BUS-COMPATIBLE PID CONTROL SYSTEM

User Guide

59168-4

February 2001

ECN00100

CONTENTS

1 MLC 9000 SYSTEM OVERVIEW

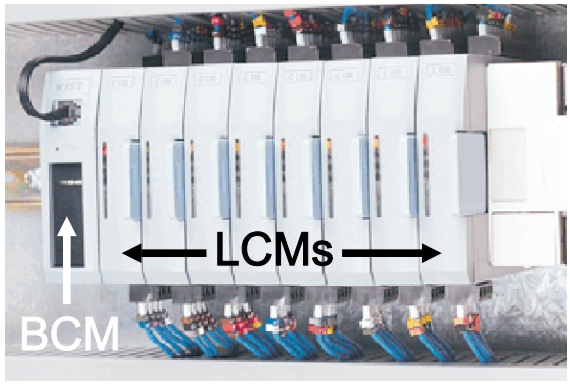


Figure 1-1 A Typical MLC 9000 System

MLC 9000 is a multi-loop DIN-rail-mounted "behind-the-panel" PID control system; each system comprises:

(a) One Bus Communications Module (BCM), mounted directly onto the DIN rail (see Figure 1-2),

(b) Up to eight Loop Controller Modules (LCMs), each one mounted via an Interconnect Module onto the DIN rail (see Figure 1-3). It is possible to mix different LCM types in the same MLC 9000 System as long as the maximum of eight LCMs per system is not exceeded.

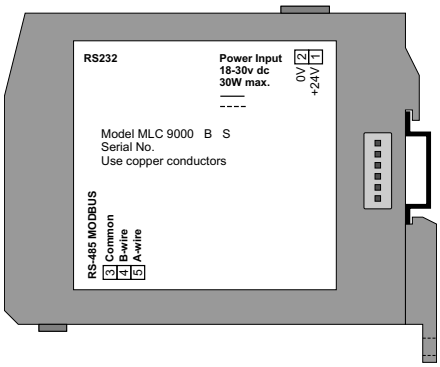


Figure 1-2 Bus Communications Module (fitted on DIN mounting rail)

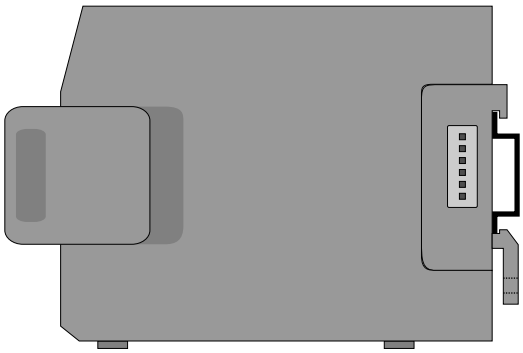


Figure 1-3 Loop Controller Module (fitted on DIN mounting rail via Interconnect Module)

The BCM provides power to the LCMs, communication with external devices, and stores LCM data in the event of a power loss. Each LCM exerts control over its' control loop(s). A block diagram of the MLC 9000 system is shown overleaf in Figure 1-4.

NOTE: The maximum number of LCMs in one system is eight; ***this maximum must not be exceeded***.

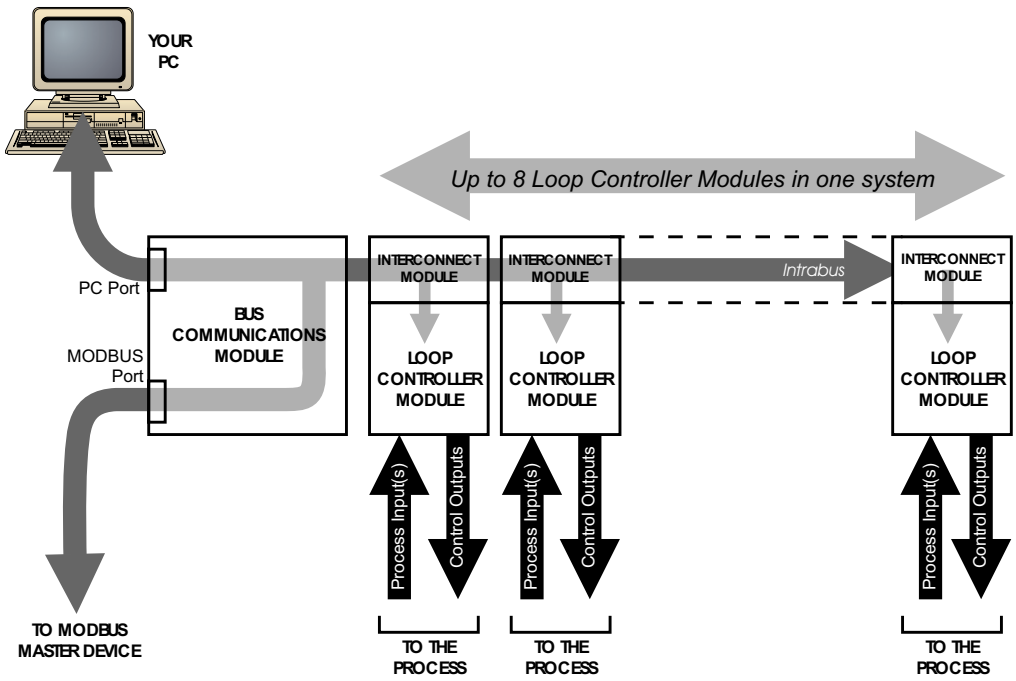
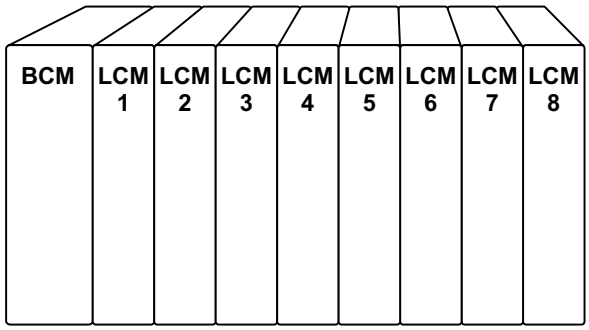


Figure 1-4 Typical MLC 9000 System Block Diagram

On power-up or system reset, addresses are assigned to the LCMs automatically according to their physical position in the MLC 9000 system; the left-most LCM i.e. the one nearest the BCM has Address 1, the next LCM to the right has Address 2 etc. (see right).



If any LCM position is unoccupied (i.e. has only the Interconnect Module), the appropriate address is still assigned to that position. The fact that there is no LCM in that position is detected by the BCM. Insertion of an LCM is detected automatically by the BCM. The range of BCMs available includes:

BCM Type	Description
B210	24-volt supply, PC Port only
B220	24-volt supply, PC Port and MODBUS Port
B230	24-volt supply, PC Port and DeviceNet Port

The range of LCMs available includes:

LCM Type	Description
C120	Single process input, two outputs, providing one control loop
C130	Single process input, three outputs, providing one control loop
C230	One process input, one Heater Break Detection input, three outputs, providing one control loop
C231	One process input, one Heater Break Detection input, three outputs, providing one control loop plus one redundant thermocouple input
C460	Four temperature inputs, quad SSR, dual relay output
C461	Four process inputs, quad SSR, dual relay output
C462	Four temperature inputs, six relay outputs
C463	Four process inputs, six relay outputs

For full details of modules and options available, refer to Section 8.

2 INSTALLATION

All procedures in this Section should be performed only by personnel competent and authorised to do so. All local and national regulations regarding electrical safety must be rigidly observed.

2.1 GENERAL

The MLC 9000 System - comprising a Bus Communications Module (BCM) and up to eight Loop Controller Modules (LCMs) - is designed for installation in an enclosure which is sealed against the ingress of dust and moisture. The enclosure must contain sufficient length of 35mm Top-Hat DIN mounting rail to accommodate the system modules (see below) plus an extra 50mm of rail to permit modules to be separated for removal/replacement. Additional lengths of DIN mounting rail may be required for any Human Machine Interface (e.g. an operator's panel) which is to be included in the enclosure. The space required by the MLC 9000 modules is shown in Figure 2-1.

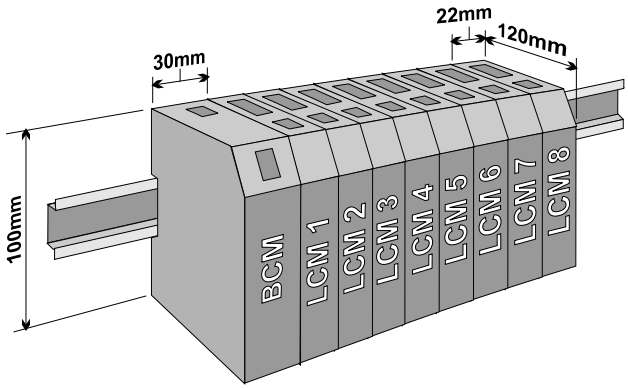


Figure 2-1 Space Required for MLC 9000 System Modules

NOTE: An additional 60mm of space is required above and below the system modules to permit ventilation and to accommodate wiring bend radii to enclosure trunking or conduits. Allow sufficient slack in all cables inside the trunking to permit "hot" swapping of modules (i.e. modules to be removed/replaced whilst the system is under power).

WARNING: The maximum of eight LCMs per system must not be exceeded. If the system includes one or more 4-Loop LCMs, the BCM must be manufactured after July 2001 in order to support the 4-Loop LCM parameter set.

It is recommended that (a) some means of preventing unauthorised access to the enclosure interior (e.g. lockable doors) is provided, and (b) that a suitable DIN rail clamp be used, once the MLC 9000 system is fully installed, to prevent the system from moving on the DIN rail. Under normal circumstances, no forced ventilation is required and the enclosure need not contain ventilation slots, but temperatures within the enclosure must be within specification (see Section 9).

The modules are installed onto the DIN rail in the following order:

1. Bus Communications Module
2. Interconnect Module(s)
3. First Loop Controller Module
4. Second Loop Controller Module
5. Third Loop Controller Module etc.

2.2 INSTALLING A BCM

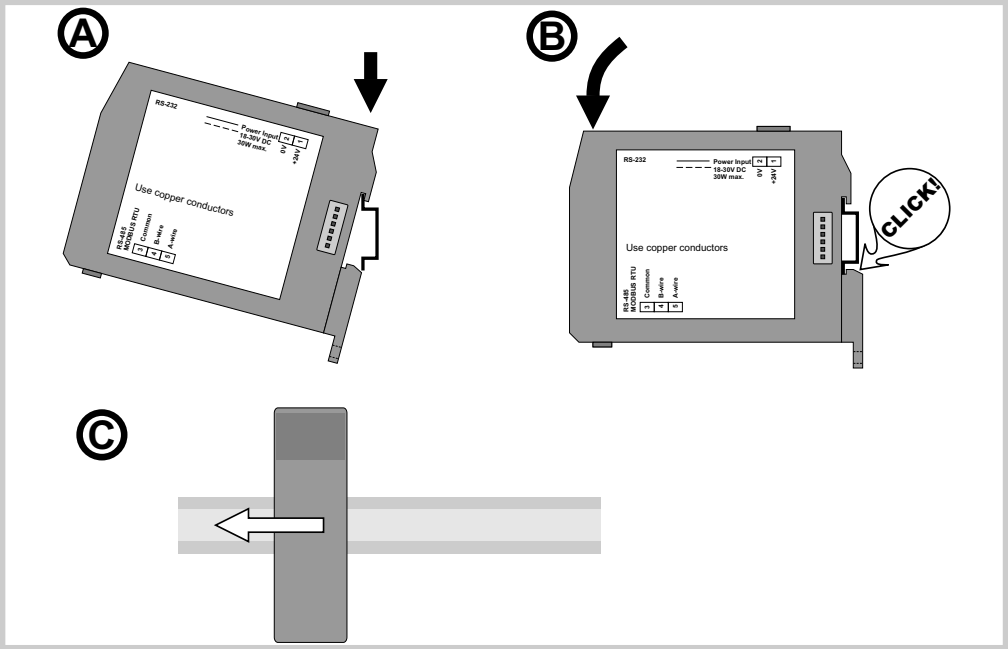


Figure 2-2 Installing a BCM

2.3 INSTALLING THE LCMS AND INTERCONNECT MODULES

Ensure that the LCM is separated from the Interconnect Module. Install the Interconnect Module first:

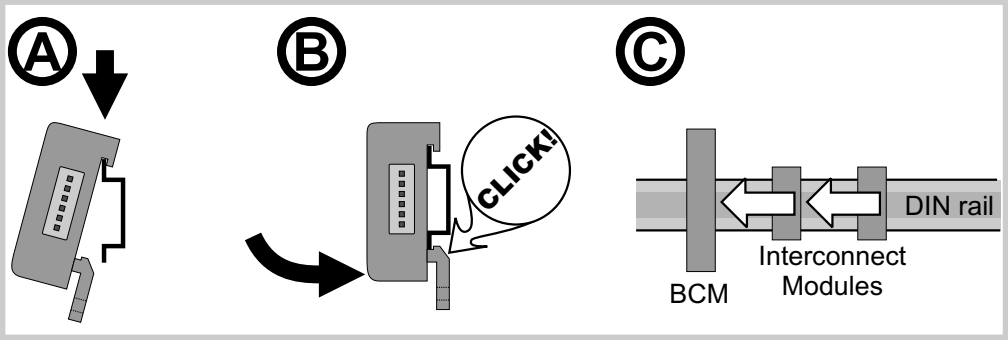


Figure 2-3 Installing an Interconnect Module

Then install the LCM:

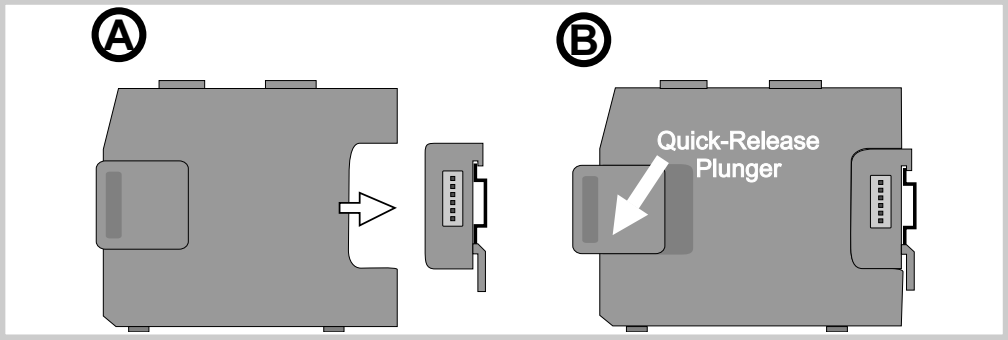


Figure 2-4 Installing an LCM

2.4 REMOVING A BCM

CAUTION: Ensure that power has been removed from all equipment currently in the enclosure before removing the BCM.

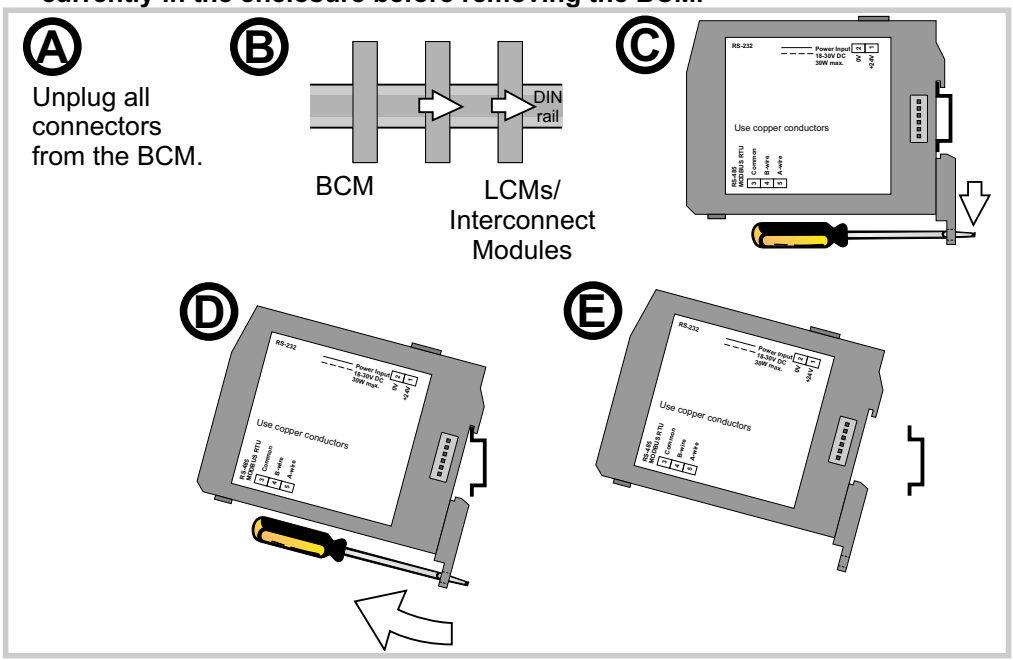


Figure 2-6 Removing a BCM

2.5 REMOVING AN LCM

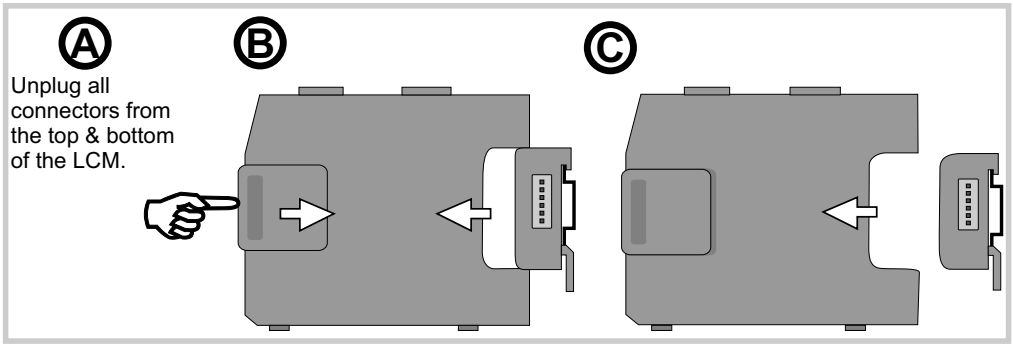


Figure 2-5 Removing an LCM

2.6 REMOVING AN INTERCONNECT MODULE

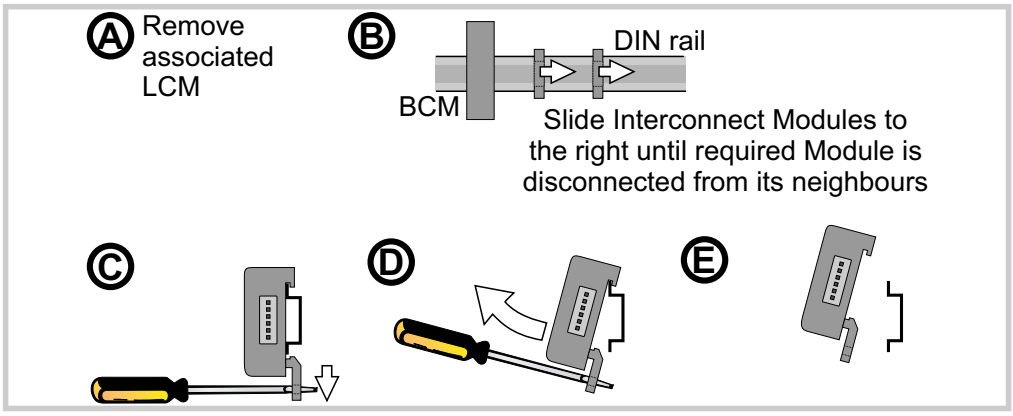


Figure 2-7 Removing an Interconnect Module

2.7 PRECAUTIONS WHILST WIRING UP

When laying wiring, the following precautions should be observed:

2.7.1 General

1. Allow sufficient free wiring (i.e. free of looming, wrapping or conduit) at the MLC 9000 system end to permit movement of connectors and modules during module installation/removal/replacement.

2. Do not run input cables adjacent to power-carrying cables. If the wiring is run in a conduit, use a separate conduit for the input wiring.

2.7.2 Thermocouple Inputs

1. The correct type of thermocouple extension leadwire/compensation cable should be used for the entire distance between the thermocouple sensor and the associated Loop Controller Module; correct polarity should be observed throughout and joints in the cable should be avoided.

2. If the thermocouple is grounded, this must be done at one point only. If the thermocouple extension leadwire is shielded, the shield must be grounded at one point only. **On the Redundant Thermocouple variant, thermocouples should not be grounded; there must be no electrical connection between the primary thermocouple and the secondary thermocouple, since this would cause inaccurate control and erratic operation.**

2.7.3 RTD (3-wire Pt 100) Inputs

1. The extension leads should be of copper.

2. The resistance of the wires connecting the resistance element to the associated Loop Controller Module should not exceed 50 ohms per lead; the leads should be of equal resistance.

2.8 ELECTRICAL CONNECTIONS - MODBUS BCM

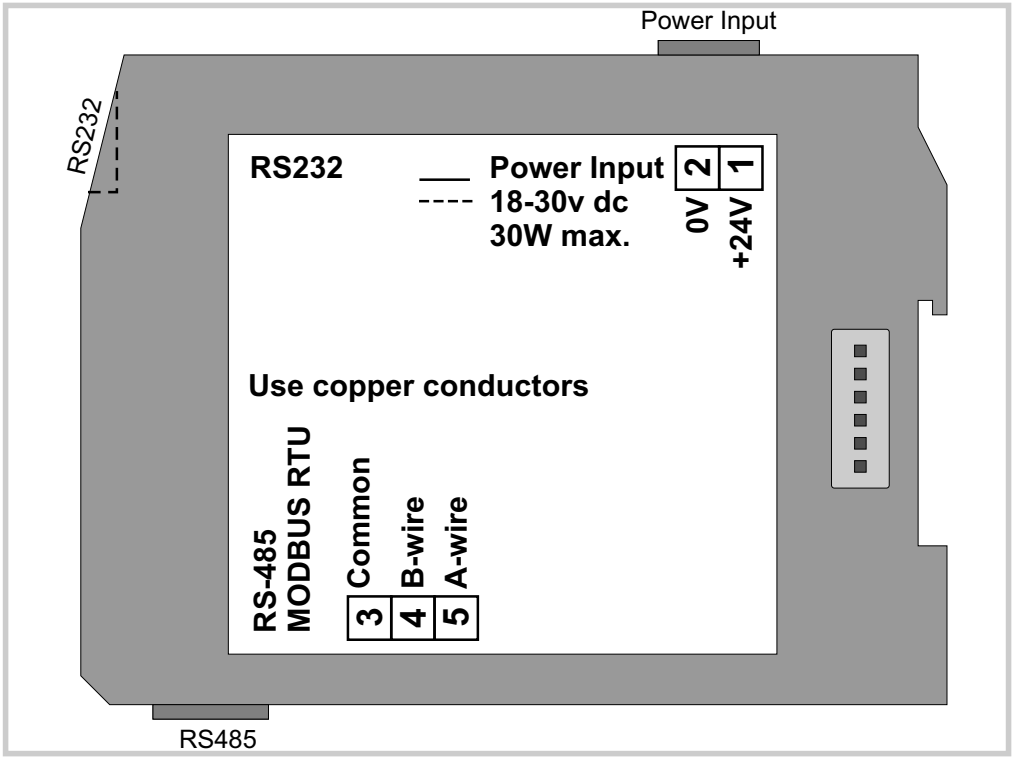


Figure 2-9 BCM Connectors

2.8.1 Power Input

The system requires a power input of 18 - 30V DC and has a maximum power consumption of 30W. It is recommended that the power supply is connected via a two-pole isolating switch (preferably situated near the System) and a 2A slow-blow fuse or a 2A Type C MCB (see Figure 2-8).

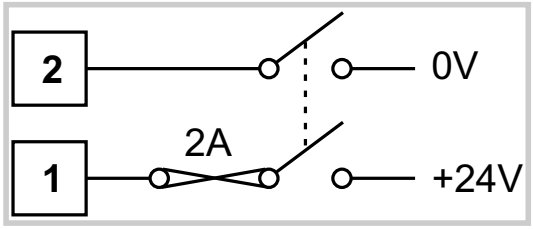


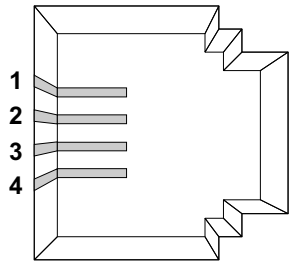
Figure 2-8 Recommended Mode of Power Connection

CAUTION: The system is designed for installation in an enclosure which provides adequate protection against electric shock. Local regulations regarding electrical installation and safety should be rigidly observed. Consideration should be given to prevention of access to the power terminations by unauthorised personnel.

2.8.2 RS232 Port

This connects the BCM to a local PC (for local configuration and basic operator functions) or HMI (e.g. a remote front panel/operator interface). Pin connections are shown on the right. A proprietory protocol is employed on this port.

Pin No.	Signal/Function
1	Receive Data
2	Transmit Data
3	No connection
4	Signal Ground



2.8.3 RS485 Port

This connects the BCM to a MODBUS master device (local operator interface/display or multi-drop PC operator and configuration network). Pin connections are shown on the right. The Common connection is provided for termination of screened (shielded) cable.

Pin No.	Signal/Function
3	Common
4	B-wire
5	A-wire

2.9 ELECTRICAL CONNECTIONS - DEVICENET BCM

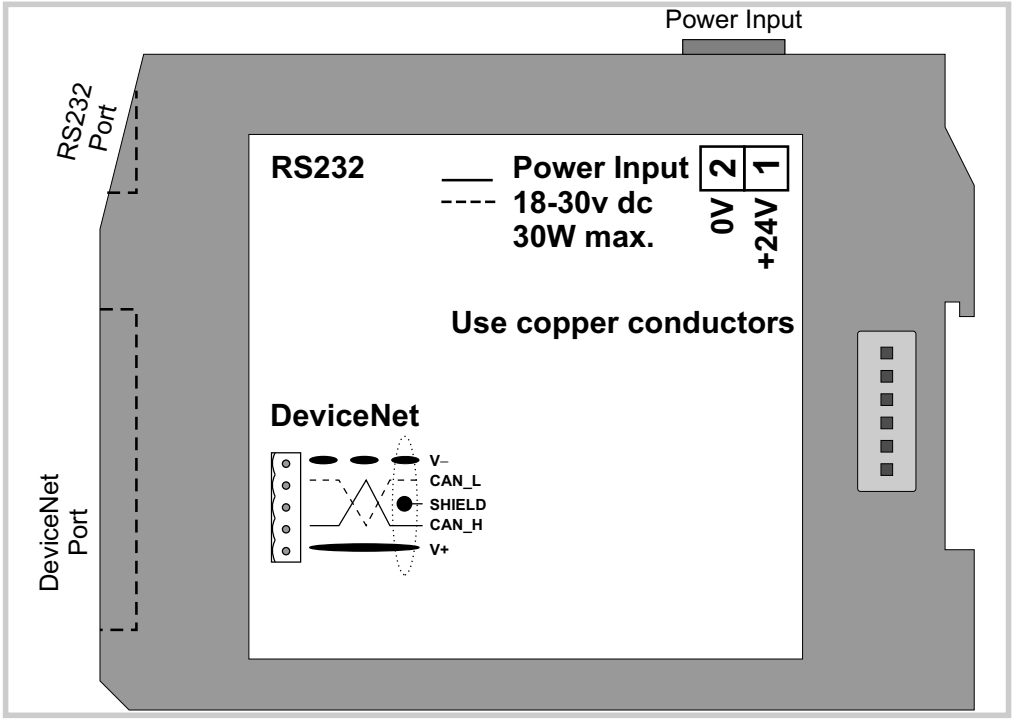


Figure 2-10 BCM Connectors

2.9.1 Power Input

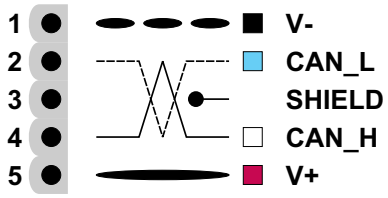
See Subsection 2.8.1.

2.9.2 RS232 Port

See Subsection 2.8.2.

2.9.3 DeviceNet Port

This connects the BCM to a DeviceNet master device (local operator interface/display or multi-drop PC operator and configuration network). Pin connections are shown on the right. The **SHIELD** connection is provided for termination of screened (shielded) cable.



2.10 ELECTRICAL CONNECTIONS - SINGLE-LOOP LCM

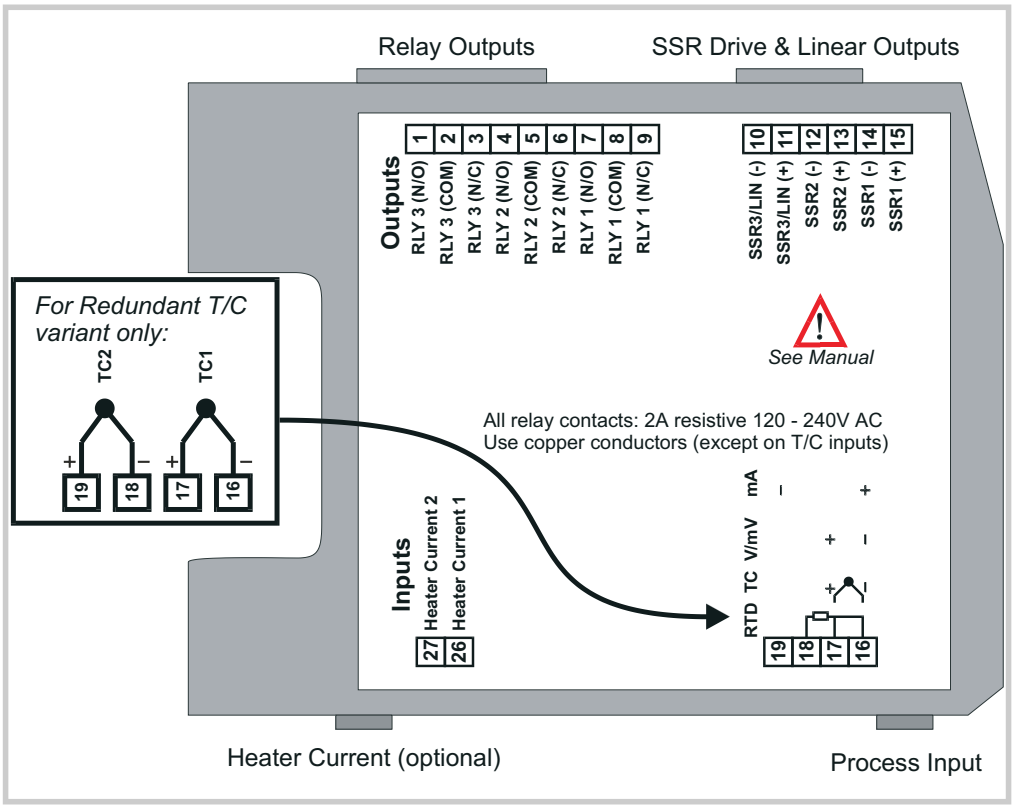
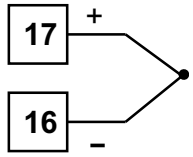
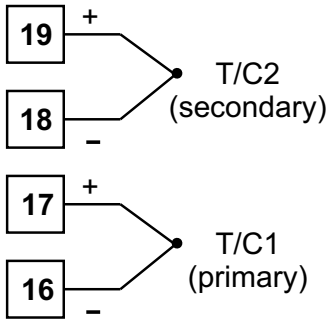


Figure 2-11 LCM Connectors

2.10.1 Thermocouple Input



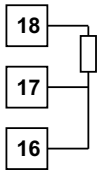
The correct type of extension leadwire/compensation cable must be used for the entire distance between the LCM connector and the thermocouple; correct polarity must be observed throughout. Joints in the cable should be avoided. **NOTE:** Do not run thermocouple cables adjacent to power-carrying conductors. If the wiring is run in a conduit, use a separate conduit for the thermocouple wiring. If the thermocouple is grounded, this must be done at one point only. If the extension lead is shielded, the shield must be grounded at one point only. **On the Redundant Thermocouple variant, thermocouples should not be grounded; there must be no electrical connection between the primary thermocouple and the secondary thermocouple, since this would cause inaccurate control and erratic operation.**



Redundant T/C Variant

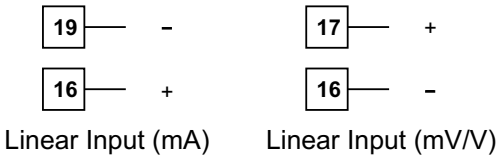
2.10.2 RTD Input (3-Wire) - Not on Redundant Thermocouple variant

The extension leads should be of copper and the resistance of the wires connecting the resistance element should not exceed 50Ω per lead (the leads should be of equal resistance).

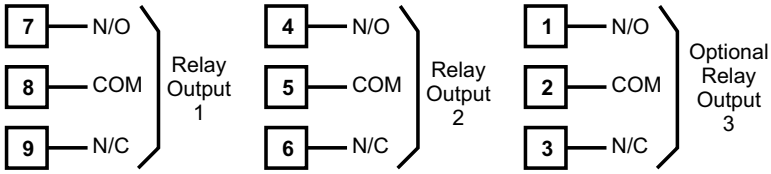


2.10.3 Linear Input - Not on Redundant Thermocouple variant

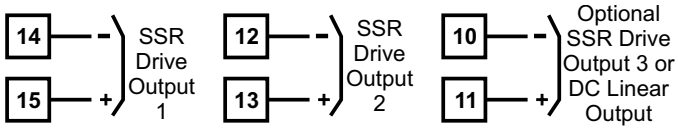
The linear input ranges are mA, mV and V based.



2.10.4 Relay Output



2.10.5 SSR Drive and DC Linear Output



2.11 ELECTRICAL CONNECTIONS - 4-LOOP LCM

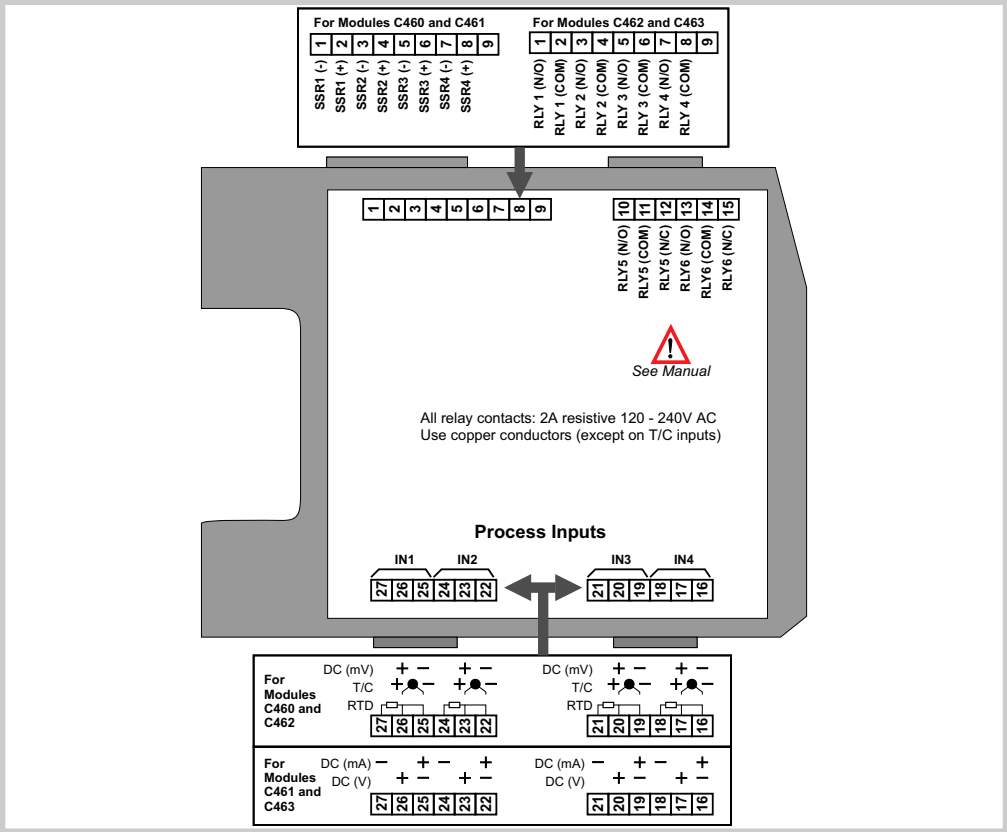
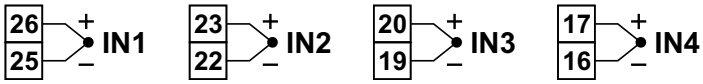


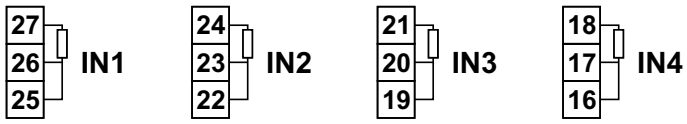
Figure 2-12 4-Loop LCM Connectors

2.11.1 Thermocouple Input (Modules C460 and C462)



The correct type of extension leadwire/compensation cable must be used for the entire distance between the LCM connector and the thermocouple; correct polarity must be observed throughout. Joints in the cable should be avoided. **NOTE:** Do not run cables adjacent to power-carrying conductors. If the wiring is run in a conduit, use a separate conduit for the thermocouple wiring. If the thermocouple is grounded, this must be done at one point only. If the extension lead is shielded, the shield must be grounded at one point only.

2.11.2 RTD (3-wire) Input (Modules C460 and C462)

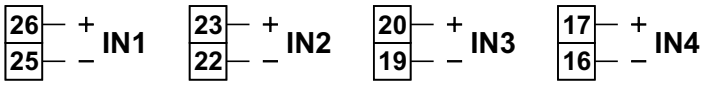


The extension leads should be of copper and the resistance of the wires connecting the resistance element should not exceed 50Ω per lead (the leads should be of equal length and resistance).

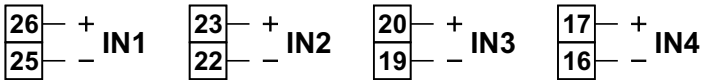
2.11.3 Linear Input

The linear input ranges are mA, mV and V based. The Volts/mA ranges are on Modules C461 and C463. The mV range is on Modules C460 and C462.

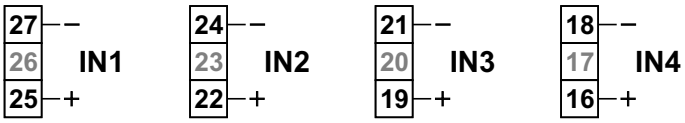
2.11.3.1 mV RANGE (Modules C460 and C462)



2.11.3.2 VOLTS RANGES (Modules C461 and C463)



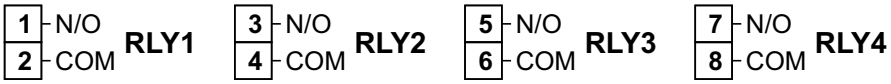
2.11.3.3 mA RANGES (Modules C461 and C463)



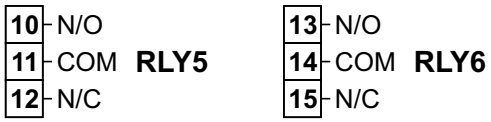
2.11.4 Relay Outputs

Relay Outputs 1 - 4 are single pole single throw (SPST) normally-open outputs (Modules C462 & C463). Relay Outputs 5 and 6 are single pole double throw (SPDT) outputs (all Modules C46x).

2.11.4.1 RELAY OUTPUTS 1 - 4 (Modules C462 and C463)

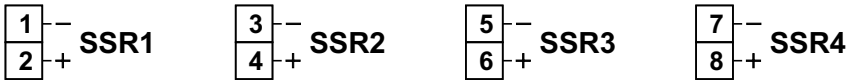


2.11.4.2 RELAY OUTPUTS 4 AND 5 (All C46x Modules)



2.11.5 SSR Drive Outputs (Modules C460 and C461)

These supply 12V DC nominal (10V DC minimum) at up to 20mA load.



3 INSTALLING THE CONFIGURATOR ON YOUR PC

3.1 PRE-REQUISITES

Your personal computer should satisfy the following minimum requirements for satisfactory operation of the software:

Microprocessor:	200MHz Pentium (400MHz recommended)
Minimum size RAM:	32MB (128MB recommended)
Minimum Hard Disk Space required:	26MB
Display:	16000-colour display recommended
Connecting Port:	9-pin (PC-AT) serial port with UART (with FIFO buffer disabled).
Operating System:	Windows 95/98/2000 or Windows NT Workstation 4.0.

3.2 INITIAL INSTALLATION

1. Insert the CD-ROM labelled **GCON100x CONFIGURATOR** into the appropriate drive on your PC. Note: The Setup program should start automatically; If it does not, navigate to the appropriate drive using Windows Explorer and run the Setup icon.

2. The Setup program will run the Setup Wizard, which will guide you through the installation procedure. You will be prompted to enter your name and company name.

3. You will be prompted to define a folder into which you want the Configurator installed. You may use the default folder or specify one of your own choice.

4. Upon completion of the installation, you will be offered the chance to run the Configurator.

3.3 ADDING SUPPORT FOR NEW MODULES

Additional support software for new modules may be added to the existing Configurator on your PC. This will enable you to use the updated Configurator to configure the new modules. To add new support software:

1. Insert the diskette or CD-ROM containing the new support software into the appropriate drive on your PC.

2. Run the existing Configurator.

3. From the **Contents** page, select the **Manage Device Drivers** option.

4. Click the **Add** button. The Add New Driver Wizard will guide you through the installation process.

5. When you are prompted for the location of the new device files, select the drive containing the new support software diskette/CD-ROM.

6. Follow the remaining steps in the Add New Driver Wizard procedure to complete the installation.

Your Configurator is now updated to include the new module(s).

3.4 PORT RESCUE APPLICATION

The GCON100x Configurator includes an additional piece of software called Port Rescue, which is installed with the Configurator. This overcomes problems with computers that have non-standard RS232 ports (mostly laptops), by reserving the communications port for use by the Configurator software. You will need to use Port Rescue if, after connecting the PC to the RS232 port of the MLC9000, the red Intrabus LED flashes.

To use Port Rescue, ensure that the Configurator application is not open and go to **Start/Programs/Configurator** and click on Port Rescue. You will now see **ComPort Reviver** open on your taskbar. To change the communications port that is to be used by the Configurator, click on the **ComPort Reviver** icon in the task bar, then click the  CLOSE button in the top right-hand corner. You will be given the option to terminate the program or change the Communications port. Select the serial port that you will be using for the Configurator (do not terminate the program).

Now open up the Configurator and use as per normal. You must leave the Port Rescue application running whilst using the Configurator.

4 PARAMETER DESCRIPTIONS

In the following Subsections, each parameter's function and its adjustment range are described. All values are in decimal form unless otherwise stated. A brief statement of the inter-dependency with other parameters is also included.

4.1 INPUT PARAMETERS (LCM Class 0)

These input parameters relate to the signal processing for the process inputs on the Loop Controller Module.

4.1.1 Process Variable (PV) Value

The current process variable value (= Measured PV + PV Offset). It is in the range (Scale Range Minimum – 5% of span) to (Scale Range Maximum + 5% of span).

4.1.2 Input Filter Time Constant

An adjustable low pass filter to reduce extraneous noise on the process input value.

Adjustment Range: 00 (0.0 secs. or OFF), 01 (0.5 secs.), 02 (1.0 secs.) ⇒⇒⇒ C8h (100.0 secs.) in 0.5-second increments.

Default Value: 04 (2.0 secs.).

Automatic Changes: None

Effect of Change on Other Parameters: None.

4.1.3 Process Variable Offset

The offset to be added to the process variable.

Adjustment Range: –(input span) to +(input span).

Default Value: 0

NOTE: Any adjustment to this parameter is, in effect, an adjustment to the control loop's calibration. Injudicious application of values to this parameter could lead to the measured process variable value having no meaningful relationship to the actual process variable value.

Automatic Changes: This parameter is set automatically to its default value if *Input Range* (see Subsection 4.1.8) is changed or if a change in Input Scale Range Maximum (see Subsection 4.1.10) or Input Scale Range Minimum (see Subsection 4.1.11) forces this parameter out of range. The units for this parameter are changed automatically if *Input Units* (see Subsection 4.1.9) is changed.

Effect of Change on Other Parameters: None.

4.1.4 Over-range Flag

Indicates whether the *Process Variable Value* is greater than the *Input Scale Range Maximum Value*. It may be either 1 (PV > Input Scale Range Max.) or 0 (PV ≤ Input Scale Range Max.).

4.1.5 Under-range Flag

Indicates whether the *Process Variable Value* is less than the *Input Scale Range Minimum Value*. It may be either 1 (PV < Input Scale Range Min.) or 0 (PV ≥ Input Scale Range Min.).

4.1.6 Sensor Break Flag

Indicates the presence/absence of a Sensor Break condition. (0 = no Sensor Break, 1 = Sensor Break). For LCM Module C231 (redundant thermocouple), this is set only when a break is detected in *both Input 1 and Input 2*.

4.1.7 Input 1 Flag & Input 2 Flag (LCM Module C231 only)

Indicates the status of the primary (Input 1 Flag) and secondary (Input 2 Flag) thermocouple inputs; 1 = correct operation, 0 = Sensor Break condition.

4.1.8 Input Range (Type/Span)

The type of input(s) on the associated LCM.

Input types available:

00 - "B" T/C (100 - 1824°C) (212 - 3315°F)
01 - "J" T/C (–200.1 - 1200.3°C) (–328.2 - 2192.5°F)
02 - "K" T/C (–240.1 - 1372.9°C) (–400.2 - 2503.2°F)
03 - "L" T/C (–0.1 - 761.4°C) (31.8 - 1402.5°F)
04 - "N" T/C (0.0 - 1399.6°C) (32.0 - 2551.3°F)
05 - "R" T/C (0 - 1759°C) (32 - 3198°F)
06 - "S" T/C (0 - 1759°C) (32 - 3198°F)
07 - "T" T/C (–240.0 - 400.5°C) (–400.0 - 752.9°F)
08 - RTD (-199.9 - 800.3°C) (-327.3 - 1472.5°F)
09 - DC Linear 0 - 50mV
0Ah - DC Linear 10 - 50mV
0Bh - DC Linear 0 - 5V
0Ch - DC Linear 1 - 5V
0Dh - DC Linear 0 - 10V
0Eh - DC Linear 2 - 10V
0Fh - DC Linear 0 - 20mA
10h - DC Linear 4 - 20mA
11h - External Input

Default: 02

NOTES

1. The RTD, linear and external input ranges are not available on the LCM C231.

2. Thermocouple, RTD and mV DC Linear ranges are not available on LCMs C461 and C463.

3. DC Linear V and mA ranges are not available on 4-Loop LCMs C460 and C462.

4. For description of external input, see Subsection 4.1.12.

Effects of change on other parameters: A change in the setting of this parameter causes the following parameters to be forced to their default values:

Input Scale Range Max. & Input Scale Range Min.
Process Variable Offset
External Input Value
Proportional Band 1 & Proportional Band 2
Rate
Reset
Bias
ON/OFF Differential
Overlap/Deadband
All setpoints (if forced out of range)
Alarm values (if forced out of range)
Alarm hysteresis values (if forced out of range)

4.1.9 Input Units

The temperature units (0 = °C, 1 = °F) for thermocouple and RTD inputs. If the input is not a thermocouple or RTD type, reading this parameter will return an indeterminate value.

NOTE: This is a configuration parameter. It is not recommended that it is changed "on the fly", owing to repercussions on other parameters. Unit conversions should be handled by the external user interface.

Adjustment Range: 0 (°C) or 1 (°F).

Default Value: 0 (Europe) or 1 (USA)

4.1.10 Input Scale Range Maximum

The input value corresponding to the maximum for the selected input range. For Thermocouple and RTD inputs, this is a range trim facility which permits proportional band-related parameters to be adjusted for a smaller input range.

Adjustment Range: For DC linear inputs, adjustment range is 8300h (–32000 dec.) to 7D00h (+32000 dec.); minimum span = 1.

For Thermocouple and RTD inputs, adjustment range is (Input Scale Range Minimum + 100 LSDs) to input range maximum.

For an External Input, the adjustment range is 8000h (–32768 dec.) to 7FFFh (+32767 dec.).

This parameter may be set to less than, but not equal to, *Input Scale Range Minimum* (see Subsection 4.1.11) to reverse the input sense.

NOTE: Input span is defined as the difference between Input Scale Range Maximum and Input Scale Range Minimum.

Default Value: Input range maximum (temperature range) or 1000 (DC linear range).

Automatic Changes: This parameter is set automatically to its default value if *Input Range* (see Subsection 4.1.8) is changed. The units for this parameter are changed automatically if *Input Units* (see Subsection 4.1.9) is changed.

Effects of Change on Other Parameters: When this parameter value is changed, the following parameters, if forced out of range, will be automatically set to their default values:

Process Variable Offset
Setpoints
Alarm values
Alarm hysteresis values

4.1.11 Input Scale Range Minimum

The input value corresponding to the minimum for the selected input range. For Thermocouple and RTD inputs, this is a range trim facility which permits proportional band-related parameters to be adjusted for a smaller input range.

Adjustment Range: For DC Linear Inputs, adjustment range is 8300h (–32000 decimal) to 7D00h (+32000 decimal). Minimum span = 1.

For Thermocouple or RTD inputs, adjustment range is input range minimum to (Input Scale Range Maximum - 100 LSDs).

For an External Input, adjustment range is 8000h (–32768 decimal) to 7FFFh (+32767 decimal).

This parameter can be set to greater than, but not equal to, *Input Scale Range Maximum* (see Subsection 4.1.10) to reverse the input sense.

Default Value: Input range minimum (temperature range) or 0 (DC Linear range).

Automatic Changes: This parameter is set automatically to its default value if *Input Range* (see Subsection 4.1.8) is changed. The units for this parameter are changed automatically if *Input Units* (see Subsection 4.1.9) is changed.

Effects of Change on Other Parameters: When this parameter value is changed, the following parameters, if forced out of range, will be automatically set to their default values:

Process Variable Offset
Setpoints
Alarm values
Alarm hysteresis values

4.1.12 External Input Value

This is the input range for the optional input source from Fieldbus (selected by the *Input Range* parameter - see Page 4-2). This input receives a directly-written input range value from an external device.

Adjustment Range: 8000h (–32768 decimal) to 7FFFh (+32767 decimal).

Default Value: Input Scale Range Maximum.

Automatic Changes: This parameter is set automatically to its default value if *Input Range* (see Subsection 4.1.8) is changed.

Effect of Change on Other Parameters: None.

4.1.13 Mains (Line) Frequency

The frequency of the mains (line) supply on the MLC 9000 site. It can be used to enhance ADC rejection of mains (line) noise picked up by input cables. *Applicable to single-loop LCMs only.*

Adjustment range: 0 (50Hz) or 1 (60Hz). *Default = 0 (Europe) or 1 (USA).*

4.2 OUTPUT PARAMETERS (LCM Class 1)

These parameters relate to the selection of output source and type of the Loop Controller Module.

4.2.1 Output Type

The type for selected output.

Available types:

00 - Relay	03 - DC Linear 0 - 10V
01 - SSR Drive	04 - DC Linear 4 - 20mA
02 - DC Linear 0 - 20mA	05 - DC Linear 0 - 5V

Single-loop LCMs: DC Linear settings are available on Output 3 only - if fitted.

4-Loop LCMs: Relay and SSR Drive outputs only. This is factory-set and cannot be changed.

Default Value:

Single-loop LCMs:	00
4-loop LCMs:	
C462 and C463:	00
C460 and C461:	01 (Outputs 1 - 4) 00 (Outputs 5 and 6)

Automatic Changes: None.

Effect of Change on Other Parameters: If Output Type is changed from SSR Drive/Relay to DC Linear and Output Usage (see Subsection 4.2.2) is not HEAT Output nor COOL Output, Output Usage is changed to Recorder Output (SP). If Output Type is changed from DC Linear to SSR Drive/Relay, Output Cycle Time (see Subsection 4.2.3) is set to its default value and, if Output Usage is initially Recorder Output (SP or PV), Output Usage is changed to Alarm 1 Direct-acting.

4.2.2 Output Usage

The use of the associated output. **NOTE:** On 4-loop LCMs, this is the only means by which outputs may be assigned to specific loops.

4.2.2.1 SINGLE-LOOP LCMs

Available Uses:

00 - HEAT (Primary Control) output
01 - COOL (Secondary Control) output
02 - Bus Power output
03 - Alarm 1 output, direct-acting
04 - Alarm 1 output, reverse-acting
05 - Alarm 2 output, direct-acting
06 - Alarm 2 output, reverse-acting
07 - Loop Alarm output, direct-acting
08 - Loop Alarm output, reverse-acting
09 - OR of Alarm 1/Alarm 2, direct-acting
10 - OR of Alarm 1/Alarm 2, reverse-acting
11 - OR of Alarm 1/Alarm 2/Loop Alarm, direct-acting
12 - OR of Alarm 1/Alarm2/Loop Alarm, reverse-acting
13 - Recorder Output (Setpoint)
14 - Recorder Output (Process Variable)
15 - Heater Break Alarm, direct-acting
16 - Heater Break Alarm, reverse-acting
NOTE: Heater Break Alarm is a logical OR of the Low Heater Break Alarm, High Heater Break Alarm and Short Circuit Heater Break Alarm.

Table 4-1 Limitations of Output Usage

Output Usage	Output Number/Type		
	Output 1 (Relay/SSR Drive)	Output 2 (Relay/SSR Drive)	Output 3 - Relay/SSR Drive/Linear (mA/V)
HEAT Power	Yes	No	Yes (if Output 1 is not HEAT Power)
COOL Power	No	Yes	Yes (linear only)
Alarm Output	Yes	Yes	Yes (Relay/SSR Drive only)
Recorder Output (SP/PV)	No	No	Yes (Linear Output only)
Bus Power	Yes	Yes	Yes (Linear Output only)

Default Values:

Output 1 - HEAT Output
Output 2 - Alarm 1 output, direct-acting
Output 3 - Alarm 1 output, direct-acting

Output usage is restricted as shown in Table 4-1.

Automatic Change:

If this parameter is not initially set to 00 (HEAT Output) nor 01 (COOL Output) and *Output Type* (see Subsection 4.2.1) is changed from Relay/SSR Drive to DC Linear, this parameter will be set to 13 (Recorder Output - Setpoint). If this parameter is initially set to 13 (Recorder Output - Setpoint) or 14 (Recorder Output - Process Variable) and *Output Type* (see Subsection 4.2.1) is changed from DC Linear to Relay/SSR Drive, this parameter will be set to 03 (Alarm 1 Output, direct-acting).

Effects of Change on Other Parameters:

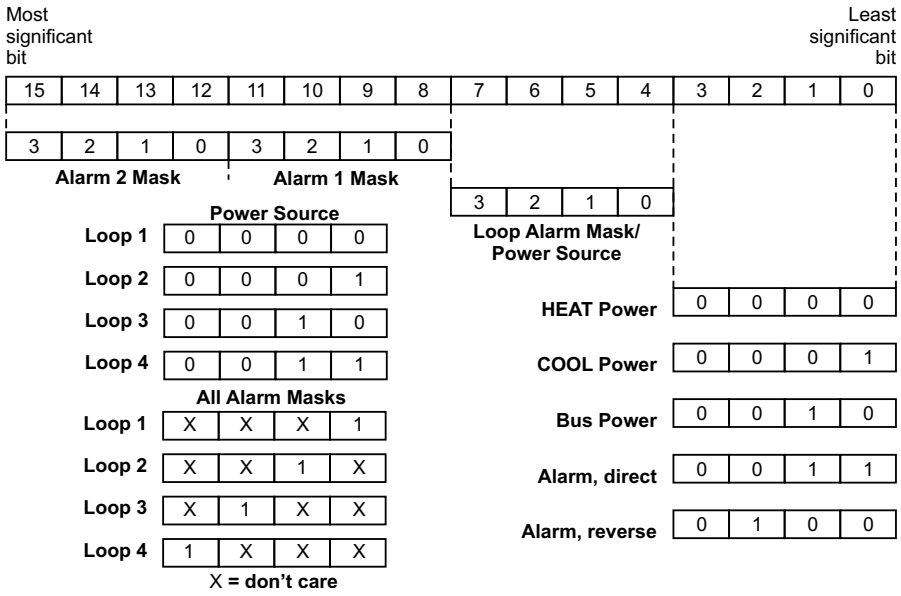
None

4.2.2.2 FOUR-LOOP LCMs

Available Uses:

HEAT (Primary Control) output - for each loop
COOL (Secondary Control) output - for each loop
Bus Power output
Alarm (Alarm or Loop Alarm), direct-acting
Alarm (Alarm or Loop Alarm), reverse-acting

The output usage is defined by writing to the Output Usage parameter; the format of the Output Usage parameter word is:



The Output Usage Word allows selection of sources:

Bits 0 - 3 select the output usage. Bits 4 - 7 select the power source instance for HEAT, COOL or Bus Power usages or the Loop Alarm Mask for direct or reverse alarms. Bits 8 - 15 are the Alarm Mask for the eight alarm instance status bits.

For example, the outputs could be set up as follows:

Output Instance	Required Usage	Output Usage Word
0	Loop 1 HEAT power	0000h
1	Loop 1 COOL power	0001h
2	Loop 2 HEAT power	0010h
3	Loop 3 HEAT power	0020h
4	Loop 4 HEAT power	0030h
5	Reverse Alarm of alarm instances 0, 2, 3, 4 and Loop Alarm for Loop 1 and Loop 3	1D54h

Default Values:

Outputs 1 to 4 - Bus Power
Output 5 - logic OR of all Alarms, direct-acting
Output 6 - logic OR of all Alarms, reverse-acting

Automatic Change:

None

Effects of Change on Other Parameters:

None

4.2.3 Output Cycle Time

The sum of the OFF time and ON time for the associated output.

Adjustment Range:

0	0.1 secs.	7	16 secs.
1	0.25 secs.	8	32 secs.
2	0.5 secs.	9	64 secs.
3	1 sec.	0Ah	128 secs.
4	2 secs.	0Bh	256 secs.
5	4 secs.	0Ch	512 secs.
6	8 secs.		

The 0.1-second and 0.25-second settings are not available for relay outputs.

NOTE: This parameter is ignored if Proportional Band for this output is set to 0 (ON/OFF control) or if this output is a linear output or alarm output.

Default Value: 8 (32 secs.)

Automatic Change: If *Output Type* (see Subsection 4.2.1) is changed from DC Linear to Relay/SSR Drive, this parameter is forced to its default setting.

Effects of Change on Other Parameters: None.

4.2.4 DC Linear Output Scale Maximum (Modules C130, C230 and C231 only)

Applicable to DC linear outputs (i.e. Output 3) only when Output Usage (see Subsection 4.2.2) for Output 3 is set to Recorder Output (SP or PV) and defines the setpoint/process variable value (as appropriate) which corresponds to the maximum output value.

Adjustment Range: 8000h (–32768 dec.) to 7FFFh (+32767 dec.).

Default Value: 2710h (+10000 dec.).

Automatic Change: Units are converted automatically when Input Units setting (see Subsection 4.1.9) is changed.

Effects of Change on Other Parameters: None.

4.2.5 DC Linear Output Scale Minimum (Modules C130, C230 and C231 only)

Applicable to DC linear outputs (i.e. Output 3) only when Output Usage (see Subsection 4.2.2) for Output 3 is set to Recorder Output (SP or PV) and defines the setpoint/process variable value (as appropriate) which corresponds to the minimum output value.

Adjustment Range: 8000h (–32768 dec.) to 7FFFh (+32767 dec.).

Default Value: 0.

Automatic Change: Units are converted automatically when Input Units setting (see Subsection 4.1.9) is changed.

Effects of Change on Other Parameters: None.

4.2.6 Bus Power

This parameter determines the Bus Control value for the associated output. It is applicable only if the Output Usage for that output has been set to Bus Power (see Subsection 4.2.2). The use of Bus Power outputs is described in Appendix C.

Adjustment Range: 00 (0%) to 64h (100%).

Default Value: 00 (0%).

Automatic Change: None.

Effects of Change on Other Parameters: None.

4.3 SETPOINT PARAMETERS (LCM Class 2)

4.3.1 Setpoint 1

This parameter defines the value of Setpoint 1.

Adjustment Range: Input Scale Range Minimum (see Subsection 4.1.11) to Input Scale Range Maximum (see Subsection 4.1.10).

Default Value: Input Scale Range Minimum.

Automatic Change: This parameter is automatically set to its default value if forced out of range by a change to *Input Range* (see Subsection 4.1.8), *Input Scale Range Maximum* (see Subsection 4.1.10) or *Input Scale Range Minimum* (see Subsection 4.1.11). The units for this parameter change if *Input Units* (see Subsection 4.1.9) is changed.

Effects of Change on Other Parameters:	Modifies Actual Setpoint value according to the actual setpoint calculation and the setting of Setpoint Select (see Subsection 4.3.3).

4.3.2 Setpoint 2

This parameter defines the value of Setpoint 2.

Adjustment Range:	Input Scale Range Minimum (see Subsection 4.1.11) to Input Scale Range Maximum (see Subsection 4.1.10).
Default Value:	Input Scale Range Minimum.
Automatic Change:	This parameter is automatically set to its default value if forced out of range by a change to *Input Range* (see Subsection 4.1.8), *Input Scale Range Maximum* (see Subsection 4.1.10) or *Input Scale Range Minimum* (see Subsection 4.1.11). The units for this parameter are changed if *Input Units* (see Subsection 4.1.9) is changed.
Effects of Change on Other Parameters:	Modifies Actual Setpoint value according to the actual setpoint calculation and the setting of Setpoint Select (see Subsection 4.3.3).

4.3.3 Setpoint Select

This parameter selects Setpoint 1 or Setpoint 2 as the active setpoint.

Adjustment Range:	01(Setpoint 1) or 02 (Setpoint 2).
Default Value:	1 (Setpoint 1)

4.3.4 Actual Setpoint

This parameter indicates the current value of the active setpoint. When the setpoint is ramping, this is calculated from the setpoint value at the start of the ramp and the setpoint ramp rate. If setpoint ramping is OFF, this parameter will always be equal to the selected setpoint.

NOTE: When the actual setpoint is ramping and the user selects Manual Control Mode (see Subsection 4.4.1), the ramp is suspended and the actual setpoint is set to be equal to the current process variable. This is in order that the ramp will resume from the process variable value when exiting from Manual Control Mode. This eliminates the possibility of increasing the manual power (increasing the process variable) then exiting from Manual Control Mode, causing the process variable to fall back to follow the setpoint ramp.

4.3.5 Setpoint Ramp Rate

This parameter defines the setpoint ramp rate in units/hour.

Adjustment Range:	0001 (1 dec.) to 270Fh (9999 dec.) and 0000 (OFF).
Default Value:	0000 (OFF).
Automatic Change:	None.
Effects of Change on Other Parameters:	If this parameter value is changed, the Actual Setpoint value (see Subsection 4.3.4) is modified according to the Actual Setpoint calculation.

4.4 CONTROL PARAMETERS (LCM Class 3)

4.4.1 Manual Control Enable/Disable

This parameter selects/de-selects Manual Control (see also Appendix C).

Adjustment Range:	1 (Manual Control ON) or 0 (Manual Control OFF).
Default Value:	0 (Manual Control OFF).
Automatic Change:	None.
Effects of Changes on Other Parameters:	When Manual Control Mode is selected, an active Loop Alarm is turned off and Loop Alarm is disabled (see Subsection 4.4.13) whilst Manual Control Mode is used. Upon exit from Manual Control Mode, the Loop Alarm is automatically re-enabled and its original state is restored.

4.4.2 Manual Power

This parameter sets the percentage of output power when manual control is selected (see also Appendix C). This parameter is not applicable if Manual Control is not selected.

Adjustment Range:	0000 (0%) to 0064h (100%) (HEAT output only configured) or FF9Ch (–100%) to 0064h (+100%) (HEAT and COOL outputs configured).
Default Value:	0000 (0%).
Automatic Change:	Forced within range, if necessary, when Control Type (see Subsection 4.4.14) is changed.
Effect of Changes on Other Parameters:	None.

4.4.3 Select/De-select RaPID Control

This parameter selects/de-selects the RaPID control feature, which optimises the PID algorithm for impulse changes in the process variable.

Adjustment Range:	1 (RaPID selected) or 0 (RaPID not selected).
Default Value:	1 (RaPID selected).
Automatic Change:	None.
Effect of Changes on Other Parameters:	None.

4.4.4 Enable/Disable Easy Tune Facility

This parameter enables/disables the Easy Tune facility. **NOTE**: Not applicable when Control Type is set to HEAT/COOL.

Adjustment Range:	1 (Easy Tune enabled - operates every power-up) or 0 (Easy Tune disabled).
Default Value:	0 (Easy Tune disabled).
Automatic Change:	Easy Tune is over-ridden by Auto Pre-Tune (it is possible to enable both facilities). Easy Tune will not be executed on LCMs with HEAT and COOL outputs, although it is possible to select Easy Tune for this configuration.
Effect of Changes on Other Parameters:	Loop Alarm, if originally enabled, is disabled during Easy Tune execution and is re-enabled upon completion of the Easy Tune operation.

NOTE: Easy Tune will not run when Soft Start is running.

A description of the Easy Tune facility is in Appendix B.

4.4.5 Pre-Tune Status

This parameter controls/indicates the status of the single-shot Pre-Tune routine:

Write operation:	1 = Instigate Pre-Tune 0 = Disable Pre-Tune
Read operation:	1 = Pre-Tune operating 0 = Pre-Tune disabled
Adjustment Range:	1 (instigate/operating) or 0 (disable/disabled).
Default Value:	0 (disabled).
Automatic Change:	None.
Effect of Changes on Other Parameters:	When Pre-Tune completes operation, PID terms may be affected.

NOTE: The Pre-Tune routine operates only if the process variable is greater than 5% of input span from the setpoint. If Pre-Tune is selected whilst Easy Tune is running, the LCM will ignore this selection; Pre-Tune will remain disabled. Pre-Tune will not operate when Soft Start is running.

A description of the Pre-Tune facility is in Appendix B.

4.4.6 Auto Pre-Tune

This parameter enables/disables the Auto Pre-Tune facility which automatically executes the single-shot Pre-Tune routine on power-up. A description of the Pre-Tune facility is in Appendix B.

Adjustment Range:	1 (Auto Pre-Tune enabled - operates every power-up) or 0 (Auto Pre-Tune disabled)
Default Value:	0 (disabled)
Automatic Change:	None.
Effect of Changes on Other Parameters:	Auto Pre-Tune over-rides Easy Tune (it is possible to enable both facilities). If Auto Pre-Tune is selected whilst Easy Tune is running, this will be ignored by the LCM until the next and subsequent power-ups, when Easy Tune will be disabled (over-ridden by Auto Pre-Tune).

NOTE: The Pre-Tune routine will be executed only if the process variable is greater than 5% of input span from the setpoint. Pre-Tune will not run when Soft Start is running.

4.4.7 Easy Tune Status

This parameter indicates the current status of the Easy Tune facility (0 = normal control or Pre-Tune operating; 1 = Easy Tune operating). A description of the Easy Tune facility is in Appendix B.. **NOTE:** Not applicable when Control Type is set to HEAT/COOL.

NOTE: Easy Tune will not run when Soft Start is running.

4.4.8 Primary Output Power Limit

This parameter defines the maximum percentage power of primary (HEAT) control output. This offers protection to the controlled process. This parameter is not applicable if Proportional Band 1 = 0 (i.e. Output 1 = ON/OFF control) - see Subsection 4.4.15).

Adjustment Range:	00 (0%) - 0064h (100%). *100% = no protection.*
Default Value:	100% (no protection).
Automatic Change:	Rendered inapplicable if Proportional Band 1 (see Subsection 4.4.15) is set to 0% (ON/OFF control).
Effect of Changes on Other Parameters:	None.

4.4.9 Soft Start Parameters

NOTE 1: If the HEAT output is connected to an internal Relay/SSR Drive then the Output Cycle Time, during Soft Start, for that output is set to 25% of its configured value, subject to a minimum of 0.5 seconds (therefore if the Output Cycle Time is set to 1 second it is actually reduced by 50% of it's value to 0.5 seconds). If the Output Cycle Time is already set to 0.5 seconds or less, it will not be reduced.

NOTE 2: Soft Start is terminated if the PV is above the Soft Start Setpoint at startup.

NOTE 3: Soft Start only operates on HEAT outputs. The Soft Start Primary Output Power Limit operation (see Subsection 4.4.9.3) is only recommended for use with reverse-acting control outputs.

4.4.9.1 Soft Start Setpoint

This parameter defines the value of setpoint used during the Soft Start time period (see Subsection 4.4.9.2).

Adjustment Range:	Input Scale Range Minimum (see Subsection 4.1.11) to Input Scale Range Maximum (see Subsection 4.1.10).
Default Value:	Input Scale Range Minimum.
Automatic Change:	Forced to default value if forced out of range by a change to Input Range (see Subsection 4.1.8), Input Scale Range Maximum (see Subsection 4.1.10) or Input Scale Range Minimum (see Subsection 4.1.11). The units for this parameter are changed if Input Units (see Subsection 4.1.9) is changed.
Effect of Changes on Other Parameters:	None.

4.4.9.2 Soft Start Time

This parameter defines the duration of the Soft Start period.

Adjustment Range:	0 to 60 minutes in 1-minute increments (0 = no Soft Start).
Default Value:	0 (no Soft Start).
Automatic Change:	None.
Effect of Changes on Other Parameters:	Non-zero values stop Easy Tune and Pre-Tune from working.

4.4.9.3 Soft Start Primary Output Power Limit

This parameter defines the Output Power Limit used instead of Primary Output Power Limit (see Subsection 4.4.8) during the Soft Start period.

Adjustment Range:	0 - 100% (100% = no Soft Start).
Default Value:	100% (no Soft Start).
Automatic Change:	This parameter is forced within range, if necessary, when Control Type (see Subsection 4.4.14) is changed.
Effect of Changes on Other Parameters:	None.

4.4.10 HEAT Output Power

This parameter indicates the current HEAT output power level. It is in the range 0% to 100% (0064h).

4.4.11 COOL Output Power

This parameter indicates the current COOL output power level. It is in the range 0% to 100% (0064h).

4.4.12 Loop Alarm Status

This parameter indicates the current status of the Loop Alarm (1 = active, 0 = inactive). See also Loop Alarm Enable (Subsection 4.4.13) and Loop Alarm Time (Subsection 4.4.17).

4.4.13 Loop Alarm Enable

This parameter enables/disables the Loop Alarm.

Adjustment Range:	0 (Disabled) or 1 (Enabled).
Default Value:	0 (Disabled).
Automatic Change:	If Loop Alarm is originally enabled, it is disabled when Manual Control Mode is selected (see Subsection 4.4.1) and is re-enabled when exit is made from Manual Control Mode. If Loop Alarm is originally enabled, it is disabled during Easy Tune execution and is re-enabled upon completion of the Easy Tune operation.
Effect of Changes on Other Parameters:	None.

The Loop Alarm is a special alarm which detects faults in the control feedback loop by monitoring continuously process variable response to the control output(s).

When enabled, the Loop Alarm repeatedly checks the control output(s) for saturation (i.e. either or both outputs being at the maximum or minimum limit). If an output is found to be in saturation, the Loop Alarm starts a timer; thereafter, if the saturated output has not caused the process variable to be corrected by a pre-determined amount **V** after a time **T** has elapsed, the Loop Alarm goes active. Subsequently, the Loop Alarm repeatedly checks the process variable and the control output(s). When the process variable value starts to change in the correct sense or when the saturated output comes out of saturation, the Loop Alarm is de-activated.

For PID control, the Loop Alarm Time **T** is always set to 2 x Reset (Integral Time Constant) value. For ON/OFF control, the user-defined Loop Alarm Time value (see Subsection 4.4.17) is used.

The value of **V** is dependent upon input type:

°C ranges:	2°C or 2.0°C
°F ranges:	3°F or 3.0°F
Linear ranges:	10 least significant display bits

For single output control, the output saturation limits are 0% and Primary Output Power Limit (see Page 4-13). For dual-output control, the output saturation limits are –100% and Primary Output Power Limit.

NOTE: Correct operation of the Loop Alarm depends upon reasonably accurate PID tuning.

4.4.14 Control Type

This parameter selects single (HEAT only) or dual (HEAT & COOL) output control.

Adjustment Range:	0 (HEAT only) or 1 (HEAT and COOL).
Default Value:	0 (HEAT only).
Automatic Change:	None.
Effect of Changes on Other Parameters:	Valid values of % Power parameters will be forced within range.

4.4.15 Proportional Band 1

This parameter defines the percentage of input span over which the HEAT output power level is proportional to the process variable. Refer to Figure 4-1.

Adjustment Range:	0000 (0.0% - ON/OFF control) or within the range 0005 (0.5%) to 270Fh (999.9%).
Default Value:	10.0%
Automatic Change:	Is forced to default value if Input Range (see Subsection 4.1.8) is changed.
Effect of Changes on Other Parameters:	Forces Loop Alarm Time/Reset Time Constant (see Subsection 4.4.17) to default value on entry into or exit from ON/OFF control.

4.4.16 Proportional Band 2

This parameter defines the percentage of input span over which the COOL output power level is proportional to the process variable. Refer to Figure 4-1.

Adjustment Range: 0000 (0.0% - ON/OFF control) or within the range 0005 (0.5%) to 270Fh (999.9%).

Default Value: 10.0%.

Automatic Change: This parameter is forced to its default value if Input Range (see Subsection 4.1.8) is changed.

Effect of Changes on Other Parameters: None.

4.4.17 Reset (Integral Time Constant)/Loop Alarm Time

This parameter defines the value of the Integral Time Constant (if Proportional Band 1 ≠ 0 - PID control) or (if Proportional Band 1 = 0 - ON/OFF control) the Loop Alarm Time value. The Loop Alarm Time parameter is not applicable if the Loop Alarm has been disabled (see Subsection 4.4.13).

Adjustment Range: 0001 (1 sec.) to 176Fh (5999 secs.) and 0000 (OFF).

NOTE: For ON/OFF control (Proportional Band 1 = 0), Loop Alarm Time is the user-defined duration of the output saturation condition after which the Loop Alarm is activated. For proportional control (Proportional Band 1 ≠ 0), Loop Alarm Time is set automatically to 2 x Reset time.

Default Value: 300 secs (PID control) or 5999 secs (ON/OFF control).

Automatic Change: Forced to default value if Input Range is changed or from entry into or exit from ON/OFF Control (i.e. Proportional Band 1 is changed from/to 0)

Effect of Changes on Other Parameters: None.

4.4.18 Rate (Derivative Time Constant)

This parameter determines the Derivative Time Constant value. This parameter is not applicable if Proportional Band 1 = 0 (ON/OFF control) - see Subsection .4.4.15

Adjustment Range: 0000 (0 secs.) to 176Fh (5999 secs.).

Default Value: 75 secs.

Automatic Change: This parameter is forced to its default value if Input Range (see Subsection 4.1.8) is changed.

Effect of Changes on Other Parameters: None.

4.4.19 Overlap and Deadband

This parameter defines the percentage of (Proportional Band 1 + Proportional Band 2) over which both HEAT and COOL outputs are active (overlap) or neither is active (deadband). This parameter is not applicable if Proportional Band 1 is set to 0 (ON/OFF control) - see Subsection 4.4.15. The operation of overlap/deadband is illustrated in Figure 4-1.

Adjustment Range: FFECh (–20%) to 0014h (+20%) (negative value = deadband, positive value = overlap).

Default Value: 0000 (0%).

Automatic Change: Forced to default value if Input Range (see Subsection 4.1.8) is changed.

Effect of Changes on Other Parameters: None.

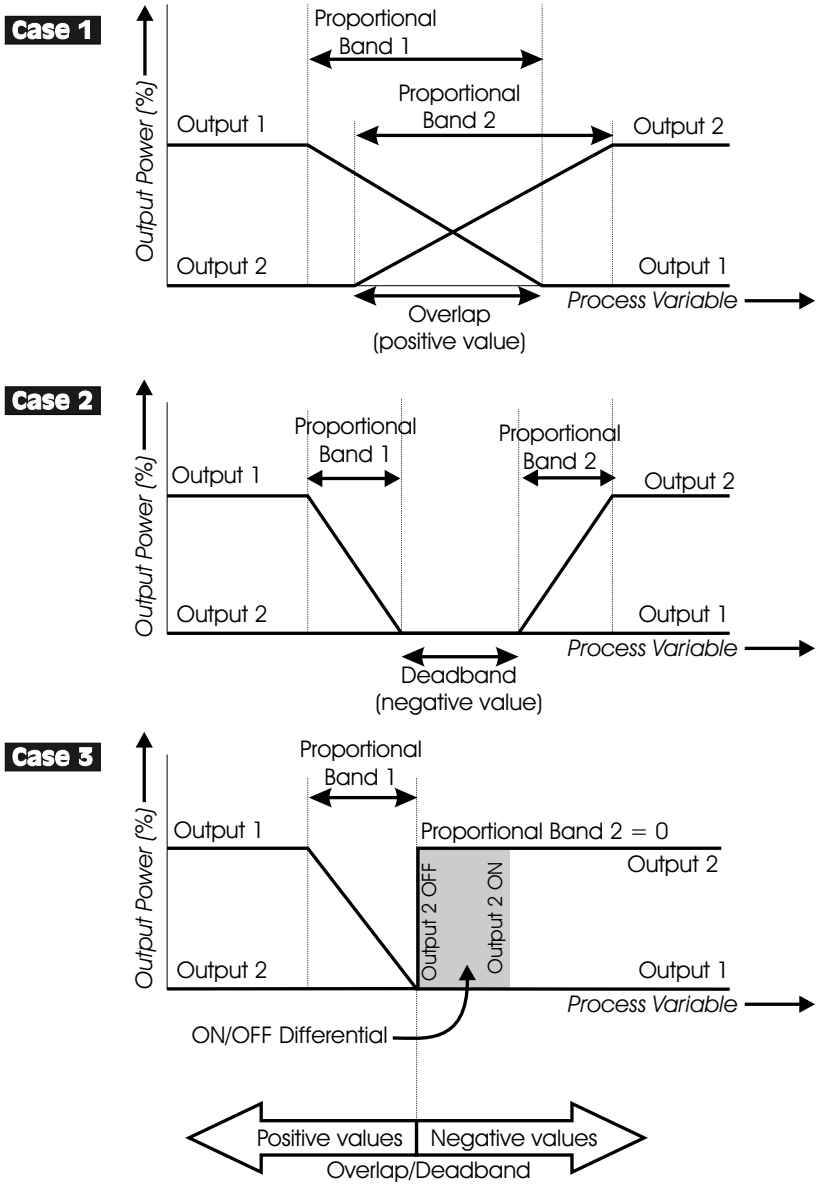


Figure 4-1 Proportional Band and Overlap/Deadband

4.4.20 Bias (Manual Reset)

This parameter defines the bias added to output power, expressed as a percentage of HEAT output power. This parameter is not applicable if Proportional Band 1 is set to 0 (ON/OFF control) - see Subsection 4.4.15.

Adjustment Range:	0000 (0%) to 0064h (100%) (HEAT output only configured) or FF9Ch (–100%) to 0064h (+100%) (HEAT and COOL outputs configured).
Default Value:	0019h (25%).
Automatic Change:	Forced to default value if Input Range (see Subsection 4.1.8) is changed.
Effect of Change on Other Parameters:	None.

4.4.21 ON/OFF Differential

This is the switching differential used with one output or both outputs set to ON/OFF control (Proportional Band = 0). The operation of ON/OFF Differential is illustrated in Case 3 in Figure 4-1.

Adjustment Range:	0001 (0.1%) to 0064h (10.0%) of input span.
Default Value:	0005 (5%).
Automatic Change:	Forced to default value if Input Range (see Subsection 4.1.8) is changed.
Effect of Change on Other Parameters:	None.

4.4.22 Control Output Action

This parameter determines the action of the PID control algorithm for the associated output.

Adjustment Range:	0 (reverse-acting) or 1 (direct-acting).
Default Value:	0 (reverse-acting).
Automatic Change:	None.
Effect of Changes on Other Parameters:	None.

4.4.23 Programmable Sensor Break

This parameter determines the output power setting in the event of a Sensor Break condition.

Adjustment Range: 1 (ON - Power held at current value, if Reset is non-zero, or at Bias value, if Reset = 0) or 0 (OFF - Preset Power Output used - see Subsection 4.4.24).

NOTE: For safety purposes, the output power level on Sensor Break is limited by Preset Power Output. For ON/OFF control, Programmable Sensor Break is disabled and both COOL and HEAT outputs are forced to zero when a sensor break is detected.

Default Value: 0 (OFF).

Automatic Change: None.

Effect of Changes on Other Parameters: None:

4.4.24 Preset Power Output

This parameter defines the output power level that will be set when, with Programmable Sensor Break OFF (see Subsection 4.4.23), a sensor break condition occurs.

Adjustment Range: 0000 (0%) to 0064h (100%) (HEAT output only configured) or FF9Ch (–100%) to 0064h (+100%) (HEAT and COOL outputs configured).

Default Value: 0000 (0%).

Automatic Change: Forced within range, if necessary, when Control Type (see Subsection 4.4.14) is changed.

Effect of Changes on Other Parameters: None.

4.5 ALARM PARAMETERS (LCM Class 04)

For single-loop LCMs, there are two alarm instances, numbered 0 and 1. For four-loop LCMs, there are eight such instances:

Loop	1		2		3		4	
Alarm Instance	0	4	1	5	2	6	3	7

Connection of each soft alarm to a built-in output port is via the parameters of the Output Class (see Subsection 4.2).

4.5.1 Alarm Type

This parameter selects the alarm type. The characteristics of the alarm types are shown in the table below (see also Figure 4-2).

Alarm Type	Minimum Value	Maximum Value	Default	Alarm Action
Process High	Input Range Min.	Input Range Max.	Input Range Max.	Active when PV ≥ alarm value
Process Low	Input Range Min.	Input Range Max.	Input Range Min.	Active when PV ≤ alarm value
Band Alarm	1	Span - limited to 7D00 (32000 dec.)	5 input units	Active when PV - SP is outside band
Deviation Alarm	–(span) - limited to FD00 (–32000 dec.)	+(Span) - limited to 7D00 (+32000 dec.)	5 input units	Active when (PV - SP) > alarm value

Adjustment Range: 0000 (Process High Alarm): 0001 (Process Low Alarm) 0002 (Band Alarm); 0003 (Deviation Alarm).

Default Value: 0000 (Process High Alarm).

Automatic Change: None:

Effect of Changes on Other Parameters: Alarm Value (see below) forced to default value for new alarm type.

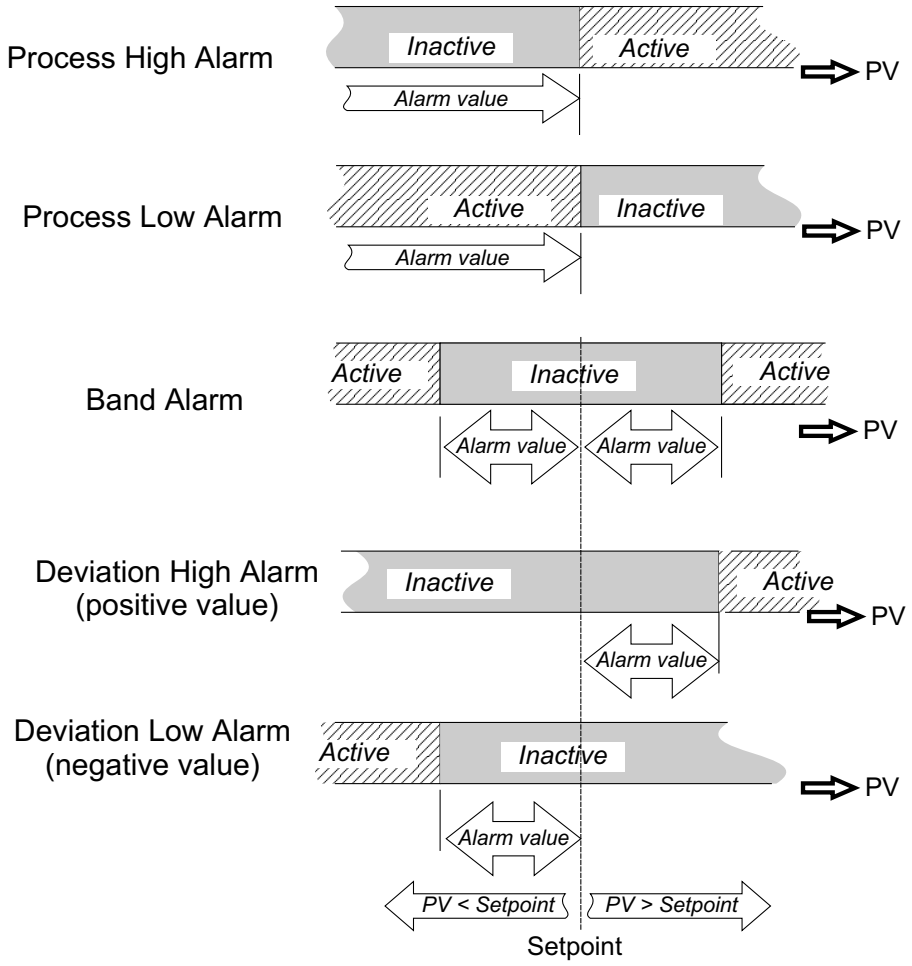


Figure 4-2 Alarm Operation

4.5.2 Alarm Value

This parameter determines the value at which the alarm becomes active. The function/adjustment range of this value depends upon alarm type (see table in Subsection 4.5.1 and Figure 4-2).

Default Value: Dependent upon alarm type; see table above.

Automatic Change: If a change to Input Range (see Subsection 4.1.8), Input Scale Range Maximum (see Subsection 4.1.10) or Input Scale Range Minimum (see Subsection 4.1.11) forces this parameter out of range, it will be set to its default value. This parameter is automatically set to its new default value if Alarm Type (see Subsection 5.5.2, 4.5.1) is changed. If Input Units (see Subsection 4.1.9) is changed, the units for this parameter will change accordingly.

Effect of Changes on Other Parameters: None.

4.5.3 Alarm Hysteresis

This parameter defines the width of a hysteresis band on the “safe” side of the alarm level for the applicable alarm. Its operation is illustrated in Figure 4-3.

Adjustment Range: 0001 (1 input unit) to 00FAh (250 input units).

Default Value: 0001 (1 input unit).

Automatic Change: If a change to Input Range (see Subsection 4.1.8), Input Scale Range Maximum (see Subsection 4.1.10) or Input Scale Range Minimum (see Subsection 4.1.11) forces this parameter out of range, it will be set to its default value. If Input Units (see Subsection 4.1.9) is changed, the units for this parameter will change accordingly.

Effect of Changes on Other Parameters: None.

4.5.4 Alarm State

This parameter indicates the state of the applicable alarm (1 = active, 0 = inactive).

4.5.5 Alarm Inhibit

This parameter enables/disables the Alarm Inhibit feature. When Alarm Inhibit is enabled, it inhibits an alarm at power-up until that alarm goes inactive. Alarm Inhibit also operates in similar manner (for dual setpoint operation) on deviation alarms and band alarms for changes from one setpoint to another.

Adjustment Range: 1 (enabled) or 0 (disabled).

Default Value: 0 (Disabled).

Automatic Change: None.

Effect of Changes on Other Parameters: None.

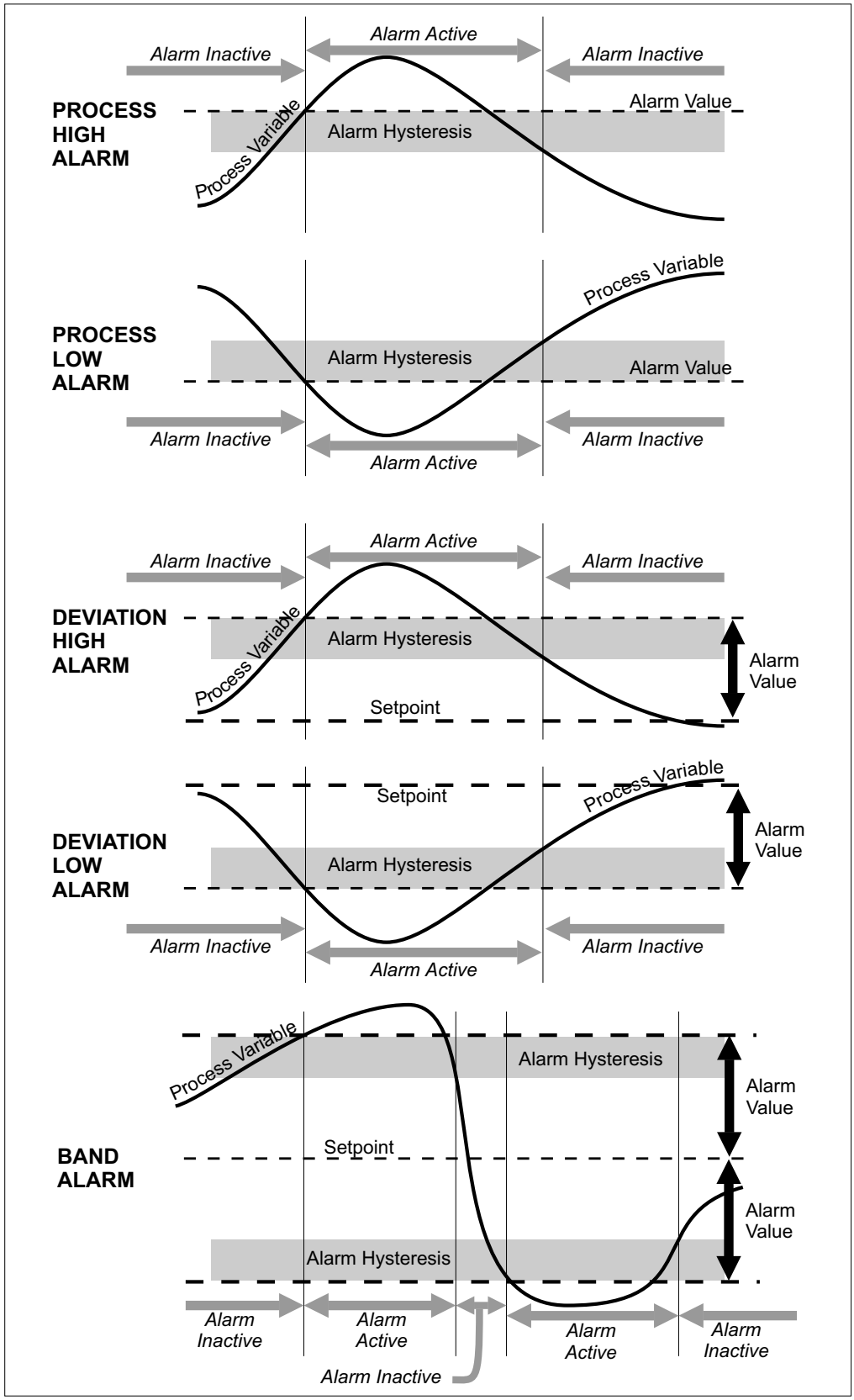


Figure 4-3 Alarm Hysteresis Operation

4.6 HEATER CURRENT PARAMETERS (LCM Class 06)

These parameters relate only to Loop Controller Modules with the Heater Current Input option. The Soft Heater Current Alarm may be connected to a physical output via the parameters of the Output Class (see Subsection 4.2).The Heater Current Input Option is available on LCMs C230 and C231 only.

4.6.1 Heater Current value

This parameter indicates the heater current value, which will be in the range 0 (0.0) to 1000 (100.0).

4.6.2 Low Heater Break Alarm value

This parameter determines the level of heater current below which the Low Heater Break Alarm becomes active.

Adjustment range:	0 (OFF) to Heater Current Scale Range Maximum.
Default Value:	0 (OFF).
Automatic Change:	If a change in Heater Current Input Range (see Subsection 4.6.8) or Heater Current Scale Range Maximum (see Subsection 4.6.9) causes this parameter to be out of range, it will be set to its default value.
Effect of Changes on Other Parameters:	None.

4.6.3 High Heater Break Alarm value

This parameter determines the level of heater current above which the High Heater Break Alarm becomes active.

Adjustment range:	0 to Heater Current Scale Range Maximum (OFF).
Default Value:	Heater Current Scale Range Maximum (OFF).
Automatic Change:	If a change in Heater Current Input Range (see Subsection 4.6.8) or Heater Current Scale Range Maximum (see Subsection 4.6.9) causes this parameter to be out of range, it will be set to its default value.
Effect of Changes on Other Parameters:	None.

4.6.4 Low Heater Break Alarm state

This parameter indicates the state of the Low Heater Break Alarm (0 = inactive, 1 = active).

4.6.5 High Heater Break Alarm state

This indicates the state of the High Heater Break Alarm (0 = inactive, 1 = active).

4.6.6 Short Circuit Heater Break Alarm state

This indicates the state of the Short Circuit Heater Break Alarm (0 = inactive, 1 = active). This alarm goes active when heater current is detected and the Heat output is not on.

4.6.7 Short Circuit Heater Break Alarm Enable/Disable

This parameter enables/disables the Short Circuit Heater Break current alarm.

Adjustment range:	0 (disabled) or 1 (enabled).
Default Value:	1 (enabled).
Automatic Change:	None.
Effect of Changes on Other Parameters:	None.

4.6.8 Heater Current Input Range

This parameter defines the heater current input source and span setting.

Adjustment Range:	0 - Standard: External current transformer used. Permits the use of the Low Heater Break Alarm, High Heater Break Alarm and Short-circuit Heater Break Alarm 1 - SCRi: Two-wire connection to a special thyristor unit (SCRs). Permits the use of Low Heater Break Alarm and High Heater Break Alarm but not Short-circuit Heater Break Alarm. 2 - Bus
Default Value:	0 (Standard).
Automatic Change:	None.
Effect of Changes on Other Parameters:	Forces to default values: Heater Current Scale Range Max. and Bus Input Value If either is forced out of range, forces to default values: Low Heater Break Alarm and High Heater Break Alarm

4.6.9 Heater Current Scale Range Maximum

This parameter defines the scale limit for the heater current (when current transformer secondary current is 50mA).

Adjustment range:	10.0A to 100.0A in 0.1A increments.
Default Value:	50.0A.
Automatic Change:	Set to default value when Heater Current Input Range (see Subsection 4.6.8) is changed.
Effect of Changes on Other Parameters:	If either is forced out of range, forces to default values Low Heater Break Alarm and High Heater Break Alarm

4.6.10 Bus Input value

This parameter provides for an input source from Fieldbus. It is available when Heater Current Input Range parameter is set to Bus.

Adjustment Range:	0 to Heater Current Scale Range Maximum.
Default Value:	0.
Automatic Change:	Set to default value when Heater Current Input Range (see Subsection 4.6.8) is changed.
Effect of Changes on Other Parameters:	None.

4.7 CALIBRATION PARAMETERS (LCM Class 14)

WARNING: Calibration must be carried out only by personnel who are technically-competent and authorised to do so. *Incorrect calibration will cause the MLC 9000 to malfunction.*

The calibration procedure for the Loop Control Module comprises five phases, according to the calibration source required:

Phase 1 - 50mV
Phase 2 - 10V
Phase 3 - 20mA
Phase 4 - RTD (200Ω)
Phase 5 - CJC (Type K Thermocouple, @ 0°C)

The calibration procedure is shown in Figure 4-4.

The pre-requisites are:

Phase 1: 50.000mV source connected to the appropriate Linear Input (mV) terminals.

Phase 2: 10.000V source connected to the appropriate Linear Input (V) terminals

Phase 3: 20.000mA source connected to the appropriate Linear Input (mA) terminals

Phase 4: 200.000Ω connected to the appropriate RTD Input terminals

Phase 5: 0°C reference connected to the appropriate Thermocouple Input terminals

For information on input connections, refer to Section 2. The calibration phases are applicable to the various LCMs as follows:

Module Type	Calibration Phase				
	1	2	3	4	5
C120	✓	✓	✓	✓	✓
C130	✓	✓	✓	✓	✓
C230	✓	✓	✓	✓	✓
C231	✓	✓	✓	✓	✓
C460	✓			✓	✓
C461		✓	✓		
C462	✓			✓	✓
C463		✓	✓		

4.7.1 Calibration Phase

This parameter selects/indicates the calibration phase which subsequent writing of the correct Calibration Password (see Subsection 4.7.2) will initiate.

Adjustment Range: 1 to Maximum Calibration Phase Number.

4.7.2 Calibration Password

This parameter defines the value which, when written, initiates calibration. When read, this parameter returns either FFFFh (Pass) or 0000 (Fail).

Adjustment Range: CAFEh

4.7.3 Calibration Value

This parameter indicates a calibration value for the current calibration phase in the range 0000 to FFFFh. In order to read back the correct calibration, it is necessary to first write the calibration phase (see Subsection 4.7.1)

Default Value (C120, C130, C230, C231): F000h (uncalibrated)

Default Value (C46x): 0000 (uncalibrated)

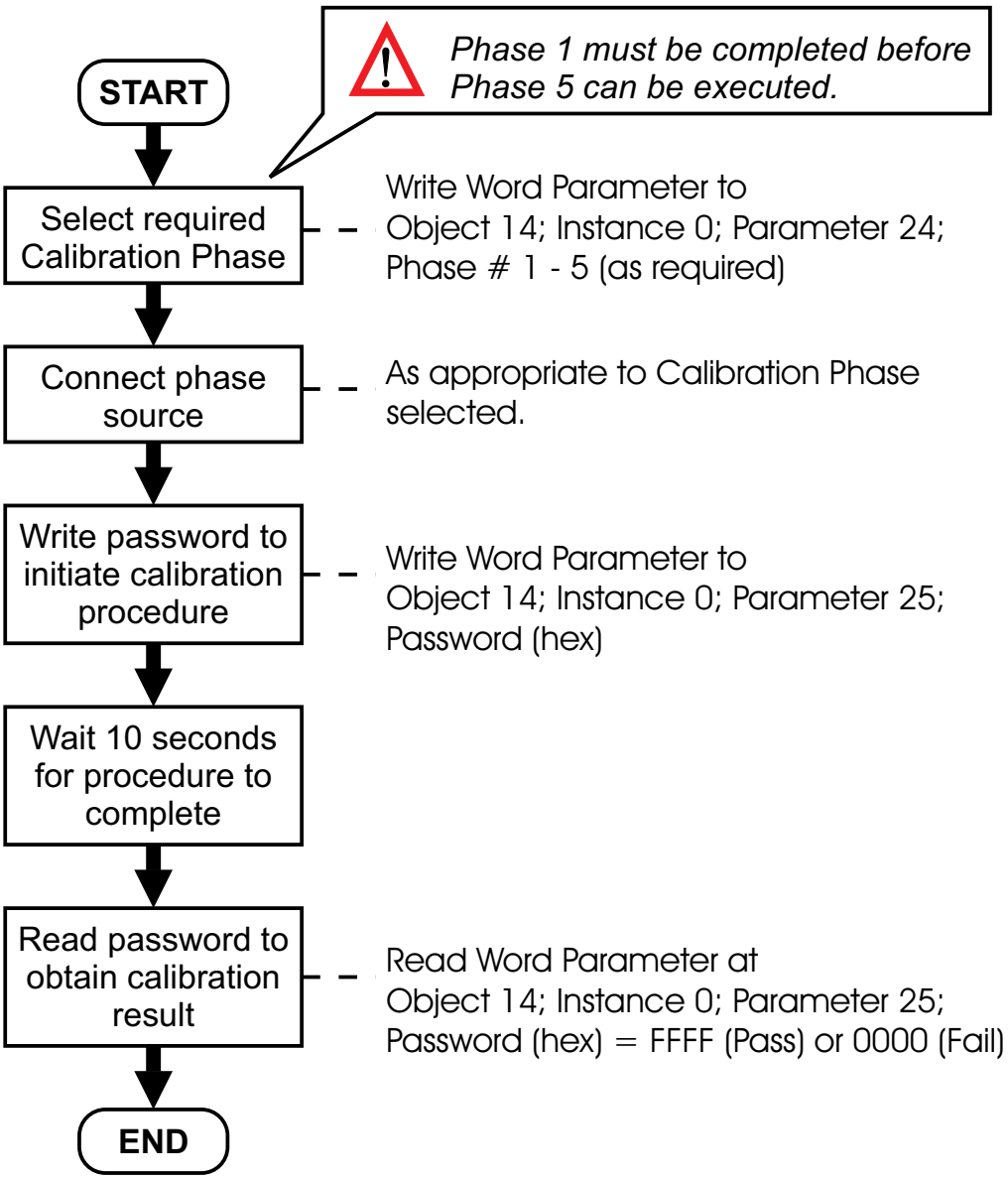


Figure 4-4 Calibration Procedure

4.8 LCM DESCRIPTOR PARAMETERS (LCM Class 15)

4.8.1 Serial Number

This Read Only parameter indicates the Serial Number of the Loop Controller Module. It is burnt into the LCM's EEPROM at manufacture. It is in the numeric range 0 to 999 999 999 999.

4.8.2 Product Identifier

This Read Only parameter identifies the product type and manufacturer. It is burnt into the LCM's EEPROM at manufacture. Value is one of:

0	C120 LCM, single input, dual output, single loop
1	C130 LCM, single input, triple output, single loop
2	C230 LCM, dual input (Heater Break), triple output, single loop
5	C231 LCM, redundant thermocouple and current transformer input, triple output
6	C460 LCM, temperature input, quad SSR drive and dual relay outputs
7	C461 LCM, DC process input, quad SSR drive and dual relay outputs
8	C462 LCM, temperature input, six relay outputs
9	C463 LCM, DC process input, six relay outputs

4.8.3 Firmware ID

This Read Only parameter indicates the LCM firmware version and issue number. It is in the range 0 to 2^{16}. The format of the ID word is:

Bits 0 - 4:	Revision Number (1, 2, etc.)
Bits 5 - 9:	Alpha version (A = 0, B = 1, etc.)
Bits 10 - 15:	Numeric version (single loop LCM = 0, 4-loop LCM = 2)

4.8.4 Database ID

This Read Only parameter identifies the valid versions of database for the LCM:

2	C120 LCM, single universal input, dual output, single loop
3	C130 LCM, single universal input, triple output, single loop
4	C230 LCM, universal and current transformer inputs, triple output, single loop
7	C231 LCM, redundant thermocouple and current transformer inputs, triple output, single loop
8	C460 LCM, temperature input, quad SSR drive and dual relay outputs, 4 loops
9	C461 LCM, DC process input, quad SSR drive and dual relay outputs, 4 loops
10	C462 LCM, temperature input, six relay outputs, 4 loops
11	C463 LCM, DC process input, six relay outputs, 4 loops

When changing LCMs, auto-configuration of the LCM database will occur only if the database ID of the replacement LCM is identical to that of the removed LCM.

4.8.5 LCM Data Assembly

This is a collection of status-type indicators, most of which are duplicates of parameters in other classes:

Parameter	Description
COOL Output Power	See Subsection 4.4.11
HEAT Output Power	See Subsection 4.4.10
Actual Setpoint Value	See Subsection 4.3.4
Process Variable Value	See Subsection 4.1.1
Status Indicators	A 16-bit word, each bit representing the status of a parameter (0 = inactive, 1 = active) as follows: Bit 0: Over-range Flag - see Subsection 4.1.4 Bit 1: Under-range Flag - see Subsection 4.1.5 Bit 2: Sensor Break Flag - see Subsection 4.1.6 * Bit 3: For non-Redundant Thermocouple variants, this is a copy of Bit 2. For Redundant Thermocouple variant, this is set to 1 when *either* thermocouple is broken. Bit 4: Loop Alarm Status - see Subsection 4.4.12 Bit 5: Easy Tune Status - see Subsection 4.4.7 Bit 6: Pre-Tune Status - see Subsection 4.4.5 Bit 7: Not used Bit 8: Alarm 1 Status - see Subsection 4.5.4 Bit 9: Alarm 2 Status - see Subsection 4.5.4 Bit 10: Output 1 State (0 = inactive, 1 = active) Bit 11: Output 2 State (0 = inactive, 1 = active) Bit 12: Output 3 State (0 = inactive, 1 = active) Bit 13: Single-loop LCM: Low Heater Break Alarm Status - see Subsection 4.6.4 4-loop LCM: Output 4 State (0 = inactive, 1 = active) Bit 14: Single-loop LCM: High Heater Break Alarm Status - see Subsection 4.6.5 4-loop LCM: Output 5 State (0 = inactive, 1 = active) Bit 15: Single-loop LCM: Heater Short Circuit Alarm Status - see Subsection 4.6.6 4-loop LCM: Output 6 State (0 = inactive, 1 = active)

* For the Redundant Thermocouple variant, the Sensor Break flag is set only when a break condition is detected on *both* thermocouple inputs - see Subsection 4.1.7.

4.9 COMMUNICATIONS CONFIGURATION PARAMETERS (BCM Class 12)

This class contains the communications control parameters for the BCM.

4.9.1 MODBUS Address

This parameter defines the MODBUS base address for the MLC 9000 system.

Adjustment Range: 1 - 247.

Default Value: 96.

4.9.2 MODBUS Data Transfer Rate

This parameter sets the data transfer rate for the MODBUS port.

Adjustment Range: 0 (2400 Baud), 1 (4800 Baud), 2 (9600 Baud) and 3 (19200 Baud).

Default Value: 2 (9600 Baud).

4.9.3 MODBUS Data Format

This parameter defines the parity for the MODBUS port (data is always eight bits per character).

Adjustment Range: 0 (none), 1 (odd) and 2 (even).

Default Value: 0 (none).

4.9.4 PC Port Poll Timeout

This parameter defines the maximum time for which the BCM will wait for an RS232 Port response.

Adjustment Range: 1 (128msecs.), 2 (256msecs.) ⇒⇒⇒ 50 (6.4secs.).

Default Value: 3 (384msecs.).

4.9.5 PC Port Minimum Poll Interval

This parameter defines the minimum interval between polls of the RS232 port.

Adjustment Range: 1 (128msecs.), 2 (256msecs.) ⇒⇒⇒ 50 (6.4secs.).

Default Value: 1 (128msecs.).

4.9.6 Fieldbus Address

This parameter determines the DeviceNet address (MacID for a DeviceNet Port).

Adjustment Range: 0 - 63 for DeviceNet

Default Value: 63 (for DeviceNet)

4.9.7 Fieldbus Data Rate

This parameter determines the data rate in Kilobits/sec.

Adjustment Range: For DeviceNet: 0 = 125, 1 = 250, 2 = 500

Default Value: For DeviceNet: 0 (125)

4.10 BCM DESCRIPTOR PARAMETERS (BCM Class 15)

4.10.1 Serial Number

This Read Only parameter indicates the Serial Number of the Bus Communications Module. It is burnt into the BCM's EEPROM at manufacture. It is in the numeric range 0 to 999 999 999 999.

4.10.2 Product Identifier

This Read Only parameter identifies the product type and manufacturer. It is burnt into the BCM's EEPROM at manufacture. Value is one of:

0 - BCM, 24V supply, RS232 Port only (B210)
1 - Reserved for future use
2 - BCM, 24V supply, RS232 Port and MODBUS Port (B220)
3 - Reserved for future use
4 - BCM, 24V supply, RS232 Port and DeviceNet Port (B230)

4.10.3 Firmware ID

This Read Only parameter indicates the BCM firmware version and issue number. It is in the range 0 to 2^{16}. The format of the ID word is:

Bits 0 - 4: Revision Number (1, 2, etc.)
Bits 5 - 9: Alpha version (A = 0, B = 1, etc.)
Bits 10 - 15: Numeric version (MODBUS BCM = 1)

4.10.4 Database ID

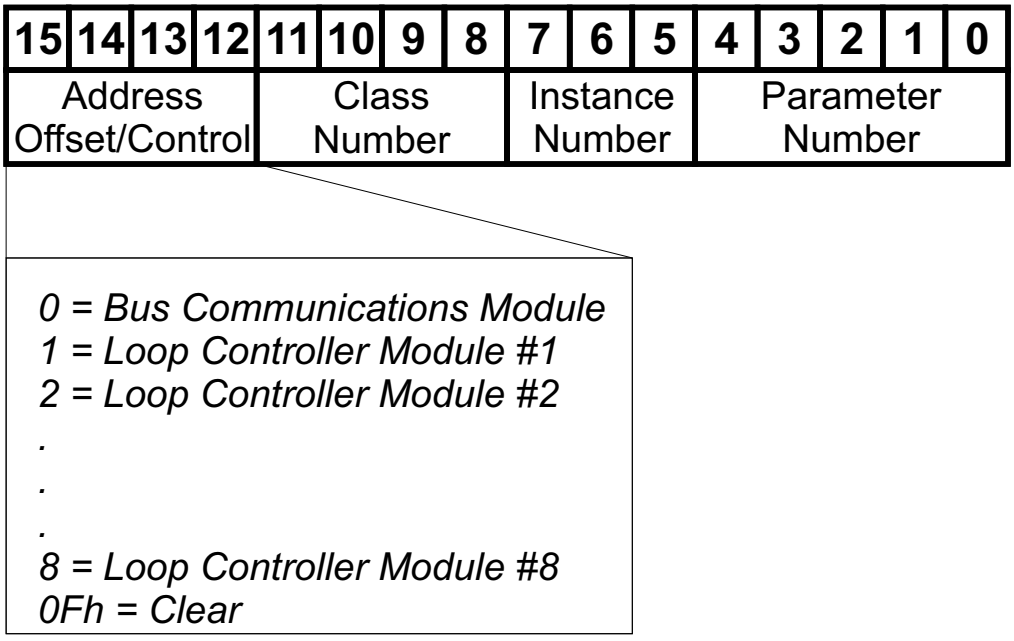
This Read Only parameter identifies the valid versions of database for the BCM. Value is one of:

0 - BCM, RS232 Port only (B210)
1 - BCM, RS232 Port and MODBUS Port (B220)
4 - BCM, RS232 Port and DeviceNet Port (B230)

4.10.5 Configurable Data Assembly Parameters

These parameters provide the data on parameters to be assembled by the Bus Communications Module prior to reading by an external application. The parameter word address is written in each Data Assembly Parameter word. When the Data Assembly Parameter is subsequently read, it will return the value of that parameter. Up to eight Data Assembly Parameter words may be addressed/read in one message.

The format of the address to be written to a Data Assembly Parameter is:



5 OVERVIEW OF MODBUS COMMUNICATIONS

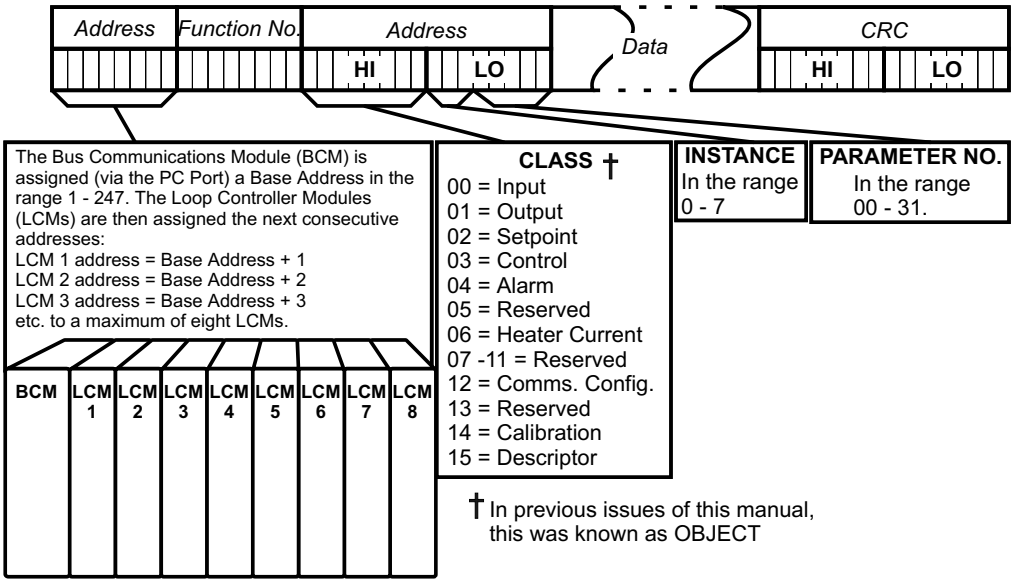
5.1 INTRODUCTION

The MLC 9000 system is connected to an RS485 MODBUS RTU master device via the MODBUS Port on the Bus Communications Module.

NOTE: Unless otherwise specified, all numbers in this Section are expressed in decimal form. Where hexadecimal numbers are used, they have the suffix h.

5.2 MODBUS MESSAGE - GENERAL FORMAT

A MODBUS message or response comprises an inter-message gap followed by a sequence of characters. The inter-message gap should be at least 3.5 character times. The message format is shown below:



Data is transmitted asynchronously as characters with one start bit, eight data bits and one stop bit. The bit rate may be set to 2400, 4800, 9600 or 19200bps. The parity is selectable to be even, odd or none.

The Cyclic Redundancy Check calculation uses the standard MODBUS polynomial expression $2^{16} + 2^{15} + 2^{2} + 1$.

For full details of the MODBUS protocol, see www.modicon.com.

5.3 ADDRESSING

The Bus Communications Module (BCM) is given a base address during configuration (via the PC Port using the Application Software in the local PC); the MLC 9000 system then occupies this and up to eight further addresses above the base address. For MODBUS BCMs with less than eight LCMs, it is recommended that the addresses of the vacant slots be reserved for future expansion. The base address may be set to any integer in the range 1 - 247. The default base address is 96 (60h). The Bus Communications Module will also accept global or broadcast commands (i.e. those addressed to all parts of the MODBUS network) with address 0. Each Loop Controller Module (LCM) in an MLC 9000 system is allocated an address relative to the base address as shown in the diagram above.

The class defines the category of parameter accessed (e.g. input, output, setpoint), as shown in the diagram above.

The Instance Number specifies which example of class is accessed:

		Number of Instances			
Class Number	**Class**	**Single-loop LCM**	**Single-loop LCM with Heater Break**	**4-Loop LCM**	**BCM**
0	Input	1	1	4	0
1	Output	2 or 3	3	6	0
2	Setpoint	1	1	4	0
3	Control	1	1	4	0
4	Alarm	2	2	8	0
5	Reserved				
6	Heater Current	0	1	0	0
7	Reserved				
8	Reserved				
9	Reserved				
10	Reserved				
11	Reserved				
12	Communications Configuration	0	0	0	1
13	Reserved				
14	Calibration	1	1	4	0
15	Descriptor	1	1	4	1

As an example of instance number allocation, consider:

For Output Class: Output 1 = Instance 0, Output 2 = Instance 1, Output 3 = Instance 2

For Alarm Class: Alarm 1 = Instance 0, Alarm 2 = Instance 1

The Parameter Number defines the parameter to be accessed (see Subsection 5.4.8, 5.5) for that Class and Instance. The Parameter Number comprises either a word address (for word parameters) or a bit address (for bit parameters - values occupying

one bit only). Bits 0 - 15 and 16 - 31 occupy word parameter numbers 0 and 26 respectively and may be addressed as a group by using the word address.

5.4 MODBUS FUNCTIONS SUPPORTED

Code (hex.)	MODBUS Function	Meaning
01 or 02	Read Coil/Input Status	Read input/output status bits at given address.
03 or 04	Read Holding/Input Registers	Read current binary value of data bytes at given address.
05	Force Single Coil	Write a single binary bit to the specified bit address.
06	Pre-set Single Register	Write two bytes to the specified word address.
08	Diagnostics	Used only for loopback test.
0Fh	Force Multiple Coils	Write consecutive bits to the specified address range. The Bus Communications Module limits the use of this function to one bit at a time. Writing multiple bits can be effected using Function Code 06.
10h	Pre-set Multiple Registers	Write consecutive two-byte values to the specified address range.

More detail on each MODBUS function is given in the following Subsections.

5.4.1 Read Coil/Input Status (Function 01/02)

Either Function 01 or Function 02 may be used interchangeably to read the content of the status bits at the specified bit address. The format is:

MESSAGE:

Slave Address	*Function*	*Address of 1st Bit*		*Number of Bits*		*CRC Checksum*	
	01/02	**HI**	**LO**	**HI**	**LO**	**HI**	**LO**

RESPONSE:

Slave Address	*Function*	*No. of Bytes*	*1st 8 Bits*	*2nd 8 Bits*		*Last 8 Bits*	*CRC Checksum*	
	01/02						**HI**	**LO**

In the response, the “No. of Bytes” indicates the number of data bytes read from the addressed Loop Controller Module (e.g. if 16 bits are returned, the count will be 2). The maximum number of bits that can be read is 16. The first bit read is the least significant bit of the first eight bits requested.

5.4.2 Read Holding/Input Registers (Function 03/04)

Either Function 03 or Function 04 may be used interchangeably to read the current binary value of the data at the specified word address. The format is:

MESSAGE:

Slave Address	*Function*	*Address of 1st Word*		*Number of Words*		*CRC Checksum*	
	03/04	**HI**	**LO**	**HI**	**LO**	**HI**	**LO**

RESPONSE:

Slave Address	*Function*	*No. of Bytes*	*1st Word*			*Last Word*		*CRC Checksum*	
	03/04		**HI**	**LO**		**HI**	**LO**	**HI**	**LO**

In the response, the “No. of Bytes” indicates the number of data bytes read from the Loop Controller Module e.g. if five words (10 bytes) are read, the count will be 0Ah. The maximum number of words which can be read is 8 returned in 16 bytes.

5.4.3 Force Single Coil (Function 05)

This function writes a single binary value to the specified slave bit address. The format is:

MESSAGE:

Slave Address	*Function*	*Address of Bit*		*State to Write*		*CRC Checksum*	
	05	**HI**	**LO**	**FF/00**	**00**	**HI**	**LO**

RESPONSE:

Slave Address	*Function*	*Address of Bit*		*State Written*		*CRC Checksum*	
	05	**HI**	**LO**	**FF/00**	**00**	**HI**	**LO**

The “Address of Bit” bytes specify the bit to which the binary value is to be written. The most significant “State to Write” byte is 0FFh if the bit is to be set (1) and 00 if the bit is to be reset (0). Note that the response normally returns the same data as that contained in the message.

The parameter address for the bit can specify any one of 32 bits but only bit parameter addresses 16 - 31 are available for writing.

5.4.4 Preset Single Register (Function 06)

This function writes two bytes to a specified word address. The format is:

MESSAGE:

Slave Address	*Function*	*Address of Word*		*Value to Write*		*CRC Checksum*	
	06	**HI**	**LO**	**HI**	**LO**	**HI**	**LO**

RESPONSE:

Slave Address	*Function*	*Address of Word*		*Value Written*		*CRC Checksum*	
	06	**HI**	**LO**	**HI**	**LO**	**HI**	**LO**

Note that the response normally returns the same data as that contained in the message.

5.4.5 Loopback Diagnostic Test (Function 08)

In this function, the function code byte is followed by a two-byte diagnostic code and two bytes of data:

MESSAGE:

Slave Address	Function	Diagnostic Code		Value		CRC Checksum	
	08	HI = 00	LO = 00	HI	LO	HI	LO

RESPONSE:

Slave Address	Function	Diagnostic Code		Value		CRC Checksum	
	08	HI = 00	LO = 00	HI	LO	HI	LO

The only diagnostic code supported is 00. Note that the response is normally an exact echo of the Message.

5.4.6 Force Multiple Coils (Function 0F)

This function writes consecutive bits to the specified address range. Its format is:

MESSAGE:

Slave Address	Function	1st Bit Number		Number of Bits		Number of Bytes	Message Byte	CRC Checksum	
	0Fh	HI	LO	00	01	01	00/01	HI	LO

RESPONSE:

Slave Address	Function	1st Bit Number		Number of Bits		CRC Checksum	
	0Fh	HI	LO	00	01	HI	LO

The MLC 9000 limits the number of bits that may be written to 1. To set the addressed bit ON (1), Bit 0 in the Message Byte = 1; to set the addressed bit OFF (0), Bit 0 = 0. To write multiple bits, consider using Preset Single Register (Function 06).

5.4.7 Preset Multiple Registers (Function 10)

This function writes consecutive two-byte values to the specified address range. Its format is:

MESSAGE:

Slave Address	Function	1st Word Address		Number of Words		Number of Query Bytes	1st Query Byte	Next Query Byte	CRC Checksum	
	10h	HI	LO	HI	LO				HI	LO

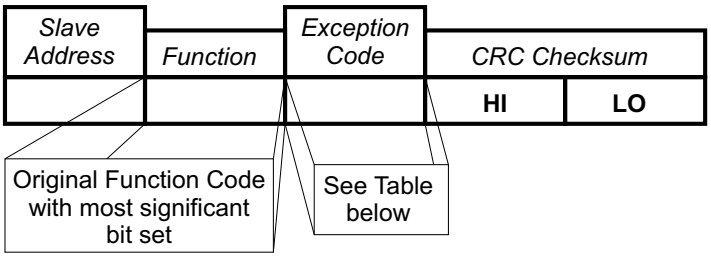
RESPONSE:

Slave Address	Function	1st Word Address		Number of Words		CRC Checksum	
	10h	HI	LO	HI	LO	HI	LO

The MLC 9000 system limits the number of consecutive words to be written to 8 (16 Message Bytes). It is not possible to write across instance boundaries.

5.4.8 Exception Responses

When a message is received which the Bus Communications Module cannot interpret, an exception response is returned in the following format:



The exception code may be one of the following:

Code	Error Condition	Interpretation
00	Not used	None
01	Illegal Function	Function Number out of range
02	Illegal Data Address	Parameter Number out of range or not supported.
03	Illegal Data Value	Attempt to write invalid data/required action not executed. This exception will also be returned if reading/writing over instance boundaries.

If multiple exceptions occur as a result of a Function, only the first exception code will be returned.

5.5 PARAMETER LIST

The right-hand column indicates the page containing the functional description of each parameter in Section 4. The **Type** column indicates access type allowed (R/O = Read Only, R/W = Read/Write, W/O = Write Only). Note that different module variants may not support all parameters listed here.

Parameter numbers are expressed as offset addresses from the base address of the instance - see Subsection 5.2. Bits within words are identified by the notation *n.m*, where *n* is the word offset and *m* is the bit number within the word. Bit-addressable parameters are also identified by their bit offset address from the base address of the instance.

Bit parameters may be addressed in either of two ways: (a) individually, using the direct bit address, or (b) extracting the bit from a 16-bit word. Both methods yield the same result but extracting the bit from a 16-bit word reduces the amount of communications traffic, because it allows more than one bit parameter within the word to be read/written in one operation.

Example:

To read the Over-Range Flag of Loop 1 at address 97 as an individual bit, the following message would be used:

LCM Address	Function	Bit Address	Number of Bits	CRC
97	01 or 02	0010h	0001h	

To read the Over-Range Flag of Loop 1 at address 97 extracting the bit from the status word, the following message would be used:

LCM Address	Function	Word Address	Number of Words	CRC
97	03 or 04	001Ah	0001h	

In the following parameter tables, the position of the bit within the word is indicated by the decimal point value of the word parameter number; for the Over-Range Flag, this is 26.0, indicating that it is the least significant bit of Word 26. If the result returned were 19h (25 decimal), this would be 0000000000011001 (binary). The value of the least significant bit is 1, indicating that the process variable is over-range. If the result were 18h (24 decimal), this would be 0000000000011000 (binary); the value of the least significant bit is 0, indicating that the process variable is not over-range. NOTE: The decimal point does not form part of the actual parameter address.

The MODBUS parameter address in decimal form can be calculated as follows:

Decimal address = [Parameter No.] + [Instance No. x 32] + [Class x 256]

These have been pre-calculated in decimal and hexadecimal form in the tables in the following subsections. Use whichever form is appropriate to your software or HMI.

5.5.1 Input Parameters

INSTANCE 0, INPUT 1 PARAMETERS (LCM Class 00)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
0	0	0000	0000	0.0	0	Mains (Line) Frequency (not applicable to LCMs C46x)	R/W	4-5
	1		0001	1		Input Type & Range	R/W	4-2
	2		0002	2		Units	R/W (T/C & RTD inputs) R/O (DC inputs)	4-3
	3		0003	3		Scale Range Maximum	R/W	4-3
	4		0004	4		Scale Range Minimum	R/W	4-4
	5		0005	5		Process Variable Offset	R/W	4-1
	6		0006	6		Input Filter Time Constant	R/W	4-1
	24		0018	24		External Input Value	R/W	4-4
	25		0019	25		Process Variable	R/O	4-1
16	26	0010	001A	26.0	16	Over-range Flag	R/O	4-2
17	26	0011	001A	26.1	17	Under-range Flag	R/O	4-2
18	26	0012	001A	26.2	18	Sensor Break Flag	R/O	4-2
19	26	0013	001A	26.3	19	Input 1 Status (1 = operating, 0 = break)	R/O - for Module C231 only	4-2
20	26	0014	001A	26.4	20	Input 2 Status (1 = operating, 0 = break)		4-2

INSTANCE 1, INPUT 2 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	33		0021	1		Input Type & Range	R/W	4-2
	34		0022	2		Units	R/W (T/C & RTD inputs) R/O (DC inputs)	4-3
	35		0023	3		Scale Range Maximum	R/W	4-3
	36		0024	4		Scale Range Minimum	R/W	4-4
	37		0025	5		Process Variable Offset	R/W	4-1
	38		0026	6		Input Filter Time Constant	R/W	4-1
	56		0038	24		External Input Value	R/W	4-4
	57		0039	25		Process Variable	R/O	4-1
48	58	0030	003A	26.0	16	Over-range Flag	R/O	4-2
49	58	0031	003A	26.1	17	Under-range Flag	R/O	4-2
50	58	0032	003A	26.2	18	Sensor Break Flag	R/O	4-2

INSTANCE 2, INPUT 3 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	65		0041	1		Input Type & Range	R/W	4-2
	66		0042	2		Units	R/W (T/C & RTD inputs) R/O (DC inputs)	4-3
	67		0043	3		Scale Range Maximum	R/W	4-3
	68		0044	4		Scale Range Minimum	R/W	4-4
	69		0045	5		Process Variable Offset	R/W	4-1
	70		0046	6		Input Filter Time Constant	R/W	4-1
	88		0058	24		External Input Value	R/W	4-4
	89		0059	25		Process Variable	R/O	4-1
80	90	0050	005A	26.0	16	Over-range Flag	R/O	4-2
81	90	0051	005A	26.1	17	Under-range Flag	R/O	4-2
82	90	0052	005A	26.2	18	Sensor Break Flag	R/O	4-2

INSTANCE 3, INPUT 4 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	97		0061	1		Input Type & Range	R/W	4-2
	98		0062	2		Units	R/W (T/C & RTD inputs) R/O (DC inputs)	4-3
	99		0063	3		Scale Range Maximum	R/W	4-3
	100		0064	4		Scale Range Minimum	R/W	4-4
	101		0065	5		Process Variable Offset	R/W	4-1
	102		0066	6		Input Filter Time Constant	R/W	4-1
	120		0078	24		External Input Value	R/W	4-4
	121		0079	25		Process Variable	R/O	4-1
112	122	0070	007A	26.0	16	Over-range Flag	R/O	4-2
113	122	0071	007A	26.1	17	Under-range Flag	R/O	4-2
114	122	0072	007A	26.2	18	Sensor Break Flag	R/O	4-2

5.5.2 Output Parameters

INSTANCE 0, OUTPUT 1 PARAMETERS (LCM Class 01)								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	257		0101	1		Output Type	R/W	4-5
	258		0102	2		Output Usage	R/W	4-6
	259		0103	3		Output Cycle Time	R/W	4-8
	260		0104	4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
	261		0105	5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
	281		0119	25		Bus Power	R/W	4-9

INSTANCE 1, OUTPUT 2 PARAMETERS (LCM Class 01)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	289		0121	1		Output Type	R/W	4-5
	290		0122	2		Output Usage	R/W	4-6
	291		0123	3		Output Cycle Time	R/W	4-8
	292		0124	4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
	293		0125	5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
	313		0139	25		Bus Power	R/W	4-9

INSTANCE 2, OUTPUT 3 PARAMETERS (LCM Class 01) *Applicable only to product variants C130, C230, C231, C460, C461, C462 and C463*								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	321		0141	1		Output Type	R/W	4-5
	322		0142	2		Output Usage	R/W	4-6
	323		0143	3		Output Cycle Time	R/W	4-8
	324		0144	4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
	325		0145	5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
	345		0159	25		Bus Power	R/W	4-9

INSTANCE 3, OUTPUT 4 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	353		0161	1		Output Type	R/W	4-5
	354		0162	2		Output Usage	R/W	4-6
	355		0163	3		Output Cycle Time	R/W	4-8
	377		0179	25		Bus Power	R/W	4-9

INSTANCE 4, OUTPUT 5 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	385		0181	1		Output Type	R/W	4-5
	386		0182	2		Output Usage	R/W	4-6
	387		0183	3		Output Cycle Time	R/W	4-8
	409		0199	25		Bus Power	R/W	4-9

INSTANCE 5, OUTPUT 6 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	417		01A1	1		Output Type	R/W	4-5
	418		01A2	2		Output Usage	R/W	4-6
	419		01A3	3		Output Cycle Time	R/W	4-8
	441		01B9	25		Bus Power	R/W	4-9

5.5.3 Setpoint Parameters

INSTANCE 0, LOOP 1 SETPOINT PARAMETERS (LCM Class 02)								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	513		0201	1		Setpoint Ramp Rate	R/W	4-11
	514		0202	2		Setpoint Select	R/W	4-10
	515		0203	3		Setpoint 1	R/W	4-9
	516		0204	4		Setpoint 2	R/W	4-10
	537		0219	25		Actual Setpoint	R/O	4-10

INSTANCE 1, LOOP 2 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	545		0221	1		Setpoint Ramp Rate	R/W	4-11
	546		0222	2		Setpoint Select	R/W	4-10
	547		0223	3		Setpoint 1	R/W	4-9
	548		0224	4		Setpoint 2	R/W	4-10
	569		0239	25		Actual Setpoint	R/O	4-10

INSTANCE 2, LOOP 3 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	577		0241	1		Setpoint Ramp Rate	R/W	4-11
	578		0242	2		Setpoint Select	R/W	4-10
	579		0243	3		Setpoint 1	R/W	4-9
	580		0244	4		Setpoint 2	R/W	4-10
	601		0259	25		Actual Setpoint	R/O	4-10

INSTANCE 3, LOOP 4 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	609		0261	1		Setpoint Ramp Rate	R/W	4-11
	610		0262	2		Setpoint Select	R/W	4-10
	611		0263	3		Setpoint 1	R/W	4-9
	612		0264	4		Setpoint 2	R/W	4-10
	633		0279	25		Actual Setpoint	R/O	4-10

5.5.4 Control Parameters

INSTANCE 0, LOOP 1 CONTROL PARAMETERS (LCM Class 03)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
768	768	0300	0300	0.0	0	Manual Control Enable/Disable	R/W	4-11
769	768	0301	0300	0.1	1	Programmable Sensor Break	R/W	4-20
770	768	0302	0300	0.2	2	Select RaPID	R/W	4-12
771	768	0303	0300	0.3	3	Select Easy Tune	R/W	4-12
772	768	0304	0300	0.4	4	Control Output Action	R/W	4-19
773	768	0305	0300	0.5	5	Control Type	R/W	4-16
774	768	0306	0300	0.6	6	Loop Alarm Enable	R/W	4-15
775	768	0307	0300	0.7	7	Auto Pre-Tune	R/W	4-13
776	768	0308	0300	0.8	8	Control Mode	R/W	4-20
	769		0301	1		Primary Output Power Limit	R/W	4-13
	770		0302	2		Proportional Band 1	R/W	4-16
	771		0303	3		Proportional Band 2	R/W	4-17
	772		0304	4		Reset/Loop Alarm Time	R/W	4-17
	773		0305	5		Rate	R/W	4-17
	774		0306	6		Overlap/Deadband	R/W	4-18
	775		0307	7		Bias (Manual Reset)	R/W	4-19
	776		0308	8		ON/OFF Differential	R/W	4-19
	777		0309	9		Manual Power	R/W	4-11
	778		030A	10		Preset Power Output	R/W	4-20
	779		030B	11		Soft Start Setpoint	R/W	4-14
	780		030C	12		Soft Start Time	R/W	4-14
	781		030D	13		Soft Start Primary Output Power Limit	R/W	4-15
	792		0318	24		HEAT Output Power	R/O	4-15
	793		0319	25		COOL Output Power	R/O	4-15
784	794	0310	031A	26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
785	794	0311	031A	26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
786	794	0312	031A	26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 1, LOOP 2 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
800	800	0320	0320	0.0	0	Manual Control Enable/Disable	R/W	4-11
801	800	0321	0320	0.1	1	Programmable Sensor Break	R/W	4-20
802	800	0322	0320	0.2	2	Select RaPID	R/W	4-12
803	800	0323	0320	0.3	3	Select Easy Tune	R/W	4-12
804	800	0324	0320	0.4	4	Control Output Action	R/W	4-19
805	800	0325	0320	0.5	5	Control Type	R/W	4-16
806	800	0326	0320	0.6	6	Loop Alarm Enable	R/W	4-15
807	800	0327	0320	0.7	7	Auto Pre-Tune	R/W	4-13
808	800	0328	0320	0.8	8	Control Mode	R/W	4-20
	801		0321	1		Primary Output Power Limit	R/W	4-13
	802		0322	2		Proportional Band 1	R/W	4-16
	803		0323	3		Proportional Band 2	R/W	4-17
	804		0324	4		Reset/Loop Alarm Time	R/W	4-17
	805		0325	5		Rate	R/W	4-17
	806		0326	6		Overlap/Deadband	R/W	4-18
	807		0327	7		Bias (Manual Reset)	R/W	4-19
	808		0328	8		ON/OFF Differential	R/W	4-19
	809		0329	9		Manual Power	R/W	4-11
	810		032A	10		Preset Power Output	R/W	4-20
	811		032B	11		Soft Start Setpoint	R/W	4-14
	812		032C	12		Soft Start Time	R/W	4-14
	813		032D	13		Soft Start Primary Output Power Limit	R/W	4-15
	824		0338	24		HEAT Output Power	R/O	4-15
	825		0339	25		COOL Output Power	R/O	4-15
816	826	0330	033A	26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
817	826	0331	033A	26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
818	826	0332	033A	26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 2, LOOP 3 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
832	832	0340	0340	0.0	0	Manual Control Enable/Disable	R/W	4-11
833	832	0341	0340	0.1	1	Programmable Sensor Break	R/W	4-20
834	832	0342	0340	0.2	2	Select RaPID	R/W	4-12
835	832	0343	0340	0.3	3	Select Easy Tune	R/W	4-12
836	832	0344	0340	0.4	4	Control Output Action	R/W	4-19
837	832	0345	0340	0.5	5	Control Type	R/W	4-16
838	832	0346	0340	0.6	6	Loop Alarm Enable	R/W	4-15
839	832	0347	0340	0.7	7	Auto Pre-Tune	R/W	4-13
840	832	0348	0340	0.8	8	Control Mode	R/W	4-20
	833		0341	1		Primary Output Power Limit	R/W	4-13
	834		0342	2		Proportional Band 1	R/W	4-16
	835		0343	3		Proportional Band 2	R/W	4-17
	836		0344	4		Reset/Loop Alarm Time	R/W	4-17
	837		0345	5		Rate	R/W	4-17
	838		0346	6		Overlap/Deadband	R/W	4-18
	839		0347	7		Bias (Manual Reset)	R/W	4-19
	840		0348	8		ON/OFF Differential	R/W	4-19
	841		0349	9		Manual Power	R/W	4-11
	842		034A	10		Preset Power Output	R/W	4-20
	843		034B	11		Soft Start Setpoint	R/W	4-14
	844		034C	12		Soft Start Time	R/W	4-14
	845		034D	13		Soft Start Primary Output Power Limit	R/W	4-15
	856		0358	24		HEAT Output Power	R/O	4-15
	857		0359	25		COOL Output Power	R/O	4-15
848	858	0350	035A	26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
849	858	0351	035A	26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
850	858	0352	035A	26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 3, LOOP 4 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
864	864	0360	0360	0.0	0	Manual Control Enable/Disable	R/W	4-11
865	864	0361	0360	0.1	1	Programmable Sensor Break	R/W	4-20
866	864	0362	0360	0.2	2	Select RaPID	R/W	4-12
867	864	0363	0360	0.3	3	Select Easy Tune	R/W	4-12
868	864	0364	0360	0.4	4	Control Output Action	R/W	4-19
869	864	0365	0360	0.5	5	Control Type	R/W	4-16
870	864	0366	0360	0.6	6	Loop Alarm Enable	R/W	4-15
871	864	0367	0360	0.7	7	Auto Pre-Tune	R/W	4-13
872	864	0368	0360	0.8	8	Control Mode	R/W	4-20
	865		0361	1		Primary Output Power Limit	R/W	4-13
	866		0362	2		Proportional Band 1	R/W	4-16
	867		0363	3		Proportional Band 2	R/W	4-17
	868		0364	4		Reset/Loop Alarm Time	R/W	4-17
	869		0365	5		Rate	R/W	4-17
	870		0366	6		Overlap/Deadband	R/W	4-18
	871		0367	7		Bias (Manual Reset)	R/W	4-19
	872		0368	8		ON/OFF Differential	R/W	4-19
	873		0369	9		Manual Power	R/W	4-11
	874		036A	10		Preset Power Output	R/W	4-20
	875		036B	11		Soft Start Setpoint	R/W	4-14
	876		036C	12		Soft Start Time	R/W	4-14
	877		036D	13		Soft Start Primary Output Power Limit	R/W	4-15
	888		0378	24		HEAT Output Power	R/O	4-15
	889		0379	25		COOL Output Power	R/O	4-15
880	890	0370	037A	26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
881	890	0371	037A	26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
882	890	0372	037A	26.2	18	Pre-Tune Status	R/W	4-12

5.5.5 Alarm Parameters

5.5.5.1 LCMs C120, C130, C230 and C231

INSTANCE 0, ALARM 1 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1024	1024	0400	0400	0.0	0	Alarm Inhibit	R/W	4-22
	1025		0401	1		Alarm Type	R/W	4-17
	1026		0402	2		Alarm Value	R/W	4-17
	1027		0403	3		Alarm Hysteresis	R/W	4-22
1040	1050	0410	041A	26.0	16	Alarm State	R/O	4-22

INSTANCE 1, ALARM 2 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1056	1056	0420	0420	0.0	0	Alarm Inhibit	R/W	4-22
	1057		0421	1		Alarm Type	R/W	4-17
	1058		0422	2		Alarm Value	R/W	4-17
	1059		0423	3		Alarm Hysteresis	R/W	4-22
1072	1082	0430	043A	26.0	16	Alarm State	R/O	4-22

5.5.5.2 LCMs C460, C461, C462 and C463

INSTANCE 0, LOOP 1 ALARM 1 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1024	1024	0400	0400	0.0	0	Alarm Inhibit	R/W	4-22
	1025		0401	1		Alarm Type	R/W	4-17
	1026		0402	2		Alarm Value	R/W	4-17
	1027		0403	3		Alarm Hysteresis	R/W	4-22
1040	1050	0410	041A	26.0	16	Alarm State	R/O	4-22

INSTANCE 1, LOOP 2 ALARM 1 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1056	1056	0420	0420	0.0	0	Alarm Inhibit	R/W	4-22
	1057		0421	1		Alarm Type	R/W	4-17
	1058		0422	2		Alarm Value	R/W	4-17
	1059		0423	3		Alarm Hysteresis	R/W	4-22
1072	1082	0430	043A	26.0	16	Alarm State	R/O	4-22

INSTANCE 2, LOOP 3 ALARM 1 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1088	1088	0440	0440	0.0	0	Alarm Inhibit	R/W	4-22
	1089		0441	1		Alarm Type	R/W	4-17
	1090		0442	2		Alarm Value	R/W	4-17
	1091		0443	3		Alarm Hysteresis	R/W	4-22
1104	1114	0450	045A	26.0	16	Alarm State	R/O	4-22

INSTANCE 3, LOOP 4 ALARM 1 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1120	1120	0460	0460	0.0	0	Alarm Inhibit	R/W	4-22
	1121		0461	1		Alarm Type	R/W	4-17
	1122		0462	2		Alarm Value	R/W	4-17
	1123		0463	3		Alarm Hysteresis	R/W	4-22
1136	1146	0470	047A	26.0	16	Alarm State	R/O	4-22

INSTANCE 4, LOOP 1 ALARM 2 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1152	1152	0480	0480	0.0	0	Alarm Inhibit	R/W	4-22
	1153		0481	1		Alarm Type	R/W	4-17
	1154		0482	2		Alarm Value	R/W	4-17
	1155		0483	3		Alarm Hysteresis	R/W	4-22
1168	1178	0490	049A	26.0	16	Alarm State	R/O	4-22

INSTANCE 5, LOOP 2 ALARM 2 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1184	1184	04A0	04A0	0.0	0	Alarm Inhibit	R/W	4-22
	1185		04A1	1		Alarm Type	R/W	4-17
	1186		04A2	2		Alarm Value	R/W	4-17
	1187		04A3	3		Alarm Hysteresis	R/W	4-22
1200	1210	04B0	04BA	26.0	16	Alarm State	R/O	4-22

INSTANCE 6, LOOP 3 ALARM 2 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1216	1216	04C0	04C0	0.0	0	Alarm Inhibit	R/W	4-22
	1217		04C1	1		Alarm Type	R/W	4-17
	1218		04C2	2		Alarm Value	R/W	4-17
	1219		04C3	3		Alarm Hysteresis	R/W	4-22
1232	1242	04D0	04DA	26.0	16	Alarm State	R/O	4-22

INSTANCE 7, LOOP 4 ALARM 2 PARAMETERS (LCM Class 04)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1248	1248	04E0	04E0	0.0	0	Alarm Inhibit	R/W	4-22
	1249		04E1	1		Alarm Type	R/W	4-17
	1250		04E2	2		Alarm Value	R/W	4-17
	1251		04E3	3		Alarm Hysteresis	R/W	4-22
1264	1274	04F0	04FA	26.0	16	Alarm State	R/O	4-22

5.5.6 Heater Current Parameters

HEATER CURRENT PARAMETERS (LCM Class 06) Applicable only to product variants C230 and C231								
MODBUS Address (Decimal		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
1536	1536	0600	0600	0.0	0	Short Circuit Heater Break Alarm Enable/Disable	R/W	4-25
	1537		0601	1		Heater Current Input Range	R/W	4-25
	1538		0602	2		Heater Current Scale Range Maximum	R/W	4-25
	1539		0603	3		Low Heater Break Alarm value	R/W	4-24
	1540		0604	4		High Heater Break Alarm value	R/W	4-24
	1560		0618	24		Bus Input value	R/W	4-26
	1561		0619	25		Heater Current value	R/O	4-24
1552	1562	0610	061A	26.0	16	Low Heater Break Alarm state	R/O	4-24
1553	1562	0611	061A	26.1	17	High Heater Break Alarm state	R/O	4-25
1554	1562	0612	061A	26.2	18	Short Circuit Heater Break Alarm state	R/O	4-25

5.5.7 Calibration Parameters

INSTANCE 0, LOOP 1 CALIBRATION PARAMETERS (LCM Class 14)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	3607		0E17	23		Calibration Value	R/O	4-27
	3608		0E18	24		Calibration Phase	R/W	4-27
	3609		0E19	25		Calibration Password	R/W	4-28

INSTANCE 1, LOOP 2 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3639		0E37	23		Calibration Value	R/O	4-27
	3640		0E38	24		Calibration Phase	R/W	4-27
	3641		0E39	25		Calibration Password	R/W	4-28

INSTANCE 2, LOOP 3 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3671		0E57	23		Calibration Value	R/O	4-27
	3672		0E58	24		Calibration Phase	R/W	4-27
	3673		0E59	25		Calibration Password	R/W	4-28

INSTANCE 3, LOOP 4 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3703		0E77	23		Calibration Value	R/O	4-27
	3704		0E78	24		Calibration Phase	R/W	4-27
	3705		0E79	25		Calibration Password	R/W	4-28

5.5.8 LCM Descriptor Parameters

INSTANCE 0, LOOP 1 LCM DESCRIPTOR PARAMETERS (LCM Class 15)								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3841 3842 3843		0F01 0F02 0F03	1 2 3		LCM Serial Number	R/O	4-29
	3844		0F04	4		Product (Module Type) Identifier	R/O	4-29
	3845		0F05	5		Firmware ID	R/O	4-29
	3846		0F06	6		Database ID	R/O	4-29
	3861		0F15	21		COOL Output Power	R/O	4-30
	3862		0F16	22		HEAT Output Power	R/O	4-30
	3863		0F17	23		Actual Setpoint Value	R/O	4-30
	3864		0F18	24		Process Variable Value	R/O	4-30
	3865		0F19	25		Status Indicators	R/O	4-30

INSTANCE 1, LOOP 2 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3873		0F21	1		LCM Serial Number	R/O	4-29
	3874		0F22	2				
	3875		0F23	3				
	3876		0F24	4		Product (Module Type) Identifier	R/O	4-29
	3877		0F25	5		Firmware ID	R/O	4-29
	3878		0F26	6		Database ID	R/O	4-29
	3893		0F35	21		COOL Output Power	R/O	4-30
	3894		0F36	22		HEAT Output Power	R/O	4-30
	3895		0F37	23		Actual Setpoint Value	R/O	4-30
	3896		0F38	24		Process Variable Value	R/O	4-30
	3897		0F39	25		Status Indicators	R/O	4-30

INSTANCE 2, LOOP 3 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3905		0F41	1		LCM Serial Number	R/O	4-29
	3906		0F42	2				
	3907		0F43	3				
	3908		0F44	4		Product (Module Type) Identifier	R/O	4-29
	3909		0F45	5		Firmware ID	R/O	4-29
	3910		0F46	6		Database ID	R/O	4-29
	3925		0F55	21		COOL Output Power	R/O	4-30
	3926		0F56	22		HEAT Output Power	R/O	4-30
	3927		0F57	23		Actual Setpoint Value	R/O	4-30
	3928		0F58	24		Process Variable Value	R/O	4-30
	3929		0F59	25		Status Indicators	R/O	4-30

INSTANCE 3, LOOP 4 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3937 3938 3939		0F61 0F62 0F63	1 2 3		LCM Serial Number	R/O	4-29
	3940		0F64	4		Product (Module Type) Identifier	R/O	4-29
	3941		0F65	5		Firmware ID	R/O	4-29
	3942		0F66	6		Database ID	R/O	4-29
	3957		0F75	21		COOL Output Power	R/O	4-30
	3958		0F76	22		HEAT Output Power	R/O	4-30
	3959		0F77	23		Actual Setpoint Value	R/O	4-30
	3960		0F78	24		Process Variable Value	R/O	4-30
	3961		0F79	25		Status Indicators	R/O	4-30

5.5.9 Communications Configuration Parameters

COMMUNICATIONS CONFIGURATION PARAMETERS (BCM Class 12)								
MODBUS Address (Decimal)		**MODBUS Address (hex)**		**MLC 9000 Parameter Number**		**Name**	**Type**	**Ref. Page**
Bit	**Word**	**Bit**	**Word**	**Word**	**Bit**			
	3073		0C01	1		PC Port Poll Timeout	R/W	4-31
	3074		0C02	2		PC Port Minimum Poll Interval	R/W	4-31
	3075		0C03	3		MODBUS Address	R/W	4-31
	3076		0C04	4		MODBUS Data Transfer Rate	R/W	4-31
	3077		0C05	5		MODBUS Data Format	R/W	4-31
	3079		0C07	7		Fieldbus Address	R/W	4-32
	3080		0C08	8		Fieldbus Data Rate	R/W	4-32

5.5.10 BCM Descriptor Parameters

BCM DESCRIPTOR PARAMETERS (BCM Class 15)								
MODBUS Address (Decimal)		MODBUS Address (hex)		MLC 9000 Parameter Number		Name	Type	Ref. Page
Bit	Word	Bit	Word	Word	Bit			
	3841 3842 3843		0F01 0F02 0F03	1 2 3		BCM Serial Number	R/O	4-32
	3844		0F04	4		Product (Module Type) Identifier	R/O	4-32
	3845		0F05	5		Firmware ID	R/O	4-32
	3846		0F06	6		Database ID	R/O	4-33
	3848		0F08	8		Configurable Data Assembly Value - Data 1	R/W	4-33
	3849		0F09	9		Configurable Data Assembly Value - Data 2	R/W	4-33
	3850		0F0A	10		Configurable Data Assembly Value - Data 3	R/W	4-33
	3851		0F0B	11		Configurable Data Assembly Value - Data 4	R/W	4-33
	3852		0F0C	12		Configurable Data Assembly Value - Data 5	R/W	4-33
	3853		0F0D	13		Configurable Data Assembly Value - Data 6	R/W	4-33
	3854		0F0E	14		Configurable Data Assembly Value - Data 7	R/W	4-33
	3855		0F0F	15		Configurable Data Assembly Value - Data 8	R/W	4-33
	3856		0F10	16		Configurable Data Assembly Value - Data 9	R/W	4-33
	3857		0F11	17		Configurable Data Assembly Value - Data 10	R/W	4-33
	3858		0F12	18		Configurable Data Assembly Value - Data 11	R/W	4-33
	3859		0F13	19		Configurable Data Assembly Value - Data 12	R/W	4-33
	3860		0F14	20		Configurable Data Assembly Value - Data 13	R/W	4-33
	3861		0F15	21		Configurable Data Assembly Value - Data 14	R/W	4-33
	3862		0F16	22		Configurable Data Assembly Value - Data 15	R/W	4-33
	3863		0F17	23		Configurable Data Assembly Value - Data 16	R/W	4-33

5.6 MODBUS EXAMPLES

In all these examples, it is assumed that the BCM in the addressed MLC 9000 System has been allocated the default address 96 (dec.).

5.6.1 Read the Process Variable Value for Loops 1 - 3

MODBUS Function 03 is used to read the PV value for LCM1 (address 97), LCM2 (Address 98) and LCM3 (address 99).

Read PV for Loop 1

Module Address	Function Number	Address of 1st Word HI	Address of 1st Word LO		Number of Words HI	Number of Words LO	CRC Checksum HI	CRC Checksum LO
97	03	00	0	25	0	1		

Parameter Number
Instance
Class

Response

Module Address	Function Number	Number of Bytes	PV Value HI	PV Value LO	CRC Checksum HI	CRC Checksum LO
97	03	02	*Binary value*			

Read PV for Loop 2

Module Address	Function Number	Address of 1st Word HI	Address of 1st Word LO		Number of Words HI	Number of Words LO	CRC Checksum HI	CRC Checksum LO
98	03	00	0	25	0	1		

Response

Module Address	Function Number	Number of Bytes	PV Value HI	PV Value LO	CRC Checksum HI	CRC Checksum LO
98	03	02	*Binary value*			

Read PV for Loop 3

Module Address	Function Number	Address of 1st Word HI	Address of 1st Word LO		Number of Words HI	Number of Words LO	CRC Checksum HI	CRC Checksum LO
99	03	00	0	25	0	1		

Response

Module Address	Function Number	Number of Bytes	PV Value HI	PV Value LO	CRC Checksum HI	CRC Checksum LO
99	03	02	*Binary value*			

In each case, the response will contain the PV value in binary form.

5.6.2 Write a New Setpoint 1 Value to Loop 2

MODBUS Function 06 writes a new Setpoint 1 value for LCM2 (address 98).

Write new Setpoint 1 value for Loop 2

Module Address	Function Number	Address of Word HI	Address of Word LO		New SP value HI	New SP value LO	CRC Checksum HI	CRC Checksum LO
98	06	02	0	3	*Binary value*			

Parameter Number
Instance
Class

Response

Module Address	Function Number	Address of Word HI	Address of Word LO		SP Value written HI	SP Value written LO	CRC Checksum HI	CRC Checksum LO
98	06	02	0	3	*Binary value*			

The new Setpoint 1 value is echoed in the response.

5.6.3 Check Status of Over-Range Flag for Loop 4

MODBUS Function 01 is used to read the Over-Range Flag for LCM4 (address 100).

Read flags for Loop 4

Module Address	Function Number	Address of 1st Bit			Number of Bits		CRC Checksum	
		HI	LO		HI	LO	HI	LO
100	01	00	0	16	0	1		

Parameter Number
Instance
Class

Response

Module Address	Function Number	No. of Bytes	8 bits	CRC Checksum	
				HI	LO
100	01	1			

LSB = 1; PV over-range
LSB = 0; PV within range

The state of the flag is displayed in the least significant bit of the eight-bit data byte in the response.

5.6.4 Set Bus Power Output Level on Loop 2 Output 2

NOTE: The Output Usage for Output 2 on LCM2 must be set to Bus Power.

MODBUS Function 06 writes a Bus Output Power value to Output 2 (Instance 1) on LCM2 (Address 98).

Write new Bus Power Output value for Loop 2

Module Address	Function Number	Address of Word			New value		CRC Checksum	
		HI	LO		HI	LO	HI	LO
98	06	01	1	25	*Binary value*			

Parameter Number
Instance
Class

Response

Module Address	Function Number	Address of Word			Value written		CRC Checksum	
		HI	LO		HI	LO	HI	LO
98	06	01	1	25	*Binary value*			

The response echoes the new Bus Power Output value.

5.7 CRC CHECKSUM CALCULATION

This is a 16-bit cyclic redundancy checksum. It is calculated in accordance with a formula which involves recursive division of the data by a polynomial, with the input to each division being the remainder of the results of the previous one.

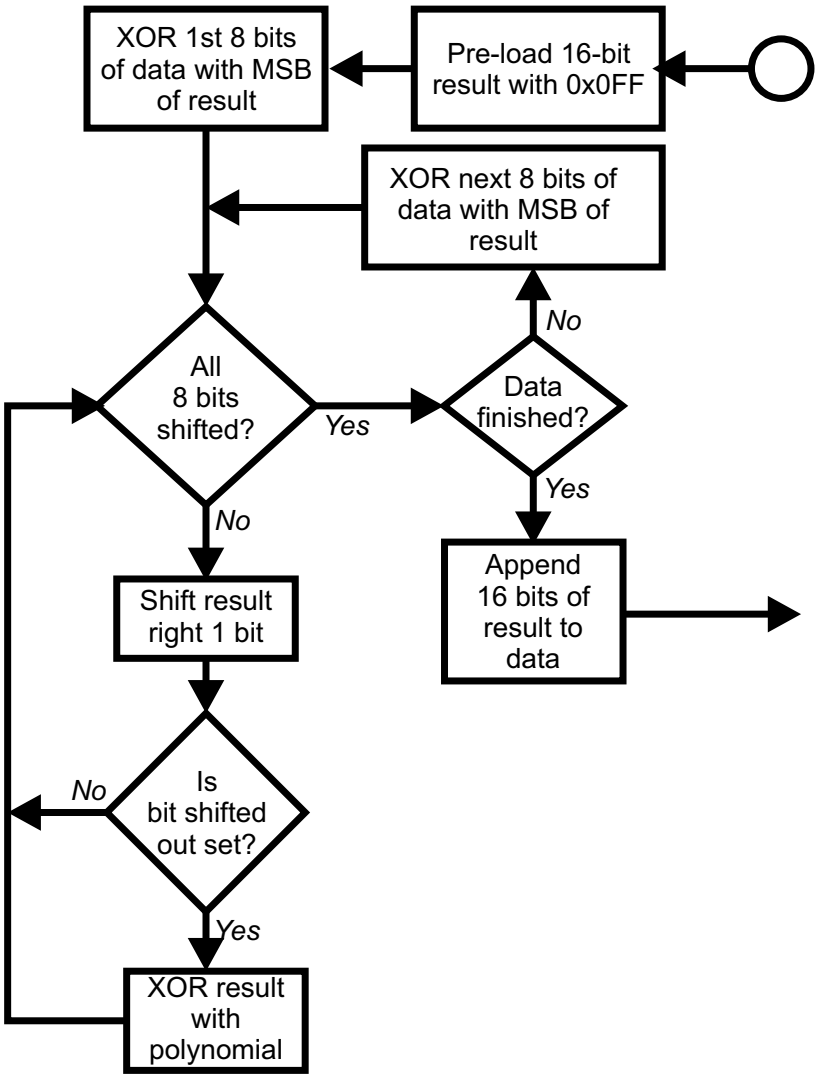
The formula specifies that input is treated as a continuous bit-stream binary number, with the most significant bit being transmitted first. However, the transmitting device sends the least significant bit first.

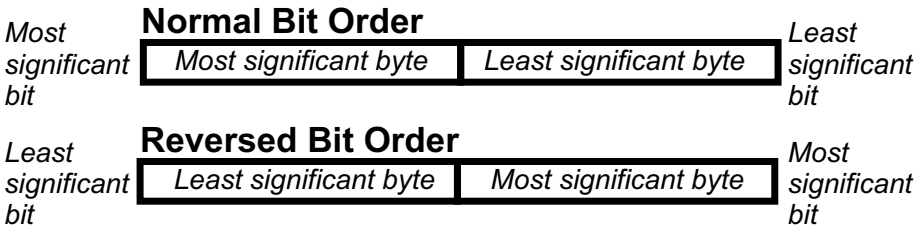
According to the formula, the dividing polynomial is $2^{16} + 2^{15} + 2^2 + 1$ (Hex 18005), but this is modified in two ways:

(i) Because the bit-order is reversed, the binary pattern is reversed also, making the MSB the rightmost bit, and

(ii) Because only the remainder is of interest, the MSB (the right-most bit) may be discarded.

This means the polynomial has the value Hex A001. The CRC algorithm is as follows:





REVERSED BIT ORDER USED

6 OVERVIEW OF DEVICENET COMMUNICATIONS

NOTE 1: This section describes DeviceNet Communications for an MLC9000 equipped with a DeviceNet Bus Communications Module. To simplify the description this module is described as the Bus Communications Module or BCM.

NOTE 2: Unless otherwise specified, all numbers in this section are expressed in decimal form.

6.1 INTRODUCTION

The MLC 9000 System is connected to a DeviceNet master device via the DeviceNet port on the Bus Communications Module. The Bus Communications Module acts as a Class 2 Slave Device.

6.2 DEVICENET MESSAGES

There are two types of DeviceNet message:

(a) I/O Messages: These provide special purpose communication paths between a data producing application and one or more consuming applications.

(b) Explicit Messages: These provide typical request/response type communications.

6.2.1 Implicit or Input/Output Messages

Compared to a most DeviceNet nodes, the MLC 9000 System contains a large number of parameters. The use of one or more I/O connections for the entire parameter set is impractical. Therefore, a flexible I/O block is used for parameter communication.

This I/O block makes available to the user the essential system parameters. All parameters however, are available through Explicit Messaging.

The MLC 9000 System communicates with the PLC via the DeviceNet network, and creates separate read and write data tables in the PLC register space:

Read Data Table			Write Data Table	
Offset	**Write Variable Number**	**Read**	**Offset**	**Write**
0		Data selected (low)	0	Read data selector (low)
1		Data selected (high)	1	Read data selector (high)
2	1	Manual Power (low)	2	Write data selector (low)
3		Manual Power (high)	3	Write data selector (high)
4	2	Control bits (low)	4	Variable low
5		Control bits (high)	5	Variable high
6	3	Proportional Band 1 (low)	6	LCM 1.0 Setpoint (low)
7		Proportional Band 1 (high)	7	LCM 1.0 Setpoint (high)
8	4	Reset (low)	8	LCM 2.0 Setpoint (low)
9		Reset (high)	9	LCM 2.0 Setpoint (high)
10	5	Rate (low)	10	LCM 3.0 Setpoint (low)
11		Rate (high)	11	LCM 3.0 Setpoint (high)
12	6	Alarm 1 (low)	12	LCM 4.0 Setpoint (low)
13		Alarm 1 (high)	13	LCM 4.0 Setpoint (high)
14	7	Alarm 2 (low)	14	LCM 5.0 Setpoint (low)
15		Alarm 2 (high)	15	LCM 5.0 Setpoint (high)
16	8	Proportional Band 2 (low)	16	LCM 6.0 Setpoint (low)
17		Proportional Band 2 (high)	17	LCM 6.0 Setpoint (high)
18	9	Overlap (low)	18	LCM 7.0 Setpoint (low)
19		Overlap (high)	19	LCM 7.0 Setpoint (high)
20	10	Bias (low)	20	LCM 8.0 Setpoint (low)
21		Bias (high)	21	LCM 8.0 Setpoint (high)
22	11	ON/OFF Hysteresis (low)	22	LCM 1.1 Setpoint (low)
23		ON/OFF Hysteresis (high)	23	LCM 1.1 Setpoint (high)
24 - 33		Primary LCM 1 Data	24	LCM 2.1 Setpoint (low)
34 - 43		Primary LCM 2 Data	25	LCM 2.1 Setpoint (high)
44 - 53		Primary LCM 3 Data	⇓	
54 - 63		Primary LCM 4 Data	⇓	
64 - 73		Primary LCM 5 Data	66	LCM 7.3 Setpoint (low)
74 - 83		Primary LCM 6 Data	67	LCM 7.3 Setpoint (high)
84 - 93		Primary LCM 7 Data	68	LCM 8.3 Setpoint (low)
94 - 103		Primary LCM 8 Data	69	LCM 8.3 Setpoint (high)

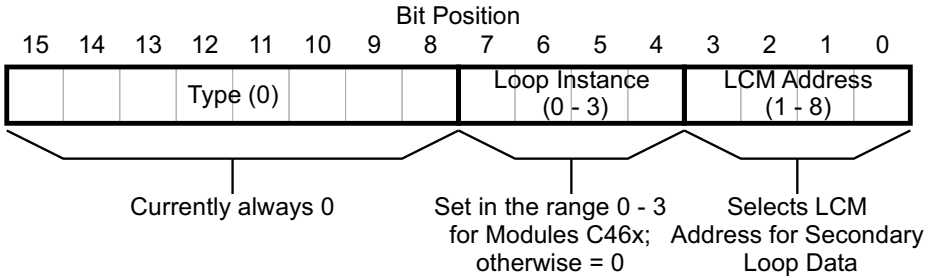
NOTE: Setpoints are addressed in the following manner:

LCM 1.0 Setpoint - LCM 8.0 Setpoint are the setpoints for the first loop of each LCM in turn.

LCM 1.1 Setpoint - LCM 8.1 Setpoint are the setpoints for the second loop (4 Loop LCM's only) of each LCM in turn etc.

The Read Data is divided into Primary LCM Data and Secondary LCM Data. Primary Data is available for up to eight loops at a time, Secondary Data (indicated by the shaded area in the table above) is available for one loop at a time; Secondary data is less frequently required than Primary Data.

The Read Data Selector determines the source of the Primary and Secondary Data read from the MLC 9000. To select the Primary and Secondary Data sources the PLC should set the Read Data Selector in the Write Data Table at byte offsets 0 and 1 to an appropriate value as described below:



To satisfy the fast data rate on DeviceNet, the BCM maintains a local image of the current Primary LCM data selected. Secondary LCM data is held only for as long as it is selected.

The I/O requirements for DeviceNet are dependent upon the number of LCMs in the MLC 9000 system. The BCM detects the highest-address LCM and sets the I/O data size accordingly. Gaps in the address range (e.g. an LCM not fitted) are allocated I/O data which is cleared to FFFFh.

6.2.1.1 READING PRIMARY DATA

The Read Input area with address (byte) offset 24 to 103 contains five variables (ten bytes) per loop (see below). Byte offsets 24 to 33 are for LCM1, offsets 34 to 43 are for LCM2 etc. For four-loop LCMs (C46x), the Loop Instance determines which loop data within the LCM is returned.

Offset	Description
0	Process Variable (low)
1	Process Variable (high)
2	Setpoint (low)
3	Setpoint (high)
4	HEAT Output Power (low)
5	HEAT Output Power (high)
6	COOL Output Power (low)
7	COOL Output Power (high)
8	Status Bits (low)
9	Status Bits (high)

NOTE: Primary Data is Read Only.

6.2.1.2 READING SECONDARY DATA

Bytes 2 to 23 in the Read Data area contain less-frequently-used loop data. This Secondary data is more likely to be used for setting up control loops. The specific loop data is established by writing to the loop instance and the LCM position of the Read Data Selector. To confirm that the read data is valid, the PLC program should check that the Data Selected value in the Read Data Table at offsets 0 and 1 contain the value of the Read Data Selector written. Only then can the PLC program be sure that the Secondary data is valid for the specified loop.

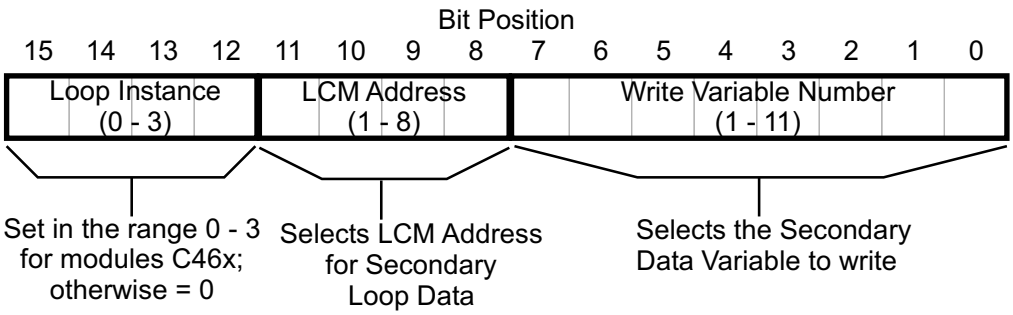
6.2.1.3 WRITING SECONDARY DATA

To write a variable in the Secondary Data area:

1. Write the required value to the Write Data Selector (bytes 2 and 3).

2. Write the required variable value into the third word (bytes 4 and 5) of the Write Data Table.

3. The PLC program should check that the correct value has been written by reading the value back from the Read Data Table.



NOTE: To prevent accidental writing of Secondary Data values, restore the Write Data Selector to a non-valid value (e.g. Write Data Selector = FFh). This will be interpreted as ‘no-action’.

6.2.1.4 WRITING PRIMARY DATA

Any of the 32 setpoint values may be written directly in to the Write Data Table.

6.2.2 Explicit Messages

The Explicit Message format comprises the required Address, Class, Instance and Parameter as follows:

Function/Data	DeviceNet
Read Word / Write Word	Get / Set Attribute
Module Address: BCM = 0 LCM = 1 - 8	Upper Nibble (4 bits) of the Instance Byte
Class 0 - 15	Class Value 170 - 185
Instance 0 - 7	Lower Nibble (4 bits) of the Instance Byte
Word Parameter Number 0 - 31	Attribute 0 - 31

Explicit messages allow access to all MLC 9000 parameters whether they can be addressed via primary or secondary implicit parameter data areas. The Class, instance and parameter number for all parameters are given in Subsection 6.4.

6.3 MESSAGE FORMATS, PROTOCOL AND FRAGMENTATION

Full details on these aspects can be found on the Open DeviceNet Vendors Association Website, *www.odva.org* and in the DeviceNet Specification.

6.4 PARAMETER LIST

The right-hand column indicates the page containing the functional description of each parameter in Section 4. The **Type** column indicates access type allowed (R/O = Read Only, R/W = Read/Write, W/O = Write Only). Note that different module variants may not support all parameters listed here.

Parameter numbers are expressed as offset addresses from the base address of the instance - see Subsection 5.2. Bits within words are identified by the notation *n.m*, where *n* is the word offset and *m* is the bit number within the word. Bit-addressable parameters are also identified by their bit offset address from the base address of the instance.

6.4.1 Input Parameters

INSTANCE 0, INPUT 1 PARAMETERS (LCM Class 00)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Mains (Line) Frequency (Single Loop LCM's only)	R/W	4-5
1		Input Type & Range	R/W	4-2
2		Units	R/W (T/C & RTD inputs); R/O (DC inputs)	4-3
3		Scale Range Maximum	R/W	4-3
4		Scale Range Minimum	R/W	4-4
5		Process Variable Offset	R/W	4-1
6		Input Filter Time Constant	R/W	4-1
24		External Input Value	R/W	4-4
25		Process Variable	R/O	4-1
26.0	16	Over-range Flag	R/O	4-2
26.1	17	Under-range Flag	R/O	4-2
26.2	18	Sensor Break Flag	R/O	4-2
26.3	19	Input 1 Status (1 = operating, 0 = break)	R/O - for Module C231 only	4-2
26.4	20	Input 2 Status (1 = operating, 0 = break)		4-2

INSTANCE 1, INPUT 2 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Not Used	n/a	
1		Input Type & Range	R/W	4-2
2		Units	R/W (T/C & RTD inputs); R/O (DC inputs)	4-3
3		Scale Range Maximum	R/W	4-3
4		Scale Range Minimum	R/W	4-4
5		Process Variable Offset	R/W	4-1
6		Input Filter Time Constant	R/W	4-1
24		External Input Value	R/W	4-4
25		Process Variable	R/O	4-1
26.0	16	Over-range Flag	R/O	4-2
26.1	17	Under-range Flag	R/O	4-2
26.2	18	Sensor Break Flag	R/O	4-2

INSTANCE 2, INPUT 3 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Not Used	n/a	
1		Input Type & Range	R/W	4-2
2		Units	R/W (T/C & RTD inputs); R/O (DC inputs)	4-3
3		Scale Range Maximum	R/W	4-3
4		Scale Range Minimum	R/W	4-4
5		Process Variable Offset	R/W	4-1
6		Input Filter Time Constant	R/W	4-1
24		External Input Value	R/W	4-4
25		Process Variable	R/O	4-1
26.0	16	Over-range Flag	R/O	4-2
26.1	17	Under-range Flag	R/O	4-2
26.2	18	Sensor Break Flag	R/O	4-2

INSTANCE 3, INPUT 4 PARAMETERS (LCM Class 00) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Not Used	n/a	
1		Input Type & Range	R/W	4-2
2		Units	R/W (T/C & RTD inputs); R/O (DC inputs)	4-3
3		Scale Range Maximum	R/W	4-3
4		Scale Range Minimum	R/W	4-4
5		Process Variable Offset	R/W	4-1
6		Input Filter Time Constant	R/W	4-1
24		External Input Value	R/W	4-4
25		Process Variable	R/O	4-1
26.0	16	Over-range Flag	R/O	4-2
26.1	17	Under-range Flag	R/O	4-2
26.2	18	Sensor Break Flag	R/O	4-2

6.4.2 Output Parameters

INSTANCE 0, OUTPUT 1 PARAMETERS (LCM Class 01)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
25		Bus Power	R/W	4-9

INSTANCE 1, OUTPUT 2 PARAMETERS (LCM Class 01)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
25		Bus Power	R/W	4-9

INSTANCE 2, OUTPUT 3 PARAMETERS (LCM Class 01) *Applicable only to product variants C230, C231, C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
4		Linear Output Scale Max. (Not applicable to LCMs C46x)	R/W	4-8
5		Linear Output Scale Min. (Not applicable to LCMs C46x)	R/W	4-9
25		Bus Power	R/W	4-9

INSTANCE 3, OUTPUT 4 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
25		Bus Power	R/W	4-9

INSTANCE 4, OUTPUT 5 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
25		Bus Power	R/W	4-9

INSTANCE 5, OUTPUT 6 PARAMETERS (LCM Class 01) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Output Type	R/W	4-5
2		Output Usage	R/W	4-6
3		Output Cycle Time	R/W	4-8
25		Bus Power	R/W	4-9

6.4.3 Setpoint Parameters

INSTANCE 0, LOOP 1 SETPOINT PARAMETERS (LCM Class 02)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Setpoint Ramp Rate	R/W	4-11
2		Setpoint Select	R/W	4-10
3		Setpoint 1	R/W	4-9
4		Setpoint 2	R/W	4-10
25		Actual Setpoint	R/O	4-10

INSTANCE 1, LOOP 2 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Setpoint Ramp Rate	R/W	4-11
2		Setpoint Select	R/W	4-10
3		Setpoint 1	R/W	4-9
4		Setpoint 2	R/W	4-10
25		Actual Setpoint	R/O	4-10

INSTANCE 2, LOOP 3 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Setpoint Ramp Rate	R/W	4-11
2		Setpoint Select	R/W	4-10
3		Setpoint 1	R/W	4-9
4		Setpoint 2	R/W	4-10
25		Actual Setpoint	R/O	4-10

INSTANCE 3, LOOP 4 SETPOINT PARAMETERS (LCM Class 02) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		Setpoint Ramp Rate	R/W	4-11
2		Setpoint Select	R/W	4-10
3		Setpoint 1	R/W	4-9
4		Setpoint 2	R/W	4-10
25		Actual Setpoint	R/O	4-10

6.4.4 Control Parameters

INSTANCE 0, LOOP 1 CONTROL PARAMETERS (LCM Class 03)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Manual Control Enable/Disable	R/W	4-11
0.1	1	Programmable Sensor Break	R/W	4-20
0.2	2	Select RaPID	R/W	4-12
0.3	3	Select Easy Tune	R/W	4-12
0.4	4	Control Output Action	R/W	4-19
0.5	5	Control Type	R/W	4-16
0.6	6	Loop Alarm Enable	R/W	4-15
0.7	7	Auto Pre-Tune	R/W	4-13
0.8	8	Control Mode	R/W	4-20
1		Primary Output Power Limit	R/W	4-13
2		Proportional Band 1	R/W	4-16
3		Proportional Band 2	R/W	4-17
4		Reset/Loop Alarm Time	R/W	4-17
5		Rate	R/W	4-17
6		Overlap/Deadband	R/W	4-18
7		Bias (Manual Reset)	R/W	4-19
8		ON/OFF Differential	R/W	4-19
9		Manual Power	R/W	4-11
10		Preset Power Output	R/W	4-20
11		Soft Start Setpoint	R/W	4-14
12		Soft Start Time	R/W	4-14
13		Soft Start Primary Output Power Limit	R/W	4-15
24		HEAT Output Power	R/O	4-15
25		COOL Output Power	R/O	4-15
26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 1, LOOP 2 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Manual Control Enable/Disable	R/W	4-11
0.1	1	Programmable Sensor Break	R/W	4-20
0.2	2	Select RaPID	R/W	4-12
0.3	3	Select Easy Tune	R/W	4-12
0.4	4	Control Output Action	R/W	4-19
0.5	5	Control Type	R/W	4-16
0.6	6	Loop Alarm Enable	R/W	4-15
0.7	7	Auto Pre-Tune	R/W	4-13
0.8	8	Control Mode	R/W	4-20
1		Primary Output Power Limit	R/W	4-13
2		Proportional Band 1	R/W	4-16
3		Proportional Band 2	R/W	4-17
4		Reset/Loop Alarm Time	R/W	4-17
5		Rate	R/W	4-17
6		Overlap/Deadband	R/W	4-18
7		Bias (Manual Reset)	R/W	4-19
8		ON/OFF Differential	R/W	4-19
9		Manual Power	R/W	4-11
10		Preset Power Output	R/W	4-20
11		Soft Start Setpoint	R/W	4-14
12		Soft Start Time	R/W	4-14
13		Soft Start Primary Output Power Limit	R/W	4-15
24		HEAT Output Power	R/O	4-15
25		COOL Output Power	R/O	4-15
26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 2, LOOP 3 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Manual Control Enable/Disable	R/W	4-11
0.1	1	Programmable Sensor Break	R/W	4-20
0.2	2	Select RaPID	R/W	4-12
0.3	3	Select Easy Tune	R/W	4-12
0.4	4	Control Output Action	R/W	4-19
0.5	5	Control Type	R/W	4-16
0.6	6	Loop Alarm Enable	R/W	4-15
0.7	7	Auto Pre-Tune	R/W	4-13
0.8	8	Control Mode	R/W	4-20
1		Primary Output Power Limit	R/W	4-13
2		Proportional Band 1	R/W	4-16
3		Proportional Band 2	R/W	4-17
4		Reset/Loop Alarm Time	R/W	4-17
5		Rate	R/W	4-17
6		Overlap/Deadband	R/W	4-18
7		Bias (Manual Reset)	R/W	4-19
8		ON/OFF Differential	R/W	4-19
9		Manual Power	R/W	4-11
10		Preset Power Output	R/W	4-20
11		Soft Start Setpoint	R/W	4-14
12		Soft Start Time	R/W	4-14
13		Soft Start Primary Output Power Limit	R/W	4-15
24		HEAT Output Power	R/O	4-15
25		COOL Output Power	R/O	4-15
26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
26.2	18	Pre-Tune Status	R/W	4-12

INSTANCE 3, LOOP 4 CONTROL PARAMETERS (LCM Class 03) *Applicable only to product variants C460, C461, C462 and C463*				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Manual Control Enable/Disable	R/W	4-11
0.1	1	Programmable Sensor Break	R/W	4-20
0.2	2	Select RaPID	R/W	4-12
0.3	3	Select Easy Tune	R/W	4-12
0.4	4	Control Output Action	R/W	4-19
0.5	5	Control Type	R/W	4-16
0.6	6	Loop Alarm Enable	R/W	4-15
0.7	7	Auto Pre-Tune	R/W	4-13
0.8	8	Control Mode	R/W	4-20
1		Primary Output Power Limit	R/W	4-13
2		Proportional Band 1	R/W	4-16
3		Proportional Band 2	R/W	4-17
4		Reset/Loop Alarm Time	R/W	4-17
5		Rate	R/W	4-17
6		Overlap/Deadband	R/W	4-18
7		Bias (Manual Reset)	R/W	4-19
8		ON/OFF Differential	R/W	4-19
9		Manual Power	R/W	4-11
10		Preset Power Output	R/W	4-20
11		Soft Start Setpoint	R/W	4-14
12		Soft Start Time	R/W	4-14
13		Soft Start Primary Output Power Limit	R/W	4-15
24		HEAT Output Power	R/O	4-15
25		COOL Output Power	R/O	4-15
26.0	16	Loop Alarm Status	R/O (Write operations to this parameter are accepted but ignored)	4-15
26.1	17	Easy Tune Status	R/O (Write operations to this parameter are accepted but ignored)	4-13
26.2	18	Pre-Tune Status	R/W	4-12

6.4.5 Alarm Parameters

6.4.5.1 LCMs C120, C130, C230 and C231

INSTANCE 0, ALARM 1 PARAMETERS (LCM Class 04)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 1, ALARM 2 PARAMETERS (LCM Class 04)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

6.4.5.2 LCMs C460, C461, C462 and C463

INSTANCE 0, LOOP 1 ALARM 1 PARAMETERS (LCM Class 04)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 1, LOOP 2 ALARM 1 PARAMETERS (LCM Class 04)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 2, LOOP 3 ALARM 1 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 3, LOOP 4 ALARM 1 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 4, LOOP 1 ALARM 2 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 5, LOOP 2 ALARM 2 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 6, LOOP 3 ALARM 2 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

INSTANCE 7, LOOP 4 ALARM 2 PARAMETERS (LCM Class 04) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Alarm Inhibit	R/W	4-22
1		Alarm Type	R/W	4-17
2		Alarm Value	R/W	4-17
3		Alarm Hysteresis	R/W	4-22
26.0	16	Alarm State	R/O	4-22

6.4.6 Heater Current Parameters

HEATER CURRENT PARAMETERS (LCM Class 06) Applicable only to product variants C230 and C231				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
0.0	0	Short Circuit Heater Break Alarm Enable/Disable	R/W	4-25
1		Heater Current Input Range	R/W	4-25
2		Heater Current Scale Range Maximum	R/W	4-25
3		Low Heater Break Alarm value	R/W	4-24
4		High Heater Break Alarm value	R/W	4-24
24		Bus Input value	R/W	4-26
25		Heater Current value	R/O	4-24
26.0	16	Low Heater Break Alarm state	R/O	4-24
26.1	17	High Heater Break Alarm state	R/O	4-25
26.2	18	Short Circuit Heater Break Alarm state	R/O	4-25

6.4.7 Calibration Parameters

INSTANCE 0, LOOP 1 CALIBRATION PARAMETERS (LCM Class 14)				
MLC 9000 Paramete Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
23		Calibration Value	R/O	4-27
24		Calibration Phase	R/W	4-27
25		Calibration Password	R/W	4-28

INSTANCE 1, LOOP 2 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Paramete Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
23		Calibration Value	R/O	4-27
24		Calibration Phase	R/W	4-27
25		Calibration Password	R/W	4-28

INSTANCE 2, LOOP 3 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Paramete Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
23		Calibration Value	R/O	4-27
24		Calibration Phase	R/W	4-27
25		Calibration Password	R/W	4-28

INSTANCE 3, LOOP 4 CALIBRATION PARAMETERS (LCM Class 14) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Paramete Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
23		Calibration Value	R/O	4-27
24		Calibration Phase	R/W	4-27
25		Calibration Password	R/W	4-28

6.4.8 LCM Descriptor Parameters

INSTANCE 0, LOOP 1 LCM DESCRIPTOR PARAMETERS (LCM Class 15)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1 2 3		LCM Serial Number	R/O	4-29
4		Product (Module Type) Identifier	R/O	4-29
5		Firmware ID	R/O	4-29
6		Database ID	R/O	4-29
21		COOL Output Power	R/O	4-30
22		HEAT Output Power	R/O	4-30
23		Actual Setpoint Value	R/O	4-30
24		Process Variable Value	R/O	4-30
25		Status Indicators	R/O	4-30

INSTANCE 1, LOOP 2 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1 2 3		LCM Serial Number	R/O	4-29
4		Product (Module Type) Identifier	R/O	4-29
5		Firmware ID	R/O	4-29
6		Database ID	R/O	4-29
21		COOL Output Power	R/O	4-30
22		HEAT Output Power	R/O	4-30
23		Actual Setpoint Value	R/O	4-30
24		Process Variable Value	R/O	4-30
25		Status Indicators	R/O	4-30

INSTANCE 2, LOOP 3 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1 2 3		LCM Serial Number	R/O	4-29
4		Product (Module Type) Identifier	R/O	4-29
5		Firmware ID	R/O	4-29
6		Database ID	R/O	4-29
21		COOL Output Power	R/O	4-30
22		HEAT Output Power	R/O	4-30
23		Actual Setpoint Value	R/O	4-30
24		Process Variable Value	R/O	4-30
25		Status Indicators	R/O	4-30

INSTANCE 3, LOOP 4 LCM DESCRIPTOR PARAMETERS (LCM Class 15) Applicable only to product variants C460, C461, C462 and C463				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1 2 3		LCM Serial Number	R/O	4-29
4		Product (Module Type) Identifier	R/O	4-29
5		Firmware ID	R/O	4-29
6		Database ID	R/O	4-29
21		COOL Output Power	R/O	4-30
22		HEAT Output Power	R/O	4-30
23		Actual Setpoint Value	R/O	4-30
24		Process Variable Value	R/O	4-30
25		Status Indicators	R/O	4-30

6.4.9 Communications Configuration Parameters

COMMUNICATIONS CONFIGURATION PARAMETERS (BCM Class 12)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1		PC Port Poll Timeout	R/W	4-31
2		PC Port Minimum Poll Interval	R/W	4-31
3		MODBUS Address	R/W	4-31
4		MODBUS Data Transfer Rate	R/W	4-31
5		MODBUS Data Format	R/W	4-31
7		Fieldbus Address	R/W	4-32
8		Fieldbus Data Rate	R/W	4-32

6.4.10 BCM Descriptor Parameters

BCM DESCRIPTOR PARAMETERS (BCM Class 15)				
MLC 9000 Parameter Number		**Name**	**Type**	**Ref. Page**
Word	**Bit**			
1 2 3		BCM Serial Number	R/O	4-32
4		Product (Module Type) Identifier	R/O	4-32
5		Firmware ID	R/O	4-32
6		Database ID	R/O	4-33
8		Configurable Data Assembly Value - Data 1	R/W	4-33
9		Configurable Data Assembly Value - Data 2	R/W	4-33
10		Configurable Data Assembly Value - Data 3	R/W	4-33
11		Configurable Data Assembly Value - Data 4	R/W	4-33
12		Configurable Data Assembly Value - Data 5	R/W	4-33
13		Configurable Data Assembly Value - Data 6	R/W	4-33

BCM DESCRIPTOR PARAMETERS (BCM Class 15)				
MLC 9000 Parameter Number		Name	Type	Ref. Page
Word	Bit			
14		Configurable Data Assembly Value - Data 7	R/W	4-33
15		Configurable Data Assembly Value - Data 8	R/W	4-33
16		Configurable Data Assembly Value - Data 9	R/W	4-33
17		Configurable Data Assembly Value - Data 10	R/W	4-33
18		Configurable Data Assembly Value - Data 11	R/W	4-33
19		Configurable Data Assembly Value - Data 12	R/W	4-33
20		Configurable Data Assembly Value - Data 13	R/W	4-33
21		Configurable Data Assembly Value - Data 14	R/W	4-33
22		Configurable Data Assembly Value - Data 15	R/W	4-33
23		Configurable Data Assembly Value - Data 16	R/W	4-33

7 DIAGNOSTICS/FAULT-FINDING

The Bus Communications Module (BCM) and Loop Controller Modules (LCMs) in the MLC 9000 System are equipped with LED indicators which serve as simple fault-diagnosis tools.

7.1 BCM B210/B220

The LED indicators associated with the PC Port and MODBUS Port serve the following diagnostic functions:

RS232 Port LED State*	Meaning	MODBUS Port LED State	Meaning
OFF	No power	OFF	No power
Green, flashing (1 second ON, 1 second OFF)*	Communication established via RS232 port	Green, continuous	Normal operation. Valid MODBUS frames have been received for this Module (reverts to flashing green after timeout if configured via the PC port)
Red, continuous*	Power ON and Bus Ready alarm present	Green, flash (at least 1 second)	A valid MODBUS frame has been received for this Module. The flash time is re-started each time a valid MODBUS frame has been detected
Green, continuous*	Power ON and OK		
Red/green, flashing (1 second red, 1 second green)	Communications established via RS232 port and Bus Ready alarm		

* On initial power-up, the RS232 Port LED will initially be orange for one second.

7.2 BCM B230

The LED indicators associated with the PC Port and DeviceNet Port serve the following diagnostic functions:

RS232 Port LED State*	Meaning	DeviceNet Port LED State	Meaning
OFF	No power	OFF	Not on-line; Duplicate MAC ID test not completed.
Green, flashing (1 second ON, 1 second OFF)	Communication established with PC (i.e. PC is responding to polls)	Green, continuous	Normal operation. On-line with connections in the established state; has been allocated a Master.
Red, continuous	Power ON and Bus Ready alarm present	Green, flashing	Normal condition, on-line with no connections in the established state; has not been allocated a Master.
Green, continuous	Power ON and OK	Red, continuous	Failed communication; bus fault or power-up self-test failed.
Red/green, flashing (1 second red, 1 second green)	Communications established with PC and Bus Ready alarm		

* On initial power-up, the RS232 Port LED will initially be orange for one second.

7.3 LCMs (C120, C130, C230, C231, C46x)

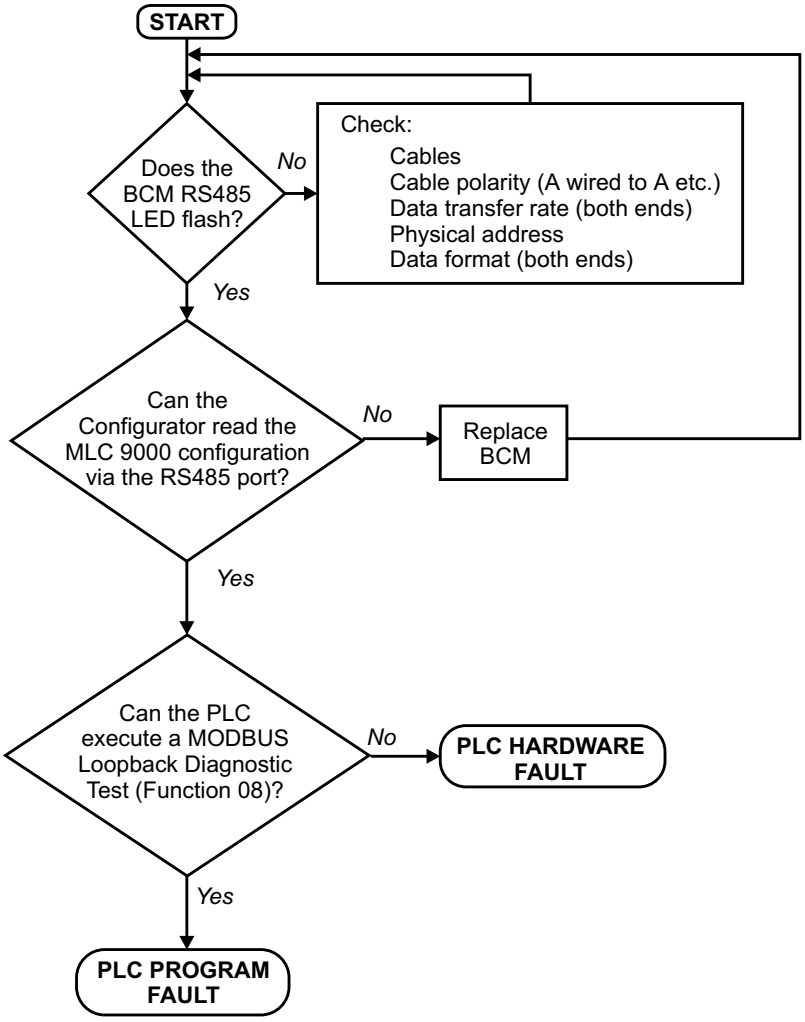
Front panel LED indication (red/green switchable) provides basic on-site diagnostic information:. Single-loop LCM's (C120, C130, C230, C231) have one LED per module. Four-loop LCM's (C46x) have 4 LEDs per module - one per loop.

LED Colour/State	Meaning
OFF	No power
Green flashing (1 second ON, 3 seconds OFF)	Process Variable < Setpoint
Green ON	Process Variable = Setpoint (on control - difference between process variable and setpoint is less than 0.1% of input span)
Green flashing (3 seconds ON, 1 second OFF)	Process Variable > Setpoint
Red flashing (1 second ON, 1 second OFF)	No communication with BCM.
Red fast flashing (0.5 seconds ON, 0.5 seconds OFF)	Auto-addressing is complete but the LCM is inhibited i.e. configuration may be incomplete.
Red ON	An alarm is active.
Orange (green and red simultaneously)	Hardware fault detected.

NOTE: An active alarm will over-ride a continuous-green indication; in the case of a flashing green state, indication of an active alarm will appear during the OFF time intervals (i.e. Indicator will flash alternate green/red).

7.4 MALFUNCTION ON THE MODBUS INTERFACE TO THE PLC

If a malfunction occurs on the MODBUS interface to the PLC, this can be investigated using the following procedure:



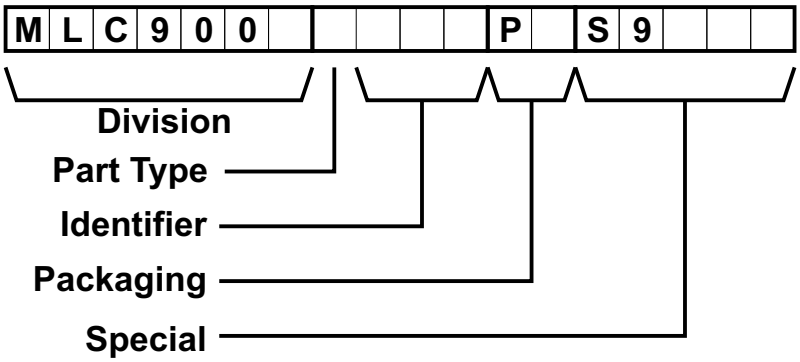
7.5 MALFUNCTION ON THE DEVICENET INTERFACE TO THE PLC

If a malfunction occurs on the DeviceNet interface to the PLC, refer to the diagnostic display information in Subsection 7.2. If more help is needed, refer to the DeviceNet diagnostics section of your PLC manufacturer's software/hardware manuals.

8 ORDERING INFORMATION

8.1 PRODUCT/VARIANT CODES

The MLC 9000 Order Code has the following format:



Each field in the Code is used as follows:

Division Field (mandatory)	
Field entry	**Meaning**
MLC9000	West Instruments - Europe
MLC9001	West Instruments - USA
MLC9002	Partlow
MLC9007	Hengstler

Part Type Field (mandatory)	
Field entry	**Meaning**
B	Bus Communications Module
C	Loop Controller Module
G	Ancillary - Gateway Product for Bus Interface
H	Ancillary - Human Machine Interface
L	Ancillary - Literature Product
F	Ancillary - Software (Firmware) Product

Identifier Field (mandatory) Bus Communications Module (Part Type B)	
Field entry	**Meaning**
210	24V DC supply, RS232 Port only
220	24V DC supply, RS232 Port & RS485 MODBUS Port
230	24V DC supply, RS232 Port & DeviceNet Port

Identifier Field (mandatory) Loop Control Module (Part Type C)	
Field entry	**Meaning**
120	Single input, dual output, single loop
130	Single input, triple output, single loop
230	Dual input (Heater Break), triple output, single loop
231	Dual input (Heater Break), triple output, single loop plus redundant thermocouple
460	Temperature input, quad SSR, dual relay output
461	Process input, quad SSR, dual relay output
462	Temperature input, six relay outputs
463	Process input, six relay outputs

Identifier Field (mandatory) Product Software/Firmware (Part Type F)	
Field entry	**Meaning**
010	Configurator PC Software plus cable
030	Loop Supervisor Software
040	CD-ROM Loopview Development Tool
120	PLC to MLC 9000 MODBUS RS485 Drivers on Floppy Disc (Mitsubishi)
121	PLC to MLC 9000 MODBUS RS485 Drivers on Floppy Disc (Allen Bradley)

Identifier Field (mandatory) Gateway for Bus Interface (Part Type G)	
Field entry	**Meaning**
G010	Profibus/DeviceNet Gateway 24V DC kit

Identifier Field (mandatory) Human Machine Interface (Part Type H)	
Field entry	**Meaning**
H010	Loopview 10 plus RS232 cable 24V DC (while stocks last)
H020	Loopview 20 plus RS232 cable 24V DC (while stocks last)
H030	Loopview 10 plus RS485 cable 24V DC (while stocks last)
H040	Loopview 20 plus RS485 cable 24V DC (while stocks last)
H200	HMI 4x20 Text Display (VT060) 24VDC (Includes RS232 & RS485 cables)
H210	HMI 4x20 Operator Terminal (VT150W) 24V DC (Includes RS232 & RS485 cables)

Identifier Field (mandatory) Human Machine Interface (Part Type H)	
Field entry	**Meaning**
H220	HMI 240x128 Mono Touch Screen (VT555W) 24VDC (Includes RS232 & RS485 cables)
H230	HMI 320x240 Mono Touch Screen (VT565W) 24VDC (Includes RS232 & RS485 cables)
H240	HMI 320x240 Colour Touch Screen (VT565W) 24VDC (Includes RS232 & RS485 cables)
H250	HMI 6450x480 Colour Touch Screen (VT585W) 24VDC (Includes RS232 & RS485 cables)
H260	External Profibus Comms Module for use with HMI's
H270	VTWIN CDROM for use with HMI's

Identifier Field (mandatory) - Product Literature (Part Type L)	
Field entry	**Meaning**
L030	MLC 9000 Users' Manual (neutral) - Hard Copy (this document)

Packaging Field (mandatory)	
Field entry	**Meaning**
0	Single Pack
2	Bulk Pack

Special Field (optional)	
Field entry	**Meaning**
S9xx	Special product code

9 TECHNICAL SPECIFICATIONS

9.1 BUS COMMUNICATIONS MODULE (B210, B220)

GENERAL	
RS232 Port:	This is a local port for connection to an RS232 port on a PC for local operator configuration and operator displays. It has EIA-232-E (RS232)-compatible inputs and outputs for TxD and RxD and provides facilities via application software to allow an installer to configure or an operator to view the operation of Loop Controller Modules connected to the Bus Communications Module. This is via a special two-metre interface lead which is available by special order.
MODBUS Port (Module B220 only)	This is an optional RS485 port for connection to a MODBUS master device. Data rate and format are configurable via the RS232 port. The MODBUS Port can fulfil a variety of roles: ¤ Multi-drop configuration: Configuration and monitoring of the system may be performed with a local RS485 MODBUS network. ¤ Fieldbus: When a plant uses MODBUS as its Fieldbus choice, this permits the system to be integrated into a Fieldbus network. ¤ Multi-Drop Operator Interface: A third party operator interface may be connected which can read and change parameters over this port. MODBUS RTU protocol is supported, using an RS485 physical layer. The load is no greater than one-quarter unit load. The data rate is selectable from 4800, 9600 or 19200 Baud. It is factory-set to 9600 Baud. Parity is selectable from none, even or odd. Each system can consist of up to eight Loop Controller Modules (each with its Interconnect Module) plus the Bus Communications Module - a total of nine addresses. The base address can be set in the range 1 - 247 (default = 96) Node addressing, data rate and character format are selectable via the Application Software running on the PC connected to the RS232 Port.
Input Power	30W maximum

ENVIRONMENTAL	
Operating Conditions	Ambient Temperature: 0°C to 55°C Relative Humidity: 30% to 90% non-condensing Supply Voltage: 18 to 30V DC (including ripple)
Storage Conditions	Ambient Temperature: -20°C to 80°C Relative Humidity: 30% to 90% non-condensing

APPROVALS	
Product Family EMC:	EN61326-1. **NOTE:** For line-conducted AM signals in the frequency range 400kHz to 1.65MHz, communications with the RS485 MODBUS and RS232 ports may be disrupted but will self-recover when the interfering signals are removed.
Safety:	Complies with EN61010-1 and UL 3121-1.

PHYSICAL		
Dimensions	Height - 100mm; Width - 30mm; Depth - 120mm	
Mounting	Directly mounted on the DIN rail	
Connectors	Power input: RS232 port: MODBUS port (optional):	2-way 5.08mm Combicon type 6-way RJII Type 2-way 5.08mm Combicon type
Weight:	0.21kg	

9.2 BUS COMMUNICATIONS MODULE (B230)

GENERAL	
RS232 Port:	This is a local port for connection to an RS232 port on a PC for local operator configuration and operator displays. It has EIA-232-E (RS232)-compatible inputs and outputs for TxD and RxD and provides facilities via the Application Software to allow an installer to configure or an operator to view the operation of Loop Controller Modules connected to the Bus Communications Module.
DeviceNet Port	This is a port for connection to a DeviceNet master device. Data rate and MAC ID are configurable via the RS232 port. The data rate is selectable from (in kbps) 125, 250 or 500. It is factory-set to 125kbps. Parity is fixed at none. The MAC ID can be set in the range 0 - 63 (default = 63).
Input Power	30W maximum

ENVIRONMENTAL	
Operating Conditions	Ambient Temperature: 0°C to 55°C Relative Humidity: 30% to 90% non-condensing Supply Voltage: 18 to 30V DC (including ripple)
Storage Conditions	Ambient Temperature: -20°C to 80°C Relative Humidity: 30% to 90% non-condensing

APPROVALS	
Product Family EMC	EN61326-1. **NOTE:** For line-conducted AM signals in the frequency ranges 16-20MHz and 5.5-7.5MHz, the DeviceNet port can suffer intermittent loss of function which is self- recoverable. In the frequency range 1-6MHz, communications with the RS232 port may be disrupted but will self-recover when the interfering signals are removed.
Safety	Complies with EN61010-1 and UL 3121-1.

PHYSICAL			
Dimensions	Height - 100mm; Width - 30mm; Depth - 120mm		
Mounting	Directly mounted on the 35mm Top Hat DIN rail		
Connectors	Power input: RS232 port: DeviceNet port:	2-way 5.08mm 6-way RJII Type 5-way 5.08mm	Combicon type Combicon type
Weight:	0.21kg		

9.3 SINGLE-LOOP LOOP CONTROLLER MODULES (C120, C130, C230 AND C231)

GENERAL	
Function:	Each Loop Controller Module performs the control function and provides the input and output connections for its own control loop. One universal process input and two outputs are provided as standard. An optional third output and Heater Break detection input are available.
Types available:	**C120:** Two output, single loop **C130:** Three output, single loop **C230:** Three output, single loop with Heater Break detection **C231:** Three output, single loop with Heater Break detection and redundant thermocouple
Process Input:	Type and scale user-selectable (see below). Sample rate = 10/second (For redundant thermocouple variant, unused thermocouple sample rate = 1/second)
Heater Current Input	Generates a Heater Current Input value for use by the Heater Break Alarm function.
Outputs:	Output 1 - Relay or SSR Drive Output 2 - Relay or SSR Drive Output 3 (optional) - Relay, SSR Drive or Linear

PROCESS INPUT Types available			
Thermocouple		**RTD**	**DC Linear**
B (100 - 1824°C) B (212 - 3315°F)	N (0.0 - 1399.6°C) N (32.0 - 2551.3°F)	-199.9 - 800.3°C –327.3 - 1472.5°F	0 - 20mA 4 - 20mA
J (–200.1 - 1200.3°C) J (–328.2 - 2192.5°F)	R (0 - 1759°C) R (32 - 3198°F)		0 - 50mV 10 - 50mV
K (–240.1 - 1372.9°C) K (–400.2 - 2503.2°F)	S (0 - 1759°C) S (32 - 3198°F)		0 - 5V 1 - 5V
L (–0.1 - 761.4°C) L (31.8 - 1402.5°F)	T (–240.0 - 400.5°C) T (–400.0 - 752.9°F)		0 - 10V 2 - 10V
NOTE: RTD and DC Linear inputs are not available on C231.			

PROCESS INPUT Over-range Detection, Under-range Detection and Sensor Break Detection	
Under-range Detection	Under-range is detected when the input value is lower than Range Minimum. The input value is valid for reading and control for up to 5% of input span under-range. The accuracy is reduced when the input is under-range.
Over-range Detection	Over-range is detected when the input value exceeds Range Maximum. The input value is valid for reading and control for up to 5% of input span over-range. The accuracy is reduced when the input is over-range.
Sensor Break Detection	Primary thermocouple input: wire break detected within two seconds. Secondary thermocouple input (redundant thermocouple variant only): wire break detected typically within three seconds. Control outputs set to OFF (0% power); All alarms become active (with the exception of heater break – if present). For DC Linear inputs, applicable to 4 - 20mA, 10 - 50mV, 1 - 5V and 2 - 10V ranges only. NOTE: On the Redundant Thermocouple variant, control outputs and alarms are affected only when a sensor break is detected on *both* thermocouple inputs. During the two seconds required to detect a break on the primary thermocouple, "fleeting" alarms will occur. When the secondary thermocouple switches in, these alarms will cease. See also Under-range Detection and Over-range Detection above.

THERMOCOUPLE INPUTS	
Types/Ranges	See above
Measurement Accuracy	Better than ±0.1% of range span ±1 LSD. NOTE: Reduced performance with Type “B” Thermocouple between 100 - 600°C (212 - 1112°F). Type “T” accuracy is ±0.5% below –100°C.
Linearisation Accuracy	Better than ±0.2°C any point, any 0.1°C resolution range (±0.05°C typical). Better than ±0.5°C any point, any 1°C resolution range.
Cold Junction Compensation	Better than ±1°C over operating temperature range. Secondary Input: Better than ±2°C over operating temperature range.
Sensor Resistance Influence	<10Ω: as measurement accuracy 100Ω: <0.1% of span error 1000Ω: <0.5% of span error

RTD INPUTS - Not on C231	
Type and Connection:	Three-wire (Pt100).
Measurement Accuracy	±0.1% of range span ±1 LSD.
Linearisation Accuracy	Better than ±0.2°C any point (±0.05°C typical).
Temperature Stability	0.01% of range span/°C change in ambient temperature.
Lead Compensation:	Automatic to 50Ω maximum lead resistance, giving less than 0.5% of span additional error.
RTD Sensor Current:	150µA ±10µA

DC LINEAR INPUTS - Not on C231	
Measurement Accuracy	Better than ±0.1% of range span ±1 LSD.
Temperature Stability	0.01% of range span/°C change in ambient temperature.
Input Resistance	mV Input: >1MΩ V Input: 47kΩ mA Input: 4.7Ω
Max. Resolution	-32000 to 32000. Equivalent to a 16-bit ADC.

HEATER CURRENT INPUT - C230 and C231 only	
Input Sampling Method:	Delta-sigma at 1kHz
Input Resolution:	8 bits over 250 msec rolling window
Accuracy:	Better than ±2%.
Isolation:	Via external current transformer
Internal Burden:	15 ohm
Source Selection:	SSR linear output 3 or Heater Current input.
Input Span:	0 – 50mA rms. (assuming sinusoidal input current waveform)
Range Maximum:	Adjustable 0.1A to 100A
Range Minimum:	Fixed 0A

RELAY OUTPUTS (Output 1, 2 or 3)	
Contact Type:	Single pole double throw (SPDT).
Rating:	2A resistive @ 120/240V AC
Lifetime:	>500,000 operations at rated voltage/current.

SSR DRIVE OUTPUTS (Output 1, 2 or 3)	
Drive Capability:	12V DC nominal (10V DC minimum) at up to 20mA load.
Isolation:	Isolated from process input and relay outputs. Not isolated from each other or linear outputs. Not isolated from other similar outputs in the same system.

LINEAR OUTPUT (Output 3 only)	
Resolution:	Eight bits in 250msecs. (10 bits in 1 second typical).
Accuracy:	±0.25% (mA into 250Ω load, V into 2kΩ load). Degrading linearly to ±0.5% for increasing burden to maximum drive capability.
Update Rate:	10samples/second.
Drive Capability:	0 - 20mA: 500Ω maximum 4 - 20mA: 500Ω maximum 0 - 5V: 500Ω minimum 0 - 10V: 500Ω minimum
Isolation:	Isolated from process input and relay outputs. Not isolated from SSR Drive outputs or other similar outputs in the same system.

ALARM CONTROL	
Maximum No. of Alarms:	Two “soft” alarms plus Loop Alarm.
Maximum No. of Alarm Outputs Available:	Any output can be used for any alarm indication.
Alarm Types Available:	Process High Alarm Process Low Alarm Band Alarm Deviation Alarm
Combinatorial Alarms:	Logical OR of alarms to an individual hardware output is available.

OPERATING CONDITIONS	
Ambient Temperature:	0°C to 55°C (operating); –20°C to 80°C (storage)
Relative Humidity:	30% - 90% non-condensing (operation and storage).
Supply Voltage:	Powered by Bus Communications Module within its operating conditions.

APPROVALS	
Product Family EMC:	EN61326-1. **NOTE:** For line-conducted AM signals in the frequency range 400kHz to 1.65MHz, communications with the RS485 MODBUS and RS232 ports may be disrupted but will self-recover when the interfering signals are removed.
Safety:	Complies with EN61010-1 and UL 3121-1.

PHYSICAL	
Dimensions:	Height - 100mm; Width - 22mm; Depth - 120mm
Mounting:	35mm Top Hat DIN rail mounting via Interconnect Module.
Connector Types:	All 5.08mm Combicon type.
Weight:	0.15kg.

9.4 4-LOOP LOOP CONTROLLER MODULES (C460, C461, C462 AND C463)

GENERAL	
Function:	Each LCM performs the control functions and provides the input and output connections for its own control loops. Four process inputs (temperature or DC) and four SSR Drive or relay (SPST) outputs are provided, along with two relay (SPDT) outputs.
Types available:	**C460:** Four temperature/mV process inputs, four SSR drive outputs, two SPDT relay outputs. **C461:** Four DC process inputs, four SSR drive outputs, two SPDT relay outputs. **C462:** Four temperature/mV process inputs, four SPST relay outputs, two SPDT relay outputs. **C463:** Four DC process inputs, four SPST relay outputs, two SPDT relay output.
Process Input:	Type and scale user-selectable (see below). Sample rate = 10/second.**Temperature process inputs:,** thermocouple, RTD or DC (mV) ranges are available. **DC process inputs**: DC (V) or DC (mA) ranges are available.
Outputs:	Outputs 1 - 4: SPST Relay or SSR Drive Outputs 5 and 6: SPDT Relay

PROCESS INPUT Types available (Range Minimum - Range Maximum)			
Thermocouple		**RTD**	**DC Linear**
B (100 - 1824°C) B (212 - 3315°F)	N (0.0 - 1399.6°C) N (32.0 - 2551.3°F)	-199.9 - 800.3°C –327.3 - 1472.5°F	0 - 20mA 4 - 20mA
J (–200.1 - 1200.3°C) J (–328.2 - 2192.5°F)	R (0 - 1759°C) R (32 - 3198°F)		0 - 50mV 10 - 50mV (available only on temperature versions)
K (–240.1 - 1372.9°C) K (–400.2 - 2503.2°F)	S (0 - 1759°C) S (32 - 3198°F)		0 - 5V 1 - 5V
L (–0.1 - 761.4°C) L (31.8 - 1402.5°F)	T (–240.0 - 400.5°C) T (–400.0 - 752.9°F)		0 - 10V 2 - 10V

PROCESS INPUT Over-range Detection, Under-range Detection and Sensor Break detection	
Under-range Detection	Under-range is detected when the input value is lower than Range Minimum. The input value is valid for reading and control for up to 5% of input span under-range. The accuracy may be reduced when the input is under-range.
Over-range Detection	Over-range is detected when the input value exceeds Range Maximum. The input value is valid for reading and control for up to 5% of input span over-range. The accuracy may be reduced when the input is over-range.
Sensor Break Detection	Wire break detected within two seconds. Control outputs set to OFF (0% power); All alarms become active. For DC Linear inputs, applicable to 0 - 50mV, 10 - 50mV, 4 - 20mA, 1 - 5V and 2 - 10V ranges only. See also Under-range Detection and Over-range Detection above.
Sensor Short Detection	Thermocouple: Input reads ambient; not detected. RTD: As for under-range operation.

THERMOCOUPLE INPUTS	
Types/Ranges	See above
Measurement Accuracy	Better than ±0.2% of range span ±1 LSD. NOTE: Reduced performance with Type “B” Thermocouple between 100 - 600°C (212 - 1112°F). Type T accuracy is ±0.5% below –100°C,
Linearisation Accuracy	Better than ±0.2°C any point, any 0.1°C resolution range (±0.05°C typical). Better than ±0.5°C any point, any 1°C resolution range.
Cold Junction Compensation	Better than ±1°C over operating temperature range.

THERMOCOUPLE INPUTS	
Sensor Resistance Influence	<10Ω: as measurement accuracy 100Ω: <0.1% of range span error 1000Ω: <0.5% of range span error

RTD INPUTS	
Type and Connection:	Three-wire (Pt100)
Measurement Accuracy	±0.2% of range span ±1 LSD.
Linearisation Accuracy	Better than ±0.2°C any point (±0.05°C typical).
Temperature Stability	0.01% of range span/°C change in ambient temperature.
Lead Compensation:	Automatic to 50Ω maximum lead resistance, giving less than 0.5% of range span additional error.
RTD Sensor Current:	150μA ±10μA

DC LINEAR INPUTS	
Measurement Accuracy	Better than ±0.1% of range span ±1 LSD.
Temperature Stability	0.01% of range span/°C change in ambient temperature.
Input Resistance	mV Input: >1MΩ; V Input: 47kΩ; mA Input: 4.7Ω
Max. Resolution	-32000 to 32000. Equivalent to a 16-bit ADC.

RELAY OUTPUTS	
Contact Type:	**RLY1 - RLY4:** Single pole single throw (SPST) N/O **RLY5 and RLY6:** Single pole changeover (SPDT).
Rating:	2A resistive @ 120/240V AC
Lifetime:	>500,000 operations at rated voltage/current.
Isolation:	Inherent.

SSR DRIVE OUTPUTS	
Drive Capability:	12V DC nominal (10V DC minimum) at up to 20mA load.
Isolation:	Isolated from process input and relay outputs. Not isolated from each other. Not isolated from other similar outputs in the same system.

ALARM CONTROL	
Maximum No. of Alarms:	Two “soft” alarms per input plus four loop alarms.
Maximum No. of Alarm Outputs Available:	Any output can be used for any alarm indication.
Alarm Types Available:	Process High Alarm, Process Low Alarm, Band Alarm Deviation Alarm
Combinatorial Alarms:	Logical OR of alarms to an individual hardware output is available.

LOOP CONTROL	
PID Single Output Loop Control	**Automatic Tuning:** Easy Tune, Pre-Tune and RaPID. **Manual Reset (Bias):** Added each control algorithm execution. **Auto/Manual Control:** User-selectable with “bumpless” transfer into and out of Manual Control.
PID Dual Output Loop Control	**Automatic Tuning:** Pre-Tune and RaPID. **Manual Reset (Bias):** Added each control algorithm execution. **Auto/Manual Control:** User-selectable with “bumpless” transfer into and out of Manual Control.

OPERATING CONDITIONS	
Ambient Temperature:	0°C to 55°C (operating); –20°C to 80°C (storage)
Relative Humidity:	30% - 90% non-condensing (operation and storage).
Supply Voltage:	Powered by BCM within its operating conditions.

APPROVALS	
Product Family EMC:	EN61326. **NOTE:** For line-conducted AM signals in the frequency range 400kHz to 1.65MHz, communications with the RS485 MODBUS and RS232 ports may be disrupted but will self-recover when the interfering signals are removed.
Safety:	Complies with EN61010-1 and UL3121-1.

PHYSICAL	
Dimensions:	Height - 100mm; Width - 22mm; Depth - 120mm
Mounting:	35mm Top Hat DIN rail mounting via Interconnect Module.
Connector Types:	5.08mm Combicon type in all cases.
Weight:	0.15kg.

10 TECHNICAL SUPPORT

For technical support, contact the appropriate one of the following centres:

GREAT BRITAIN
West Instruments Ltd
The Hyde Business Park
Brighton
East Sussex
BN2 4JU
England
Tel: +44 (0) 1273 606271
Fax: +44 (0) 1273 609990
www.west-inst.co.uk
Email: info@west-inst.co.uk

FRANCE
Hengstler Contrôle Numérique
Z.I. des Mardelles - B.P.71
94-106 rue Blaise Pascal
93602 Aulnay-sous-Boix, Cédex
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Hengstler GmbH
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Tel: +49 (0) 7424 89 0
Fax: +49 (0) 7424 89 470
www.hengstler.com
Email: info@hengstler.de

U.S.A.
Danaher Controls
1675 Delany Road
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www.partlow.com

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Fax: +39 0331 533516
www.cdautomation.com

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Japan
Tel: +81 (0)3 5338-8360
Fax: +81 (0)3 5338-8361
Email: k_hirao@hengstler.co.jp

APPENDIX A DECIMAL-TO-HEXADECIMAL CONVERSION

For decimal-to-hexadecimal conversion, it is recommended that calculators are used. The calculator provided by Windows is ideal, and engineers' hand-held calculators usually include this feature. If these tools are not available, the table below may be used as a simple ready reckoner.

		Least significant (right-hand) Hexadecimal Digit															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Most significant (left-hand) Hexadecimal Digit	0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
	3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
	4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
	5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
	6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
	7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
	8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
	9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
	A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
	B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
	C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
	D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
	E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
	F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

EXAMPLES:

(i) To convert 196 (decimal) to hexadecimal form:

In the look-up table above, for **196** (decimal), the least significant hexadecimal digit is **4** and the most significant hexadecimal digit is **C**; therefore **196** (decimal) equals **C4** (hexadecimal).

(Ii) To convert E8 (hexadecimal) to decimal form:

Trace the line for the most significant hexadecimal digit = **E** to where it intersects the column for the least significant hexadecimal digit = **8**; this intersection gives the decimal value **232**.

APPENDIX B EASY TUNE AND PRE-TUNE

NOTE: Pre-Tune, Auto Pre-Tune and Easy Tune will not run when Soft-Start is running.

B.1 EASY TUNE

Easy Tune is an automatic tuning method which operates on a control loop at power-up. After each power-up, PID terms are computed. By remembering the overshoot from the previous power-up, Easy Tune is able to improve the start-up behaviour (and subsequent tuning terms) of the control loop on each new power-up. It also gives faster attainment of setpoint from power-up compared with convention pre-tune methods. It is best used on single output (HEAT only) control loops.

Easy Tune applies maximum power for a period, removes it, then measures the overshoot characteristics to compute terms. Power is removed when the process variable is at the “stored overshoot” value below setpoint. Figure B-1 shows a typical Easy Tune start-up trace.

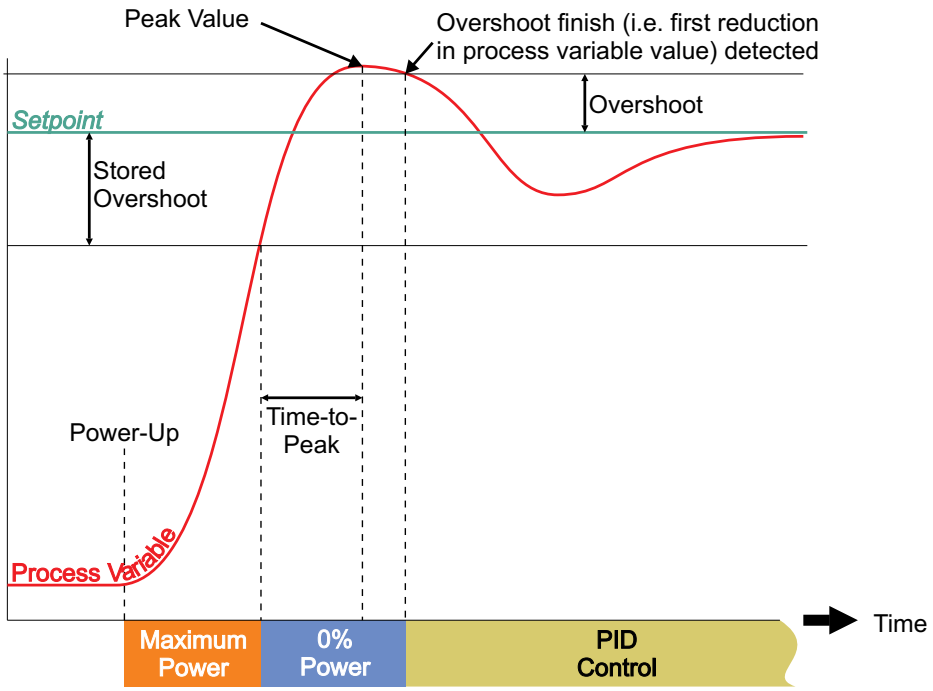

Figure B-1 A Typical Easy Tune Start-up Trace

When a control loop’s parameters are defaulted (e.g. the input range is changed or on initial power-up), the “stored overshoot is set to 20°C, 20°F or 20 engineering units, depending on the input range selected.

When Easy Tune is enabled, it will only run at process power-up if the process variable is more than 5% of input span from the setpoint. Once it is started, Easy Tune will abort if disabled or if a soft start, manual power, a ramping setpoint, ON/OFF control mode or a sensor break occurs. If it is aborted, the previously-established PID terms are used.

During the initial phase, maximum power (as set by the user) is applied until:

(setpoint - process variable) = “stored overshoot”

Zero power is then applied and the peak value of the overshoot is measured when the process variable value has dropped by an amount equal to the noise band. If the process is noisy, additional input filtering may be required to guarantee detection of the proper peak. This overshoot is used, together with the time-to-peak value, to determine the optimum PID terms. The stored overshoot is then updated in preparation for the next power-up. The computed PID terms are then used by the normal PID control algorithm to control the power applied to the process.

Note that, on the next process power-up (when Easy Tune is enabled - see Subsection 4.4.4), the maximum power is turned off when the process variable is below the setpoint by the new stored overshoot value. It is expected that the subsequent overshoot above the setpoint will then be much less than previously.

> **NOTE:** Easy Tune is run from process power-up and will always produce best results when used in this manner. If the process has not cooled more than 5% of input span below setpoint or by more that the stored overshoot value below setpoint, Easy Tune will not operate and PID terms and stored overshoot value will be unchanged. In processes with a large overshoot, this could lead to confusion as to whether Easy Tune is operating correctly or not.

B.2 PRE-TUNE

Pre-Tune is initiated either at power-up (see Auto Pre-Tune - Subsection 4.4.6) or manually using the Pre-Tune parameter. Pre-Tune can be initiated at any time but will only operate when the process variable is at least 5% of input span away from the setpoint. Pre-Tune calculates optimum values of Proportional Band, Integral Time Constant and Derivative Time Constant after examination of system response to step changes in output power (see Figure B-2).

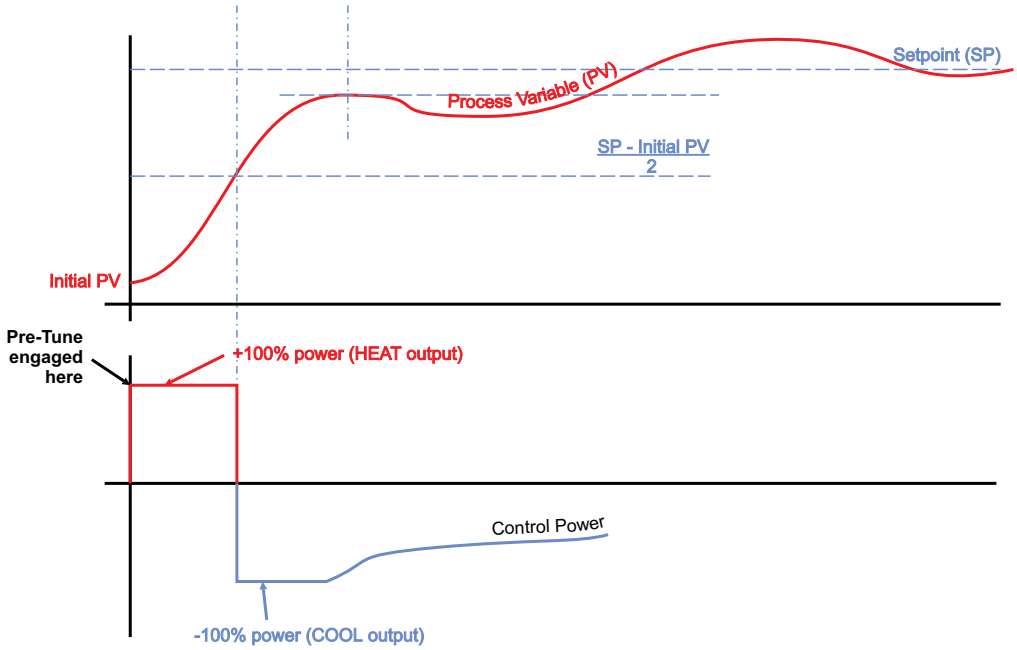

Figure B-2 Pre-Tune Operation

Pre-Tune can be used on single output (HEAT only) or dual output (HEAT and COOL) control loops.

Once it is started, Pre-Tune will abort if disabled or if a soft start, manual power, a ramping setpoint, ON/OFF control mode or a sensor break occurs.

APPENDIX C USING MANUAL CONTROL AND BUS POWER OUTPUTS

The Manual Control facility and the Bus Power Output facility are used when it is required to abandon automatic control of the process.

C.1 MANUAL CONTROL

When its selection is enabled, Manual Control Mode is used *temporarily* to control the process manually. The communications link is used to assign power levels to a control loop's output(s). The adjustment range is between 0% and +100% for a loop with only one (HEAT) control output or between -100% and +100% for a loop with two (HEAT and COOL) control outputs. (Negative values apply power to the COOL output, positive values apply power to the HEAT output). Thus, to apply 25% power to the COOL output of a two-output loop, the value should be –25%; to apply 50% power to a loop's HEAT output, the value should be +50%. See also Subsections 4.4.1 and 4.4.2.

NOTES

1. It is not possible to apply power to both outputs of a two-output control loop simultaneously in Manual Control Mode.

2. If a power failure or power-down occurs whilst a loop is in Manual Control Mode, the manual control output power setting at the instant of power interruption is saved; it is re-instated when power is restored.

C.2 BUS POWER OUTPUTS

A Bus Power Output is configured when there is a *continuous* requirement for manual control of the power level at that output. When a control output's usage is configured to be Bus Power, the third party device (human-machine interface, SCADA system etc.) may be used to set an output power value at that specific output (in the range 0% to +100%). See also Subsections 4.2.2 and 4.2.6.

NOTES

1. If a dual output (i.e. HEAT output and COOL output) control loop has the usage for both control outputs set to Bus Power, it is possible to apply power to both outputs simultaneously.

2. If a power failure or power-down occurs on a control loop with a Bus Power output, the output power setting is not saved; the output power is reset to 0% when power is restored, in preparation for receiving new values from the third party device.

APPENDIX D AUTO-CONFIGURATION AND SLAVE INHIBIT

Auto-configuration is the method the MLC 9000 uses to download the LCM parameters from the BCM when the system is re-powered or when LCMs are hot-swapped. Slave Inhibit is a related feature designed to protect the process being controlled by the LCM if a LCM incompatible with the saved configuration is installed. This Subsection provides important information relating to these features.

D.1 INITIAL SYSTEM INSTALLATION

On initial system installation and power-up, all Loop Controller Modules (LCMs) assume default settings for their parameters. The Bus Communications Module (BCM) enforces a Slave Inhibit condition, which forces all LCM outputs to their OFF state and suspends the control algorithm in each LCM. The BCM then up-loads the Database ID parameter for each LCM into its own EEPROM. The user must then check the LCM parameters (and to change them if necessary), either using the Configurator via the RS232 port or using the MODBUS port. Any changes will be recorded automatically by the BCM. When all required changes have been made and recorded by the BCM, t*he user must clear the Slave Inhibit condition (see Subsection E.5) before process control can start.*

The MLC 9000 Configurator automatically clears the Slave Inhibit condition when downloading a configuration recipe to an LCM.

> **NOTE:** The Configurator will only communicate with DeviceNet BCM B230 via the RS232 port.

D.2 SUBSEQUENT POWER-UP

If an MLC 9000 system is temporarily powered-down and no modules are changed during the power-down period, on power-up, the BCM will enforce a Slave Inhibit condition whilst it up-loads the Database ID parameter for each LCM for comparison with the LCM Database ID parameters already held in its own EEPROM. When the comparison reveals the two sets of Database ID parameters to be identical, the BCM clears the Slave Inhibit condition automatically after it has downloaded the configuration data to the LCM.

D.3 CHANGING AN LCM

The LCMs in an MLC 9000 system may be hot-swapped (i.e. may be changed without powering-down the system) - see the Loop Controller Module Installation Manual. When this occurs, the BCM immediately imposes a Slave Inhibit condition on the replacement LCM and up-loads the Database ID parameter for that LCM for comparison with that already held in the BCM for that LCM address.

If the Database IDs are identical, the BCM down-loads the configuration parameters to the LCM and clears the Slave Inhibit condition, whereupon control is resumed.

If the Database IDs are identical but the BCM detects some minor difference in the new LCM type (e.g. input units in °F instead of °C), the BCM down-loads to the LCM as many parameters as possible but maintains the Slave Inhibit condition. The user must then check and (if necessary) change the configuration parameters for the new LCM. The Slave Inhibit condition is maintained until it is cleared by the user (see Subsection D.5).

If the Database IDs are not identical (i.e. the new LCM is a different or incorrect type), the BCM forces LCM parameters to their default values. The user must then check and (if necessary) change the configuration parameters for the new LCM. The Slave Inhibit condition is maintained until it is cleared by the user (see below).

D.4 INTERRUPTION BY POWER FAILURE

If power failure occurs whilst Auto-Configuration is in progress, upon restoration of power, Auto-Configuration will be re-started automatically.

D.5 CLEARING A SLAVE INHIBIT CONDITION

To clear an existing Slave Inhibit condition on an LCM, send a MODBUS message of the following format - in this example, to LCM1 with BCM address = 96 (default - giving an LCM1 address of 97):

Write "Clear Slave Inhibit" value to LCM1

Module Address	Function Number	Address of Word HI	Address of Word LO		Binary Value HI	Binary Value LO	CRC Checksum HI	CRC Checksum LO
97	06	13	0	22	00010010	00110100	⁄ ⁄ ⁄	⁄ ⁄ ⁄

Parameter No.
Instance
Object Type

Response

Module Address	Function Number	Address of Word HI	Address of Word LO		Binary Value Written HI	Binary Value Written LO	CRC Checksum HI	CRC Checksum LO
97	06	13	0	22	00010010	00110100	⁄ ⁄ ⁄	⁄ ⁄ ⁄

D.6 FORCING A SLAVE INHIBIT CONDITION

To force a Slave Inhibit condition on an LCM, send a MODBUS message of the following format - in this example, to LCM1 with BCM address = 96 (default - giving an LCM1 address of 97):

NOTE: The Force Slave Inhibit instruction should be used to suspend control on an LCM *only when to do so will not cause damage to the process being controlled.*

Write "Force Slave Inhibit" value to LCM1

Module Address	Function Number	Address of Word HI	Address of Word LO		Binary Value HI	Binary Value LO	CRC Checksum HI	CRC Checksum LO
97	06	13	0	22	00000000	00000000	⁄ ⁄ ⁄	⁄ ⁄ ⁄

Parameter No.
Instance
Object Type

Response

Module Address	Function Number	Address of Word HI	Address of Word LO		Binary Value Written HI	Binary Value Written LO	CRC Checksum HI	CRC Checksum LO
97	06	13	0	22	00000000	00000000	⁄ ⁄ ⁄	⁄ ⁄ ⁄