Lenze
AC Tech



MC Series Drives

Modbus Communications Reference Guide

About These Instructions

This documentation applies to the use of an MC 1000 Series and an MC 3000 Series Variable Frequency Drive in a Modbus Network and should be used in conjunction with the MC Series Installation and Operation Manual (Document M101 or M301, respectively) that shipped with the drive. These documents should be read in their entirety as they contain important technical data and describe the installation and operation of the drive.

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1 Safety Information

1.1 Warnings, Cautions and Notes

1.1.1 General

Some parts of Lenze controllers (frequency inverters, servo inverters, DC controllers) can be live, moving and rotating. Some surfaces can be hot.

Non-authorized removal of the required cover, inappropriate use, and incorrect installation or operation creates the risk of severe injury to personnel or damage to equipment.

All operations concerning transport, installation, and commissioning as well as maintenance must be carried out by qualified, skilled personnel (IEC 364 and CENELEC HD 384 or DIN VDE 0100 and IEC report 664 or DIN VDE0110 and national regulations for the prevention of accidents must be observed).

According to this basic safety information, qualified skilled personnel are persons who are familiar with the installation, assembly, commissioning, and operation of the product and who have the qualifications necessary for their occupation.

1.1.2 Application

Drive controllers are components designed for installation in electrical systems or machinery. They are not to be used as appliances. They are intended exclusively for professional and commercial purposes according to EN 61000-3-2. The documentation includes information on compliance with EN 61000-3-2.

When installing the drive controllers in machines, commissioning (i.e. the starting of operation as directed) is prohibited until it is proven that the machine complies with the regulations of the EC Directive 98/37/EC (Machinery Directive); EN 60204 must be observed.

Commissioning (i.e. starting drive as directed) is only allowed when there is compliance to the EMC Directive (2004/108/EC).

The drive controllers meet the requirements of the Low Voltage Directive 2006/95/EC. The harmonised standards of the series EN 50178/DIN VDE 0160 apply to the controllers.

The availability of controllers is restricted according to EN 61800-3. These products can cause radio interference in residential areas. In the case of radio interference, special measures may be necessary for drive controllers.

1.1.3 Installation

Ensure proper handling and avoid excessive mechanical stress. Do not bend any components and do not change any insulation distances during transport or handling. Do not touch any electronic components and contacts. Controllers contain electrostatically sensitive components, which can easily be damaged by inappropriate handling. Do not damage or destroy any electrical components since this might endanger your health! When installing the drive ensure optimal airflow by observing all clearance distances in the drive's user manual. Do not expose the drive to excessive: vibration, temperature, humidity, sunlight, dust, pollutants, corrosive chemicals or other hazardous environments.

1.1.4 Electrical Connection

When working on live drive controllers, applicable national regulations for the prevention of accidents (e.g. VBG 4) must be observed.

The electrical installation must be carried out in accordance with the appropriate regulations (e.g. cable cross-sections, fuses, PE connection). Additional information can be obtained from the regulatory documentation.

The regulatory documentation contains information about installation in compliance with EMC (shielding, grounding, filters and cables). These notes must also be observed for CE-marked controllers.

The manufacturer of the system or machine is responsible for compliance with the required limit values demanded by EMC legislation.

1.1.5 Operation

Systems including controllers must be equipped with additional monitoring and protection devices according to the corresponding standards (e.g. technical equipment, regulations for prevention of accidents, etc.). You are allowed to adapt the controller to your application as described in the documentation.



DANGER!
- After the controller has been disconnected from the supply voltage, do not touch the live components and power connection until the capacitors have discharged. Please observe the corresponding notes on the controller.
- Do not continuously cycle input power to the controller more than once every three minutes.
- Close all protective covers and doors during operation.



WARNING!
Network control permits automatic starting and stopping of the inverter drive. The system design must incorporate adequate protection to prevent personnel from accessing moving equipment while power is applied to the drive system.

Table 1: Pictographs used in these instructions

Pictograph	Signal word	Meaning	Consequences if ignored
	**DANGER!**	Warning of Hazardous Electrical Voltage.	Reference to an imminent danger that may result in death or serious personal injury if the corresponding measures are not taken.
	**WARNING!**	Impending or possible danger for persons	Death or injury
	**STOP!**	Possible damage to equipment	Damage to drive system or its surroundings
	**NOTE**	Useful tip: If observed, it will make using the drive easier	

1.2 Reference and Links

MC Series Variable Frequency Drives visit: http://www.lenze-actech.com

Modbus-IDA visit: http://www.modbus-IDA.org

2 Introduction

This document defines the specifics required for Modbus serial communication with a Lenze-AC Tech standard MC 1000 or MC 3000 Series drive for control, status monitoring, and programming parameters. A familiarity with normal drive capabilities and operations is assumed. If this is not the case, refer to the MC Series Installation and Operation manual (M101 or M301, respectively) for more information.

2.1 Modbus Details

A. AC Tech Drives running the Modbus communication protocol use the RTU (Remote Terminal Unit) transmission mode and are slaves only. Therefore, the device communicating with the drives must be a Modbus Master. The baud rate is 9600, no parity (two stop bits). The bit sequence is:

	DATA									
Start bit	1	2	3	4	5	6	7	8	Stop bit	Stop bit

B. At this time the AC Tech drives do not support the broadcast function of the protocol.

C. IMPORTANT NOTE: Modbus 3X and 4X Registers are numbered starting at 1. However, when transmitted to a slave over the serial link, the actual address transmitted is one less. This is because the addresses are numbered starting from 0. AC Tech register numbers are also numbered starting from 0. Therefore, AC Tech register numbers always correspond exactly with the address transmitted. As a result, MODBUS REGISTER NUMBERS ARE ALWAYS ONE GREATER THAN AC TECH REGISTER NUMBERS. WHENEVER THE WORDS “REGISTER #xx” APPEAR, IT SHOULD BE ASSUMED THAT THEY MEAN “AC TECH REGISTER xx” and the Modbus Register number will be one larger. In some instances we may show both for clarity. For example: “Register #24 (Modbus Register #25) . . .”

D. The function codes supported by AC Tech drives are:

03 Read Holding Registers (4X references). In general we can read only one register at a time. However, there are a few limited exceptions.

Exception One:
Register #24 - 29 (Modbus Register #25 - 30) can also be read as a group of 6 words.

Exception Two:
AC Tech uses a method of reading a group of related registers that may not be consecutive within the drive memory map. When this is done for the registers below, the response from the drive will be for the number of words requested but will not be with consecutive registers.

Register #100 (Modbus Register #101), Fault history, should be read as a group of 4 words.

Register #101 (Modbus Register #102), Software version, should be read as a group of 4 words.

04 Read Input Registers (3X references). As with function 03, we read one register at a time except where noted.

06 Preset Single Register (4X references). Write single register.

16 Preset Multiple Registers (4X references). Although the function is for multiple registers, we will accept only a single register to be written.

Note: Since we do not differentiate between 4X and 3X references, function codes 03 and 04 are treated identically.

E. Exception codes:

01 - Command rejected, Illegal function

02 - No such register

03 - Data out of range

04 - Wrong data format

06 - Slave device busy. In Keypad Programming mode, cannot write registers.

F. The AC Tech drive will most nearly conform to the Modicon® Micro 84 in capabilities. This may be of importance when configuring networks for DDE Servers.

G. Modbus® and Modicon® are registered trademarks of Schneider Electric. For more information about the Modbus Protocol please refer to the Modicon Modbus Protocol Reference Guide. Web resources: http://www.Modbus-IDA.org and http://www.schneider-electric.com.

2.2 Universal Registers

Lenze-AC Tech manufactures several drive families. Currently the QC, MC, MCH, SC, TC, *smd*, *Tmd* and SMV Series drives support Modbus based communications. Since each drive family has different parameters and size ranges, the parameter (register) definitions are in many cases quite different. In order to facilitate communication in a network with a mix of drive types, certain AC Tech Register locations have been made universal among AC Tech drives. While their locations are consistent, their contents may vary as defined in Table 2.

Table 2: Contents of Universal Registers

AC Tech Reg #	Function			
1	Drive Control (WRITE ONLY). Not all drives will have all control functions but when the function is available it will be at a defined bit location within Register #1. Drive Family and register Configuration Number dependent.			
19	Drive Family (READ ONLY) This register is CONSISTENT AMONG ALL AC TECH DRIVES:			
	- 64 -- QC family	- 67 --	- 70 -- TC family	
	- 65 -- MC family	- 68 -- MCH family	- 71 -- *Tmd* family	
	- 66 -- SC family	- 69 -- *smd* family	- 72 -- SMV family	
21	Drive Size (READ ONLY). Code to identify Power (HP/KW) and Line Voltage of the drive. Family dependent. For the MC series drive size refer to section 5.3.			
24	Drive Status (READ ONLY). Various operational variables.			
48	Unlock Control (WRITE ONLY).			
49	Unlock Writing of registers (WRITE ONLY).			
50	Parameter Configuration Number (READ ONLY).			



3 Data Representation - Internal and External

3.1 Register Format

All registers are 16 bits. The data within these registers can take on the following forms:

- Individual bit commands (16 per register). Example: Register #1 (Modbus Register #2).
- Individual bit flags (16 per register).
- A chain of two 8 bit unsigned integers.
- A 16 bit unsigned integer.
  This unsigned integer could represent many different types of data with various scaling rules and units, which are defined by the DATA TYPE of the register.

3.2 Data Types

Data passed in registers across the Modbus communications link are always in INTERNAL units. The drive itself may show the information in alternate DISPLAYED units. For Example: drive speeds are always stored internally as hundredths of a Hz but the drive may display that speed in terms of RPM's using programmed conversion factors. Table 3 lists examples of the internal units used on the MC series.

Table 3: MC Series Internal Units

Type	Unit	Example
SPEED	.01 Hz	60.00 Hz = 6000
TIME	.1 Sec	30.0 Sec = 300

The data type "PID" requires further explanation. The internal range of any data of PID type is 0 to 32736. Many variables can be controlled in a PID system (pressure, temperature, flow, etc.). To simplify drive calculation, the drive programmer enters the type and range of the controlled variable (actually it is the range of the feedback device that we are scaling) and this range is mapped to the internal range (0-32736). If the feedback device measured 0 to 200 PSI, then 0 PSI is 0 internal units, and 200 PSI is 32736 internal units. To command a setpoint of 100 PSI the LOCAL PID command (Register #41) can be written with the value 16368 (32736*100/200). Thus to control PID operations using real world units, the Modbus Master must have knowledge of the range of the feedback device.

3.3 AC Tech Drive Registers

Registers #0 - #50: (Modbus Reg #1 - #51) Reserved for configuration and control
Registers #51 - #260 (Modbus Reg #52 - #261) Reserved for drive's programming mode parameters
Programming Mode Parameters are the parameters accessible from the local keypad on the drive. There is a direct correspondence between the MC Drive Programming Mode Parameter number and the AC Tech Register number (and consequently, the Modbus register number):

AC Tech Register # = (MC Programming Parameter #) + 51
Modbus Register # = (MC Programming Parameter #) + 52

The Table 6 entries are based on MC Drive Software # 213-083 Revision 13 (Parameter Configurations = 188, 189 & 190). If a later revision of software were to change register definitions, drive operation could be seriously affected. Examine Register #50 (Parameter Configuration Number) for revision. The number displayed at power up on drive display also identifies it. If it is not 188, 189 or 190, writing to any register on the drive MUST NOT BE ATTEMPTED unless your Controller has been setup to support the new configuration.

4 MC Drive Setup & Operation

4.1 Serial Address

All AC Tech drives have a Serial Address Parameter that must be programmed prior to attempting to operate the serial interface (Programming Parameter #58 / AC Tech Register #109).

TIP - Avoid using address 1. Most Modbus devices ship with a default address of 1. As duplicate addressing on a Modbus network is not allowed, this can lead to conflicts when replacing and commissioning nodes. To avoid this it is recommended that you do not set the slave address to 1.

4.2 Serial Communications Parameter

All AC Tech drives have a Serial Communications Parameter that governs the operation of the Serial Link. On MC drives this is #57 SERIAL LINK (register #108). Table 4 lists the selections for MC Parameter 57, SERIAL LINK.

Table 4: MC Parameter 57 Selections

Setting	Description	Watchdog Timeout Period
00	DISABLE	
01	WITH TIMER	10 sec
02	WITHOUT TIMER	

Explanation of Terms:

- DISABLED serial link not operational
- WITH TIMER serial link allows reading & writing of both control & programming parameters. Watchdog timer is enabled (refer to section 4.6, *Watchdog Timer*).
- WITHOUT TIMER serial link allows reading & writing of both control & programming parameters. Watchdog timer is disabled (refer to section 4.6, *Watchdog Timer*).

Prior to attempting to communicate with the drive, Serial Communications Parameter must be appropriately programmed.

4.3 Control Parameter

The Control Parameter on MC drives (Programming Parameter #30 / AC Tech Register #81) determines how much control a user has over a drive via the serial link. The Control Parameter must be appropriately programmed for a particular application. Refer to the MC Series Installation and Operation Manual (M101 or M301, respectively) for a detailed explanation on programming the drive parameters.

TIP - For most serial applications, CONTROL is set to LOCAL on the MC1000 and SERIAL on the MC3000. Refer to Table 5 for Control settings.

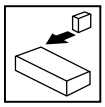


Table 5: Control (Parameter #30)

MC1000			MC3000	
Setting	**Description**		**Setting**	**Description**
00	LOCAL (default)		00	LOCAL (default)
01	REMOTE		01	REMOTE
02	BOTH		02	SERIAL
			03	KEYPAD
			04	TB STRIP
			05	KEYPAD 2

All control options are subject to the Parameter and Control Locking/Unlocking procedures.

4.4 Unlocking & Locking Controls

Registers #48 and #1 are used in Unlocking and Locking Controls.

- A write to Register #48 (Unlock Controls) with a value of 0 will unlock controls. This enables the writing of Register #1 – the Drive Control Register.
- If Register #48 (Unlock Controls) is written with a value that is the Drive's Programming Password, then in addition to Register #1(Drive Control), writing to all other writeable registers is enabled (e.g.: register #52 -- Preset Speed #1). The factory default password for MC series drives is 19.
- Once Register #48 (Unlock Controls) has been written, Controls are unlocked until the Lock Security flag (Bit 1 of Register#1) has been set or until a Watchdog Timeout occurs.
- Writing to Register #1 (Drive Control) with bit 1 set will Lock both Controls and Parameters (prevents writing to any register).
- The serial drive control can only be unlocked when the drive is not in programming mode.
- When LOCK is asserted, the drive drops out of SERIAL control and reverts back to the previous source of control.
- Even though drive might be locked, and thus parameters and control cannot be written, parameters and status can always be read. Refer to section 4.7, *Monitoring Only Operation*.

4.5 Unlocking & Locking Programming Parameters only

Registers #49 and #1 are used in Unlocking and Locking Programming Parameters.

- Writing to any writeable register other than #1 can be enabled by writing the Drive's Programming Password to Register #49 (Unlock Parameters). This would be done when Drive Control (start, forward/reverse, keypad speed control, etc.) is not required.
- The Factory Default password is 19.
- Once Register #49 (Unlock Parameters) has been written, the writing of parameter registers is enabled until Bit 1 of Register #1 has been set.

4.6 Watchdog Timer

All AC Tech drives are equipped with a Serial Link "Watchdog Timer". If the Modbus Master wishes to control the drive (start, stop, forward, reverse, etc.) it must first "Unlock Controls" (refer to section 5.10). If the Watchdog Timer is enabled and controls have been unlocked, the Master MUST PERIODICALLY COMMUNICATE with the drive or the timer will timeout. The timeout period is fixed at 10 seconds. It is recommended that the drive be polled at least once every 5 seconds. Register #24 can be used for this purpose.

The action of a Watchdog timeout depends on the setting of the CONTROL parameter. If the CONTROL parameter is set for:

– LOCAL : the drive will stop when a serial timeout occurs.

– KEYPAD 2 (LOCAL contol without the need for TB-1 to run): the drive will stop when a serial timeout occurs.

– REMOTE: serial timeout will not work since the drive cannot be unlocked in REMOTE mode.

– MC1000/3000 drives STOP when a serial timeout occurs. There is no fault for this. Any time CONTROL is changed from LOCAL to REMOTE the drive STOPS immediately.

The Watchdog Timer does not operate unless Controls have been UNLOCKED via Register #48, or Parameter writing has been unlocked via Register #49. In the case of unlocking parameters only, the watchdog timer will disable write permissions but will otherwise continue with normal operation.

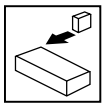
Watchdog Timer Controls

– For some applications, it is inappropriate to shut down the drive because of a Watchdog Timeout. Therefore, we have provided a means of disabling the Watchdog using Programming Parameter #57 (SERIAL LINK):

  Programming Parameter #57 controls both the enabling of the serial link and the Watchdog. By setting Parameter #57 to WITH TIMER enables the serial link WITH the Watchdog. Conversely, setting Parameter #57 to WITHOUT TIMER enables the serial link WITHOUT the Watchdog.

– A Watchdog failure can be recognized by reading the drive status (AC Tech Registers #24 – 29) and looking at the control mode. If it has reverted from SERIAL to LOCAL without the Modbus Master commanding it via Register #1 bit 1 (LOCK) then a watchdog failure has occurred. Serial Control can be reestablished by writing another unlock message to Register #48.

– If the Watchdog Timer has been disabled, the Unlock Control Register #48 or Unlock Writing Register #49 must still be asserted in order to write to Register #1 (Drive Control) or to any of the programming parameters (in case of unlocking writing). However, there are no longer any constraints on how often the Master must communicate with the drive.



4.7 Monitoring Only Operation

1. Power up drive with serial enabled.
2. Simply read AC Tech Register #24 (Modbus Register #25) or any other readable register.
3. No unlocking or watchdog issues apply for monitoring.

4.8 Normal Control Operation Sequence

1. Power up drive with serial enabled.
2. Unlock control by writing a zero to Register #48.
3. Control drive operation via various commands to Register #1 (Start, Stop, Reverse direction, etc.).
4. If the Watchdog Timer is enabled, keep it from timing out by repeated reads of drive status (Register #24 – 6 registers) performed at reasonable intervals (typically less than 5 seconds between reads because the Watchdog typically faults at 10 seconds).
5. Lock Control when drive operations are complete by writing a 2 to Register #1 (assert bit 1 of Register #1).
6. Drive is now returned to LOCAL mode (control from the drive keypad).

4.9 Start/Stop, Speed Control and Parameter Change Operation

The typical sequence for a Start/Stop, Speed Control or Parameter Change operation is listed herein.

1. Power up drive with serial enabled.
2. Unlock Controls and Parameters by writing the current programming password (default 19) to Register #48.
3. Put drive in MANUAL mode so that it responds to speed commands from the Keypad Speed Command register. This is done by sending 0200 hex to Register #1 (bit 9 asserted).
4. Control Drive Operation via various commands to Register #1 (Start, Stop, Reverse direction, etc.).
5. Control Drive Speed by writing the Speed Commands to Register #40 (Keypad Speed Command).
6. Change the programming parameters (e.g., change the acceleration rate by writing new acceleration rate to register #59)
7. If the Watchdog Timer is enabled, keep it from timing out by insuring that repeated reads of any of the registers are performed at reasonable intervals (typically less than 5 seconds between reads because the Watchdog typically faults at 10 seconds). Note: It is suggested that the drive status register (#24) be used for this function.
8. Lock Controls and Parameters when drive operations are complete by writing a 2 to Register #1 (assert bit 1 of Register #1).
9. Drive is now returned to the control method programmed in Parameter 30, CONTROL (i.e., local control from the drive keypad).

5 MC Drive Control Registers

Table 6 describes the MC Drive Control Registers in ascending order of AC Tech Register #. The HEX representation is given in parenthesis next to the AC Tech Register # in the left-most column.

Table 6: MC Drive Control Registers

ACT# (HEX representation)	REGISTER NAME	R/W/RS	MESSAGE								MIN	MAX	UNITS	[NOTE] or Section
1 (01)	Drive Control	W	SA	06	00	01	DH	DL	CRCH	CRCL	Refer to Section 5.2			[1]
		RS	SA	06	00	01	DH	DL	CRCH	CRCL				
19 (13)	Drive Family	R	SA	03	00	13	00	01	CRCH	CRCL	Refer to Section 5.2			[2]
		RS	SA	03	02	00	41	CRCH	CRCL					
21 (15)	Drive Size	R	SA	03	00	15	00	01	CRCH	CRCL	Refer to Section 5.3			
		RS	SA	03	02	00	00	CRCH	CRCL					
24 (18)	Drive Status (6 register read) (reg. #24 to 29)	R	SA	03	00	18	00	06	CRCH	CRCL	Refer to Section 5.4			[3a] [3b] [3c]
		RS	SA	03	0C	D1H	D1L	D2H	D2L					
						D3H	D3L	D4H	D4L					
						D5H	D5L	D6H	D6L					
								CRCH	CRCL					
24 (18)	Command Speed	R	SA	03	00	18	00	01	CRCH	CRCL	0	2400	0.1 Hz	
		RS	SA	03	02	DH	DL	CRCH	CRCL					
25 (19)	Actual Speed	R	SA	03	00	19	00	01	CRCH	CRCL	0	2400	0.1 Hz	
		RS	SA	03	02	DH	DL	CRCH	CRCL					
26 (1A)	Load (DH) / Status (DL)	R	SA	03	00	1A	00	01	CRCH	CRCL	Refer to Section 5.4.1/2			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
27 (1B)	Actual Direction (DH) / Control Mode (DL)	R	SA	03	00	1B	00	01	CRCH	CRCL	Refer to Section 5.4.3/4			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
28 (1C)	Speed Source (DH) / Speed Reference (DL)	R	SA	03	00	1C	00	01	CRCH	CRCL	Refer to Section 5.4.5/6			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
29 (1D)	Fault (DH) / Commanded Direction (DL)	R	SA	03	00	1D	00	01	CRCH	CRCL	Refer to Section 5.4.7/8			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
30 (1E)	Motor Voltage	R	SA	03	00	1E	00	01	CRCH	CRCL	0	999	V	5.5
		RS	SA	03	02	DH	DL	CRCH	CRCL					
36 (24)	Total Run Time Hours	R	SA	03	00	24	00	01	CRCH	CRCL	Refer to Section 5.7			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
37 (25)	Total Run Time Minutes	R	SA	03	00	25	00	01	CRCH	CRCL	Refer to Section 5.7			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
38 (26)	PID Setpoint (MC1000 w/PID, MC3000)	R	SA	03	00	26	00	01	CRCH	CRCL	Refer to Section 5.8			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
39 (27)	PID Feedback (MC1000 w/PID, MC3000)	R	SA	03	00	27	00	01	CRCH	CRCL	Refer to Section 5.8			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
40 (28)	Keypad Speed Command	R	SA	03	00	28	00	01	CRCH	CRCL	0	65000	0.01 Hz	5.6
		RS	SA	03	02	DH	DL	CRCH	CRCL					
		W	SA	06	00	28	DH	DL	CRCH	CRCL				
		RS	SA	06	00	28	DH	DL	CRCH	CRCL				

ACT# (HEX representation)	REGISTER NAME	R/W/RS	MESSAGE								MIN	MAX	UNITS	[NOTE] or Section
41 (29)	Local PID Command (MC1000 w/PID, MC3000)	R	SA	03	00	29	00	01	CRCH	CRCL	Refer to Section 5.8			
		RS	SA	03	02	DH	DL	CRCH	CRCL					
		W	SA	06	00	29	DH	DL	CRCH	CRCL				
		RS	SA	06	00	29	DH	DL	CRCH	CRCL				
48 (30)	Unlock Commands	W	SA	06	00	30	DH	DL	CRCH	CRCL	0	9999	None	5.10
		RS	SA	06	00	30	DH	DL	CRCH	CRCL				
49 (31)	Unlock Parameters	W	SA	06	00	31	DH	DL	CRCH	CRCL	0	9999	None	5.11
		RS	SA	06	00	31	DH	DL	CRCH	CRCL				
50 (32)	Register Version	R	SA	03	00	32	00	01	CRCH	CRCL	0	65535	None	5.12
		RS	SA	03	02	DH	DL	CRCH	CRCL					

5.1 Abbreviations

Table 7 lists the abbreviations used in Table 6 MCH Drive Control Registers:

Table 7: Abbreviations

Abbreviation	Description
R	Read
W	Write
RS	Response
SA	Slave Address (typically 01 through F7 hex)
CRCH	CRC High byte
CRCL	CRC Low byte
DH	Data High byte
DL	Data Low byte
ACT#	AC Tech Register # (Modbus Register numbers are 1 larger)

5.2 Drive Control - Register #1

Table 8 illustrates the Data format of Register #1, Drive Control.

Table 8: Drive Control - Register #1

	Bit	Command
Data Low Byte	0	UPDATE BUFFERS
	1	LOCK SECURITY
	2	STOP DRIVE
	3	START DRIVE
	4	UNUSED
	5	UNUSED
	6	SET REVERSE
	7	SET FORWARD
Data High Byte	8	AUTO MODE
	9	MANUAL MODE
	10	UNUSED
	11	UNUSED
	12	UNUSED
	13	UNUSED
	14	UNUSED
	15	UNUSED

The appropriate bit is set to 1. For example, to stop the drive bit two is set (send 0004H). To start the drive send 0008H. Setting update buffers bit, enables to start the drive using downloaded data. Locking security disables the serial drive control, the communications watchdog timer and prevents any further writing to control or parameter registers.

NOTE 1 - Drive Control

- During each write to Register #1 only one bit should be set in the drive control word.
- If more than 1 bit is set, the drive responds to stop bit only.
- If stop bit is not set, but more than 1 bit is set, drive responds with exception 04.

NOTE 2 - Drive Family

- The QC and DL Series drives return 64 (40H)
- The MC Series drives return 65 (41H)
- The SC Series drives return 66 (42H)
- The MCH Series drives return 68 (44H)
- The *smd* Series drives return 69 (45H)
- The TC Series drives return 70 (46H)
- The *Tmd* Series drives return 71 (47H)
- The SMV Series drives return 72 (48H)

5.3 Drive Size - Register #21

Table 9 lists the MC1000 and MC3000 Series drives. Register 21 will contain the value in the "Size" column.

Table 9: Drive Size - Register #21

Size	HP	Voltage	Size	HP	Voltage
0	0.25	120	29	2	590
1	0.25	240	30	3	590
2	0.5	240	31	5	590
3	1	240	32	7.5	590
4	1.5	240	33	10	590
5	2	240	34	15	590
6	3	240	35	20	590
7	5	240	36	25	590
8	7.5	240	37	30	590
9	10	240	38	40	590
10	15	240	39	50	590
11	20	240	40	60	590
12	25	240	41	75	590
13	50	480	42	100	590
14	60	480	43	125	590
15	1	480	44	150	590
16	1.5	480	45	200	590
17	2	480	46	75	480
18	3	480	47	100	480
19	5	480	48	125	480
20	7.5	480	49	150	480
21	10	480	50	200	480
22	15	480	51	30	240
23	20	480	52	40	240
24	25	480	53	50	240
25	30	480	54	60	240
26	40	480	55	75	240
27	1	590	56	100	240
28	1.5	590	57	N/A	N/A

5.4 Drive Status - Registers #24-29

5.4.1 Reading Register #24

When reading register #24, the number of wordscan either be 1 or 6. This is an exception to the rule of being able to read only one register at a time. If 6 words are requested at register #24, the following will be returned:

Table 10: 6 Register read at #24

Parameter	Data Byte
Command Speed	D1H D1L
Actual Speed	D2H D2L
Load	D3H
Operation Status	D3L
Rotational Direction	D4H
Control Mode	D4L
Speed Command Source	D5H
Speed Reference	D5L
Present Fault	D6H
Command Rotation	D6L

NOTE 3a - Command Speed (Bytes D1H and D1L or Register #24)

- In hundredths of a Hz
- Most significant byte is first, followed by Least significant
- Example: 02 01 in hex converts to 5.13Hz in decimal.

NOTE 3b - Actual Speed (Bytes D2H and D2L or Register #25)

- In hundredths of a Hz
- Most significant byte is first, followed by Least significant

NOTE 3c - Load (Bytes D3H or Register #26 DH)

- In percent of full load
- Example: 64 (one byte in hex) ==> 100 in decimal ==> 100% (drive load).

5.4.2 Operational Status - Registers #24 & 26

Table 11 lists the Operational Status (byte D3L)

Table 11: Operational Status - Register #26

Setting	Parameter
0	FAULT LOCKOUT
1	FAULT
2	START PENDING
3	STOP
4	DC BRAKE
5	RUN AT 0Hz
6	RUN
7	ACCEL
8	DECEL
9	CURRENT LIMIT
10	DECEL OVERRIDE
11	LOWER TRANSISTORS SWITCHING ON
12	SLEEP

5.4.3 Actual Rotational Direction - Registers #24 & 27

Table 12 lists the Actual Rotational Direction (Register #24 byte D4H or Register #27 DH).

Table 12: Actual Rotational Direction

Setting	Direction
0	FORWARD
1	REVERSE

5.4.4 Control Mode - Registers #24 & 27

Table 13 lists the Control Mode (Register #24 byte D4L or Register #27 DL).

Table 13: Control Mode

Setting	Control	Operation
0	LOCAL	Start/Stop operation controlled from drive's keypad
1	REMOTE	Start/Stop operation controlled from the drive's terminal strip
2	SERIAL	Start/Stop operation controlled via serial link

5.4.5 Speed Command Source - Registers #24 & 28

Table 14 lists the Speed Command Source (Register #24 byte D5H or Register #28 DH).

Table 14: Speed Command Source

Setting	Source
0	KEYPAD
1	0 – 10VDC
2	4 – 20mA
3	PRESET 1
4	PRESET 2
5	PRESET 3
6	PRESET 4
7	MOP
8	RESERVED
9	KEYPAD SPEED (PID enabled)
10	PID KEYPAD SETPOINT
11	0-10 VDC PID SETPOINT
12	4-20mA PID SETPOINT

5.4.6 Speed Reference - Registers #24 & 28

Table 15 lists the Speed Reference Control (Register #24 byte D5L or Register #28 DL).

Table 15: Speed Reference Control

Setting	Control
0	AUTO
1	MANUAL

5.4.7 Present Fault - Registers #24 & 29

Table 16 lists the Present Fault (Register #24 byte D6H or Register #29 DH)

Table 16: Present Fault

Setting	Fault	Display
0	NO FAULT	
1	OUTPUT (TRANSISTOR) FAULT	OUTPUT
2	Reserved	
3	HIGH DC BUS VOLTAGE	HI VOLTS
4	HIGH DRIVE TEMPERATURE	HI TEMP
5	THERMAL OVERLOAD	OVERLOAD
6	Reserved	
7	LOW DC BUS VOLTAGE	LO VOLTS
8	Reserved	
9	DC BRAKE ERROR	DB ERROR
10	FOLLOWER LOSS	FLWR/SER
11	DYNAMIC BRAKE OVERLOAD	DB ERROR
12	POWER SAG	PWR SAG
13	CONTROL FAULT	CONTROL
14	LANGUAGE FAULT	LANGUAGE
15	EXTERNAL FAULT	EXTERNAL
16	INTERNAL 16	INTERNAL
17	POWER TRANSIENT	PWR TRAN
18	INTERNAL ERROR #18	INTERN #18
19	INTERNAL ERROR #19	INTERN #19
20	INTERNAL ERROR #20	INTERN #20
21	INTERNAL ERROR #21	INTERN #21
22	INTERNAL ERROR #22	INTERN #22
23	INTERNAL ERROR #23	INTERN #23

5.4.8 Commanded Rotational Direction - Registers #24 & 29

Table 17 lists the Commanded Rotational Direction (Register #24 byte D6L or Register #29 DL)

Table 17: Commanded Rotational Direction

Setting	Direction
0	FORWARD
1	REVERSE

5.5 Motor Volts - Register #30

Output Voltage to the motor expressed in volts. This is the effective output voltage to the motor. It is not the same as the incoming voltage to the drive from the line.

5.6 Keypad Speed - Register #40

This register enables the user to set the keypad speed to desired value.

- Range is 0 - 65000 in hundredths of a Hz
- Most significant byte is first, followed by Least significant
- CONTROL OF THE DRIVE SPEED VIA THE SERIAL LINK IS NORMALLY DONE USING THIS PARAMETER. This register can be written only after enabling serial drive control.

5.7 Total Run Time - Registers #36 & 37 (MC3000 only)

Register #36 - Total Run TIme in Hours Example: A value of 20 in decimal equals 20 Hours

Register #37 - Total Run TIme in Minutes Example: A value of 42 in decimal equals 42 Minutes

5.8 PID Commands - Registers #38, 39, 41 & 43

Registers #38 (PID Setpoint Command), #39 (PID Feedback Value), #41 (Local PID Setpoint Command) and #43 (Serial PID Command) are all in drive internal units with a range of 0 to 32736. The real world parameter being controlled is mapped into this internal range based on the feedback device for the parameter being measured and controlled.

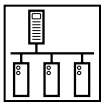
For Example, if the device measures temperature in °C with a range of 10°C to +110°C, then 10°C maps to 0 in internal units and 110 maps to 32736. A setpoint of 30 °C for the Local PID Setpoint (Register #41) would be written with a value of 6547 (1993 hex). (32736 * {30 – 10} / {110 – 10}).

5.10 Unlock Commands - Register #48

Register #48 (Unlock Commands) unlocks commands by using 0000 for the password. If the correct Programming mode password is entered then the appropriate programming parameters can also be accessed (refer to the full parameter protocol specification if access to programming parameters is required). Enabling commands also activates the drive Watchdog timer if programming parameter #15 (Serial) is set to W/TIMER (it uses a fixed 10 seconds timeout). If the drive sees no activity within the update time period it will stop the drive. Whenever a communications session (where #48 or #49was activated) is to be ended, register #1 bit 1 (Lock Security) must be asserted. This disables the watchdog and prevents further accesses to registers. Note: Terminal TB1 must be closed in order to unlock serial control.

5.11 Unlock Parameters - Register #49

Register #49 (Unlock Parameters) unlocks programming parameters for writing when the proper Programming Password is entered. Whenever a parameter writing session (where #49 was activated) is to be ended, register #1 bit 1 (Lock Security) must be asserted. This disables the watchdog and prevents further write access to Parameter Registers.



5.12 Register Version

Register Version is the number to identify if current version of software has any register changes relative to previous versions: a register has been added or deleted, a register's min/max limits have changed, a register's function has been changed, or a register's default value has been changed. Generally it is the programming parameters that are changed. Typically the Control Registers (AC TECH Register #1 through #50) are quite stable.

6 MC Programming Parameters

6.1 Format

NOTE - Attention

Parameter list presented in Section 6.2 is valid only for MC Software revision 213-083. For revisions, refer to appropriate MC1000 (M101) or MC3000 (M301) Manual.

Abbreviations:

SA (1byte) drive address (1-247)

RA (1byte) register address

CRCH (1 byte) Cyclic Redundancy Check High

CRCL (1 byte) Cyclic Redundancy Check L

READING:

Message structure for reading 1 word: (most of parameters)

Request:	SA	03	00	RA	00	01	CRCH	CRCL
Response:	SA	03	02	DH	DL	CRCH	CRCL	

Message structure for reading 4 word: (Reg. #100 Fault history and #101 Software Version)

Request:	SA	03	00	RA	00	04	CRCH	CRCL				
Response:	SA	03	08	D1H	D1L	D2H	D2L	D3H	D3L	D4H	D4L	CRCH	CRCL

WRITING:

Message structure for writing 1 word: (all parameters)

Request:	SA	06	00	RA	DH	DL	CRCH	CRCL
Response:	SA	06	00	RA	DH	DL	CRCH	CRCL

LEGEND for Parameter List

1st Column: **AC Tech Register #** MC Register # followed by Hex value in parenthesis: 51 (33H)

2nd Column: **Parameter**
[1] = Drive's programming parameter number
[2] = MC1000 without PID (SW version 213-083, revision 13 or older)
[3] = MC1000 with PID
[4] = MC3000

4th Column: **Range of Adjustment** The Modbus values are whole numbers. One decimal place is assumed. A superscript [5] denotes parameter where two decimal places are assumed.
For example, to program a value of 28.20 Hz, the user can program 28.20 into the MC drive and the drive will display 28.20 but for Modbus communications, the user must input 2820. The one decimal place is assumed. If the user wanted a value of 282 Hz, then for Modbus communications he would have to input 28200.

5th Column: **Default Value** [5] = Two decimal places assumed (hundredths)

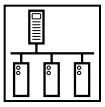
6.2 Parameter List

AC Tech Register Number (hexadecimal representation)	Parameter [1]	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
51 (33)	0	LINE VOLTS	00 - High 01 - Low 02 - Auto	02 - Auto
52 (34)	1	SPEED #1	Min. Freq - Max. Freq (0.00 - 120.00 Hz)	2000 (20.00 Hz) [5]
53 (35)	2	SPEED #2	Min. Freq - Max. Freq	2000 (20.00 Hz) [5]
54 (36)	3	SPEED #3	Min. Freq - Max. Freq	2000 (20.00 Hz) [5]
55 (37)	4	SPEED #4	Min. Freq - Max. Freq	2000 (20.00 Hz) [5]
56 (38)	5	SKIP #1	MC1: 0 - 65000 (.00 - 650.00 Hz) MC3: 0 - Max Freq (.00 Hz - Max. Freq)	0 (.00 Hz) [5]
57 (39)	6	SKIP #2	MC1: 0 - 65000 (.00 - 650.00 Hz); MC3: .0 - Max Freq (00 Hz - Max. Freq)	0 (.00 Hz) [5]
58 (3A)	7	BAND WID	0 - 1000 (.00 - 10.00 Hz)	100 (1.00 Hz) [5]
59 (3B)	8	ACCEL	Refer to Note 4	300 (30.0 sec)
60 (3C)	9	DECEL	Refer to Note 5	300 (30.0 sec)
61 (3D)	10	MIN FREQ	0 - Max Frequency (0.00 - 120.00 Hz)	50 (.50 Hz) [5]
62 (3E)	11	MAX FREQ	Min Frequency - 12000 (120.00 Hz) Note 6	6000 (60.00 Hz) [5]
63 (3F)	12	DC BRAKE	Refer to Note 7	0 (.0 VDC)
64 (40)	13	DC TIME	0 - 9999 (.0 - 999.9 sec)	0 (.0 sec)
65 (41)	14	DYN BRAKE	00 - Off 01 - On	00 - Off
67 (43)	16	CURRENT	25 - 180 (25 - 180%), Refer to Note 8	180 (180%)
68 (44)	17	MOTOR OL	25 - 100 (25 - 100%)	100 (100%)
69 (45)	18	BASE	2000 - 36000 (20.00 - 360.0 Hz)	6000 (60.00 Hz) [5]
70 (46)	19	FX BOOST	0 - 300 (0.0 - 30.0%)	Refer to Note 9
71 (47)	20 [2,3]	AC BOOST	0 - 200 (0.0 - 20.0%)	0 (.0%)
72 (48)	21 [2,3]	SLIP CMP	0 - 50 (0.0 - 5.0%)	0 (.0%)
73 (49)	22	TORQUE	00 - Contant 01 - Variable 02 - CT/NOCMP	00 - Constant
74 (4A)	23	CARRIER	00 - 2.5 kHz 01 - 6 kHz 02 - 8 kHz 03 - 10 kHz 04 - 12 kHz 05 - 14 kHz	00 - 2.5 kHz

1 = Drive's programming parameter number; 2 = MC1000 without PID (SW ver 213-083, rev 13 or older); 3 = MC1000 with PID; 4 = MC3000; 5 = Hundredths place

AC Tech Register Number (hexadecimal representation)	Parameter [1]	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
76 (4C)	25 [2,3]	START	00 - Normal 01 - Power-Up 02 - Auto Re- 03 - Re-Brake	00 - Normal
76 (4C)	25 [4]	START	00 - Normal 01 - Power-Up 02 - Auto 1 03 - Auto 2 04 - Auto 3	00 - Normal
77 (4D)	26	STOP	00 - Ramp 01 - Coast	01 - Coast
78 (4E)	27 [2,3]	ROTATION	00 - Forward 01 - Reverse 02 - FWD & REV 03 - FWD@LOC	00 - Forward
79 (4F)	28 [2,3]	AUTO/MAN	00 - Both 01 - Auto 02 - Manual	00 - Both
79 (4F)	28 [4]	AUTO/MAN	00 - A/M LOC 01 - Auto 02 - Manual 03 - A/M SPD	00 - A/M LOC
80 (50)	29 [2,3]	MANUAL	00 - Keypad 01 - 0-10 VDC	00 - Keypad
81 (51)	30 [2,3]	CONTROL	00 - Local 01 - Remote 02 - Both	00 - Local
81 (51)	30 [4]	CONTROL	00 - Local 01 - Remote 02 - Serial 03 - Keypad 04 - TB Strip 05 - Keypad	00 - Local
82 (52)	31 [2]	HZ UNITS	00 - Hertz 01 - RPM 02 - % Hz 03 - /SEC 04 - /MIN 05 - /HR 06 - GPH 07 - None	00 - Hertz

1 = Drive's programming parameter number; 2 = MC1000 without PID (SW ver 213-083, rev 13 or older); 3 = MC1000 with PID; 4 = MC3000

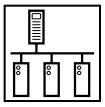


AC Tech Register Number (hexadecimal representation)	Parameter [1]	Parameter Name	Range of Adjustment Modbus value (decimal value)				Factory Default
82 (52)	31 [3,4]	UNITS	**Speed:** 00 - Hertz 01 - RPM 02 - % Hz 03 - /SEC 04 - /MIN	05 - /HR 06 - GPH 07 - None	**PID:** 08 - % 09 - PSI 10 - FPM 11 - CFM 12 - GPM 13 - IN 14 - FT	15 - /SEC 16 - /MIN 17 - /HR 18 - F 19 - C 20 - MPM 21 - GPH	00 - Hertz
83 (53)	32	HZ MULT	10 - 65000 (.10 - 650.00)				100 (1.00) [5]
84 (54)	33	SPEED DP	00 - XXXXX 01 - XXX.X 02 - XX.XX 03 - X.XXX 04 - .XXXX				00 - XXXXX
84 (54)	33	UNITS DP	00 - XXXXX 01 - XXX.X 02 - XX.XX 03 - X.XXX 04 - .XXXX				00 - XXXXX
85 (55)	34	LOAD MLT	95 - 139 (95 - 139%)				100 (100%)
86 (56)	35	CONTRAST	00 - Low 01 - Medium 02 - High				02 - High
87 (57)	36	SLEEP TH	0 - 36000 (.00 - 360.00 Hz)				0 (0.00) [5]
88 (58)	37	SLEEP DL	0 - 3000 (.00 - 30.00 Hz)				3000 (30.00) [5]
89 (59)	38 [3,4]	SLEEP BW	0 - PID Feedback Range				0 (0.0)
90 (5A)	39	TB5 MIN	0 - 36000 (.00 - 360.00 Hz)				0 (.00 Hz) [5]
91 (5B)	40	TB5 MAX	0 - 36000 (.00 - 360.00 Hz)				0 (.00 Hz) [5]
92 (5C)	41	AIN FLTR	1 - 1000 (0.01 - 10.00 sec)				2 (0.02 sec) [5]
93 (5D)	42	TB10A OUT	00 - None 01 - 0 - 10 VDC 02 - 2 - 10 VDC				00 - None
94 (5E)	43	@TB10A	0 - 36000 (0.00 - 360.00 Hz)				6000 (60.00 Hz) [5]
95 (5F)	44	TB10B OUT	00 - None 01 - 0 - 10 VDC 02 - 2 - 10 VDC				00 - None
96 (60)	45	@TB10B	10 - 200 (10 - 200%)				125 (125%)

1 = Drive's programming parameter number; 2 = MC1000 without PID (SW ver 213-083, rev 13 or older); 3 = MC1000 with PID; 4 = MC3000; 5 = Hundredths place

AC Tech Register Number (hexadecimal representation)	Parameter [1]	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
98 (62)	47	TB13A	00 - None 01 - 0 - 10 VDC 02 - 4 - 20 mA 03 - Speed #1 04 - Loc Sel 05 - Dec Freq	00 - None
99 (63)	48 [2,3]	TB13B	00 - None 01 - 0 - 10 VDC 02 - 4 - 20 mA 03 - Speed #2 04 - Inc Freq 05 - Jog Fwd 06 - Jog Rev	00 - None
99 (63)	48 [4]	TB13B	00 - None 01 - 0 - 10 VDC 02 - 4 - 20 mA 03 - Speed #2 04 - Inc Freq	00 - None
100 (64)	49 [2,3]	TB13C	00 - None 01 - 0 - 10 VDC 02 - 4 - 20 mA 03 - Speed #3 04 - Loc Sel 05 - Run Rev 06 - Strt Rev	00 - None
100 (64)	49 [4]	TB13C	00 - None 01 - 0 - 10 VDC 02 - 4 - 20 mA 03 - Speed #3 04 - Loc Sel 05 - Strt Rev	00 - None
101 (65)	50	TB13D	00 - EXT Fault 01 - EXT /Fault 02 - EXT Clear	00 - EXT Fault
103 (67) 104 (68) 105 (69)	52 [2] 53 [2] 54 [2]	TB14OUT TB15OUT RELAY	00 - None 01 - Run 02 - Fault 03 - /Fault 04 - Lock 05 - @ Speed 06 - Above #3 07 - I Limit 08 - Auto/Man 09 - Follower Present 10 - Reverse	00 - None

1 = Drive's programming parameter number; 2 = MC1000 without PID (SW ver 213-083, rev 13 or older); 3 = MC1000 with PID; 4 = MC3000



AC Tech Register Number (hexadecimal representation)	Parameter [1]	Parameter Name	Range of Adjustment Modbus value (decimal value)		Factory Default
103 (67) 104 (68) 105 (69)	52 [3,4] 53 [3,4] 54 [3,4]	TB14OUT TB15OUT RELAY	00 - None 01 - Run 02 - Fault 03 - /Fault 04 - Lock 05 - @ Speed 06 - Above #3 07 - I Limit 08 - Auto/Man 09 - Follower Present	10 - Min/Max 11 - /Min/Max 12 - Min Alarm 13 - /Min Alarm 14 - Max Alarm 15 - /Max Alarm 16 - Reverse 17 - Sleep 18 - SPD = 0Hz	00 - None
106 (6A)	55 [3,4]	TB5B LOSS	00 - Fault 01 - SP#4 02 - None		00 - Fault
108 (6C)	57	SERIAL	00 - Disable 01 - w/ Timer 02 - w/o Timer		00 - Disable
109 (6D)	58	ADDRESS	1 - 247		30
112 (70)	61	PASSWORD	0000 - 9999		0019
114 (72)	63	SOFTWARE	(View Only)		(N/A)
115 (73)	64	MONITOR	00 - OFF 01 - ON		01 - ON
116 (74)	65	PROGRAM	00 - Maintain 01 - Reset 60 02 - Reset 50 Refer to Note 10		01 - Reset 60
117 (75)	66	HISTORY	00 - Maintain 01 - Clear		00 - Maintain
121 (79)	70 [3,4]	PID MODE	00 - Off 01 - Normal 02 - Reverse		00 - Off
125 (7D)	74 [3,4]	PID FB	00 - TB-5A 01 - TB-5B		00 - TB-5A
126 (7E)	75 [3,4]	FB @ MIN	0 - 65000		0 (0.0%)
127 (7F)	76 [3,4]	FB @ MAX	0 - 65000		65000 (100%)
129 (81)	78 [3,4]	I GAIN	0 - 100 (0.0 - 10.0 sec)		0 (0.0 sec)
130 (82)	79 [3,4]	D GAIN	0 - 100 (0.0 - 10.0 sec)		0 (0.0 sec)
131 (83)	80 [3,4]	PID ACC	0 - 1000 (0.0 - 100.0 sec)		300 (30.0 sec)
132 (84)	81 [3,4]	MIN ALRM	FB @ MIN - FB @ MAX		0.0%
133 (85)	82 [3,4]	MAX ALRM	FB @ MIN - FB @ MAX		0.0%
149 (95)	69 [2] 98	LANGUAGE	Refer to Note 11		English
150 (96)	70 [2] 99 [3,4]	FAULT HISTORY	(View Only)		(N/A)

1 = Drive's programming parameter number; 2 = MC1000 without PID (SW ver 213-083, rev 13 or older); 3 = MC1000 with PID; 4 = MC3000

NOTE 4 - Acceleration Limits

Acceleration Limits	
HP	**Adjustment Range**
.025 - 20	1 - 36000 (0.1 - 3600 sec)
25 - 60	3 - 36000 (0.3 - 3600 sec)

NOTE 5 - Deceleration Limits

Deceleration Limits				
HP			**Adjustment Range**	
240/200 VAC	480/400 VAC	590/480 VAC	without dB	with dB
0.25 - 7.5	1 - 7.5		3 - 36000 (0.3 - 3600 sec)	1 - 36000 (0.1 - 3600 sec)
10 - 15	10 - 20	1 - 7.5	5 - 36000 (0.5 - 3600 sec)	1 - 36000 (0.1 - 3600 sec)
20 - 30	25 - 60	10 - 20	10 - 36000 (1.0 - 3600 sec)	2 - 36000 (0.2 - 3600 sec)
		25 - 60	20 - 36000 (2.0 - 3600 sec)	2 - 36000 (0.2 - 3600 sec)

NOTE 6 - MAX FREQUENCY (Register 62)

The Maximum limit is 650 Hz on drives with high frequency software.

NOTE 7 - MAX DC BRAKE VOLTAGE (Register 63)

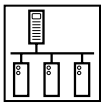
Maximum DC Brake Voltage				
Model	**M3100/M1100**	**M3200/M1200**	**M3400/M1400**	**M3500/M1500**
Voltage	**240/120 Vac**	**240/200 Vac**	**480/400 Vac**	**590/480 Vac**
MAX Brake Voltage	24 V	24 V	48 V	59 V

NOTE 8 - CURRENT (Register 67)

If LINE VOLTS, Register 51, is set to LOW (or set to Auto an the input voltage is low), the range for CURRENT is 25 - 150%.

NOTE 9 - FX BOOST (Register 70)

FX BOOST Factory Default Settings				
HP	**All Models**	**HP**	**480/400 Vac 590/480 Vac**	**240/200Vac**
0.25 - 1	5.30%	25	1.80%	1.80%
1.5 - 2	4.40%	30	1.60%	1.60%
3	3.60%	40	1.20%	2.30%
5	3.00%	50 - 60	0.80%	2.10%
7.5	2.70%	75	2.00%	N/A
10	2.40%	100 -125	1.90%	N/A
15	2.20%	150	1.80%	N/A
20	2.00%			



NOTE 10 - PROGRAM (Register 116)

"RST HIGH" will appear as another option on drives that are configured for high frequency.

NOTE 11 - LANGUAGE (Register 150)

The MC Series drive can support other languages with the addition of an optional LANGUAGE EEPROM chip installed in socket U11 on the control board of the drive. If the EEPROM is not present, the default language will be ENGLISH. Also, this parameter is not affected when the parameters are reset using Parameter 65 - PROGRAM. Therefore, if a language other than ENGLISH is selected, it will remain in effect after a RESET.

7 Quick Start Instructions

Follow these Quick Start instructions to use ModBus Communications for basic network control of an MC drive. These instructions are a reprint of Application Note AN0035, *Basic Network Control of the MC Drive using Modbus™ Communications*. To download the MC product manual or application note visit the AC Tech Technical Library at http://www.lenze-actech.com.

7.1 Initial Settings

1. Set the Modbus Master to 9600 bps with 8 data bits, no parity and 2 stop bits. The MC1000/3000 series drives do NOT support any other baud rates or data formats.

2. Set Parameter 58 (ADDRESS) to the desired network address that the Modbus master will poll. Valid Modbus addresses are 1-247.

   TIP - Avoid using address 1. Most Modbus devices ship with a default address of 1. As duplicate addressing on a Modbus network is not allowed, this can lead to conflicts when replacing and commissioning nodes. To avoid this it is recommended that you do not set the slave address to 1.

3. The MC1000/3000 series drive has the provision for a watchdog timer to monitor network communications to the drive. The timer is fixed at a value of 10 seconds. If the drive is under network control and the master does not communicate with the MC1000/3000 drive for longer than the 10 second timeout period, the drive will STOP. The timer can either be enabled or disabled as outlined in the next step.

4. Set Parameter 57 (SERIAL) to either W/TIMER or W/O TIMR as desired in order for serial communication to function.

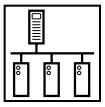
7.2 Drive Control

1. Start/Stop Control: Please be advised that while the drive is under network control the local STOP circuit is always enabled. The drive's control registers (i.e. start, auto/manual, direction) cannot be written to unless the drive is operating in LOCAL control mode. If Parameter 29 (CONTROL) is set to REMOTE or if it is set to BOTH and no LOC SEL terminal is asserted, the network cannot control the drive. Drive parameters can still be written.

   Also, if Parameter 29 (CONTROL) is set to BOTH and a LOC SEL terminal is asserted the drive can only be started over the network if the TB1 input is also asserted. If TB1 is not to be used as an external stop contact, simply jumper the TB1 input to TB2.

   If Parameter 29 (CONTROL) is set LOCAL, the TB1 input does not need to be asserted for the drive to be started over the network.

2. Use either Modbus function code 16 with a length of 1 or Modbus function code 06 to perform any writes to the drive.



Unlocking the Drive:

1. The first write necessary to the drive to perform any function (start,change speed, change a parameter, etc) needs to be an unlock command.

   To control the drive over the network but not modify any of the drive's programming parameters, you can write a value of 0 to the drive's Modbus register 40049 (AC Tech register 48).

   To both control the drive and alter any programming parameters then write the drive's programming password to Modbus register 40049. The default password for the MC1000/3000 series drive is 0019.

2. You should only need to send the unlock command once after power up. As long as the communications do not timeout you should not need to write another unlock to the drive before writing any other function.

   NOTE: The drive's control registers cannot be written to when the drive is in REMOTE control (i.e. When Parameter 30 – CONTROL is set to REMOTE or when it is set to BOTH with no LOC SEL terminal asserted).

Setting the Drive to Manual Mode:

In order for the drive to respond to speed commands written to the keypad speed register, Parameter 29 (MANUAL) must be set to KEYPAD and the drive must be put into manual mode. To do this write a value of 200H to Modbus register 40002 (the drive's control register). This step is not necessary if there are no other speed references setup on any TB-13x terminal.

7.3 Basic Drive Commands

The following are the basic drive commands. ONLY ONE OF THESE CAN BE DONE AT A TIME:

1. To STOP the drive using the stop method programmed in Parameter 26 (STOP), write a value of 0004hex to Modbus register 40002 (AC Tech register 1).

2. To Start the drive write a value of 0008hex to Modbus register 40002.

3. To Set Reverse direction write a value of 0040hex to Modbus register 40002. On MC1000 drives, this command will not be accepted if Parameter 27 (ROTATION) is not set to REVERSE or FWD&REV.

4. To Set Forward direction write a value of 0080hex to Modbus register 40002. On MC1000 drives, this command will not be accepted if Parameter 27 (ROTATION) is set to REVERSE.

5. If you want the network to control the speed of the drive, set Parameter 29 (MANUAL) to KEYPAD and write the speed to the Keypad Speed Command Register, Modbus register 40041 (AC Tech register 40). Speed is written in 0.01Hz (so 4120 would be 41.20 Hz). In this mode the drive's initial speed reference on power up will be the last speed written to the drive.

7.4 Basic Drive Status

AC Tech register 24 is a 6 word entity containing the drive's status information. To retrieve the entire status block (Modbus registers 24-29) send a read command to Modbus register 40025 using Modbus function code 03 with a register count of 6. The low byte of the third word in this block of data contains the operational status.

The value of that low byte of data corresponds to the following operational states:

Operational Status (byte D3L or Register #26 DL)

Value*	Operational State
0	FAULT LOCKOUT
1	FAULT
2	START PENDING
3	STOP
4	DC BRAKE
5	RUN AT 0Hz
6	RUN
7	ACCEL
8	DECEL
9	CURRENT LIMIT
10	DECEL OVERRIDE
16	SLEEP MODE

* This is the decimal equivalent value of the binary number of the bits in that byte.

7.5 Basic Drive Network Programming

The programming parameters of the MC1000/3000 series drive may be altered by a Modbus master. To do so simply write the desired value to the appropriate Modbus register. The translation is as follows:

Modbus register number = MC parameter number +52

As an example if you wanted to change the acceleration time (Parameter 8) of the MC drive, write the time desired into Modbus register 40060. Note that time is written in 0.1 seconds (so 200 would be 20.0 sec).

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