Modbus Control of Minarik AC200 Series Drives

INSTALLATION AND OPERATION INSTRUCTIONS
Document Number: 250-0307

Scope

This document is intended to define the specifics required for serial communication with Minarik Corporation Standard AC200 Series drives for control, status monitoring, and programming parameters. A familiarity with normal drive capabilities and operations is assumed. If this is not the case, please refer to the appropriate Minarik Installation and Operation manual as necessary.

Modbus® Details

A) Minarik 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). There are provisions for Odd parity 1 stop bit and Even parity 1 stop bit as well. The bit sequence is:

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

B) At this time the Minarik drives do not support the broadcast function of the protocol.

Warning

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. Minarik register numbers are also numbered starting from 0. Therefore, Minarik register numbers always correspond exactly with the address transmitted. As a result, MODBUS REGISTER NUMBERS ARE ALWAYS ONE GREATER THAN MINARIK REGISTER NUMBERS. WHENEVER THE WORDS "REGISTER #xx" APPEAR, IT SHOULD BE ASSUMED THAT THEY MEAN "MINARIK 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) . . ."

C) The function codes supported by Minarik drives are:

1. 03 - Read Holding Register (4X references). In general only one register is read at a time. However there are a few limited exceptions.

   Exception One:

   a) Register #24 (Modbus Register #25), Drive Status, can also be read as a group of 6 words.

   Exception Two:

   Minarik 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.

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

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

2. 04 - Read Input Register (3X references). As with function 03, read one register at a time except where noted.
3. 06 - Preset Single Register (4X references). Write single register.
4. 16 - Preset Multiple Register (4X references). Although the function is for multiple registers, will accept only a single register to be written.
5. Note: Do not differentiate between 4X and 3X references, function codes 03 and 04 are treated identically.

D) Exception codes:

01 - Command rejected, Illegal function.
02 - No such register.
03 - Data out of range.
04 - Wrong data format.
05 - Slave device busy. In Keypad Programming mode, cannot write registers.

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

F) 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. The 24 hour support telephone number for Schneider Electric is 1-800-468-5342.

Universal Registers

Currently the AC400 Series, AC300 Series and AC200 Series of Minarik Drives support Modbus-based communications. Since the three families of drives have quite 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 Minarik Register locations have been made universal among Minarik drives. While their locations are consistent, their contents may vary as defined in the following table:

Minarik Reg #	Function
1	Drive Control (WRITE ONLY) Not all drives will have control functions. But when the function is available it will be at a defined bit location within Register #1
19	Drive Family (READ ONLY) This register is CONSISTENT AMONG ALL MINARIK DRIVES: - 65 -- AC300 & AC400 Series - 66 -- AC200 Series
21	Drive Size (READ ONLY) Code to identify Power (HP/KW) and Line Voltage of the drive. Family dependent. For the AC200 Series it always reads zero.
24	Drive Size (READ ONLY) Various operational variables.
48	Unlock Control (WRITE ONLY)
49	Unlock Writing of registers (WRITE ONLY)
50	Parameter Configuration Number (READ ONLY)

Data Internal and External Representation

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

1) Individual bit commands (16 per register).
Example: Register #1 (Modbus Register #2).
2) Individual bit flags (16 per register).
Example: Register #22.
3) A concatenation of two 8 bit unsigned integers.
4) A 16 bit unsigned integer. This unsigned integer could in turn represent many different types of data with various scaling rules and units, which are defined by the DATA TYPE of the register.

B) 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 tenths of a Hz but the drive may display that speed in whole Hz by dropping the tenth using programmed conversion factors. The following are examples of the internal units used on the AC200 series:

Type	Unit	Example
SPEED	.1 Hz	60 Hz = 600
TIME	.1 Sec	30.0 Sec = 300

See Programming Parameter List

Minarik Drive Parameters

Registers #0 through #50 (Modbus Registers #1 to #51) are reserved for Configuration and Control. Registers #51 through #255 (Modbus Register #52 to #256) are reserved for the Drives' Programming Mode Parameters. Programming Mode Parameters are the parameters that can be accessed from the local keypad on the drive. There is a direct correspondence between the AC200 Drive Programming Mode Parameter number and the Minarik Register number (and consequently, the Modbus register number):

Minarik Register # = (AC200 Programming Parameter #) + 50
Modbus Register # = (AC200 Programming Parameter #) + 51

The entries in Table 1 are based on AC200 Drive Software #213-064 Revision 03 (Parameter Configuration = 312). If a later revision of software were to change register definitions, drive operation could be seriously affected. This will be identified for a given drive by examining Register #50 (Parameter Configuration Number). The number displayed at power up on drive display can also identify it. If it is not 312, writing to any register on the drive MUST NOT BE ATTEMPTED unless your Controller has been setup to support the new configuration.

AC200 Operational Details

A) Serial Address

All Minarik drives have a Serial Address Parameter that must be programmed prior to attempting to operate the serial interface (Programming Parameter #43 / Minarik Register #93).

B) Serial Communications Parameter

1) All Minarik drives have a Serial Communications Parameter that governs the operation of the Serial Link. On AC200 drives this is #15 SERIAL LINK (register #65). It has the following selections:

1 = DISABLE
2 = 9600, N, 2 WITH TIMER (10 sec) ← *default*
3 = 9600, N, 2 WITHOUT TIMER
4 = 9600, E, 1 WITH TIMER (10 sec)
5 = 9600, E, 1 WITHOUT TIMER
6 = 9600, O, 1 WITH TIMER (10 sec)
7 = 9600, O, 1 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 (see "F" on page 5).
- WITHOUT TIMER - serial link allows reading & writing of both control & programming parameters. Watchdog timer is disabled (see "F" on page 5).

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

C) Control Parameter

1) Programming parameter #14 (control) must be programmed to 01 (terminal strip only). Serial operation will not work correctly if 02 (remote keypad only) or 03 (terminal strip or remote keypad) are selected.

D) Unlocking & Locking Controls

1) 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 and register #40 (keypad speed command).
Note: Terminal TB1 must be closed in order to unlock serial control.
2) 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 #81 - Preset Speed #1). The factory default password for AC200 series drives is 225.

3) Once Register #48 (Unlock Controls) has been written, Controls are unlocked until Register #1 bit 1 (Lock Bit) has been written, Watchdog Timeout occurs or terminal TB1 is opened.
4) Writing to Register #1 (Drive Control) with bit 1 set will Lock both controls and Parameters (prevents writing to any register).
5) The serial drive control can be unlocked only if terminal TB1 is closed and the drive is not in programming mode.
6) When LOCK is asserted, the drive drops out of SERIAL control and reverts back to the previous source of control.
7) Even though the drive might be locked, and thus parameters and control cannot be written, parameters and status can always be read. See section (G) below.

E) Unlocking & Locking Programming Parameters only

1) Writing to any writeable register other than #1 and #40 (keypad speed) is enabled by writing the Drive's Programming Password to Register #49 (Unlock Parameter). This is done when Drive Control (start, stop, etc.) and keypad speed control (reg. #40) is not required.
2) The factory default password is 225.
3) Once Register #49 (Unlock Parameters) has been written, the writing of parameter registers is unlocked until Register #1 bit 1 (Lock Bit) has been set.

F) Watchdog Timer

1) All Minarik 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" (See "D" on page 4). If the Watchdog Timer is enabled and controls have been unlocked, the Master MUST PERIODICALLY COMMUNICATE with the drive or the timer will timeout. A Watchdog timeout forces the drive to stop because it is assumed that the failure of periodic communications with the drive could be a loss of the serial link with the accompanying loss of ability to command the drive to stop. The Watchdog Timer does not operate unless Controls have been UNLOCKED via Register #48, or parameters writing have been unlocked via Register #49. In case of unlocking parameters only, watchdog timer will disable write permission but will not stop the drive.
2) Watchdog Timer Controls
    a) 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 #15 (SERIAL LINK):

        Programming Parameter #15 controls both the enabling of the serial link and the Watchdog. By setting Parameter #15 to one of the selections WITH TIMER enables the serial link WITH the Watchdog. Conversely, setting Parameter #15 to WITHOUT TIMER enables the serial link WITHOUT the Watchdog.

    b) 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.

G) Monitoring Only Operation

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

H) Normal Control Operation Sequence

1) Power up drive with serial enabled and TB1 closed.
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.) and change the keypad command speed by writing to Register #40.

    NOTE: Drive must be in "MANUAL" (see Register #1 [drive control]) and Parameter #5 (standard speed source) must be set to 01 (keypad) in order to control speed via Register #40.

4) Since the Watchdog Timer is enabled, keep it from timing out by insuring that repeated reads of drive status (Register #24 - 6 registers) are 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 TERMINAL mode (control from the drive's terminal).

I) Start/Stop, Speed control and parameter Change Operation Typical Sequence.

1) Power up drive with serial enabled and TB1 closed.
2) Unlock Controls and Parameters by writing the current programming password (default 225) to Register #48.
3) Set parameter #5 (standard speed source) to 01 (keypad), and 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 #69).
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 TERMINAL mode (control from the drive's terminal).

TABLE 1 - AC200 Drive Control Registers

** See Note [1], for an explanation of the abbreviations used below.*

ACT # (HEX representation)	REGISTER NAME	R/W/RS	MESSAGE								MIN	MAX	UNITS	NOTES
1 (01)	Drive Control	W	SA	06	00	01	DH	DL	CRC		See Notes			[2]
		RS	SA	06	00	01	DH	DL	CRC					
19 (13)	Drive Family	R	SA	03	00	13	00	01	CRC		See Notes			[3]
		RS	SA	03	02	00	42	CRC						
21 (15)	Drive Size	R	SA	03	00	15	00	01	CRC		See Notes			[4]
		RS	SA	03	02	00	00	CRC						
22 (16)	Drive H/W	R	SA	03	00	15	00	01	CRC		See Notes			[5]
		RS	SA	03	02	DH	DL	CRC						
24 (18)	Drive Status (6 register read) (reg. #24 to 29)	R	SA	03	00	18	00	06	CRC		See Notes			[6]
		RS	SA	03	0C	D1H	D1L	D2H	D2L					
						D3H	D3L	D4H	D4L					
						D5H	D5L	D6H	D6L	CRC				
24 (18)	Command Speed	R	SA	03	00	18	00	01	CRC		0	2400	0.1 Hz	[6a]
		RS	SA	03	02	DH	DL	CRC						
25 (19)	Actual Speed	R	SA	03	00	19	00	01	CRC		0	2400	0.1 Hz	[6b]
		RS	SA	03	02	DH	DL	CRC						
26 (1A)	Load (DH) / Status (DL)	R	SA	03	00	1A	00	01	CRC		See Notes			[6c]
		RS	SA	03	02	DH	DL	CRC						
27 (1B)	Act. Direction (DH)/ Control Mode (DL)	R	SA	03	00	1B	0	01	CRC		See Notes			[6d]
		RS	SA	03	02	DH	DL	CRC						
28 (1C)	Speed Source (DH)/ Auto/Manual (DL)	R	SA	03	00	1C	00	01	CRC		See Notes			[6e]
		RS	SA	03	02	DH	DL	CRC						
29 (1D)	Fault (DH)/ Commanded Direction (DL)	R	SA	03	00	1D	00	01	CRC		See Notes			[6f]
		RS	SA	03	02	DH	DL	CRC						
30 (1E)	Motor Voltage	R	SA	03	00	1E	00	01	CRC		0	250	1%	[7]
		RS	SA	03	02	DH	DL	CRC						
40 (28)	Keypad Speed Command	R	SA	03	00	28	00	01	CRC		0	2400	0.1 Hz	[8]
		RS	SA	03	02	DH	DL	CRC						
		W	SA	06	00	28	DH	DL	CRC					
		RS	SA	06	00	28	DH	DL	CRC					
48 (30)	Unlock Commands	W	SA	06	00	30	DH	DL	CRC		0	9999	None	[9]
		RS	SA	06	00	30	DH	DL	CRC					
49 (31)	Unlock Parameters	W	SA	06	00	31	DH	DL	CRC		0	9999	None	[10]
		RS	SA	06	00	31	DH	DL	CRC					
50 (32)	Register Version	R	SA	03	00	32	00	01	CRC		0	65535	None	[11]
		RS	SA	03	02	DH	DL	CRC						

NOTES:

Note [1]: Following are the abbreviations used above:

R	Read
W	Write
RS	Response
SA	Slave Address (typically 01 through F7 hex)
CRC	CRC high + CRC low (see CRC calculations section in MODBUS manual)
DH	Data High byte
DL	Data Low byte
B	Byte
ACT#	Minarik Register # (Modbus Register numbers are 1 large)

Note [2]: Register #1 (Drive Control):

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	
	11	
	12	
	13	
	14	
	15	

The appropriate bit is set to 1. For example, to stop the drive bit 2 is set (send 0004H). To start the drive send 0008H. Setting update buffers bit enables the drive to start using downloaded data. Locking security disables the serial drive control, communications watchdog timer and prevents any further writing to control or parameter registers.

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

Note [3]: Minarik Corp's AC400 and AC300 Series drives return 65 (41H) and AC200 series drives always return 66 (42H).

Note [4]: On AC200 series drives this register always reads zero.

Note [5]: Register #22 (Drive hardware configuration)
Bits represent specific hardware configuration.

AC200 Series Drive:

BIT #	SETTINGS	MEANING
0	1	Not isolated drive (hot)
0	0	Isolated
1	1	Reserved
1	0	Reserved
2	1	OEM defaults present
2	0	No OEM defaults
3	1	EPM Parameter version is different but compatible
3	0	Either the parameter version of the EPM matches the current software or the EPM is not compatible. If incompatible then one of the following faults are responsible: CF (control fault), cF (incompatibility fault) or GF (data fault).

** All other bits (4-15) are unused at this time.*

Note [6]: When reading parameter #24, the group of words requested can be either 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 parameter #24, the following will be returned:

6 Register read at #24:

Command Speed	D1H D1L
Actual Speed	D2H D2L
Load	D3H
Operation Status	D3L
Rotational Direction	D4H
Control Mode	D4L
Speed Command Source	D5L
Auto/Manual Status	D5H
Present Fault	D6H
Command Rotation	D6L

Note [6a]: Command Speed (bytes D1H and D1L or Register #25)
- In tenths of a Hz.
- Most significant byte is first, followed by least significant.
- Example: 02 01 in hex converts to 51.3 Hz in decimal (assumed one decimal place).

Note [6b]: Actual Speed (bytes D2H and D2L or Register #25)
- In tenths of a Hz.
- Most significant byted is first followed by least significant.

Note [6c]: Load (byte D3H or Register #26 DH)
- In percent of full load.
- Example: 64 (one byte in hex) → 100 (in decimal) → 100% (drive load).

Operational Status (byte D3L or Register #26 DL)

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

Note [6d]: Actual Rotational Direction (Register #24 byte D4H or Register #27 DH)

0	FORWARD
1	REVERSE

Control Mode (Register #24 byte D4L or Register #27 DL)

0	TERMINAL	Start/Stop operation controlled from drive's control board terminal strip.
1	REMOTE KEYPAD	Start/Stop operation controlled from remote keypad.
2 or 3	SERIAL	Start/Stop operation controlled via serial link.

Note [6e]: Speed Command Source (Register #24 byte D5H or Register #28 DH)

0	KEYPAD
1	0 - 10 VDC
2	4 - 20 MA
3	PRESET 1
4	PRESET 2
5	PRESET 3
6	PRESET 4
7	PRESET 5
8	PRESET 6
9	PRESET 7
10	JOG
11	MOP

Auto/Manual Status (Register #24 byte D5L or Register #28 DL)

0	AUTO
1	MANUAL

Note [6f]: Present Fault (Register #24 byte D6H of Register #29 DH)

0	NO FAULT
1	OUTPUT (TRANSISTOR) FAULT ("OF")
2	HIGH DRIVE TEMPERATURE ("AF")
3	HIGH DC BUS VOLTAGE ("HF")
4	LOW DC BUS VOLTAGE ("LF")
5	THERMAL OVERLOAD ("PF")
6	CONTROL FAULT ("CF")
7	EXTERNAL ("EF")
8	OEM FAULT ("GF")
9	START ERROR ("UF")
10	INTERNAL1 (EPM) ("F1")
11	INTERNAL2 ("F2")
12	INTERNAL3 ("F3")
13	INTERNAL4 ("F4")
14	INTERNAL5 ("F5")
15	INTERNAL6 ("F6")
16	INTERNAL7 ("F7")
17	INTERNAL8 ("F8")
18	INTERNAL9 ("F9")
19	INTERNALo ("Fo")
20	SINGLE PHASE FAULT ("SF")
21	INCOMPATIBILITY FAULT ("cF")
22	DYNAMIC BRAKE OVERHEATED ("dF")
23	SERIAL LINK FAULT ("JF")

Commanded Rotational Direction (Register #24 byte D6L or Register #29 DL)

0	FORWARD
1	REVERSE

Attention: Register not used on AC200 drives prior to software version 48, revision 7 (4807) and software version 57, revision 3 (5703).

Note [7]: Register #30 - Motor Volts. Output voltage to the motor expressed as a percentage of nominal drive voltage.

Note [8]: Register #40 - Keypad Speed. This register sets keypad speed to a desired value.
- In tenths 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.

Note [9]: 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 (see 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 #49 was activated) is to be ended, register #1 bit 1 (Lock Security) must be asserted. This disables the watchdog and prevents further access to registers. Note: Terminal TB1 must be closed in order to unlock serial control.

Note [10]: 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.

Note [11]: 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 (Minarik Register #1 through #50) are quite stable.

AC200 Series Programming Parameters Details

Attention

Parameter list presented below is valid only for AC200 software revision 6403. For revisions, refer to appropriate AC200 manual.

SA (1 byte) drive address (1-247)
RA (1 byte) register address
CRC (2 bytes) Cyclic Redundancy Check

READING:

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

Request:	SA	03	00	RA	00	01	CRC	
Response:	SA	03	02	DH	DL	CRC		

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

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

WRITING:

Message structure for writing 1 word: (all parameters)

Request:	SA	06	00	RA	DH	DL	CRC
Response:	SA	06	00	RA	DH	DL	CRC

PROGRAMMING PARAMETER LIST

Minarik Register Number (heaxadecimal representation)	Parameter Number *	Parameter Name	Range of Adjustment (values representing selection)	Factory Default
51 (33H)	1	Line Voltage	High (01), Low (02)	High (01)
52 (34H)	2	Carrier Frequency	4 kHz (01), 6 kHz (02), 8 kHz (03), 10 kHz (04)	6 kHz (02)
53 (35H)	3	Start Method	Normal (01), Start on Power-up (02) Start w/ DC Brake (03), Auto Restart w/ DC Brake (04), Flying Restart 1 (05), Flying Restart 2 (06), Flying Restart 3 (07)	Normal (01)
54 (36H)	4	Stop Method	Coast (01), Coast with DC Brake (02) Ramp (03), Ramp with DC Brake (04)	Coast (01)
55 (37H)	5	Speed Source	Keypad (01), Preset #1 (02) 0 - 10 VDC (03), 4 - 20 mA (04)	Keypad (01)
56 (38 H)	6	TB-14 OC Output	None (02), Run (02), Fault (03), Inverse Fault (04), Fault Lockout (05), At Set Speed (06), Above Preset #3 (07), Current Limit (08), Auto Speed (speed source selected via terminal strip) (09), Reverse (rotation direction indication) (10)	None (01)
	7	**Not Used**		
58 (3AH)	8	TB-30 Analog Output	None (01), 0 - 10 VDC Freq (02), 2 - 10 VDC Freq (03), 0 - 10 VDC %Load (04), 2 - 10 VDC %Load (05	None (01)
59 (3BH)	9	TB-31 Analog Output	None (01), 0 - 10 VDC Load (02), 2 - 10 VDC Load (03), Dynamic Braking (04)	None (01)
60 (3CH)	10	TB-13A Input	None (01), 0 - 10 VDC (02), 4 - 20 mA (03), Preset Speed #1 (04), Run Reverse (05), Start Reverse (06), External Fault (07), Remote Keypad Control (08), Dynamic Brake Fault (09), Ramp To Stop (10), Accel / Decel #2 (11)	None (01)
61 (3DH)	11	TB-13B Input	None (01), 0 - 10 VDC (02), 4 - 20 mA (03), Preset Speed #2 (04), Decrease Freq (MOP) (05), Jog Forward (06), Jog Reverse (07), Ramp To Stop (08)	None (01)

62 (3EH)	12	TB-13C Input	None (01), 0 - 10 VDC (02), 4 - 20 mA (03), Preset Speed #3 (04), Inc Freq (MOP) (05), External Fault (06), Remote Keypad Control (07), Dynamic Braking (08), Accel / Decel #2 (09)	None (01)
63 (3FH)	13	TB-15 OC Output	None (01), Run (02), Fault (03), Inverse Fault (04), Fault Lockout (05), At Set Speed (06), Above Preset #3 (07), Current Limit (08), Auto Speed (speed source selected via terminal strip) (09), Reverse (rotation direction indication) (10)	None (01)
64 (40H)	14	Control	Terminal Strip Only (01), Remote Keypad Only (02), Selectable at Terminal (03)	Terminal Strip (01)
65 (41H)	15	Serial Link	Disable (01) 9600, 8, N, 2 with Timer (02), 9600, 8, N, 2, without Timer (03), 9600, 8, E, 1 with Timer (04), 9600, 8, E, 1, without Timer (05) 9600, 8, O, 1 with Timer (06) 9600, 8, O, 1, without Timer (07)	9600, N, 2 with Timer (02)
66 (42H)	16	Units Ending	Tenths of Units (01), Whole Units (02)	Whole Units (02)
67 (43H)	17	Rotation	Forward Only (01), Forward and Reverse (02)	Forward Only (01)
	18	**Not Used**		
69 (45H)	19	Acceleration Time	1 - 3600 (0.1 sec - 3600.0 sec)	200 (20.0 sec)
70 (46H)	20	Deceleration Time	1 - 3600 (0.1 sec - 3600.0 sec)	200 (20.0 sec)
71 (47H)	21	DC Brake Time	0 - 3600 (0.0 sec - 3600.0 sec)	0 (0.0 sec)
72 (48H)	22	DC Brake Voltage	0 - 300 (0.0 - 30.0% of nominal voltage)	0 (0.0%)
73 (49H)	23	Minimum Frequency	0 - Maximum Frequency	0 (0.0 Hz)
74 (4AH)	24	Maximum Frequency	Minimum Frequency - 2400 (240.0 Hz)	600 (60.0 Hz)
75 (4BH)	25	Current Limit	30% - 180%	180 (180%)
76 (4CH)	26	Motor Overload	30 - 100%	100 (100%)
77 (4DH)	27	Base Frequency	250 (25.0 Hz) - 5000 (500.0 Hz)	600 (60.0 Hz)
78 (4EH)	28	Fixed Boost	0 - 300 (0.0 - 30.0%)	10 (1.0%)
79 (4FH)	29	Accel Boost	0 - 200 (0.0 - 20.0%)	0 (0.0%)
80 (50H)	30	Slip Compensation	0 - 50 (0.0 - 5.0%)	0.00%
81 (51H)	31	Preset Speed #1	0.0 - Maximum Frequency	0.0 Hz
82 (52H)	32	Preset Speed #2	0.0 - Maximum Frequency	0.0 Hz
83 (53H)	33	Preset Speed #3	0.0 - Maximum Frequency	0.0 Hz
84 (54H)	34	Preset Speed #4	0.0 - Maximum Frequency	0.0 Hz
85 (55H)	35	Preset Speed #5 / Skip Frequency #1	0.0 - Maximum Frequency	0.0 Hz

86 (56H)	36	Preset Speed #6 / Skip Frequency #1	0.0 - Maximum Frequency	0.0 Hz
87 (57H)	37	Preset Speed #7 / Skip Frequency #2	0.0 - Maximum Frequency	0.0 Hz
88 (58H)	38	Skip Bandwidth	0.0 - 10.0 Hz	0.0 Hz
89 (59H)	39	Speed Scaling	0 - 65000 (0.0 - 6500.0)	0
90 (5AH)	40	Frequency Scaling	30 - 2000 (3.0 - 200.0 Hz)	600 (20.0 sec)
91 (5BH)	41	Load Scaling	10 - 200%	200 (200%)
92 (5CH)	42	Accel / Decel #2	1 - 3600 (0.1 sec - 3600.0 sec)	200 (20.0 sec)
93 (5DH)	43	Serial Address	1 - 247	1
94 (5EH)	44	Password	000 - 999	225
	45	**Not Used**		
	46	**Not Used**		
97 (61H)	47	Clear History	Maintain (01), Clear (02)	Maintain (01)
98 (62H)	48	Program Selection	User Settings (01), OEM Settings (02)	Reset 50 (04)
			Reset OEM (03), Reset 60 (04), Reset 50 (05)	
99 (63H)	49	**Not Used**		

DIAGNOSTIC - READ ONLY PARAMETERS! (50# - 60#)

100 (64H)	50	FAULT HISTORY	Must Read 4 Words (Read Only	See Note [1]
101 (65H)	51	SOFTWARE VERSION	Must Read 1 or 4 Words (Read Only)	See Note [2]
102 (66H)	52	BUS VOLTAGE [%]	0 - 250 (Read Only)	Min 0% Max 250%
103 (67H)	53	ACTUAL MOTOR VOLTAGE [%]	0 - 250 (Read Only)	Min 0% Max 250%
104 (68H)	54	MOTOR LOAD [%]	0 - 250 (Read Only)	Min 0% Max 250%
105 (69H)	55	0 - 10 VDC analog input [100% = 10VDC]	0 - 250 (Read Only)	Min 0% Max 250%
106 (6AH)	56	4 - 20 mA analog input [100% = 20 mA]	0 - 250 (Read Only)	Min 0% Max 250%
107 (6BH)	57	DIGITAL I/O	SERIAL READ - DIGITAL I/O REPRESENTATION	See Note [3]
108 (6CH)	58	DIGITAL I/O	SERIAL READ - DIGITAL I/O REPRESENTATION	See Note [4]
109 (6DH)	59	ANALOG OUTPUT TB30 [100% = 10VDC]	0 - 250 (Read Only)	Min 0% Max 250%
110 (6EH)	60	ANALOG TB31 [100% = 10VDC]	0 - 250 (Read Only)	Min 0% Max 250%

** Drives programming parameter number*

NOTES:

Note [1]: When parameter #100 is read, the number of Points has to be 4. The drive will send 8 bytes of data back to the MASTER. It does not mean read function reads parameter #100, #101, #102, and #103. This is a special case to handle the data string. Number in every byte represents fault in fault history. Latest fault is in the first data byte, oldest fault is in the last data byte.

0	NO FAULT
1	OUTPUT (TRANSISTOR) FAULT ("OF")
2	HIGH DRIVE TEMPERATURE ("AF")
3	HIGH DC BUS VOLTAGE ("HF")
4	LOW DC BUST VOLTAGE ("LF")
5	THERMAL OVERLOAD ("PF")
6	CONTROL FAULT ("CF")
7	EXTERNAL ("EF")
8	OEM FAULT ("GF")
9	START ERROR ("UF")
10	INTERNAL1 (EPM) ("F1")
11	INTERNAL2 ("F2")
12	INTERNAL3 ("F3")
13	INTERNAL4 ("F4")
14	INTERNAL5 ("F5")
15	INTERNAL6 ("F6")
16	INTERNAL7 ("F7")
17	INTERNAL8 ("F8")
18	INTERNAL9 ("F9")
19	INTERNALo ("Fo")
20	SINGLE PHASE FAULT ("SF")
21	INCOMPATIBILITY FAULT ("cF")
22	DYNAMIC BRAKE OVERHEATED ("dF")
23	SERIAL LINK FAULT ("JF")

Note [2]: When parameter #101 is read, the number of points can be 1 or 4. In case of 4 register read, the drive will send 8 bytes of data back to the MASTER. It does not mean the read function reads parameter #101, #102, #103, and #104. This is a special case to handle the ASCII string representing software version. The ASCII string may look like this: "SCF6403". In case of reading one register, received high byte contains software version and low byte revision number. If received word contains hexadecimal number 0x4003 it translates to:

0x40 $\rightarrow$ decimal 64 (software version) and
0x03 $\rightarrow$ decimal 3 (revision number).

Note [3]:

Data Low Byte	0	PROTECT (pin FAULT1)
	1	PROTECT (pin FAULT2)
	2	PROTECT (pin FAULT3)
	3	FCLIM (pin FAULT4)
	4	STOP
	5	TB12A
	6	TB13A
	7	TB13B
Data High Byte	8	TB13C
	9	OPEN COLLECTOR 0
	10	OPEN COLLECTOR 1
	11	CHARGE RELAY
	12	
	13	
	14	
	15	

Note [4]:

Data Low Byte	0	
	1	
	2	
	3	UP PB
	4	DOWN PB
	5	DOWN PB
	6	
	7	FAST CLIM
Data High Byte	8	PROTECTION
	9	
	10	
	11	
	12	
	13	
	14	
	15	