MSC-3
OPTION BOARD 3
MODBUS PROTOCOL

ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1978 Zener Electric has supplied many thousands of AC drives to industry. These drives have been installed into numerous applications resulting in a wealth of in house experience. The Zener MSC-3 AC variable speed controller is the culmination of this experience, modern technology and industrial application requirements. The Zener Quality Assurance program ensures that every MSC-3 manufactured has proven to operate correctly in the production test bay before dispatch.

MSC-3 PRODUCT WARRANTY

Zener Electric warrants the MSC-3 against defective workmanship and materials for a period of 24 months from the date of dispatch. Such defects will be rectified free of charge for both labour and material, at Zener Electric's premises subject to:

1. Zener Electric's customer raising an order upon Zener for service and/or repairs, subject to a warranty claim. The order is to state particulars of the model and serial number, the date of original purchase and invoice/delivery docket number.
2. All damage resulting from incorrect installation or use other than in accordance with the instruction manuals issued by Zener Electric is excluded from this warranty.
3. The Warranty being rendered invalid if the product is misused or if any unauthorised alteration, modification or substitution of any part of the product be made or the serial number of the product is defaced or altered.
4. The cost of transportation (both ways) is to be met by the owner if it's necessary to return the product, or any part of it, to Zener Electric's premises.
5. A charge being accepted by the owner for travelling time and expenses incurred in connection with warranty service at the user's site as requested by the owner.
6. If the product was not purchased from Zener Electric directly, then a warranty claim must be lodged with the original supplier in the first instance. Repairs will not be effected by Zener Electric unless approved by the original supplier. Goods not of our own manufacture incorporated in our supply or sold by us, carry their maker's warranty only.
7. Goods returned for claim under warranty will be accepted on the condition that should the claim be rejected then all costs, including inspection, will be charged to the customer's account.
8. Zener Electric is not liable for any consequential loss.

SAFETY

Your MSC-3 must be applied, installed and operated in a safe manner. It is the responsibility of the user to ensure compliance with all regulations and practices covering the installation and wiring of your MSC-3. The instruction manual should be completely read and understood before attempting to connect or operate the MSC-3. Only skilled personnel should install this equipment.

THE CONTENTS OF THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE

MSC-3 Option Board Manual

Contents

MSC-3 Option Board Manual

Introduction

This manual describes the installation, features and operations of the **MSC-3** communication option. The features of this option include:

MODBUS RTU compliant communications protocol

- Drive ID - 1 to 247
- Group ID - 0 to 247
- User selectable baud rate and parity

Extra speed preset

- For more convenient use with communications
- Allows all of the existing presets to be used

Fault Log

- Saves the last 10 faults, with time / date stamp
- A fault mask, enabled or disabled by the user to filter out power fail / under voltage events to avoid filling the log. The user can clear the log.
- Viewable fault log

Kilowatt-hour meter

- Non volatile storage
- Can be reset

Hours run meter

- Non volatile storage
- Can be reset

Essential services operation (ESO) log

- With supplementary information of ESO activation and drive stress in ESO operation (i.e. trips ignored)

Real time clock with battery backup.

- Set Date/Time
- Used to Date/Timestamp log entries

Compatibility

This manual describes the features of the MODBUS Protocol option with software version 1.04 and is compatible with MSC-3 Control Board Software version 1.41 or later.

Restrictions:

MODBUS Protocol software version 1.03 or later will only support an Extended Features Option board (P/N AF03001 or AQ03001) installed on the left option connector of the MSC-3 Control Board with the Modbus Option on the right.

Function code 16, (Preset Multiple Registers) is implemented for additional flexibility and will operate on one holding register only.

Installation

WARNING! The MSC3 under operation has hazardous internal voltages. Ensure all power sources are removed for the duration of the Option Board installation. Allow at least 2 minutes for hazardous voltage levels to discharge.

IP30 Chassis A Installation

1. Ensure all power sources have been removed for at least 2 minutes and that they remain that way for the rest of the installation.
2. Remove the bottom section of the MSC3 blue plastic moulding to reveal the power terminals.
3. Remove the screw holding the control board/display assembly and pull it off the drive.
4. Turn the control board/display assembly over and plug the Option Board into one of the available option connectors.
5. Lay the Mylar insulation sheet on top off the exposed metal work and replace the control board/display/option assembly.
6. Replace the original mounting screw and install the Option Board mounting screw. The Option Board is ready for control wiring. Refer to the wiring diagram for wiring examples.
7. Once control wiring is complete replace the bottom moulding.
8. When the MSC-3 is switched on change the K02 DRIVE ID to a unique value. Refer to the K02 DRIVE ID section (page 10) of this manual for details.

IP 66 Chassis A Installation and all other chassis

1. Ensure all power sources have been removed for at least 2 minutes and that they remain that way for the rest of the installation.
2. Open the front door and remove the screws securing the control board to the chassis and lift of the control board.
3. Turn the control board over and plug the Option Board into one of the available option connectors.
4. Lay the Mylar insulation sheet on top off the exposed metal work and replace the control board/option assembly.
5. Replace the mounting screws. The Option Board is ready for control wiring. Refer to the wiring diagram for wiring examples.
6. Once control wiring is complete close the front door.
7. When the MSC-3 is switched on change the K02 DRIVE ID to a unique value. Refer to the K02 DRIVE ID section (page 10) of this manual for details.

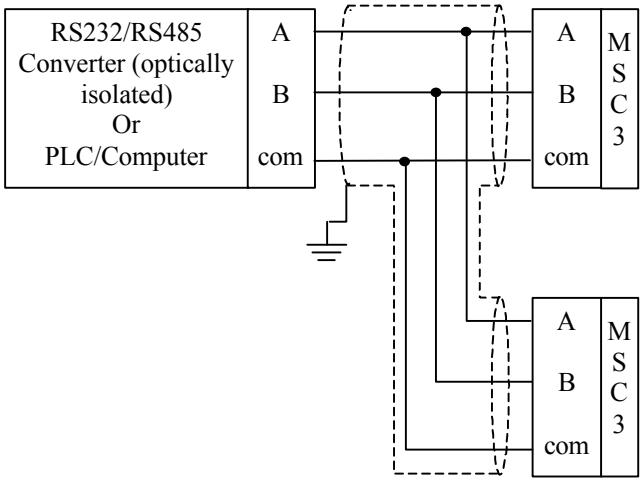
Battery Replacement

The battery used for time keeping is a **CR2032 3V Lithium** type. To replace the battery follow the first few steps of the installation section above to access the option board. Replace the old battery. Reassemble the drive as described in the installation section above.

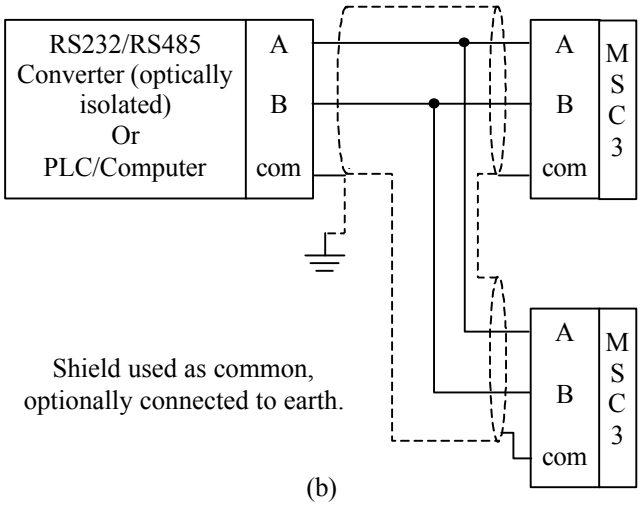
Installation - Wiring

If the MODBUS feature is to be used, extra wiring is required as shown in Figure 1, which contains the two network configurations supported. In each case some wiring installation precautions will help minimise the risk of network failure. These precautions include:

- Use twisted pair shielded communications cable.
- It is recommended that the circuit commons be connected in addition to communication conductors.
- Each length of cable should have its shield connected to ground at one end only (earthing recommended at the computer / controller end). The shield connection should be made as close as possible to the earthing conductor.
- Avoid laying communication cables adjacent to power cabling and wiring. If not possible utilise the best separation of communication cabling and power cabling.
- If possible communication cables should cross power cables at right angles to each other.
- Up to 64 drives may be connected to the same network without the need of a RS-485 Repeater.



(a)



(b)

Figure 1: Wiring configurations for RS-485. Use shielded cable in all cases to minimise susceptibility to electrical noise.

MSC-3 Option Board 3 provides for termination and line bias of the communication cabling by switch selection of SW1. SW1.1 selects the positive line bias, SW1.2 selects the line termination and SW1.3 selects the negative line bias. Figure 2 has details of SW1 designation and shows the default switch configuration.

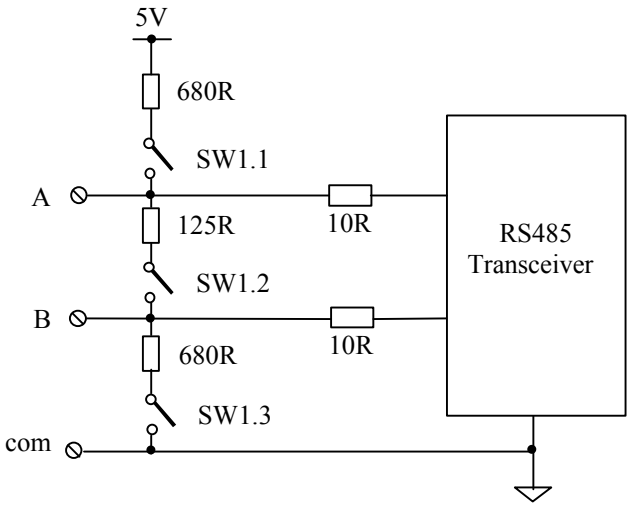


Figure 2: RS485 interface circuit configuration showing location of DIP Switches used to configure the port.

Communications Setup

Communication setup must be completed or at least checked before communications can begin. For the MSC3 the K00 COMMS SETUP menu is where alterations to the setup may be made. Setup items include protocol selection, drive ID selection and group ID selection.

K00 COMMS SETUP

Menu Location: First menu

Choices: K01 Protocol
K02 Drive ID
K03 Group ID

K01 Protocol

Menu Location: K00 Communications

Choices: 19200,8,even,1
19200,8,odd,1
19200,8,none,1
9600,8,even,1
9600,8,odd,1
9600,8,none,1 (initial setting)
4800,8,even,1
4800,8,odd,1
4800,8,none,1

The communication protocol may be changed to any of those listed above. Each choice specifies the bit rate, the data length, the parity type and the number of stop bits. Use the up and down push buttons to move through the list, press Enter to accept the displayed setting or Esc to abort the selection of a protocol.

K02 Drive ID

Menu Location: K00 Communications

Range: 1 (initial setting) to 247

Each MSC-3 with an Option Board 3 requires a unique drive ID. The drive ID is used to identify the drive on the communication network. Use the up & down push buttons to alter the ID, press Enter to accept or Escape to abort.

K03 Group ID

Menu Location: K00 Communications

Range: 0 (initial setting) to 247

This setting permits one communication packet to be processed by a group of MSC3's. This happens when the contents of the address field within the communication packet matches the group ID and no response is generated. Use the up or down push buttons to change the group ID, press Enter to accept the displayed setting or Esc to abort the change of group ID.

Fault Log

The fault log will record the date, time and drive status when a fault or trip occurs. The last 10 faults are recorded. A fault mask is provided to filter out power fail and under volt trips to avoid filling the log with power down trips.

K04 Fault Log

Menu Location: First menu

Choices: K05 View Log
K06 PF/UV Mask
K07 Clear Log

K05 View Log

Menu Location: K04 Fault Log

Display format: top line FF: XXXXXXXXX
bottom line yyyyMMMdd hh:mm

Where:

FF is the fault where 1 is the latest fault and 10 is the oldest.

XXXXXXXXX fault status code (a '1' indicates the corresponding fault). The digits are read left to right and the corresponding trip is read top to bottom

Output Short Circuit
Over Voltage
Over current
DC Low
Power Fail
Supply Fail
Over temperature
I2t trip
Thermistor over temperature

yyyyMMMdd is the date of the fault

hh:mm is the time of the fault

The up and down push buttons move through the log. Press Enter or Esc to finish viewing the log. To facilitate correct logging check for correct date and time. See menu K16 DATE/TIME for details.

K06 PF/UV Mask

Menu Location: K04 Fault Log

Choices: K23 Enabled
K24 Disabled (initial setting)

The K06 PF/UV Mask when enabled prevents a power fail or undervolts trip from making an entry in the fault log. This may be useful in those applications where the power is cycled on and off regularly. Use the up and down push buttons to select enable or disable, press Enter to accept the displayed setting or Esc to abort the change.

K07 Clear Log

Menu Location: K04 Fault Log

This is a two step sequence to clear the fault log. Press Enter once and the "K25 continue ?" question is displayed which provides an opportunity to abort clearing the fault log. Press Enter a second time to clear the fault log or press Esc to abort.

Run Log

The run log records motor and drive run time information, such as hours run and kilowatt-hours.

K08 Run log

Menu Location: First menu

Choices: K09 Hours run
K10 kWh
K11 Clear Log

K09 Hours run

Menu Location: K08 Run log

Initial value: 0

The number of hours the motor has been running for is recorded in the run log. If the drive is on and the motor has not been running as indicated by the O00 RUN relay output, no time is recorded. Press Esc to return to the menu.

K10 KWh

Menu Location: K08 Run log

Initial value: 0

The kWh log records the energy used by the motor. Press Esc to return to the menu.

K11 Clear log

Menu Location: K08 Run log

This is a two step sequence to clear the run log. Press Enter once and the “K25 continue?“ question is displayed which provides an opportunity to abort clearing the run log. Press Enter a second time to clear the run log or press Esc to abort.

Essential Services Override Log

Supplementary ESO information is recorded by the MSC3. The date and time of ESO feature activation is recorded as well as the date and time of drive stress (operated beyond design specifications) in ESO mode. Reset of the activation and stressed date and time is security code protected.

K12 ESO log

Menu Location: First menu

Choices: K13 ESO activated
K14 ESO stressed
K15 Clear log

K13 ESO activated

Menu Location: K12 ESO log

Display format: top line K13 ESO activated
bottom line yyyyMMMdd hh:mm

Where:

yyyyMMMdd is the date of activation
hh:mm is the time of activation

This menu displays the date and time of the last activation of the ESO feature. Activation is detected when the MSC3 enters ESO mode operation. Press Esc to return to the menu.

K14 ESO stressed

Menu Location: K12 ESO log

Display format: top line K13 ESO stressed
bottom line yyyyMMMdd hh:mm

Where:

yyyyMMMdd is the date when the MSC3 was stressed
hh:mm is the time when the MSC3 was stressed

In ESO mode the MSC3 will ignore any of the following trips: SUPPLY F, I2T TRIP, OT and OT THERM. When this occurs, the MSC3 and/or motor is operated beyond design specifications. The date and time of the last occurrence of this event is recorded in the K14 ESO stressed menu. Press Esc to return to the menu.

K15 Clear log

Menu Location: K12 ESO log

The ESO log is security coded against accidental clearing. Press Enter and MSC3 waits for the security code **1472** to be entered. Use the Up and Down push buttons to set the code and press Enter to accept the code and if correct it will clear the ESO log.

Time Keeping

There are several features that require a date and time. To support these features time keeping needs to be set with the correct time. Date and time adjustments are done in the K15 Date/Time menu. Press Enter to begin time adjustment.

K15 Date/Time

Menu Location: First menu

K16 Year

Menu Location: K15 Date/Time

Initial value: 2000

Range: 2000...2099

Use the up and down push buttons to adjust the year. Press Enter to accept the setting or Esc to abort. Pressing Esc will abort the adjustment and proceed to the month setting.

K17 Month

Menu Location: K15 Date/Time

Choices:			
	JAN (initial value)	MAY	SEP
	FEB	JUN	OCT
	MAR	JUL	NOV
	APR	AUG	DEC

Use the up and down push buttons to change the month. Press Enter to accept the setting or Esc to abort. Pressing Esc will abort the adjustment and proceed to the day adjustment

K18 Day

Menu Location: K15 Date/Time

Initial value: 1

Range: 1…31

Use the up and down push buttons to adjust the day of the month. Press Enter to accept the setting or Esc to abort. Pressing Esc will abort the adjustment and proceed to the hour setting.

K19 Hours

Menu Location: K15 Date/Time

Initial value: 0

Range: 0...23

Use the up and down push buttons to adjust the hour. Press Enter to accept the setting or Esc to abort. Pressing Esc will abort the adjustment and proceed to the minute setting.

K20 Minutes

Menu Location: K15 Date/Time

Initial value: 0

Range: 0...59

Use the up and down push buttons to adjust the minutes. Press Enter to accept the setting or Esc to abort.

Preset Speed

K22 COMMS PRESET

Menu Location: Reference selection list

Range: -100...100 %

The "K22 COMMS PRESET" is an additional speed reference is provided for use with external communications. Use the up and down push buttons to adjust the reference between -100 to 100% of the maximum speed. Press Enter to accept the value or Esc to abort.

Note: Adjustment of the K22 COMMS PRESET through the console will be remembered after the power has been cycled. This is not the case when accessed by communications.

MSC3 MODBUS PROTOCOL

Option Board 3 of the MSC-3 Option Board family is for communication and control of the MSC-3 via a half duplex, RS-485 serial link and a MODBUS compliant protocol. It has a multi drop capability allowing up to 64 MSC-3 units on one network. An MSC-3 connected to a MODBUS network is a slave device and all the modes, controls and parameters can be controlled and monitored from a MODBUS master such as PLC.

RS-485 is a term that identifies the physical specification. It is a 'differential' (balanced) circuit where signal transmission is done over a pair of cable conductors (the signal and it's logical complement). The advantage of this technique is its ability to reject common mode interference. RS-485 permits several devices to be connected to a single pair of conductors in a multi-drop or parallel configuration and can achieve 100 kBit/sec over a cable length of 1200 meters.

Some network masters such as a computer, do not have RS-485 capabilities and typically have RS-232 serial ports instead. In such cases an RS-232 to RS-485 converter is required however, not all converters are alike. We recommend an isolated converter known by **Zener** to work well. We currently support / have most experience with the JAMECO isolated RS232/485 converter (Jameco part no. 122956).

MODBUS Protocol is the name of a communication specification that describes the data format that is transferred over the network. Option board 3 implements a subset of these formats. The remainder of this manual describes the supported MODBUS functions and the RS485 physical link of Option board 3. Refer to the application manuals for information about network master / controller operations.

The MSC-3 implements RTU (Remote Terminal Unit) Framing, which is a binary representation of the MODBUS information. This section describes these data formats in hexadecimal notation as denoted by suffix capital H.

Independent of the bit rate, the MSC-3 requires that the idle time between characters in a packet be less than 6 milliseconds. The MSC-3 will reject packets with longer idle times.

MSC3 SUPPORTED MODBUS FUNCTIONS

The MSC-3 supports the following MODBUS functions:

Function Code	Name
03	Read Holding Register
05	Force Single Coil
06	Preset Single Register
16	Preset Multiple Registers

Table 1: Supported MODBUS Function Codes

MODBUS FUNCTION 03 – READ HOLDING REGISTERS

This function reads the binary contents of holding registers in the MSC-3. An attempt to read more than one holding register at a time will generate an Exception Response as ILLEGAL DATA VALUE. Broadcast and multiple reading of Holding Registers are not supported in this function mode.

The query message from master specifies the slave address, function code, starting register and quantity of registers to be read. In case of MSC-3 slave unit, only one register is read in one message. Registers are addressed starting at zero. In other words holding registers 40001 ... 40045 are addressed as 0 ... 44 respectively.

Figure 3 is an example of a request to read Holding register 40024 from MSC-3 slave device 20:

Slave Address	MODBUS Function Code	Starting Data Address (Hi)	Starting Data Address (Lo)	Number of Holding Registers(fixed to 00H)	Number of Holding Registers(fixed to 01H)	CRC-16 (Hi)	CRC-16 (Lo)
14H	03H	00H	17H	00H	01H	36H	CBH

Fig 3 Example of Function code 3 MODBUS Query message using RTU Framing.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Data is scanned in the slave and the response is returned when the data is completely assembled. Figure 4 is an example of a response to the above query:

Slave Address	MODBUS Function Code	Byte Count	Data Value (Hi)	Data Value (Lo)	CRC-16 (Hi)	CRC-16 (Lo)
14H	03H	02H	00H	34H	B4H	50H

Fig 4 Example of Function code 3 MODBUS Response message using RTU Framing.

MODBUS FUNCTION 05 – FORCE SINGLE COIL

Forces a single coil to either ON or OFF. When broadcasted, the function forces the same coil in all attached MSC-3 slaves in the MODBUS network.

The query message specifies the coil to be forced. Coils are addressed starting at zero ie coil 1 is addressed as 0.
The requested ON / OFF state is specified by a constant in the query data field. A value of FF 00 hex requests the coil to be ON. A value of 00 00 hex requests it to be OFF. All other values are illegal and will not affect the coil.

Figure 5 is an example of a request to force coil 11 ON in slave device 8:

Slave Address	MODBUS Function Code	Coil Address High	Coil Address Low	Force Data High	Force Data Low	CRC-16 (Hi)	CRC-16 (Lo)
08H	05H	00H	0AH	FFH	00H	ACH	A1H

Fig 5 Example of Function code 5 MODBUS Query message using RTU Framing.

The response to the MODBUS master is simply the echo of the above query.

MODBUS FUNCTION 06 – PRESET SINGLE REGISTER

Presets a value into a single holding register. When broadcasted, the function presets the same register in all attached MSC-3 slaves in the MODBUS network.

The query message specifies the register to be preset. Registers are addressed starting at zero ie holding register 40001 is addressed as 0.

The requested preset value is specified in the query data field. Figure 6 is an example of a request to preset register 40014 to 00 03 hex in slave device 18:

Slave Address	MODBUS Function Code	Register Address (Hi)	Register Address (Lo)	Preset Data High	Preset Data Low	CRC-16 (Hi)	CRC-16 (Lo)
12H	06H	00H	0DH	00H	03H	5AH	ABH

Fig 6 Example of Function code 6 MODBUS Query message using RTU Framing.

The response from the MSC-3 slave device to the master in the network is an echo of the above packet.

MODBUS FUNCTION 16 – PRESET MULTIPLE REGISTERS

Presets a value into multiple registers. However, the current implementation operates with one register only. When broadcasted, the function presets the same register in all attached MSC-3 slaves in the MODBUS network.

The query message specifies the first register to be preset. Registers are addressed starting at zero ie holding register 40001 is addressed as 0.

The requested preset value is specified in the query data field. Figure 7 is an example of a request to preset register 40014 to 00 03 hex in slave device 18:

Slave Address	MODBUS Function Code	Register Address	Register Count (fixed)	Byte Count (fixed)	Preset Data	CRC-16 (Hi)	CRC-16 (Lo)
12H	10H	000DH	0001H	02H	0003H	7CH	3EH

Fig 7 Example of Function code 6 MODBUS Query message using RTU Framing.

The response from the MSC-3 slave device to the master is:

Slave Address	MODBUS Function Code	Register Address	Register Count	CRC-16 (Hi)	CRC-16 (Lo)
12H	10H	000DH	0001H	A9H	92H

Exception Responses

Except for broadcast messages, when a master device sends a query to the MSC-3 drive it expects a normal response. One of four possible events can occur from the master's query:

1) If the MSC-3 receives the query without a communication error, and can handle the query normally, it returns a normal response.

2) If the MSC-3 does not receive the query due to a communication error, no response is returned. The master program will eventually process a timeout condition for the query.

3) If the MSC-3 receives the query, but detects a communication error (parity or CRC), no response is returned. The master program will eventually process a timeout condition for the query.

4) If the MSC-3 receives the query without a communication error, but cannot handle it (for example, if the request is to read a nonexistent coil or register), the MSC-3 will return an exception response informing the master of the nature of the error.
The exception response message has two fields that differentiate it from a normal response:

Function Code Field

In a normal response, the MSC-3 echoes the function code of the original query in the function code field of the response. All function codes have a most significant bit (MSB) of 0 (their values are all below 80 hexadecimal). In an exception response, the MSC-3 sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response.

With the function code's MSB set, the master's application program can recognize the exception response and can examine the data field for the exception code.

Data Field

In a normal response, the MSC-3 may return data or statistics in the data field (any information that was requested in the query). In an exception response, the MSC-3 returns an exception code in the data field. This defines the MSC-3 condition that caused the exception. Figure 8 and 9 are examples of a master query and a slave exception response.

Slave Address	MODBUS Function Code	Starting Data Address (Hi)	Starting Data Address (Lo)	Number of Holding Registers (always = 00H)	Number of Holding Registers (always = 01H)	CRC-16 (Hi)	CRC-16 (Lo)
19H	03H	00H	32H	00H	01H	26H	1DH

Fig 8 Example of an Exception Query

Slave Address	MODBUS Function Code	Exception Code	CRC-16 (Hi)	CRC-16 (Lo)
19H	03H	02H	40H	F6H

Fig 9 Example of an Exception Response

In this example, the master addresses a query to the MSC-3 Slave number 25 (19 hex). The function code (03) is for Reading the
Binary contents of the Holding Register at address 40051 (0032 hex).

Note: Only one (fixed) Holding Register is to be read, as specified by the number of Holding Register field (0001H) for MSC-3 drive.

Since the Holding Register address is nonexistent in the MSC-3, the MSC-3 will return the exception response with the exception code (02). This specifies an illegal data address for the MSC-3.

The MSC-3 drive supports the following exception codes:

Exception Codes

Code	Name	Meaning
01	ILLEGAL FUNCTION	The Function Code received in the query is not an allowable function in the MSC-3
02	ILLEGAL DATA ADDRESS	The Data Address received is not an allowable address for the MSC-3
03	ILLEGAL DATA VALUE	The Value contained in the Data Value field is not an allowable value for the MSC-3

MSC3 MODBUS HOLDING REGISTERS AND COILS

MSC-3 HOLDING REGISTERS AND COILS

MSC-3 consists of 169 holding registers and 18 discrete coils, which could be accessed via MODBUS protocol system. The tables 2 to 9 below outlines the available holding registers and coils that can be addressed to retrieve information from the MSC-3 (slave) drive. The items in the tables are sorted in ascending MODBUS address order.

TABLE 2: CONTROL BOARD – Holding Registers

Address	Engineering Scale	Raw Scale	Raw Default	Access	Console Menu Description
PERSISTENT VARIABLE ACCESS					
40001	(Refer Table 10 for other choices)		31	R/W	A01 Run Variable
40002	0…3/10...9999	0…3/10...9999	1/500 (Refer Note 1)	R/W	A02 Run scale & decimal points
40003	(Refer to Appendix B)		"Hz "	R/W	A03 Run Units
40004	(Refer to Appendix B)		" "	R/W	A03 Run Units
40005	(Refer to Appendix B)		" "	R/W	A03 Run Units
40006	(Refer to Appendix B)		" "	R/W	A03 Run Units
40007	200...900 Volts	200...900	415	R/W	B01 Motor Volts
40008	18...137% of IRMSMAX Amps (Refer Note 2)	4170…31742	IMOTORDEF (Refer Note 2)	R/W	B02 Motor Amps
40009	30…200Hz	30…200	50/60	R/W	B03 Motor Hz
40010	500…60 x MotorHz RPM	500…60 x MotorHz	1465/1765	R/W	B04 Motor RPM
40011	0…195Hz	0…195	0	R/W	C01 Min Hz
40012	5…200Hz	5…200	50/60	R/W	C02 Max Hz
40013	0.5…600.0 sec	5…6000	100	R/W	C04 Acceleration Time
40014	0.5…600.0 sec	5…6000	100	R/W	C05 Deceleration Time
40015	0.01…40.00 sec	1…4000	1	R/W	C06 S Time
40016	0…150%	0…6144	1024	R/W	C07 Flux Plus %
40017	0…150%	0…6144	0	R/W	C09 Slip Comp
40018	Auto Select, 2, 4, 8, 16 kHz	0, 409, 819, 1638, 3276	0	R/W	C11 Audible Freq
40019	18…100% of IRMSMAX (Refer Note 2)	4170…23170	ICLIMDEF * IRMSMAX / 32768	R/W	D01 Current Lim
40020	18…100% of IRMSMAX (Refer Note 2)	4170…23170	IMOTORDEF (Refer Note 2)	R/W	D02 I^2T
40021	18…100% of IRMSMAX (Refer Note 2)	4170…23170	IMOTORDEF (Refer Note 2)	R/W	D03 I^2T Zero Hz
40022	2…200Hz	2…200	10	R/W	D02 I^2T Cnr Hz
40023	0…15 restarts 0.1…20.0 mins	0…15 1…200	0 /200 (Refer Note 3)	R/W R/W	E08 A/Rs Allowed E09 A/R Clr Time
40024	(Refer Table 13 for other choices)		52	R/W	F01 Remote
40025	(Refer Table 13 for other choices)		55	R/W	F02 Local
40026	(Refer Table 13 for other choices)		53	R/W	F03 Eso
40027	(Refer Table 13 for other choices)		53	R/W	F04 JogFwd
40028	(Refer Table 13 for other choices)		53	R/W	F05 JogRev
40029	(Refer Table 11 for other choices)		47	R/W	G11 Dig IN1
40030	(Refer Table 11 for other choices)		42	R/W	G12 Dig IN2
40031	(Refer Table 11 for other choices)		40	R/W	G13 Dig IN3
40032	(Refer Table 11 for other choices)		51	R/W	G14 Dig IN4
40033	(Refer Table 12 for other choices)		56	R/W	G15 Relay1
40034	(Refer Table 12 for other choices)		57	R/W	G16 Relay2
40035	(Refer Table 14 for details)			R/W	Features
40036	0…100%	0…32767	6553	R/W	O06 Under Speed %
40037	0…100%	0…32767	26213	R/W	O07 Over Speed %
40038	-1000…1000%	-1000…1000	0	R/W	R01 Ref At 0%
40039	-1000…1000%	-1000…1000	100	R/W	R02 Ref At 100%
40040	-100...100%	-32768…32767	19660	R/W	R03 Preset
40041	-200…200Hz	-32768…32767	0	R/W	R04 Motorizd Pot

MSC3 MODBUS ADDITIONAL HOLDING REGISTERS

Additional holding registers are available that allow function code 06 and 16 to operate MSC-3. The table below lists the additional addresses and their function. The functions listed are input terminal wiring functions as described in the MSC3 Instruction manual. Please refer to this manual for function specifics.

Please note that these addresses provide alternative access to coil functions accessed through the 05 function code.

In each case:

- A **NON-ZERO** value written to one of these addresses will activate the respective terminal input function.
- A **value of zero** written to one of these addresses will deactivate the respective terminal input function.

ADDITIONAL – Holding Registers

Address	Access	Function
40042	W	FWD&LATCH operation
40043	W	REV&LATCH
40044	W	~STOP
40045	W	FWD
40046	W	REV
40047	W	UP
40048	W	DOWN
40049	W	RESET
40050	W	ESO
40051	W	JOGFWD
40052	W	JOGREV
40053	W	REMOTE
40054	W	ACTIVATE SETTINGS

In order to check on the status of these terminal functions, refer to holding register 40062, which is Drive status flag register 1

DRIVE STATUS ACCESS					
40061	(Refer Table 15 for details)			R	Drive Status Flag Reg 0
40062	(Refer Table 15 for details)			R	Drive Status Flag Reg 1
40063	(Refer Table 15 for details)			R	Drive Status Flag Reg 2
40064	(Refer Table 15 for details)			R	Drive Status Flag Reg 3
40065	(Refer Table 15 for details)			R	Drive Status Flag Reg 4
DRIVE TYPE PARAMETER ACCESS					
40081	(Refer Table 16 for details)			R	DRIVEID
40082	(Refer Table 16 for details)			R	SIZEDISP
40083	(Refer Table 16 for details)			R	VBUSSCALE
40084	(Refer Table 16 for details)			R	ISCALE
40085	(Refer Table 16 for details)			R	ISCALERMS
40086	(Refer Table 16 for details)			R	IRMSMAX
40087	(Refer Table 16 for details)			R	PWRSCALE
40088	(Refer Table 16 for details)			R	ICLIMDEF
40089	(Refer Table 16 for details)			R	IMOTORDEF
VOLATILE VARIABLE ACCESS (Run Variable)					
40101	-256…255.99Hz	-32768…32767		R	Speed
40102	-8000…7999%	-32768…32767		R	Load
40103	±ISCALERMS^2	-32768…32767		R	Current
40104	±VBUSSCALE^2	-32768…32767		R	DCVolts
40105	±PWRSCALE^2	-32768…32767		R	Power
40106	±VBUSSCALE^2	-32768…32767		R	ACVolts
40107	0…500 °K	-32768…32767		R	Temp
40108	±ISCALERMS^2	-32768…32767		R	I^2TUsed
REFERENCES ACCESS					
40121		-32768…32767		R	R00 Analog Input
40122		-32768…32767		R	R03 Preset
40123		-32768…32767		R	R04 Motorizd Pot
40124		-32768…32767		R	R07 Console Ref
MSC3 SOFTWARE VERSION ACCESS					
40141	First 2 ASCII characters of 6 ASCII characters			R	MSC3 Version Information
40142	Second 2 ASCII characters of 6 ASCII characters			R	MSC3 Version Information
40143	Third 2 ASCII characters of 6 ASCII characters			R	MSC3 Version Information

Note 1: To calculate Raw Value for Run Scale and Decimal point, use this formula: Decimal Point (0…3) x 2^{14} + Scale Value (10…9999)

For Example to calculate Raw Value for the Run Scale as 50.0 with one Decimal point (1/500 default case), then use Raw Value = 1 x 2^{14} + 500 = 16884 = 0x41F4 as MODBUS data.

Note 2: Refer to Table 16 for the drive parameter definitions.

Note 3: To calculate Raw Value for A/Rs Allowed and A/R Clr Time, use this formula: restarts (0…15) x 2^8 + Scale Value (1…200)

For Example to calculate Raw Value for the A/Rs Allowed as 0 and A/R Clr Time as 20 minutes (0/200 default case), then use Raw Value = 0 x 2^8 + 200 = 200 = 0x00C8 as MODBUS data.

TABLE 3: CONTROL BOARD – Coils

Address	Coil Set	Coil Cleared	Default	Access	Description
00001	Enabled	Disabled	Disabled	W	I00 Fwd&Latch
00002	Enabled	Disabled	Disabled	W	I01 Rev&Latch
00003	Enabled	Disabled	Disabled	W	I02 ~Stop
00004	Enabled	Disabled	Disabled	W	I03 Fwd
00005	Enabled	Disabled	Disabled	W	I04 Rev
00006	Enabled	Disabled	Disabled	W	I05 Up
00007	Enabled	Disabled	Disabled	W	I06 Down
00008	Enabled	Disabled	Disabled	W	I07 Reset
00009	Enabled	Disabled	Disabled	W	I08 Eso
00010	Enabled	Disabled	Disabled	W	I09 JogFwd
00011	Enabled	Disabled	Disabled	W	I10 JogRev
00012	Enabled	Disabled	Disabled	W	I11 Remote
00013	Enabled	Disabled	Disabled	W	Activate Settings

TABLE 4: OPTION BOARD 1 (Left option) – Holding Registers

Address	Engineering Scale	Raw Scale	Raw Default	Access	Console Menu Description
PERSISTENT VARIABLE ACCESS					
40501	(Refer Table 10)		SELHERTZ	R/W	P01 Analog Opt
40502	-100...100%	-100..100	0	R/W	P02 Zero Opt %
40503	-1000...1000%	-1000..1000	100	R/W	P03 Max Opt %
40504	-100...100%	-100..100	0	R/W	P04 Min Opt %
40505	(Refer Table 13)		SELANIPT	R/W	P06 User Ref 1
40506	(Refer Table 13)		OPSELANIN	R/W	P07 User Ref 2
40507	-100…100%	-32768...32767	3276	R/W	P08 Preset 1
40508	-100…100%	-32768...32767	6552	R/W	P09 Preset 2
40509	-100…100%	-32768...32767	9828	R/W	P10 Preset 3
40510	-100…100%	-32768...32767	13104	R/W	P11 Preset 4
40511	-100…100%	-32768...32767	16380	R/W	P12 Preset 5
40512	-100…100%	-32768...32767	19656	R/W	P13 Preset 6
40513	(Refer Table 11)		SELECTOR1	R/W	P18 OP DIG IN 1
40514	(Refer Table 11)		SELECTOR2	R/W	P19 OP DIG IN 2
40515	(Refer Table 11)		SELECTOR3	R/W	P20 OP DIG IN 3
40516	(Refer Table 11)		SELREVLCH	R/W	P21 OP DIG IN 4
40517	-1000…1000%	-1000…1000	0	R/W	P23 Ref at 0%
40518	-1000…1000%	-1000…1000	100	R/W	P24 Ref at 100%
40519	-1000…1000%	-1000…1000	300	R/W	P26 PB (%)
40520	0…20.00 sec	0…2000	200	R/W	P27 Ti (sec/r)
40521	0…5.00 sec	0…500	0	R/W	P28 Td (sec)
40522	0…100 %	0…32767	32767	R/W	P29 +I Clamp
40523	-100…0%	-32767…0	-32767	R/W	P30 –I Clamp
40524	0…100 %	0…32767	32767	R/W	P31 +O Clamp
40525	-100…0 %	-32767…0	0	R/W	P32 –O Clamp
40526	(Refer Table 13)		SELANIPT	R/W	P33 SV Choice
40527	(Refer Table 13)		SELZERO	R/W	P34 FF Choice
40528	(Refer to Appendix B)		" % "	R/W	P35 PID Units
40529	(Refer to Appendix B)		" "	R/W	P35 PID Units
40530	(Refer to Appendix B)		" "	R/W	P35 PID Units
40531	(Refer to Appendix B)		" "	R/W	P35 PID Units
40532	10…9999	10…9999	100	R/W	P36 Scaling
40533	-100…100	-32768…32767	26214	R/W	P39 PV Over %
40534	-100…100	-32768…32767	6552	R/W	P40 PV Under %
40535	(Refer Table 12)		SELRUN	R/W	P41 Op Dig Out
REFERENCE ACCESS					
40601		-32768…32767		R	Digital Input Reference Selector
40602		-32768…32767		R	Zero Speed Reference
40603		-32768…32767		R	PID Output Reference
40604		-32768…32767		R	Analog Input Reference

TABLE 5: OPTION BOARD 1 (Left option) – Coils

Address	Coil Set	Coil Cleared	Default	Access	Description
00101	Enabled	Disabled	Disabled	W	Activate Settings –Left option 1

TABLE 6: OPTION BOARD 1 (Right option) – Holding Registers

Address	Engineering Scale	Raw Scale	Raw Default	Access	Console Menu Description
PERSISTENT VARIABLE ACCESS					
41001	(Refer Table 10)		SELHERTZ	R/W	P01 Analog Opt
41002	-100...100%	-100..100	0	R/W	P02 Zero Opt %
41003	-1000...1000%	-1000..1000	100	R/W	P03 Max Opt %

41004	-100...100%	-100..100	0	R/W	P04 Min Opt %
41005	(Refer Table 13)		SELANIPT	R/W	P06 User Ref 1
41006	(Refer Table 13)		OPSELANIN	R/W	P07 User Ref 2
41007	-100…100%	-32768...32767	3276	R/W	P08 Preset 1
41008	-100…100%	-32768...32767	6552	R/W	P09 Preset 2
41009	-100…100%	-32768...32767	9828	R/W	P10 Preset 3
41010	-100…100%	-32768...32767	13104	R/W	P11 Preset 4
41011	-100…100%	-32768...32767	16380	R/W	P12 Preset 5
41012	-100…100%	-32768...32767	19656	R/W	P13 Preset 6
41013	(Refer Table 11)		SELECTOR 1	R/W	P18 OP DIG IN 1
41014	(Refer Table 11)		SELECTOR 2	R/W	P19 OP DIG IN 2
41015	(Refer Table 11)		SELECTOR 3	R/W	P20 OP DIG IN 3
41016	(Refer Table 11)		SELREVLCH	R/W	P21 OP DIG IN 4
41017	-1000…1000%	-1000…1000	0	R/W	P23 Ref at 0%
41018	-1000…1000%	-1000…1000	100	R/W	P24 Ref at 100%
41019	-1000…1000%	-1000…1000	300	R/W	P26 PB (%)
41020	0…20.00 sec	0…2000	200	R/W	P27 Ti (sec/r)
41021	0…5.00 sec	0…500	0	R/W	P28 Td (sec)
41022	0…100 %	0…32767	32767	R/W	P29 +I Clamp
41023	-100…0%	-32767…0	-32767	R/W	P30 –I Clamp
41024	0…100 %	0…32767	32767	R/W	P31 +O Clamp
41025	-100…0 %	-32767…0	0	R/W	P32 –O Clamp
41026	(Refer Table 13)		SELANIPT	R/W	P33 SV Choice
41027	(Refer Table 13)		SELZERO	R/W	P34 FF Choice
41028	(Refer to Appendix B)		" % "	R/W	P35 PID Units
41029	(Refer to Appendix B)		" "	R/W	P35 PID Units
41030	(Refer to Appendix B)		" "	R/W	P35 PID Units
41031	(Refer to Appendix B)		" "	R/W	P35 PID Units
41032	10…9999	10…9999	100	R/W	P36 Scaling
41033	-100…100	-32768…32767	26214	R/W	P39 PV Over %
41034	-100…100	-32768…32767	6552	R/W	P40 PV Under %
41035	(Refer Table 12)		SELRUN	R/W	P41 Op Dig Out
REFERENCE ACCESS					
41101		-32768…32767		R	Digital Input Reference Selector
41102		-32768…32767		R	Zero Speed Reference
41103		-32768…32767		R	PID Output Reference
41104		-32768…32767		R	Analog Input Reference

TABLE 7: OPTION BOARD 1 (Right option) – Coils

Address	Coil Set	Coil Cleared	Default	Access	Description
00201	Enabled	Disabled	Disabled	W	Activate Settings –Right option 1

TABLE 8: OPTION BOARD 3 – Holding Registers

Address	Engineering Scale	Raw Scale	Raw Default	Access	Console Menu Description
PERSISTENT VARIABLE ACCESS					
41501	2000…2099			R/W	Year Field

41502	1…12			R/W	Month Field
41503	1…31			R/W	Day Field
41504	0…23			R/W	Hour Field
41505	0…59			R/W	Minute Field
41506	(Refer Note 4)			R/W	PF/UV Mask
41507	0…999999 (BCD)			R	Reading kWh
41508	0…999999 (BCD)			R	Reading Hours Run
41509	(Refer Note 5)			R	Reading ESOactivated
41510	(Refer Note 5)			R	Reading ESOstressed
41511	(Refer Note 6)			R	Reading Fault Log 1 (14 Bytes)
41512	(Refer Note 6)			R	Reading Fault Log 2 (14 Bytes)
41513	(Refer Note 6)			R	Reading Fault Log 3 (14 Bytes)
41514	(Refer Note 6)			R	Reading Fault Log 4 (14 Bytes)
41515	(Refer Note 6)			R	Reading Fault Log 5 (14 Bytes)
41516	(Refer Note 6)			R	Reading Fault Log 6 (14 Bytes)
41517	(Refer Note 6)			R	Reading Fault Log 7 (14 Bytes)
41518	(Refer Note 6)			R	Reading Fault Log 8 (14 Bytes)
41519	(Refer Note 6)			R	Reading Fault Log 9 (14 Bytes)
41520	(Refer Note 6)			R	Reading Fault Log 10 (14 Bytes)
REFERENCE ACCESS					
41551	-100%…100%			R/W	CPRESET (volatile)

Note 4: The Read and Write Data can be as follows:

0 == read the status
1 == disable the PFUV mask
2 == enable the PFUV mask

Note 5: The response data format will be in the following form.

yyyy	MM	dd	hh	mm

Note 6: When the response is received, the 14 bytes of data format is as follows:

yyyy	MM	dd	hh	mm	Status0	Status1	status2	status3

Where:

yyyy	is the year field with range 2000..2099 in integer format.
MM	is the month field with range 1..12 in unsigned char format
dd	is the day field with range 1..31 in unsigned char format
hh	is the hour field with range 0..23 in unsigned char format
mm	is the minute field with range 0..59 in unsigned char format
status 0:3	is a record of the status at the time of the trip. Refer to Table 15 to interpret the status

TABLE 9: OPTION BOARD 3 – Coils

Address	Coil Set	Coil Cleared	Default	Access	Description
00301	Enabled	Disabled	Disabled	W	Clearing the fault log
00302	Enabled	Disabled	Disabled	W	Clearing the run log
00303	Enabled	Disabled	Disabled	W	Clearing the ESO log

Table 10: Choices for Run variable assignment

Symbol	Value	Description
CONTROL BOARD		
SELHERTZ	0x001F	Output frequency run variable
SELRPM	0x0020	Output speed run variable
SELLOAD	0x0021	Motor load run variable
SELAMPS	0x0022	Motor current magnitude run variable
SELDCVOLTS	0x0023	DC bus run variable
SELPOWER	0x0024	Output power run variable
SELVOLTS	0x0025	Output volts run variable
SELHSNKTMPC	0x005C	Heat sink temperature degree Celsius run variable
SELHSNKTMPF	0x005D	Heat sink temperature degree Fahrenheit run variable
SELI2TUSED	0x005E	Motor thermal overload run variable
OPTION BOARD 1		
SELPIDVAR	0x0220 (left option) 0x0A20 (right option)	PID Output run variable

Table 11: Choices for Digital input assignment

Symbol	Value	Description
CONTROL BOARD		
SELFWDLCH	0x0028	Forward and latch terminal function
SELREVLCH	0x0029	Reverse and latch terminal function
SELDIGSTOP	0x002A	Stop terminal function
SELFWD	0x002B	Forward terminal function
SELREV	0x002C	Reverse terminal function
SELUP	0x002D	Motorised potentiometer UP terminal function
SELDOWN	0x002E	Motorised potentiometer DOWN terminal function
SELRESET	0x002F	Trip reset terminal function
SELESO	0x0030	Essential Services Override terminal function
SELJOGFWD	0x0031	JOG forward terminal function
SELJOGREV	0x0032	JOG reverse terminal function
SELREMOTE	0x0033	Remote / local terminal function
OPTION BOARD 1		
SELECTOR 1	0x0212 (left option) 0x0A12 (right option)	Option Board Selector Input 1 Function
SELECTOR 2	0x0213 (left option) 0x0A13 (right option)	Option Board Selector Input 2 Function
SELECTOR 3	0x0214 (left option) 0x0A14 (right option)	Option Board Selector Input 3 Function

Table 12: Choices for Digital output assignment

Symbol	Value	Description
CONTROL BOARD		
SELRUN	0x0038	Run status relay output function
SELTRIP	0x0039	Trip status relay output function
SELOPTESO	0x003A	ESO status relay output function
SELPROOF	0x003B	Proof status relay output function
SELZEROSPD	0x003C	Zero speed status relay output function
SELATSPD	0x003D	At speed status relay output function
SELCMPUSPDOPT	0x003E	Under speed status relay output function
SELCMPOSPDOPT	0x003F	Over speed status relay output function
SELOPTON	0x0042	Relay ON output function
SELOPTOFF	0x0043	Relay OFF output function
SELARFAIL	0x0044	Auto restart failure status relay output function
SELOPTFWD	0x0045	Forward status relay output function
SELOPTREV	0x0046	Reverse status relay output function
SELENABLED	0x0047	Enabled status relay output function
SELI2TTRIP	0x0048	I^2t trip status relay output function
SELOVERTEMP	0x0049	Over temperature status relay output function
OPTION BOARD 1		
OPSELPVO	0x0224 (left option) 0x0A24 (right option)	Process variable over alarm
OPSELPVU	0x0225 (left option) 0x0A25 (right option)	Process variable under alarm

Table 13: Choices for Speed references

Symbol	Value	Description
CONTROL BOARD		
SELANIPT	0x0034	Analog input speed reference
SELPRESET	0x0035	Internal preset speed reference
SELMOTPOT	0x0036	Motorised potentiometer speed reference
SELCONREF	0x0037	**Console** speed reference
OPTION BOARD 1		
REFSELECTOR	0x021B (left option) 0x0A1B (right option)	Digital input reference selector
SELZERO	0x021C (left option) 0x0A1C (right option)	Zero speed reference
SELPIDOPT	0x021D (left option) 0x0A1D (right option)	PID output reference
OPSELANIN	0x0223 (left option) 0x0A23 (right option)	Analog input reference

Table 14: Control Board Bit definitions for Feature selections

bit 15	Reserved
bit 14 High speed flux plus	=> 0=disabled, 1=enabled
bit 13 DC input	=> 0=1/3 phase AC input, 1=DC input
bit 12	Reserved
bit 11 EN/RST function	=> 0=Enable only, 1=Enable +ve edge RESET
bit 10 Motorised pot	=> 0=reset, 1=persistent
bit 9,8	00=ramp to stop 01=coast to stop 10=DC brake to stop (not available)
bit 7 Reverse	=> 0=disabled, 1=enabled
bit 6 Menu protect	=> 0=disabled, 1=enabled
bit 5	Reserved
bit 4	Reserved
bit 3 Dynamic braking	=> 0=disabled, 1=enabled

bit 2 Power fail reset	=> 0=disabled, 1=enabled
bit 1 Power fail ride through	=> 0=disabled, 1=enabled
bit 0	Reserved

Note: Option boards may have their own feature list

Table 15: Control Board Status flag definitions

Flag symbol	Word.bit	WHEN CLEARED	WHEN SET
OC_EF	0.15	NO Over Current Earth Fault	Hardware detected OC or EF
OVERVOLTAGE	0.14	NO Over voltage trip	Hardware detected Over voltage
OVERCURRENT	0.13	Current magnitude < threshold	Software detected Over current
DC_LOW	0.12	Bus voltage > threshold	Software detected Under voltage
PWRFAIL	0.11	No power fail detected	Software detected power fail
SUPPLYFAIL	0.10	Supply good	Software detected supply fault
OVERTEMP	0.9	Internal temperatures normal	Too hot
I2TTRIP	0.8	Thermal load < threshold	Software thermal overload
	0.7 (reserved)		
TRIPPED	0.6	The drive is not tripped	The drive is tripped
VLIMIT	0.5	NOT in voltage limit	In voltage limit
CLIMIT	0.4	NOT in current limit	In current limit
ZEROSPEED	0.3	Speed NOT zero	Speed is zero
ATSPEED	0.2	Speed does NOT equal the reference	Speed is equal to the reference
SHUTOFF	0.1	Output switching permitted	Output NOT switching
RUN	0.0	The drive is not running	The drive is running
INITDONE	1.15	Initialisation incomplete	Initialisation complete
ESO	1.14	No ESO input	ESO input true
STOPBAR	1.13	Motor permitted to start	Motor stopping or stopped.
FORWARD	1.12	No forward input	Forward input true
FWDLATCH	1.11	No latch forward input	Forward and latch input true
UPENTER	1.10	No console jog forward input	Console jog forward true
UP	1.9	No motorised potentiometer UP input	Motorised potentiometer UP input true
JOGFWD	1.8	No jog forward input	Jog forward input true
CONUP	1.7	No console UP input	Console UP input detected
REVERSE	1.6	No reverse input	Reverse input true
REVLATCH	1.5	No latch reverse input	Reverse and latch input true
DOWNENTER	1.4	No console jog reverse input	Console reverse jog input true
DOWN	1.3	No motorised potentiometer DOWN input	Motorised potentiometer DOWN input true
JOGREV	1.2	No jog reverse input	Jog reverse input true
CONDOWN	1.1	No console DOWN input	Console DOWN input true
REMOTE_T	1.0	Local control	Remote control
AR_FAIL	2.15	A/R has not failed	Drive failed to A/R
SWITCHING	2.14	No output switching	Output is switching
ESOMODE	2.13	Drive in normal mode	Drive in ESO mode
RAMP2ZERO	2.12	Not ramping to zero speed	Ramping to zero speed
COASTING	2.11	Not coasting	Coasting
	2.10 (reserved)		
	2.9 (reserved)		
LATCHREV	2.8	Drive is not latched in reverse	Drive is latched in reverse
LATCHFWD	2.7	Drive is not latched in forward	Drive is latched in forward
T_RESET	2.6	No Reset from terminals	Reset from terminals
PB_RESET	2.5	No Reset from push button	Reset from stop push button
PF_RESET	2.4	No reset from PF	Reset from PF
AR_RESET	2.3	No Reset from AR	AR generated reset
ENABLED	2.2	Drive not enabled	Drive enabled
POWEREDUP	2.1	Bus relay is not energised	Bus relay is energised
BUSCHARGED	2.0	Bus has not been charged	Bus has been charged

Flag Symbol	word.bit	When Cleared	When Set
TRIPPENDING	3.15	No trip waiting	There is a trip waiting
JOGSELECT1	3.14	Using JOG REVERSE reference	Using JOG FORWARD reference
JOGSELECT2	3.13	No JOG reference required	A JOG reference required
REFSELECT	3.12	Zero reference is required	A reference is required
REVERSEDIR	3.11	Stopped or forward operation	Reverse operation
BIPOLARREF	3.10	Unipolar reference	Bipolar reference required
MOTPOTUP	3.9	No motorised potentiometer speed increase	Increasing motorised pot speed
MOTPOTDOWN	3.8	No motorised potentiometer speed decrease	Decreasing motorised pot speed
MOTPOTEDGE	3.7	No MOTPOTUP/ MOTPOTDOWN edge	negative MOTPOTUP/ MOTPOTDOWN edge
STARTPULSE	3.6	Drive stopped or running	Drive required to start
PWRBDBAD	3.5	S/W supports power board	Power Board Not Supported
ESOSTRESSED	3.4	No ESO stress since power on	ESO has been stressed
STSUPDPENDING	3.3	No status message waiting	Status message waiting
RUNDISPLAY	3.2	Display is in menu mode	Display is in run mode
PFCONDITION	3.1	Power OK	Power Fail
	3.0 (reserved)		
OPTION 0	4.15	Option not present	Option present
OPTION 1	4.14	Option not present	Option present
OPTION 2	4.13	Option not present	Option present
OPTION 3	4.12	Option not present	Option present
OPTION 4	4.11	Option not present	Option present
OPTION 5	4.10	Option not present	Option present
OPTION 6	4.9	Option not present	Option present
OPTION 7	4.8	Option not present	Option present
OPTION 8	4.7	Option not present	Option present
OPTION 9	4.6	Option not present	Option present
OPTION 10	4.5	Option not present	Option present
OPTION 11	4.4	Option not present	Option present
OPTION 12	4.3	Option not present	Option present
OPTION 13	4.2	Option not present	Option present
OPTION 14	4.1	Option not present	Option present
OPTION 15	4.0	Option not present	Option present

Table 16: The drive parameter definitions

Symbol	Holding Register	Description
DRIVEID	40081	Drive ID (read from bit coded power board)
SIZEDISP	40082	Two numerals (ASCII characters) that indicate the drive size
VBUSSCALE	40083	DC bus voltage scale in volts
ISCALE	40084	Current scale in Amps x 10
ISCALERMS	40085	Current scale in Amps rms x 10
IRMSMAX	40086	Maximum current scale for editing in Amps rms x 10
PWRSCALE	40087	Power scale in kW x 10
ICLIMDEF	40088	Default current limit value
IMOTORDEF	40089	Default motor current in Amps rms x 10

MSC-3 GLOBAL AND GROUP BROADCASTING

The MSC-3 supports MODBUS Functions 05 (Force Single Coil) and 06 (Preset Single Register) are the only supported MODBUS functions for Global and Group Broadcast addressing.

GLOBAL BROADCAST

The global broadcast addressing is used to access all the MSC-3 slave drives connected on a MODBUS system simultaneously. When the master transmits a message addressed to slave ZERO, all slaves drives on the MODBUS Network accept the query message but does not issue a response.

GROUP BROADCAST

The Group Broadcast addressing is used to access a particular group of drives together in one MODBUS network. Logically, a total of 247 individual MSC-3 slave drives and slave PLCs can be connected to a MODBUS system. A broadcast group can consist of any number of drives and are formed by assigning the Group ID (Screen K03) to the drive. The drives with same Group ID belong to the one Group. Thus when a master transmits a group broadcast message, the drives in the same group will accept the message and will not respond. The Table 17 depicts some typical scenario.

Table 17: Typical Scenario

Drive ID	Group ID	Explanation
4	0(default)	Responds to query addressed to Slave drive 4 only and do not belong to any broadcast group.
7	24	Responds to query addressed to Slave drive 7. Also accepts query message addressed to Slave 24 and treats it as a group broadcast. This drive belongs to broadcast group 24.
153	24	Responds to query addressed to slave drive 153. Also accepts query message addressed to Slave 24 and treats it as a group broadcast. This drive belongs to broadcast group 24.
246	7	This scenario is OK but try to avoid it. Here the Group ID (7) of this drive is equal to Drive ID (7) of another drive. In this case the drive responds to query addressed to 246 and also accept message addressed to Slave drive 1 and treats it as a group broadcast.

Note

- All Drive ID must be assigned unique Slave address.
- All Drive ID is subjected to Global Broadcast by default.
- Drive ID and Group ID must not be same for any particular drive.
- Avoid assigning a Group ID that is already assigned as a Drive ID to another drive.

Example Set Up

Example 1: Normal Broadcast

An application requires several MSC3 drives to be linked together and operated by a master PLC in the control room via MODBUS two wire RS-485 communication network. Suitable shielded multi-core cable is run from the master PLC to the first of the MSC3's. Another cable is run from that MSC3 to the next and so on in a multi drop fashion.

At each MSC3 the following procedure was carried out:

1. After power had been removed the MSC3 Option board 3 was installed as per the installation procedure. Using the diagram of figure 1a of this manual, the installer used conductor insulation colour as a logical means to achieve correct and consistent wiring and was careful to wire the shield to the earth at the PLC end only.

2. It had been decided to run each MSC3 in remote mode and so the remote terminal (default is D4, terminal 5) was wired to terminal 1 (+5V).

3. Power was then reapplied and the following changes to the default configuration were made:

    i) The K22 COMMS PRESET speed reference was selected as the remote reference. Remote reference is found in the F00 REFERENCES menu of the MSC3. (Refer to the MSC3 User manual for details on reference selection).
    ii) The K02 DRIVE ID was changed to a unique value.
    iii) Additional feature settings were made as per customer requirements.

When work on each MSC3 was complete, the MODBUS messages were sent and received from the master PLC as shown below:

1) Set 60% for K22 COMMS Preset speed at slave address 8.

Query: 08H, 06H, 06H, 0EH, 4CH, CCH, DC, 8D
Response: 08H, 06H, 06H, 0EH, 4CH, CCH, DC, 8D

2) Start the MSC-3 drive at slave address 8.

Query: 08H, 05H, 00H, 03H, FFH, 00H, 7C, A3
Response: 08H, 05H, 00H, 03H, FFH, 00H, 7C, A3

3) Stop the MSC-3 drive at slave address 8.

Query: 08H, 05H, 00H, 02H, FFH, 00H, 2D, 63
Response: 08H, 05H, 00H, 02H, FFH, 00H, 2D, 63

Example 2: Global Broadcast

In a Flourmill, all the feed roll drives of the roller mills has to be controlled together for synchronous starting and stopping. The MSC-3 drives are connected to each feed roll drives via MODBUS network. In this application, same message has to be transmitted to all the drives. Thus global broadcast addressing could be deployed here.

To implement a global broadcast, the address **ZERO** is used instead of the individual slave ID/address of the MSC-3 drives in the network. When this global address is used, all the units receive the query message but do not respond.

An example of global broadcast is illustrated below for stopping all the MSC-3 drives.

Query: 00H, 05H, 00H, 02H, FFH, 00H, 2C, 2B
Response: no response

Example 3: Group Broadcast

The group broadcast is a reduced subset of the global broadcast. This type of addressing allows the MODBUS master to control a group of MSC-3 drives simultaneously. Group addressing is very similar in operation to global addressing but uses user defined group address of the MSC-3 drives in the network. MSC-3 drives with the same group address form one group.

For example, a plant engineer wishes to control the speed of two conveyors separately and yet have the capability of starting and stopping them synchronously. Each conveyor has three motors connected to individual MSC-3 drives in a MODBUS network. The simplest way to accomplish this would be to group the MSC-3 drives from each conveyor into one MODBUS group. Assign Slave Address (Screen K02) and Group Address (Screen K03) for the drives as shown in Table 18.

Table 18: Example 3

Group Broadcasting Example	**Conveyor Number 1**			**Conveyor Number 2**		
	MSC-3 drive 1	MSC-3 drive 2	MSC-3 drive 3	MSC-3 drive 1	MSC-3 drive 2	MSC-3 drive 3
Slave Address (K02)	1	2	3	4	5	6
Group Address (K03)	7	7	7	8	8	8

Once the MSC-3 drives are configured as per Table 18, the MODBUS master can start and stop all the drives simultaneously by using the global broadcast address (0). While still retaining the flexibility to control the speed of each conveyor separately by using the different group broadcast addresses (7 and 8).

Interface Specifications

SOFTWARE	
Communication Protocol (User selected)	Industry Standard MODBUS Protocol Compliant
Transmission mode	Remote Terminal Unit (RTU)
Baud Rates (User selected)	4800/9600/19200 bits/second
Data length	8 bit
Parity (User selected)	Even/Odd/None
Stop bit	1 bit
Error Detection	CRC-16 (Cyclic Redundancy Check)
HARDWARE	
Communication Interface	2 wire RS-485 (multi point)
Interface Terminals (isolated circuits)	1 (A) RS485 (positive logic) 2 (B) RS485 (negative logic) 3 (USP COM) signal common

Appendix A – CYCLIC REDUNDANCY CHECK

The error check sum is used by the MODBUS master and the MSC-3 slave devices to detect transmission errors. To detect transmission errors between the sender and the receiver an error check field is added to the message sent. The error detection system used by the MODBUS RTU framing is a cyclic redundancy check (CRC).

The receiver will calculate the CRC error check field over the incoming message and compare it against the one received. On mismatch, the whole message will be discarded. It is not possible to recover faults within the message.

Theory

The bare message without start/stop or parity bits is considered as one continuous number whose most significant bit is transmitted first. The message is pre-multiplied by 2^{16} (shifted 16 bits left) and then divided by the CRC-16 polynomial : $X^{16} + X^{15} + X^2 + 1$.

The quotient is discarded and the 16-bit remainder is appended to the message. The remainder is pre-initialised to 0FFFFH to avoid the case of all zeros being an accepted message.

The receiver does a division with the same polynomial on the message (including the received CRC) and will get a zero remainder if no errors have occurred.

The device used to serialise the data for transmission will send the conventional LSB or right most bit of each character first. In generating the CRC, the first bit transmitted is defined as the MSB of the dividend. For convenience then, and since there are no carries used in arithmetic, let's assume that the MSB is on the right. To be consistent, the bit order of the generating polynomial must be reversed. The MSB is dropped since it affects only the quotient and not the remainder. So the original : $X^{16} + X^{15} + X^2 +$ 1represented as 11000000000000101 results in the polynomial 1010 0000 0000 0001 (A001H).

C CODE FOR GENERATING A CRC-16 CHECKSUM

```
#define POLYNOMIAL 0xA001                                   //CRC Polynomial : X16 + X15 + X2 + 1

unsigned int CRC16(unsigned char *ucpBuf, unsigned char ucLength)
{
unsigned int uiCRC = 0xFFFF;                                //Init. the CRC Accumulator
unsigned char i,j;                                          //Loop variables
unsigned char ucData;

        for(i=0;i<ucLength;i++)                             //Loop for the length of the packet
                {
                ucData = *ucpBuf;                           //Assign the Character from Buffer
                ucpBuf++;                                   //Increment Buffer pointer
                uiCRC = uiCRC^(unsigned int)ucData;
                  for(j=0;j<8;j++)                                  //Loop 8 times
                        {
                        if((uiCRC&0x0001)==1)               //Check if the last bit is 1
                          {
                                uiCRC = (uiCRC>>1)^POLYNOMIAL;  // Shift right and XOR
                          }
                        else
                                uiCRC = uiCRC>>1;           // Else just XOR
                        }
                }
        return uiCRC;
}
```

Appendix B – MSC-3 Character Set

NOTES

Australian Manufacturers

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