BEDFORD PUMPS LTD.

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TECHNICAL MANUAL

For

BEDFORD PUMPS LTD

PUMP CONDITION MONITOR Mk II

EQUIPMENT SUPPLIED BY:
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PUMP CONDITION MONITOR Mk II

Software Version 1.0

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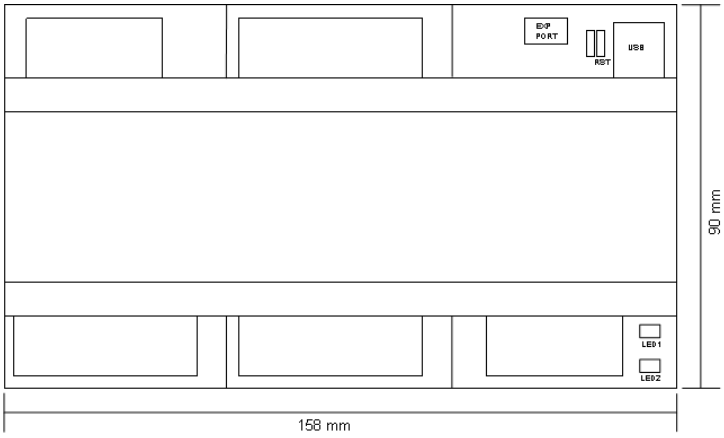
Section 1: Introduction

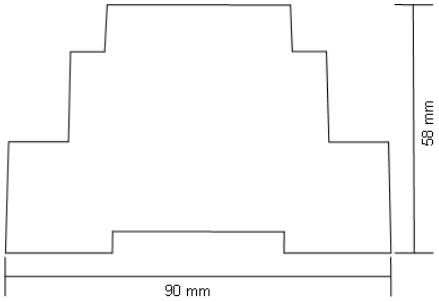
The BPL Pump Condition Monitor II (PCM) provides supervisory status and recording of various protection and indicators installed into modern submersible pumps. The monitor is standalone or can communicate with external PLC networks via an RS485 connection. A display is available to give live local status information.

The monitor has inputs available for 3 additional auxiliary signals, enabling the recording of data from any source providing a 0-20mA, 0-1V or 0-10V signal. This information can later be downloaded, scaled and analysed.

Section 2: Specifications

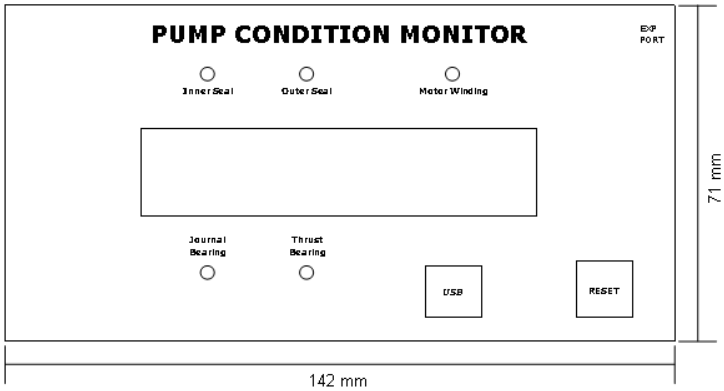
2.1 PCM Enclosure



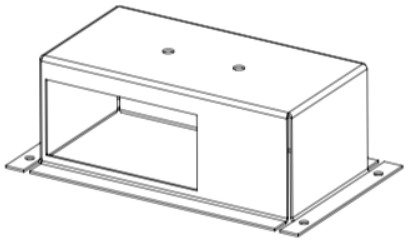


2.2 Display

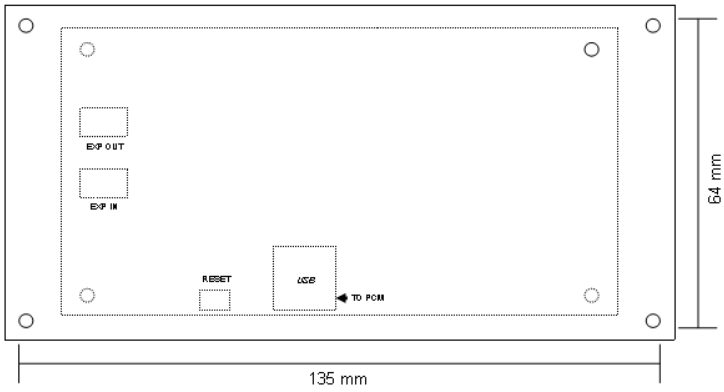
Front View



Display Back Box

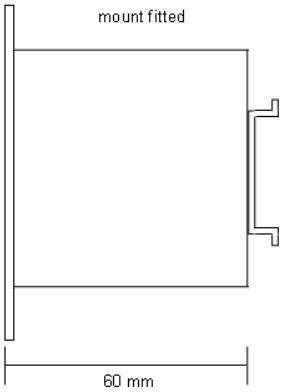


Rear View



Side View

Clamping Plate with DIN rail mount fitted



2.3 Power

Supply	24V DC
Circuit Protection	1 AMP

2.4 General

Enclosure

Dimensions	Length	150 mm
	Width	90 mm
	Height	58 mm
IP Rating	IP20	
Mounting Position	DIN rail NS35/7.5	
Operating Temperature Range	0-50˚C	

Display

Dimensions	Length	142 mm
	Height	71 mm
	Depth inc DIN	41 mm
Panel Door Hole Dimensions	Length	135 mm
	Height	64 mm
IP Rating	IP10 – When installed on the control panel	
Mounting Position	Control Panel Door	
Operating Temperature Range	0-50˚C. Readability of display 10-45˚C	

2.5 Wiring connections

Unit is supplied with plug in connectors
Connectors accept 0.5 to 2.5mm² cable

2.6 USB Connection

Connection to the PCM is via the female USB-B Port on the unit or display. Device drivers for the USB port are not required for Windows operating systems after Windows 7.

2.7 PCM II Initialisation

The **PCM II waits 10 seconds upon start up/reset** to allow all sensors to feedback actual readings without relaying a false fault and tripping the system.

2.8 PCM II Memory

The PCM II has an inbuilt memory capable of storing approximately 43000 data entries. The data is stored in a ‘rolling’ format so that the data from the first entries is overwritten first.

Section 3: Installation

3.1 PCM (Enclosure only)

The PCM is DIN rail mounted within a control panel and connected as Section 9 during manufacture.

3.2 PCM and Display

The PCM complete with the display may be installed as one unit as the display holder has a DIN rail fitted (Section 2.2). (Power for the display is supplied by the PCM).

1 Cut a hole in the panel door 137mm x 66mm.
2 Remove the clamping plate from the back of the display (see Section 2.2).
3 Insert the display into the panel door hole.

4 Place the clamping plate onto the display studding. Fit and tighten the washers and nuts.
5 Attach the ribbon cable to the expansion port of the PCM II and the display circuit board (see Section 2.2).
6 Fit the DIN rail to the back of the display and attach the PCM to the DIN rail (see Section 2.2).
7 Connect the ribbon cable to the PCM (see Section 2.1)
8 Connect the USB cable from the display to the PCM (see Section 2.1 & 2.2)
9 Connect the wiring to the PCM II as per Section 9.
10 Close panel doors and turn on the isolator.
11 Leave 10 seconds for the display and PCM to boot up and show actual values. This is an in-built time delay within the PCM.
12 The display will show the sensor values and Green LEDs if the system is in a healthy state.

For *Retrofitting the PCM II* see Appendix 1.

Section 4: Sensors

The PCM is the interface between the sensors listed below. The threshold values are adjustable via the RS485 or USB connection.

Each Sensor status is averaged over a 10 second period.
Recorded values are date and time stamped every 3 minutes when the pump is running.

Via Windows software the bearing temperature sensor type can be selected from ***either***:
i) Precision 10k thermistor,
ii) PT100 or
iii) Thermal switch
depending on which is fitted within the pumpset.

The default values are represented in the tables shown here:

4.1 Seal Chamber Monitor (Conductivity Probe/Resistive Sensor)

Status	Action	Display Notification		Event/Flag
		LED	Value	
Open circuit *	Cable Fault (O/C)	Red	OPEN	OS_OPEN in Fault Register
Normal operation	51%-100%	Green	%	% value in Motor Chamber Register
Inboard Seal beginning to degrade	ALARM at 50%	Red Flashing	%	OS_ALARM in Fault Register
Inboard Seal Failed	Trip signal	Red	000%	OS_FAIL in Fault Register
Short circuit	Cable fault (S/C)	Red	SHORT	OS_SHORT in Fault Register

* NB: The 'Open Circuit' feature needs to be enabled within the *Data Viewing Software* if required.

4.2 Motor Chamber Monitor (Conductivity Probe/Resistive Sensor)

Status	Action	Display Notification		Event/Flag
		LED	Value	
Open circuit *	Cable Fault (O/C)	Red	OPEN	IS_OPEN in Fault Register
Normal operation	51%-100%	Green	%	% value in Motor Chamber Register
Inboard Seal beginning to degrade	ALARM at 50%	Red Flashing	%	IS_ALARM in Fault Register
Inboard Seal Failed	Trip signal	Red	000%	IS_FAIL in Fault Register
Short circuit	Cable fault (S/C)	Red	SHORT	IS_SHORT in Fault Register

* NB: The 'Open Circuit' feature needs to be enabled within the *Data Viewing Software* if required.

4.3 Journal Bearing Sensor (Thermistor) Range 1-150°C

Status	Action	Display Notification		Event/Flag
		LED	Value	
Open circuit*	Cable Fault (O/C)	Red	OPEN	BJ_OPEN in Fault Register
Normal operation	Temperature	Green	Temperature in °C	Temperature in Journal Bearing
Bearing temperature above set alarm value	Alarm Signal	Red Flashing	Temperature in °C	BJ_ALARM in Fault Register
Bearing Over Temperature	Trip signal	Red	Temperature in °C	BJ_TRIP in Fault Register
Short circuit	Cable fault (S/C)	Red	SHORT	BJ_SHORT I Fault Register

When the sensor type has been selected, fault conditions and temperature readings change to suit.
* NB: The 'Open Circuit' feature needs to be enabled within the *Data Viewing Software* if required.

4.4 Thrust Bearing Sensor (Thermistor) Range 1-150°C

Status	Action	Display Notification		Event/Flag
		LED	Value	
Open circuit*	Cable Fault (O/C)	Red	OPEN	BT_OPEN in Fault Register
Normal operation	Temperature	Green	Temperature in °C	Temperature in Thrust Bearing
Bearing temperature above set alarm value	Alarm Signal	Red Flashing	Temperature in °C	BT_ALARM in Fault Register
Bearing Over Temperature	Trip signal	Red	Temperature in °C	BT_TRIP in Fault Register
Short circuit	Cable fault (S/C)	Red	SHORT	BT_SHORT in Fault Register

When the sensor type has been selected, fault conditions and temperature readings change to suit.
* NB: The 'Open Circuit' feature needs to be enabled within the *Data Viewing Software* if required.

4.5 Motor Thermistor

Status	Action	Display Notification		Event/Flag
		LED	Value	
Open circuit	Trip	Red	OPEN	M_OPEN in Motor Status Register
Motor windings over temperature	Trip	Red	TRIP	M_TRIP in Motor Status Register
Normal operation	Normal Operating Range	Green	OK	M_OK in Motor Status Register
Short circuit	Trip	Red	SHORT	M_SHORT in Motor Status Register

Section 5: Inputs and Auxiliary Analogue Inputs

5.1 Start / Stop Signal (Volt free contact input)

Start / Stop events are recorded in the log with the date and time. The START signal flags an increase in the total number of Starts counter by 1.

Contact Status	Action	Event/Flag
Open	Pump Stopped	STOPPED in Motor Status Register
Closed	Pump Started	RUNNING in Motor Status Register

5.2 Remote and Local Reset

The remote reset can perform a full system reset using a remotely connected volt free contact. The local reset is will achieve a total 'hard reset' when a short is made across the reset jumpers on the PCB.

Either method will reset the Trips if a fault has been rectified. Either reset will not change a healthy status.

5.3 Auxiliary Analogue Inputs

3 auxiliary analogue inputs are available with their own set of dip switches on the PCB which enable each input to monitor either a 4-20mA, 0-10V or 0-1V signal input. Current and voltage inputs and current sinks are non-isolated but should be externally isolated.

	Switch A	Switch B	Switch C
0-20mA	1	1	1
0-10V	1	1	0
0-1V	0	1	0

The auxiliary analogue inputs are, by default programmed not to record data. To record data, they need to be activated within the *Data Reviewing Software*.

The input signal is recorded as raw data (0-4095) and can be scaled via a PLC or other software package.

Section 6: Outputs

6.1 Motor Over Temperature Relay

Motor Status	Relay
Motor over temperature	Energised (N/O -> C)
Motor temperature normal	Not Energised (N/C -> C)

This relay complies with BS EN 600034-11/2004

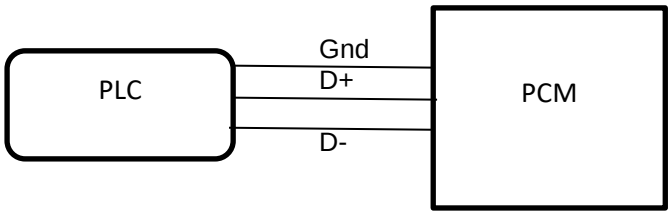
6.2 Common Trips and Alarm Relays

Event	Relay
Any Trip	Common Trip Relay Energised (N/O -> C)
No Trips	Common Trip Relay Not Energised (N/C -> C)
Any Alarms	Common Trip Relay Energised (N/O -> C)
No Alarms	Common Trip Relay Not Energised (N/C -> C)

Section 7: Communications

Communication to the PCM is via a RS485 connection. RS485 supports MODBUS RTU.

7.1 RS485 MODbus – Hardware



7.2 RS485 MODbus – Software

Communication over the RS485 link can be made directly by customer's software, firmware using MODbus protocol.

Interface: RS485/Serial

Baud Rate: 57600 bps

MODBUS Variation: RTU

PCM Unit (Slave) Address: 0xAA (HEX) or 170 (DEC)

RS485 Termination: Fit Jumper J2 located behind top/middle connector. Termination is 120 ohms.

Function Codes Implemented:

0x03 (03) – Read Holding Registers
0x06 (06) – Write Single Register
0x11 (17) – Report Slave ID

Holding Registers: 40011 to 40100 (Some registers are reserved)
Coils: N/A

Data and Control:

Holding Registers are divided into two sections; Data Registers and Control Registers. Data Registers are read only and contain sensor readouts, status, fault data and counters. Control Registers are read/write and control functionality of the unit.

Data Registers start at 40011 and end at 40029.
Control Registers start at 40030 and end at 40058.

Example: Read register 40014 to obtain thrust bearing temperature in degrees C
Example: Write non-zero to 40030 to reset the unit

Identification:

ID Registers are located from 40060 to 40100 and are read only. However, the ID string can be set using the engineer's USB port.

Errors:

MODBUS Error responses are fully implemented for the above function codes.

Slave ID:

The expected response from function 0x11 is 5 bytes: "PCM" + 1 bytes for the version in HEX + 0xFF for the run status.

7.4 USB Port – Hardware

The PCM and display have female USB 'B' sockets for connection to a computer using a standard USB A<>B cable. Device drivers for the USB port are not required for Windows operating systems after Windows 7.

For details with reference to connecting to the PCM II see the *Data Review Software* manual.

Section 8: Principal of Operation

8.1 Seal Health

Probes mounted in submersible pumps monitor the status of the barrier oil (Outboard Seal) and defect moisture ingress to the motor cavity (Inboard Seal) or terminal box.

This system operates by detecting an increase in conductivity between earth and the sentry probes mounted in the pump. The monitor applies a voltage to the probe which falls as the proportion of moisture increases. The seal 'health' display is scaled 100% to 0% at the trip value.

The following table is a typical guide on how to interpret the indication.

'Health'	Comments
100% to 80%	Healthy, no moisture present
80% to 50%	Some moisture present. Possible seal leakage. Service required in the foreseeable future
50%	Alarm indication (default setting *)
50% to 0%	Service is recommended and should be planned
Failed Indication (default Trip setting*)	Indicates seal failure or serious water ingress. The pump should not be operated in this condition

*Actual alarm and trip settings are user adjustable within the Windows software.

8.2 Bearing Temperature

Precision temperature sensors are mounted in the bearing housing(s). The PCM monitors the change in resistance and displays the bearing temperature in degrees Centigrade.

The default settings are 110 º C alarm, 120ºC trip.

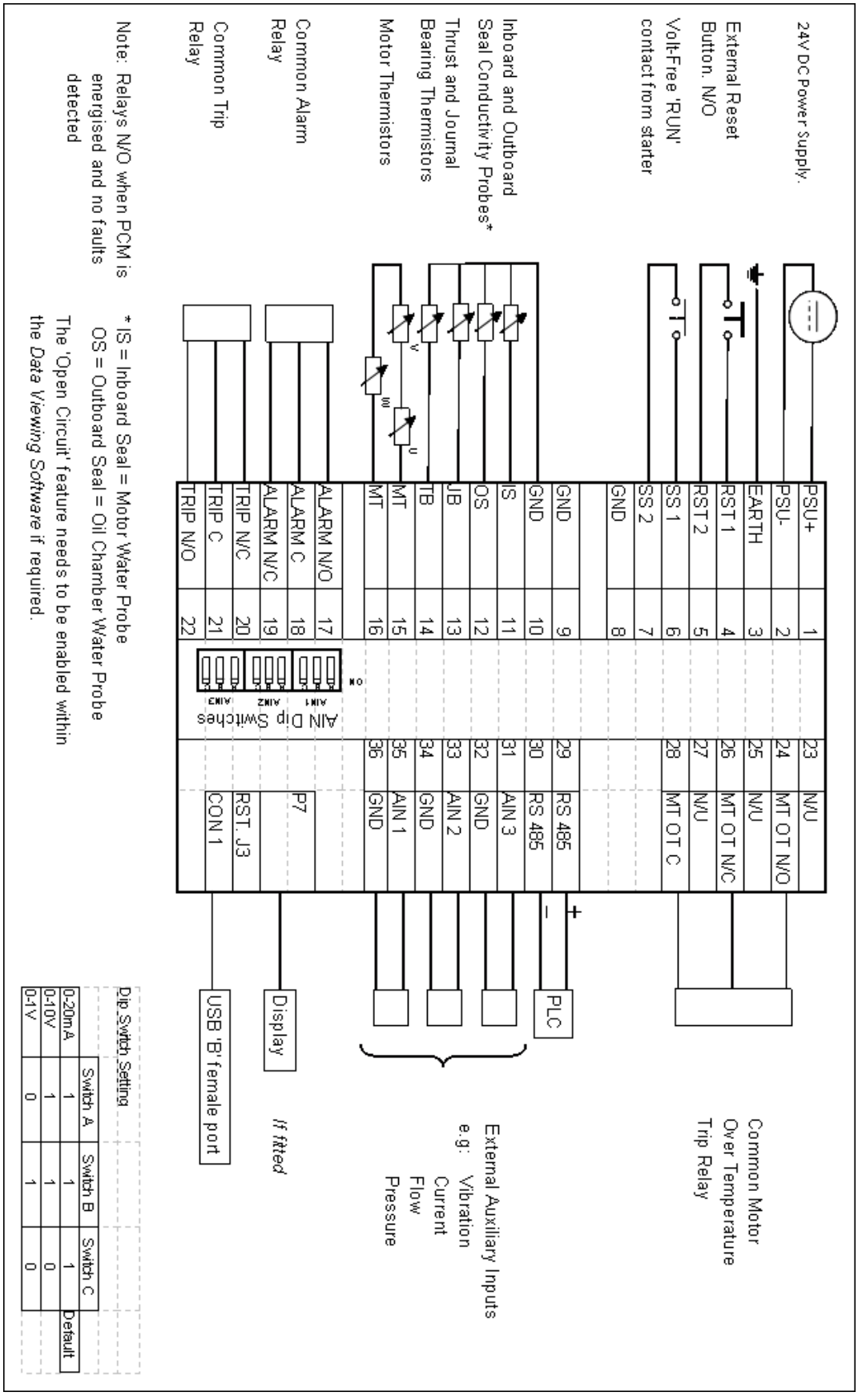
8.3 Motor Winding Temperature

Motor embedded thermistors are used to protect the windings against over-temperature. The monitor replaces a 'standard' thermistor relay circuit.

8.4 Motor Run / Stop

This input is used to log pump operation and start data recording. It should be supplied from a volt-free, main contactor auxiliary contact for fixed speed applications or a 'running' contact from a variable speed drive.

Section: 9 Connection Diagram – Sensor Connections: Bedford Pumps



Section: 10: Unit Configuration (sample sheet)

Terminal	Short name	Description	Supply Rating	Power Source	Comment	LED Fault Status	Configuration Default	Configuration as supplied
1	PSU+	Power Supply	24V AC/DC	External				
2	PSU-	Power Supply	24V AC/DC	External				
3	EARTH	Earth	Ground	External				
4	RST 1	Remote Reset	Common		External volt-free contact			
5	RST 2	Remote Reset	3.3V	PCM	External volt-free contact			
6	SS 1	Start/Stop	3.3V	PCM	External volt-free contact			
7	SS 2	Start/Stop	Common		External volt-free contact			
8	GND	Ground	Common					
9	GND	Ground	Common					
10	GND	Ground	Common					
11	IS	Inboard Seal Status	12V	PCM	Conductivity Probe /	LED 2 RED	Conductivity probe	
12	OS	Outboard Seal Status	12V	PCM	Conductivity Probe /	Trip LED	Conductivity probe	
13	JB	Journal Bearing	12V	PCM	Thermsistor / PT100 /	LED 2 RED	Thermsistor	
14	TB	Thrust Bearing	12V	PCM	Thermsistor / PT100 /	LED 2 RED	Thermsistor	
15	MT	Motor Thermistor 1	12V	PCM	PTC Thermsistor / Switch	LED 2 RED	PTC Thermsistor	
16	MT	Motor Thermistor 2	Common					
17	Alarm N/O	Alarm Relay N/O	6A. 250V		Change-over contact			
18	Alarm C	Alarm Relay C	6A. 250V					
19	Alarm N/C	Alarm Relay N/C	6A. 250V					
20	Trip N/C	Trip Relay N/C	6A. 250V		Change-over contact			
21	Trip C	Trip Relay C	6 A. 250V					
22	Trip N/O	Trip Relay N/O	6A. 250V					
23	N/U	Not Used						
24	MT OT N/O	Motor OT Relay N/O	10A. 250V		Change-over contact			
25	N/U	Not Used						
26	MT OT N/C	Motor OT Relay N/C	10A. 250V		Change-over contact			
27	N/U	Not Used						
28	MT OT C	Motor OT Relay C	10A. 250V		Change-over contact			
29	RS 485	RS 485	+		MODbus, PROFIbus etc			
30	RS 485	RS 485	-					
31	AIN 3	Analogue Input Number 3	+	External	0-1V / 0-10V / 0-20mA		0-20mA	
32	AIN 3GND	Analogue Input Number 3	Common					
33	AIN 2	Analogue Input Number 2	+	External	0-1V / 0-10V / 0-20mA		0-20mA	
34	AIN2 GND	Analogue Input Number 2	Common					
35	AIN 1	Analogue Input Number 1	+	External	0-1V / 0-10V / 0-20mA		0-20mA	
36	AIN 1 GND	Analogue Input Number 1	Common					
	P7	Expansion port			e.g. Display		Not Used	
	RST. J3	Local Reset Jumper			On board			
	CON 1	USB Type B Socket	5V					

Note: All Commons are linked and connected to ground (terminal 3)

Dip Switch Setting

	Switch A	Switch B	Switch C	
0-20mA	1	1	1	Default
0-10V	1	1	0	
0-1V	0	1	0	

Appendix 1

Retrofitting the PCM II

The PCM II complete with the display has been designed to retrofit existing panel door holes made for the original BPL PCM. (Power for the display is supplied by the PCM)

1 Isolate control panel.
2 Remove existing PCM and connectors.
3 Remove the clamping plate from the back of the display (see Section 2.2).
4 Insert the display into the panel door hole.
5 Place the clamping plate onto the display studding. Fit and tighten the washers and nuts.
6 Attach the ribbon cable to the expansion port and the display circuit board (see Section 2.2).
7 Fit the DIN rail to the back of the display and attach the PCM to the DIN rail (see Section 2.2).
8 Connect the ribbon cable to the PCM (see Section 2.1)
9 Connect the USB cable from the display to the PCM (see Section 2.1 & 2.2)
10 Connect the existing instrument cable to the connectors as per Section 10.
11 Connect the external Reset switches and RUN/STOP relays, if fitted, to the connectors as per Section 10.
12 Alarm and Trip relays are commoned. Care must be taken to ensure the existing (retrofit) wires are identified as N/O N/C or C before final connections are made.
13 Connect the 24V supply.
14 Close panel doors and turn on the isolator.
15 Leave 10 seconds for the display and PCM to boot up and show actual values. This is an in-built time delay within the PCM.
16 The display will show the sensor values and Green LEDs if the system is in a healthy state.

Appendix 2

MODbus Register Map

Modbus Address	Array Index	Description	Values	Represents
40011	0	Seal Chamber Value	0 - 100	Percent
40012	1	Motor Chamber Value	0 - 100	Percent
40013	2	Journal Bearing	0 - 151	Degrees C
40014	3	Thrust Bearing	0 - 151	Degrees C
40015	4	Motor Stat Register	0 - 65535	Binary Encoded
40016	5	Fault Register	0 - 65535	Binary Encoded
40017	6	AN1	0 - 4095	Anal Input
40018	7	AN2	0 - 4095	Anal Input
40019	8	AN3	0 - 4095	Anal Input
40020	9	Start Counter	0 - 65535	Starts
40021	10	Runtime	0 - 65535	Hours
40022	11	Motor thermistor	0-65535	Millivolts
40023	12	Reserved		
40024	13	Reserved		
40025	14	Reserved		
40026	15	Reserved		
40027	16	Reserved		
40028	17	Reserved		
40029	18	Reserved		
40030	19	RESET	0 or FFFF	Reset Unit
40031	20	Clock YY	16 - 99	RTC Year
40032	21	Clock MM	1 - 12	RTC Month
40033	22	Clock DD	1 - 31	RTC Date
40034	23	Clock HH	0 - 23	RTC Hour
40035	24	Clock mm	0 - 59	RTC Minute
40036	25	Clock SS	0 - 59	RTC Seconds
40037	26	Reserved		
40038	27	Reserved		
40039	28	LogAna	0 or FFFF	Analogue Log Control
40040	29	BSType	0 or FFFF	Sensor Type Control
40041	30	OCDET	0 to 16	Binary Encoded
40042	31	Trip Level: Seal Ch	0 to 100	Percent
40043	32	Trip Level: Motor Ch	0 to 100	Percent
40044	33	Trip Level: JNL	0 to 150	Deg C

Data Registers (READ ONLY)

Control Registers (READ/ WRITE)

40045	34	Trip Level: THR	0 to 150	Deg C
40046	35	Alarm Level: Seal Ch	0 to 100	Percent
40047	36	Alarm Level: Motor Ch	0 to 100	Percent
40048	37	Alarm Level: JNL	0 to 150	Deg C
40049	38	AlarmLevel: THR	0 to 150	Deg C
40050	39	Reserved		
40051	40	Reserved		
40052	41	Reserved		
40053	42	Reserved		
40054	43	Reserved		
40055	44	Reserved		
40056	45	Reserved		
40057	46	Reserved		
40058	47	Reserved		
40059	48			
40060	49	SNUM		S/Num Digit 1
40061	50	SNUM		S/Num Digit 2
40062	51	SNUM		S/Num Digit 3
40063	52	SNUM		S/Num Digit 4
40064	53	SNUM		S/Num Digit 5
40065	54	SNUM		S/Num Digit 6
40066	55	SNUM		S/Num Digit 7
40067	56	SNUM		S/Num Digit 8
40068	57	SNUM		S/Num Digit 9
40069	58	SNUM		S/Num Digit 10
40070	59	ID		ID String Digit 1
40071	60	ID		ID String Digit 2
40072	61	ID		ID String Digit 3
40073	62	ID		ID String Digit 4
40074	63	ID		ID String Digit 5
40075	64	ID		ID String Digit 6
40076	65	ID		ID String Digit 7
40077	66	ID		ID String Digit 8
40078	67	ID		ID String Digit 9
40079	68	ID		ID String Digit 10
40080	69	ID		ID String Digit 11
40081	70	ID		ID String Digit 12
40082	71	ID		ID String Digit 13
40083	72	ID		ID String Digit 14
40084	73	ID		ID String Digit 15
40085	74	ID		ID String Digit 16
40086	75	ID		ID String Digit 17
40087	76	ID		ID String Digit 18
40088	77	ID		ID String Digit 19

IDENT Registers (READ ONLY) Set via USB

40089	78	ID		ID String Digit 20	
40090	79	ID		ID String Digit 21	
40091	80	ID		ID String Digit 22	
40092	81	ID		ID String Digit 23	
40093	82	ID		ID String Digit 24	
40094	83	ID		ID String Digit 25	
40095	84	ID		ID String Digit 26	
40096	85	ID		ID String Digit 27	
40097	86	ID		ID String Digit 28	
40098	87	ID		ID String Digit 29	
40099	88	ID		ID String Digit 30	
40100	89	ID		ID String Digit 31	

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