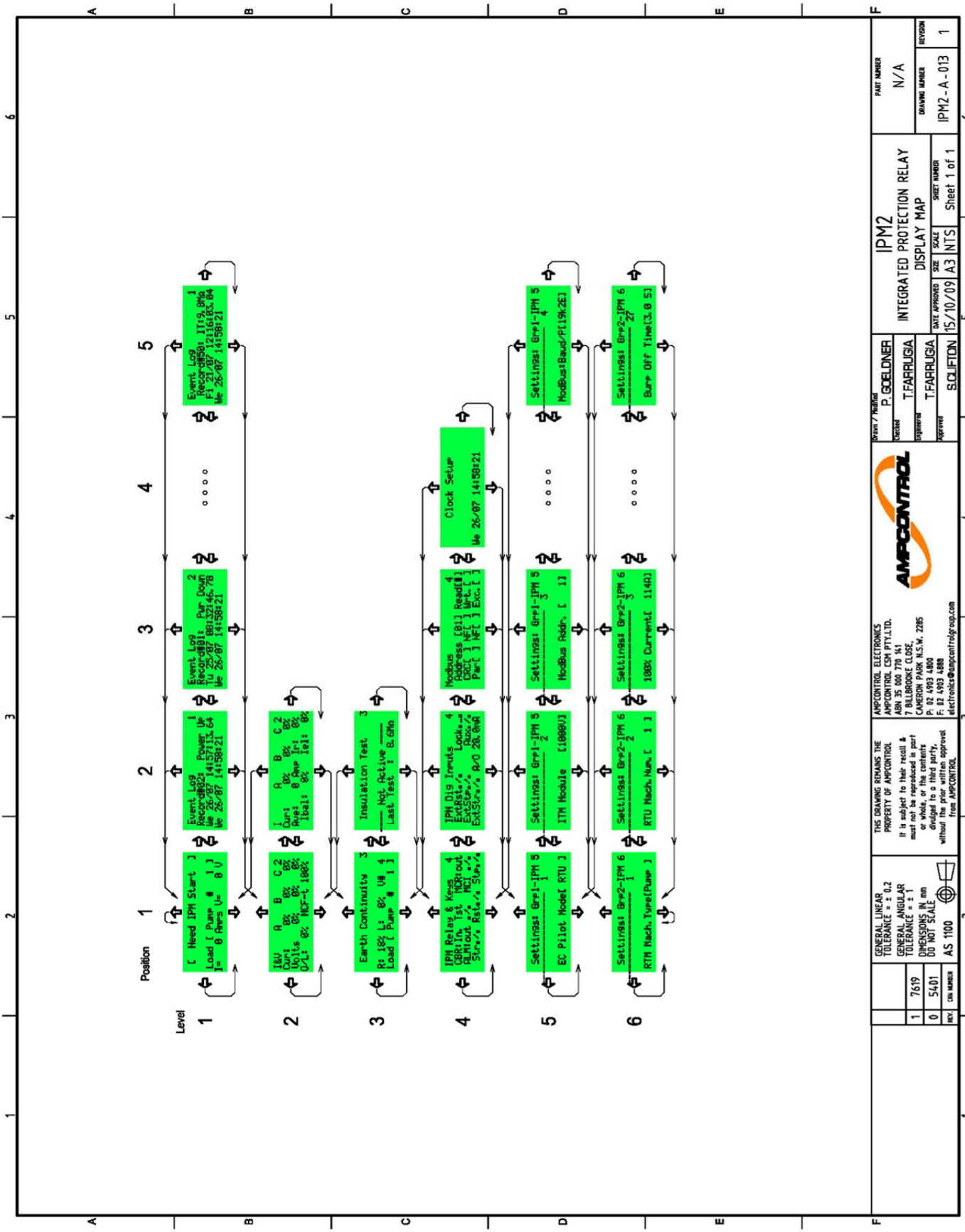
Modbus Addr	Description
52	O/L Reset Level 0 = Invalid Data 1 = 30% 2 = 40% 3 = 50% 4 = 60% 5 = 70% 6 = 80% 7 = 90% 8 = A-30% 9 = A-40% 10 = A-50% 11 = A-60% 12 = A-70% 13 = A-80% 14 = A-90%
53	Current Balance Trip: 0 = Invalid Data 1 = 5% 2 = 10% 3 = 20% 4 = 50% 5 = Off
54	Under I Trip: 0 = Invalid Data 1 = 32% 2 = 40% 3 = 48% 4 = 56% 5 = 64% 6 = 72% 7 = 80% 8 = 88% 9 = 96% 10 = None
55	Ires Trip Level (%FLC): 0 = Invalid Data 1 = 10% 2 = 20% 3 = 30% 4 = 40% 5 = 50% 6 = 60% 7 = 80% 8 = 100% 9 = 120% 10 = 150% 11 = 200% 12 = 250% 13 = OFF
56	Ires Trip Time: 0 = Invalid Data 1 = 100ms 2 = 200ms 3 = 500ms 4 = 1.0 Sec
56 Cont.	5 = 2.0 Sec 6 = 3.0 Sec 7 = 5.0 Sec
57	RCD Trip Level 0 = Invalid Data 1 = 25mA 2 = 50mA 3 = 100mA 4 = 150mA 5 = Off
58	RCD Time: 0 = Invalid Data 1 = Ins. (Instantaneous) 2 = 50ms 3 = 100ms 4 = 150ms
59	Pilot Trip Time 0 = Invalid Data 1 = 80ms 2 = 120ms 3 = 160ms 4 = 200ms 5 = 300ms 6 = 400ms 7 = 500ms
60	Remote Start 0 = Invalid Data 1 = No 2 = Yes
61	Pilot Latch 0 = Invalid Data 1 = On 2 = Off
62	Meg Level 0 = Invalid Data 1 = 1.0M 2 = 2.0M 3 = 5.0M 4 = 10M 5 = 20M 6 = None
63	Under Voltage Trip Level 0 = Invalid Data 1 = 40% 2 = 50% 3 = 60% 4 = 70% 5 = 75% 6 = 80% 7 = 85% 8 = 90% 9 = 95% 10 = OFF

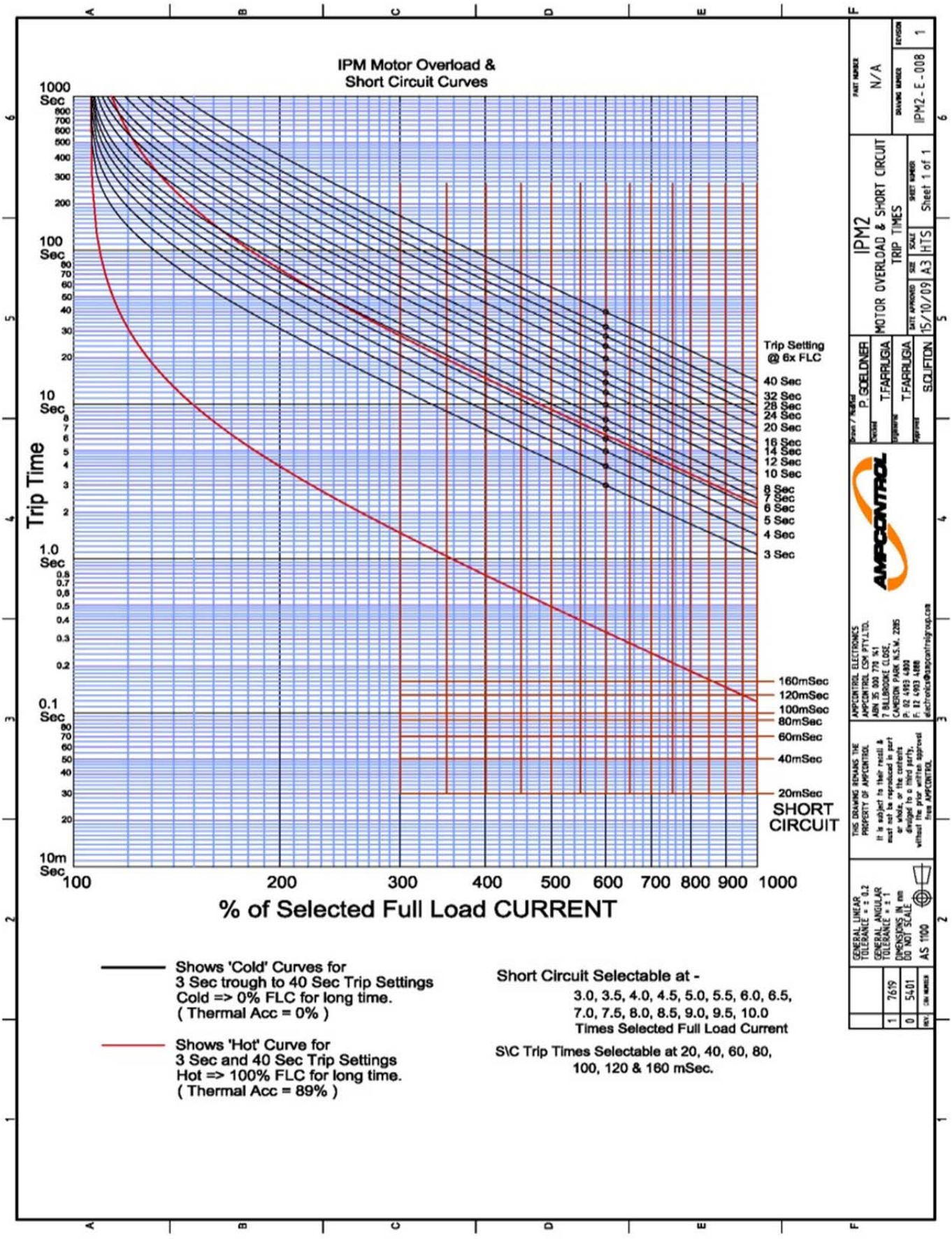
Modbus Addr	Description
64	Back EMF Time 0 = Invalid Data 1 = 2 Sec 2 = 5 Sec 3 = 10 Sec 4 = 15 Sec 5 = 20 Sec
65	High Current Alarm 0 = Invalid Data 1 = 100% 2 = 108% 3 = 120% 4 = 140% 5 = 160% 6 = 200% 7 = 240% 8 = 280% 9 = 320% 10 = 360% 11 = 400% 12 = 500% 13 = 600% 14 = OFF
66	O/L Alarm Level 0 = Invalid Data 1 = 50% 2 = 60% 3 = 70% 4 = 75% 5 = 80% 6 = 85% 7 = 90% 8 = 95% 9 = OFF
67	Under Current Alarm 0 = Invalid Data 1 = 32% 2 = 40% 3 = 48% 4 = 56% 5 = 64% 6 = 72% 7 = 80% 8 = 88% 9 = 96% 10 = Off
68	Earth Leakage Alarm 0 = Invalid Data 1 = 10% 2 = 20% 3 = 30% 4 = 40% 5 = 50% 6 = 60% 7 = 70% 8 = Off
Modbus Addr	**Description**

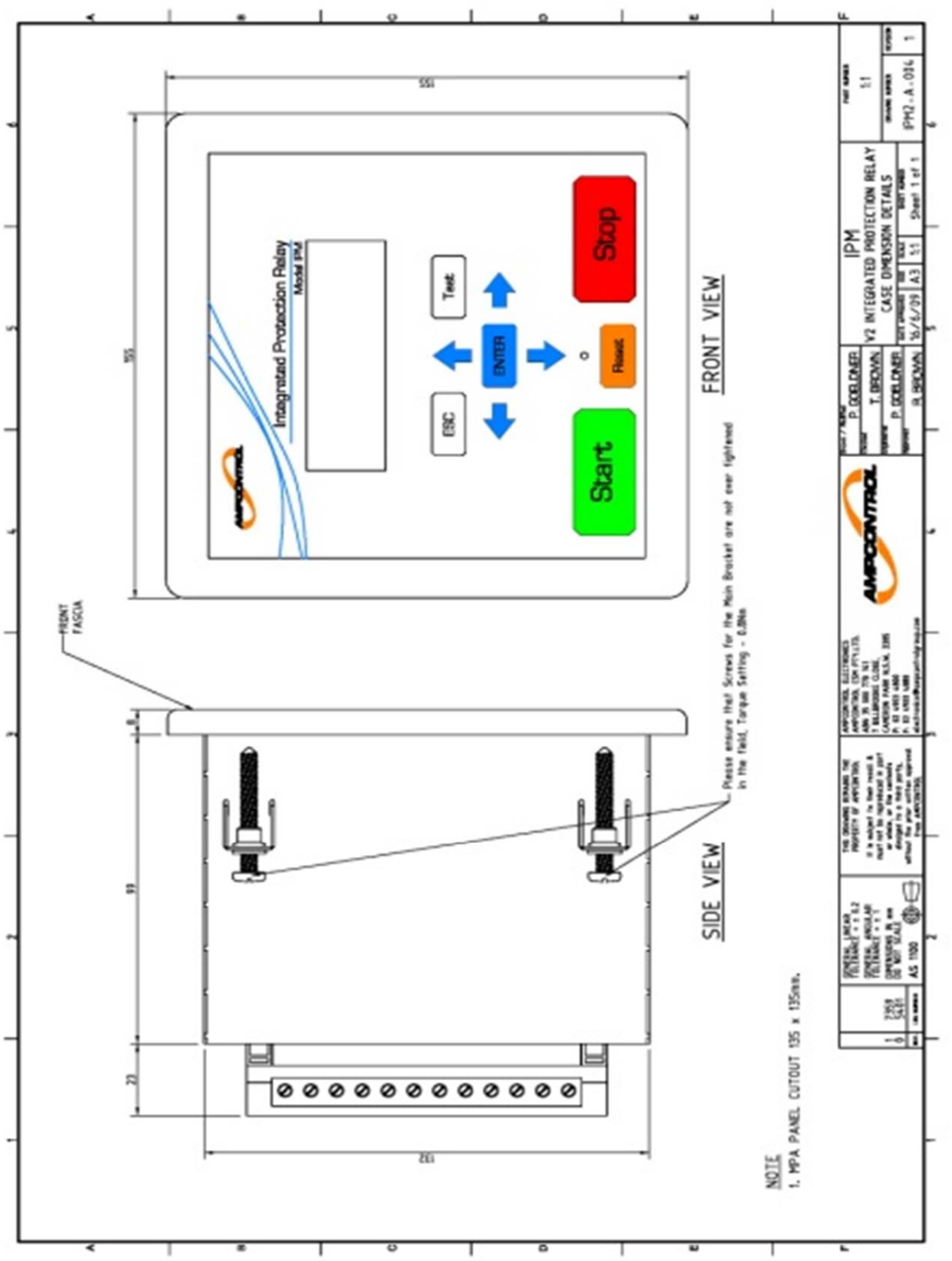
69	# Burp Pulses:
	0 = Invalid Data
	1 = None
	2 = 1
	3 = 2
	4 = 3
	5 = 4
	6 = 5
	7 = 6

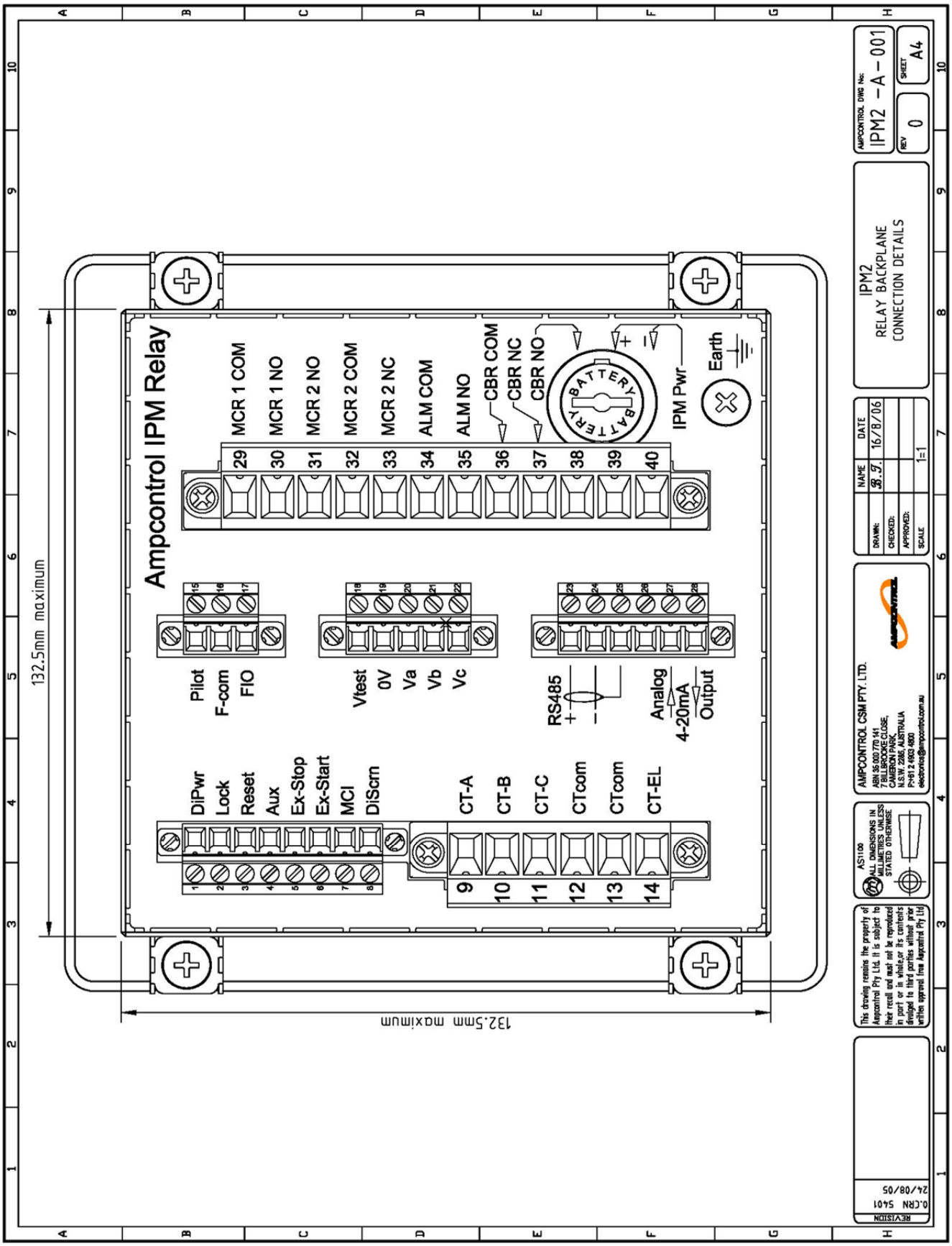
70	Burp On Time 0 = Invalid Data 1 = 0.6 S 2 = 0.8 S 3 = 1.0 S 4 = 1.2 S 5 = 1.5 S 6 = 2.0 S 7 = 2.5 S 8 = 3.0 S
71	Burp Off Time: 0 = Invalid Data 1 = 0.6 S 2 = 0.8 S 3 = 1.0 S 4 = 1.2 S 5 = 1.5 S 6 = 2.0 S 7 = 2.5 S 8 = 3.0 S
72	4-20mA Output 0 = Invalid Data 1 = O/L 2 = Iave 3 = Iel 4 = MΩ
73-78	N/A

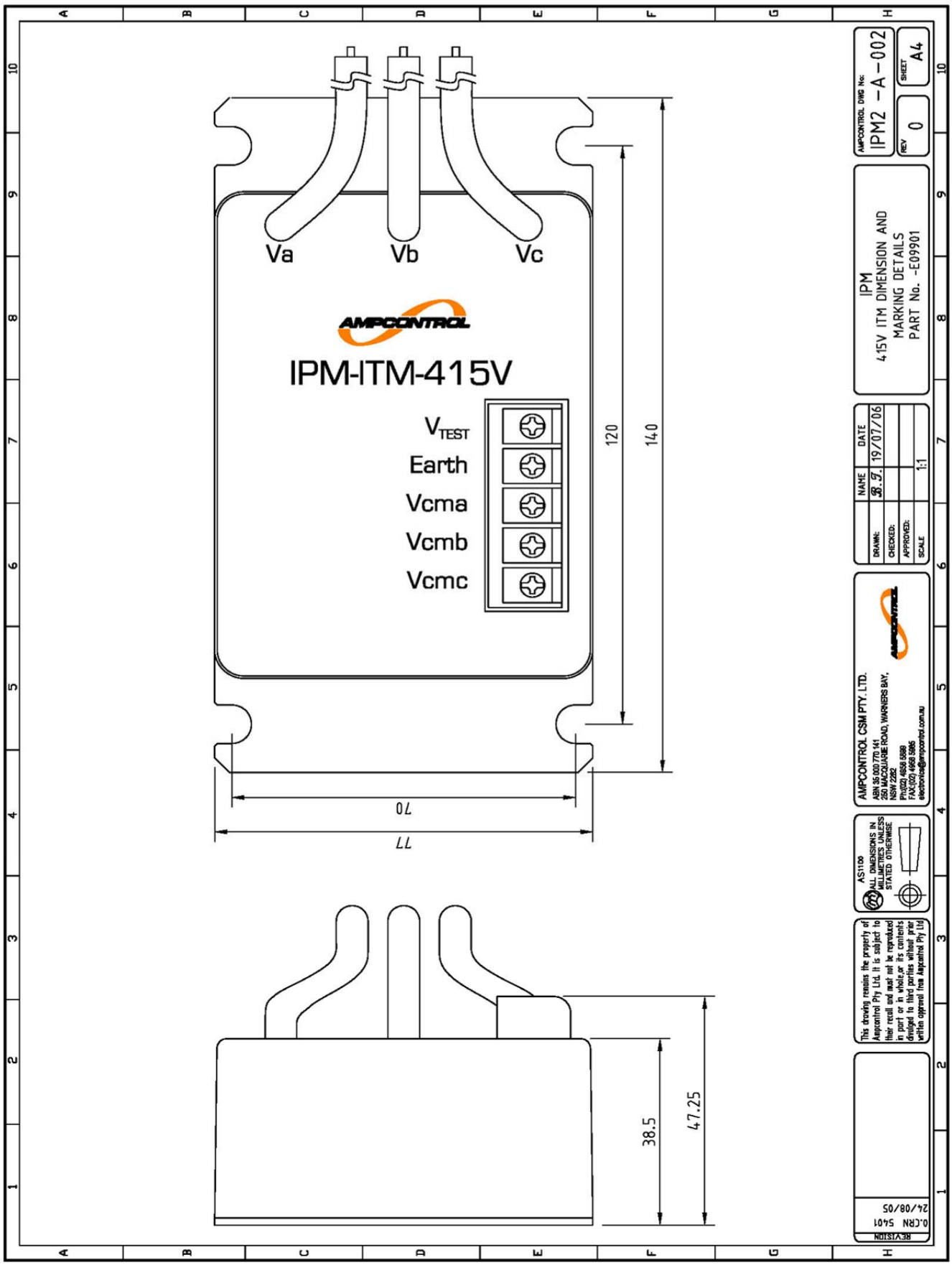

Ampcontrol IPM Connections
IPM
V2 INTEGRATED PROTECTION RELAY
CONNECTION DIAGRAM
IPM2 -E-002
AMPCONTROL CSM PTY. LTD.
ABN 35 000 770 141
250 MACQUARIE ROAD, WARNERS BAY, NSW 2282
Ph (02) 4956 5999
FAX (02) 4956 5985
electronics@ampcontrol.com.au
Main Contact Relay
Alarm Relay
Circuit Breaker
IPM Power 24V AC/DC
COM
N/O
N/C
MCR
ALM
CBR
POWER SUPPLY
EARTH
Pilot
F-com
FIO
RTM
OR
ITM INTERFACE
Vtest
0V
Va
Vb
Vc
RS485 PORT
ANALOG OUTPUT
4-20mA
+Di
Lock
Reset
Aux
Ex-Stop
Ex-Start
MCI
DI Screen
CT-A
CT-B
CT-C
CT-COM
CT-EL
Phase CTs : Ampcontrol 1000/1, P/No. C18023
* Optional Core Balance E\L

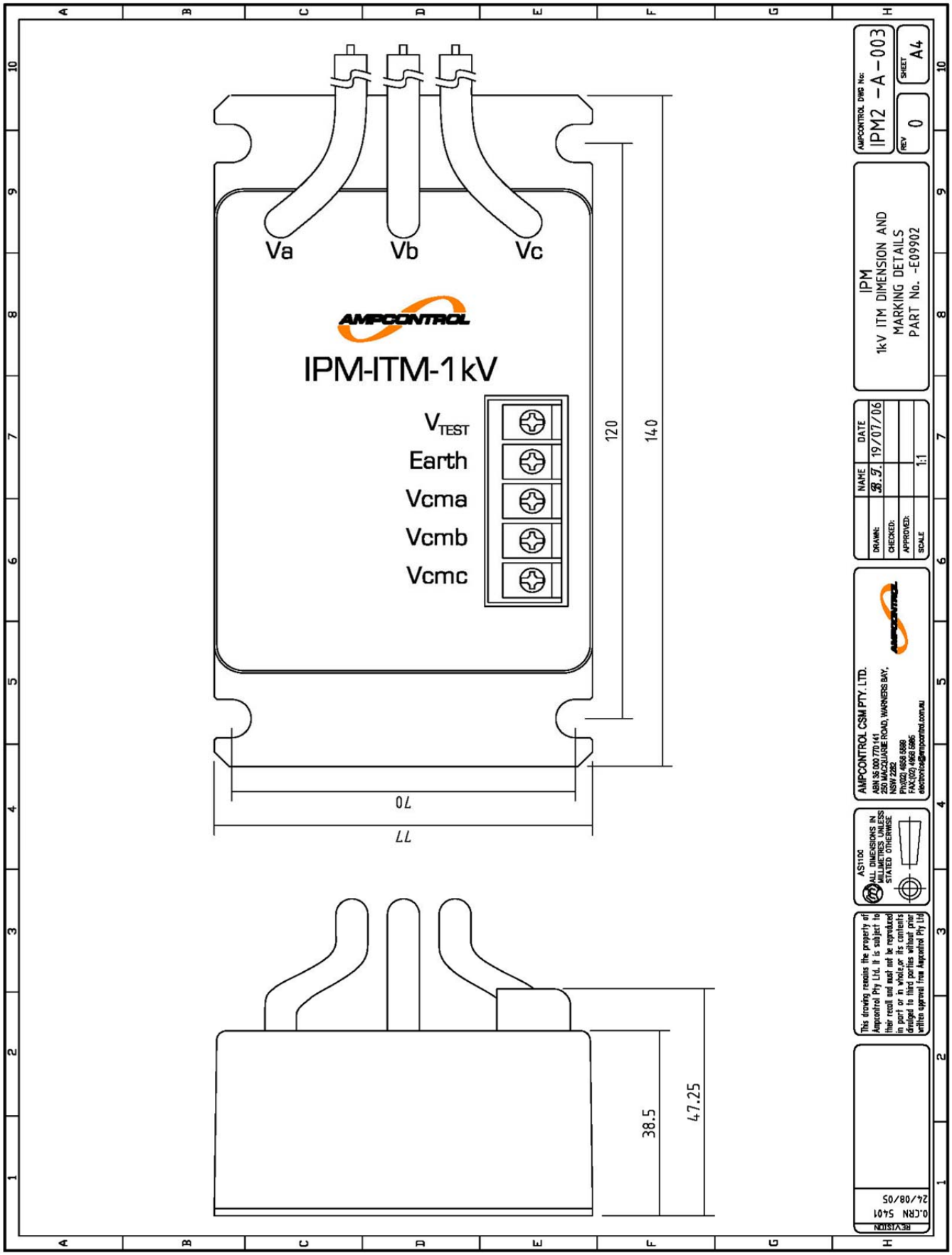

Position
Level
IPM2
INTEGRATED PROTECTION RELAY
DISPLAY MAP
AMPCONTROL ELECTRONICS
AMPCONTROL CSM PTY.LTD.
ABN 35 000 770 141
7 BILLBROOKE CLOSE
CAMERON PARK N.S.W. 2285
P: 02 4953 1800
F: 02 4953 1888
electronics@ampcontrolgroup.com
P.GOELDNER
T.FARRUGIA
T.FARRUGIA
SCLIFTON
15/10/09
A3
NTS
Sheet 1 of 1
N/A
IPM2-A-013
1
7619
5401
AS 1100
GENERAL LINEAR TOLERANCE = ± 0.2
GENERAL ANGULAR TOLERANCE = ± 1
DIMENSIONS IN mm
DO NOT SCALE
THIS DRAWING REMAINS THE PROPERTY OF AMPCONTROL
It is subject to their recall & must not be reproduced in part or whole, or the contents divulged to a third party, without the prior written approval from AMPCONTROL

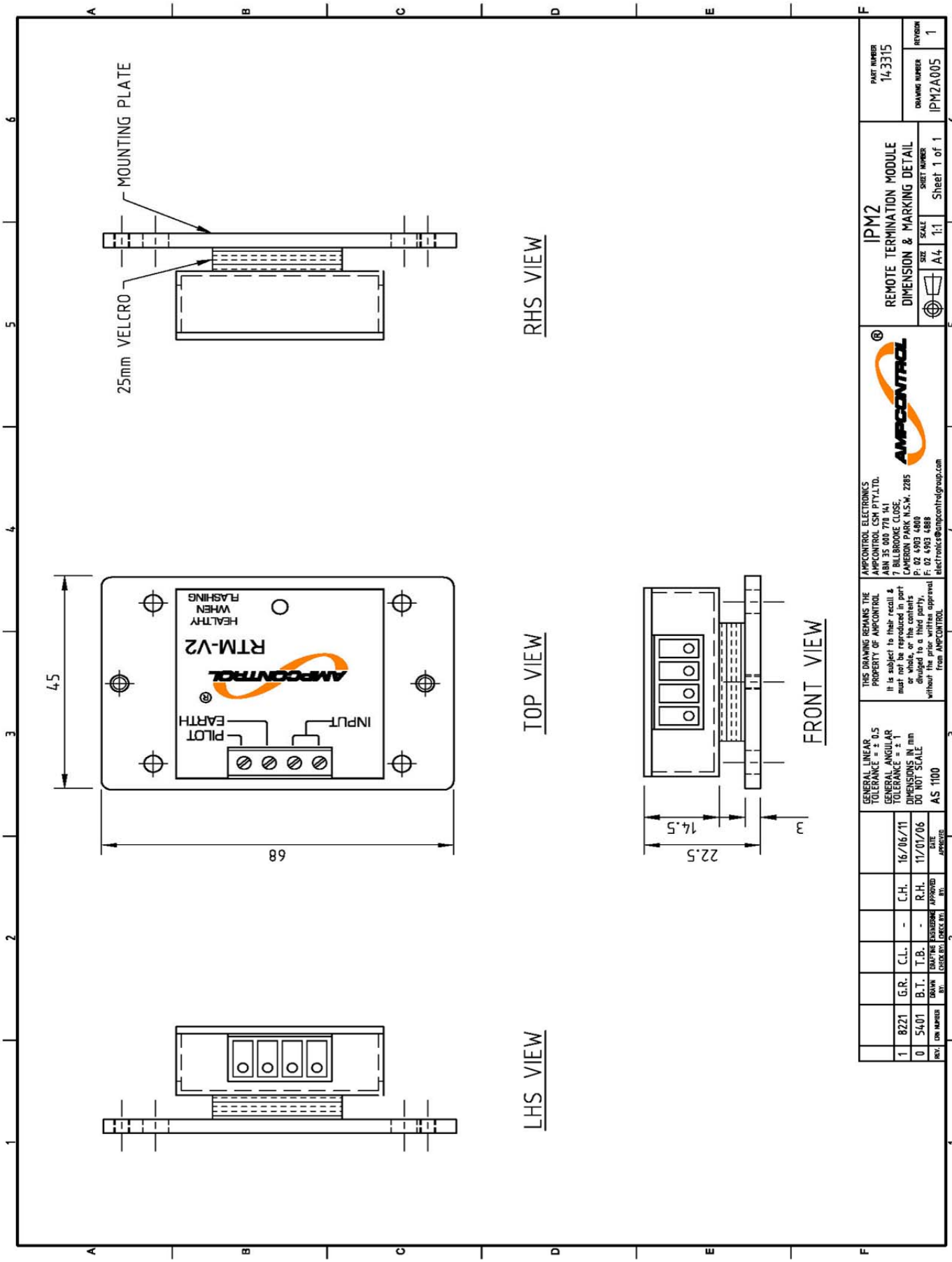

IPM Motor Overload &
Short Circuit Curves
Trip Time
1000 Sec
100 Sec
10 Sec
1.0 Sec
0.1 Sec
10m Sec
Trip Setting @ 6x FLC
40 Sec
32 Sec
28 Sec
24 Sec
20 Sec
16 Sec
14 Sec
12 Sec
10 Sec
8 Sec
7 Sec
6 Sec
5 Sec
4 Sec
3 Sec
160mSec
120mSec
100mSec
80mSec
60mSec
40mSec
20mSec
SHORT CIRCUIT
100 200 300 400 500 600 700 800 900 1000
% of Selected Full Load CURRENT
Shows 'Cold' Curves for
3 Sec trough to 40 Sec Trip Settings
Cold => 0% FLC for long time.
(Thermal Acc = 0%)
Shows 'Hot' Curve for
3 Sec and 40 Sec Trip Settings
Hot => 100% FLC for long time.
(Thermal Acc = 89%)
Short Circuit Selectable at -
3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5,
7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0
Times Selected Full Load Current
S\C Trip Times Selectable at 20, 40, 60, 80,
100, 120 & 160 mSec.
IPM2
MOTOR OVERLOAD & SHORT CIRCUIT
TRIP TIMES
IPM2-E-008
Sheet 1 of 1
P.GOELDNER
T.FARRUGIA
S.CLIFTON
15/10/09
AMPCONTROL

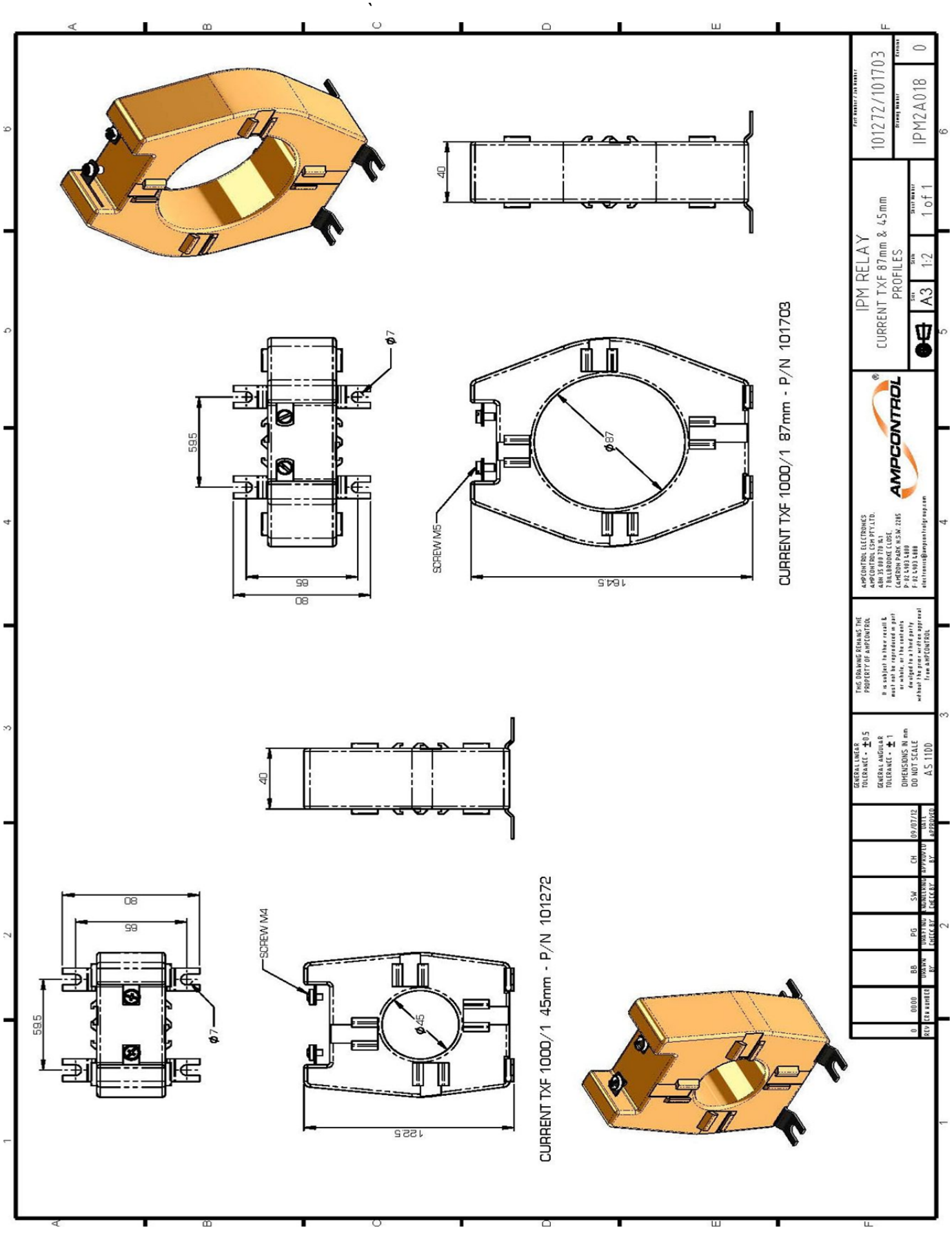

FRONT VIEW
SIDE VIEW
Integrated Protection Relay
Model IPM
Stop
Start
Reset
Test
ENTER
ESC
FRONT FASCIA
Please ensure Hex Screws for the Main Bracket are not over tightened in the field, Torque Setting - 0.8Nm
NOTE
1. MPA PANEL CUTOUT 135 x 135mm.
IPM
V2 INTEGRATED PROTECTION RELAY
CASE DIMENSION DETAILS
IPM2-A-016


Ampcontrol IPM Relay
MCR 1 COM
MCR 1 NO
MCR 2 NO
MCR 2 COM
MCR 2 NC
ALM COM
ALM NO
CBR COM
CBR NC
CBR NO
IPM Pwr
Earth
29 30 31 32 33 34 35 36 37 38 39 40
Pilot
F-com
FIO
15 16 17
Vtest
0V
Va
Vb
Vc
18 19 20 21 22
RS485
+
-
23 24 25 26 27 28
Analog
4-20mA
Output
DiPwr
Lock
Reset
Aux
Ex-Stop
Ex-Start
MCI
DiScrn
1 2 3 4 5 6 7 8
CT-A
CT-B
CT-C
CTcom
CTcom
CT-EL
9 10 11 12 13 14
132.5mm maximum
132.5mm maximum
IPM2
RELAY BACKPLANE
CONNECTION DETAILS
AMPCONTROL DWG No:
IPM2 -A- 001
REV 0
SHEET A4
NAME DATE
DRAWN: B.J. 16/8/06
CHECKED:
APPROVED:
SCALE 1=1
AMPCONTROL CSM PTY. LTD.
ABN 35 000 770 141
7 BALLBROOKE CLOSE,
CHATSWOOD NSW,
N.S.W. 2065, AUSTRALIA
P:+61 2 4903 4800
electronics@ampcontrol.com.au
AS1100
ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE
This drawing remains the property of Ampcontrol Pty Ltd. It is subject to their recall and must not be reproduced in part or in whole or its contents divulged to third parties without prior written approval from Ampcontrol Pty Ltd
REVISION
0. CRN 5401
24/08/05


Va
Vb
Vc
AMPCONTROL
IPM-ITM-415V
VTEST
Earth
Vcma
Vcmb
Vcmc
120
140
70
77
38.5
47.25
AMPCONTROL DWG No:
IPM2 -A-002
REV
0
SHEET
A4
IPM
415V ITM DIMENSION AND
MARKING DETAILS
PART No. -E09901
NAME
DATE
DRAWN:
S.F.
19/07/06
CHECKED:
APPROVED:
SCALE
1:1
AMPCONTROL CSM PTY. LTD.
ABN 35 003 770 141
250 MACQUARIE ROAD, WARNERS BAY,
NSW 2282
Ph:(02) 4958 5988
FAX:(02) 4958 5985
electronics@ampcontrol.com.au
AS1100
ALL DIMENSIONS IN
MILLIMETRES UNLESS
STATED OTHERWISE
This drawing remains the property of
Ampcontrol Pty Ltd. It is subject to
their recall and must not be reproduced
in part or in whole,or its contents
divulged to third parties without prior
written approval from Ampcontrol Pty Ltd
REVISION
0.CRN 5401
24/08/05


Va
Vb
Vc
AMPCONTROL
IPM-ITM-1kV
V_{TEST}
Earth
Vcma
Vcmb
Vcmc
120
140
70
77
38.5
47.25
IPM
1kV ITM DIMENSION AND
MARKING DETAILS
PART No. -E09902
AMPCONTROL DWG No:
IPM2 -A-003
REV 0
SHEET A4
DRAWN: 19/07/06
CHECKED:
APPROVED:
SCALE 1:1
AMPCONTROL CSM PTY. LTD.
ABN 36 000 770 141
250 MACQUARIE ROAD, WARNERS BAY,
NSW 2282
Ph(02) 4958 5888
FAX(02) 4958 5865
electronics@ampcontrol.com.au
AS1100
ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE
This drawing remains the property of Ampcontrol Pty Ltd. It is subject to their recall and must not be reproduced in part or in whole or it's contents divulged to third parties without prior written approval from Ampcontrol Pty Ltd
REVISION
O.CRN 5401
24/08/05


MOUNTING PLATE
25mm VELCRO
RHS VIEW
TOP VIEW
FRONT VIEW
LHS VIEW
RTM-V2
HEALTHY WHEN FLASHING
PILOT
EARTH
INPUT
45
68
22.5
14.5
3
IPM2
REMOTE TERMINATION MODULE
DIMENSION & MARKING DETAIL
PART NUMBER 143315
DRAWING NUMBER IPM2A005
REVISION 1
SIZE A4
SCALE 1:1
SHEET NUMBER Sheet 1 of 1
AMPCONTROL ELECTRONICS
AMPCONTROL CSM PTY.LTD.
ABN 35 000 778 141
7 BILLBROOKE CLOSE
CAMERON PARK N.S.W. 2285
P: 02 4903 4800
F: 02 4903 4888
electronics@ampcontrolgroup.com
THIS DRAWING REMAINS THE PROPERTY OF AMPCONTROL
It is subject to their recall & must not be reproduced in part or whole, or the contents divulged to a third party, without the prior written approval from AMPCONTROL
GENERAL LINEAR TOLERANCE = ± 0.5
GENERAL ANGULAR TOLERANCE = ± 1
DIMENSIONS IN mm
DO NOT SCALE
AS 1100
1 8221 G.R. C.L. - C.H. 16/06/11
0 5401 B.T. T.B. - R.H. 11/01/06
REV. CDN NUMBER DRAWN BY: DRAFTING CHECK BY: ENGINEERING CHECK BY: APPROVED BY: DATE APPROVED


CURRENT TXF 1000/1 87mm - P/N 101703
CURRENT TXF 1000/1 45mm - P/N 101272
SCREW M5
SCREW M4
595
40
80
85
ø7
ø87
ø45
1645
1225
IPM RELAY
CURRENT TXF 87mm & 45mm
PROFILES
IPM2A018
101272/101703
AMPCONTROL