



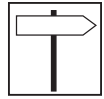
TCF Series Drives Modbus Communications Reference Guide

About These Instructions

This documentation applies to the use of an TCF Series Variable Frequency Drive in a Modbus Network and should be used in conjunction with the TCF Series Installation and Operation Manual (Document TF01) 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.



Safety Information

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

TCF Series Variable Frequency Drives visit: <http://www.lenze-actech.com>

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

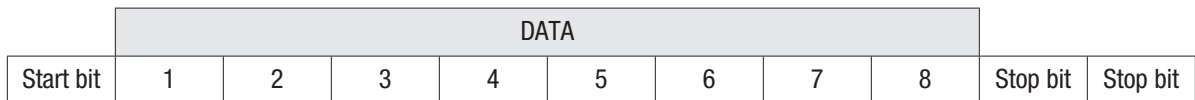


2 Introduction

This document defines the specifics required for Modbus serial communication with a Lenze-AC Tech standard TCF 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, refer to the TCF Series Installation and Operation manual (TF01) 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). There are provisions for Odd parity 1 stop bit and Even parity 1 stop bit as well. The bit sequence is:



- 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 (Modbus Register #25) Drive Status, 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.



Introduction

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. Registers cannot be written when the drive is in keypad programming mode.

F. The TCF 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 -- <i>Tmd</i> family
	- 66 -- SC family - 69 -- <i>smd</i> 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 TCF drive index value (RAM copy) 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).
Example: Register #1.
- A chain of two 8 bit unsigned integers.
- 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.

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 tenths of a Hz but the drive may display that speed in whole Hz by dropping the tenth using programmed conversion factors. Table 3 lists examples of the internal units used on the TCF series.

Table 3: TCF Series Internal Units

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

3.3 AC Tech Drive Registers

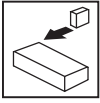
Registers #0 through #50:
Registers #51 through #255

(Modbus Registers #1 to #51) Reserved for configuration and control
(Modbus Registers #52 to #256) 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 TCF Drive Programming Mode Parameter number and the AC Tech Register number (and consequently, the Modbus register number):

$$\text{AC Tech Register \#} = (\text{TCF Programming Parameter \#}) + 50$$

$$\text{Modbus Register \#} = (\text{TCF Programming Parameter \#}) + 51$$

The entries in Table 5 are based on TCF Drive Software # 213-128 Revision 01 (Parameter Configuration = 501). 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 501, writing to any register on the drive MUST NOT BE ATTEMPTED unless your Controller has been setup to support the new configuration.



Drive Setup & Operation

4 TCF 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 #43 / AC Tech Register #93).

4.2 Serial Communications Parameter

All AC Tech drives have a Serial Communications Parameter that governs the operation of the Serial Link. On TCF drives this is #15 SERIAL LINK (register #65). Table 4 lists the selections for TCF Parameter 15, SERIAL LINK.

Table 4: TCF Parameter 15 Selections

Setting	Description	Watchdog Timeout Period
1	DISABLE	
2	9600,N,2 WITH TIMER	10 sec
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	

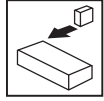
Explanation of Terms:

- **DISABLED** serial link not operational
- **WITH TIMER** serial link allows reading & writing of both control & programming parameters. Watchdog timer is enabled (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

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.



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 and register #40 (keypad speed command).

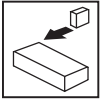
Note: Terminal TB1 must be asserted in order to unlock serial control.

- 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 TCF series drives is 225.
- 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.
- 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 be unlocked only if terminal TB1 is asserted and 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 and #40 (keypad speed) can be enabled by writing the Drive's Programming Password to Register #49 (Unlock Parameters). This would be done when Drive Control (start, stop, etc.) and keypad speed control (reg.#40) is not required.
- The Factory Default password is 225.
- 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.



Drive Setup & Operation

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 5.7). If the Watchdog Timer is enabled and controls have been unlocked, the Master **MUST PERIODICALLY COMMUNICATE** with the drive or the timer will timeout. Communications should typically be done at less than 5sec intervals as the Watchdog Timer faults at 10 seconds. 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 has been unlocked via Register #49. In case of unlocking parameters only, watchdog timer will disable write permission but will not stop the drive.

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 #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.

- 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.

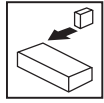
4.7 Monitoring Only Operation

1. Power up drive in TERMINAL mode 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 and TB1 asserted.
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.

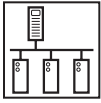


4. If the Watchdog Timer is enabled, keep it from timing out by ensuring that repeated reads of drive status (Register #24 – 6 registers) are performed at reasonable intervals (typically less than 5 seconds between reads because the Watchdog typically faults at 10 seconds).
5. Lock Control when drive 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).

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 and TB1 asserted.
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).



Drive Control & Communication

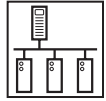
5 TCF Drive Control Registers

Table 5 describes the TCF 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 5: TCF Drive Control Registers

AC Tech Register # (HEX representation)	REGISTER NAME	R/W/RS	MESSAGE								MIN	MAX	UNITS	[NOTE] or Section
			SA	06	00	01	DH	DL	CRC					
1 (01)	Drive Control	W	SA	06	00	01	DH	DL	CRC		Refer to Section 5.2			[1]
		RS	SA	06	00	01	DH	DL	CRC					
19 (13)	Drive Family	R	SA	03	00	13	00	01	CRC		Refer to Section 5.2			[2]
		RS	SA	03	02	00	42	CRC						
21 (15)	Drive Size - RAM copy	R	SA	03	00	15	00	01	CRC		Refer to Section 5.3			
		RS	SA	03	02	00	00	CRC						
24 (18)	Drive Status (6 register read) (reg. #24 to 29)	R	SA	03	00	18	00	06	CRC		Refer to Section 5.4			
		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	[3a]
		RS	SA	03	02	DH	DL	CRC						
25 (19)	Actual Speed	R	SA	03	00	19	00	01	CRC		0	2400	0.1 Hz	[3b]
		RS	SA	03	02	DH	DL	CRC						
26 (1A)	Load (DH) / Status (DL)	R	SA	03	00	1A	00	01	CRC		Refer to Section 5.4.2			[3c]
		RS	SA	03	02	DH	DL	CRC						
27 (1B)	Actual Rot. Direction (DH)/ Control Mode (DL)	R	SA	03	00	1B	00	01	CRC		Refer to Section 5.4.3/4			
		RS	SA	03	02	DH	DL	CRC						
28 (1C)	Speed Source (DH)/ Auto/Manual (DL)	R	SA	03	00	1C	00	01	CRC		Refer to Section 5.4.5/6			
		RS	SA	03	02	DH	DL	CRC						
29 (1D)	Fault (DH)/ Commanded Direction (DL)	R	SA	03	00	1D	00	01	CRC		Refer to Section 5.4.7/8			[3d]
		RS	SA	03	02	DH	DL	CRC						
30 (1E)	Motor Voltage	R	SA	03	00	1E	00	01	CRC		0	250	1%	5.5
		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	5.6
		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	5.7
		RS	SA	06	00	30	DH	DL	CRC					
49 (31)	Unlock Parameters	W	SA	06	00	31	DH	DL	CRC		0	9999	None	5.8
		RS	SA	06	00	31	DH	DL	CRC					
50 (32)	Register Version	R	SA	03	00	32	00	01	CRC		0	65535	None	5.9
		RS	SA	03	02	DH	DL	CRC						

Drive Control & Communication



5.1 Abbreviations

Table 6 lists the abbreviations used in Table 5 TCF Drive Control Registers:

Table 6: Abbreviations

Abbreviation	Description
R	Read
W	Write
RS	Response
SA	Slave Address (typically 01 through F7 hex)
CRC	Cyclic Redundancy Check High + Low bytes
DH	Data High byte
DL	Data Low byte
B	Byte
ACT#	AC Tech Register # (Modbus Register numbers are 1 larger)

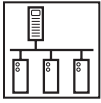
5.2 Drive Control - Register #1

Table 7 illustrates the Data High Byte and Data Low Byte format of Register #1, Drive Control.

Table 7: Drive Control - Register #1

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 two is set (send 0004H). To start the drive send 0008H. Setting the update buffers bit, enables starting 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.



Drive Control & Communication



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

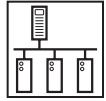
- The QC Series drives return 64 (40H)
- The MC Series drives return 65 (41H)
- The SC Series drives return 66 (42H)
- The MCH Series drives return 68 (44H)
- The *smd* Series drives return 69 (45H)
- The TCF Series drives return 70 (46H)
- The *Tmd* Series drives return 71 (47H)
- The SMV Series drives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

5.3 Drive Size - Register 21

Table 8 lists the drive index number, voltage, input phase and horsepower ratings for the TCF Series Drives. The "Drive Index #" is the RAM copy of Register 21.

Table 8: TCF Drive Index

Drive Index #	Voltage	Input Phase	HP	Drive Index #	Voltage	Input Phase	HP	Drive Index #	Voltage	Input Phase	HP
01	208/240	1	0.5	25	400/480	3	0.5	40	480/590	3	0.5
02	208/240	1	1	26	400/480	3	1	41	480/590	3	1
03	208/240	1	1.5	27	400/480	3	1.5	42	480/590	3	1.5
04	208/240	1	2	28	400/480	3	2	43	480/590	3	2
05	208/240	1	3	29	400/480	3	3	44	480/590	3	3
06	208/240	1	5	30	400/480	3	5	45	480/590	3	5
13	208/240	3	0.5	31	400/480	3	7.5	46	480/590	3	7.5
14	208/240	3	1	32	400/480	3	10	47	480/590	3	10
15	208/240	3	1.5	33	400/480	3	15	48	480/590	3	15
16	208/240	3	2	34	400/480	3	20	49	480/590	3	20
17	208/240	3	3	35	400/480	3	25	50	480/590	3	25
18	208/240	3	5	36	400/480	3	30	51	480/590	3	30
19	208/240	3	7.5	37	400/480	3	40	52	480/590	3	40
20	208/240	3	10	38	400/480	3	50	53	480/590	3	50
21	208/240	3	15	39	400/480	3	60	54	480/590	3	60
22	208/240	3	20								
23	208/240	3	25								
24	208/240	3	30								



5.4 Drive Status - Registers #24-29

5.4.1 Reading Register #24

When reading register #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 register #24, the following will be returned:

Table 9: 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
Auto/Manual Status	D5L
Present Fault	D6H
Command Rotation	D6L



NOTE 3a - 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 51.3Hz in decimal (assumed 1 decimal place).



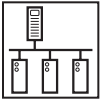
NOTE 3b - Actual Speed (Bytes D2H and D2L or Register #25)

- In tenths 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).



Drive Control & Communication

5.4.2 Operational Status - Registers #24 & 26

Table 10 lists the Operational Status (Register #24 byte D3L or Register #26 DL)

Table 10: Operational Status

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

5.4.3 Actual Rotational Direction - Registers #24 & 27

Table 11 lists the Actual Rotational Direction (Register #24 byte D4H or Register #27 DH).

Table 11: Actual Rotational Direction

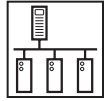
Setting	Direction
0	FORWARD
1	REVERSE

5.4.4 Control Mode - Registers #24 & 27

Table 12 lists the Control Mode (Register #24 byte D4L or Register #27 DL).

Table 12: Control Mode

Setting	Control	Operation
0	TERMINAL	Start/Stop operation controlled from the drive's terminal strip
1	REMOTE KEYPAD (Control)	Start/Stop operation controlled from remote keypad
2	REMOTE KEYPAD (Program)	Remote keypad used for drive programming; Start/Stop operation controlled from the drive's terminal strip
3	SERIAL	Start/Stop operation controlled via serial link



5.4.5 Speed Command Source - Registers #24 & 28

Table 13 lists the Speed Command Source (Register #24 byte D5H or Register #28 DH).

Table 13: Speed Command Source

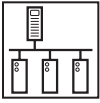
Setting	Source
0	KEYPAD
1	0 – 10VDC
2	4 – 20MA
3	PRESET 1
4	PRESET 2
5	PRESET 3
6	PRESET 4
7	PRESET 5
8	PRESET 6
9	PRESET 7
10	JOG
11	MOP

5.4.6 Auto/Manual Status - Registers #24 & 28

Table 14 lists the Auto/Manual Status (Register #24 byte D5L or Register #28 DL).

Table 14: Auto/Manual Control

Setting	Control
0	AUTO
1	MANUAL



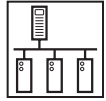
Drive Control & Communication

5.4.7 Present Fault - Registers #24 & 29

Table 15 lists the Present Fault (Register #24 byte D6H of Register #29 DH)

Table 15: Present Fault

Setting	Fault	Display
0	NO FAULT	
1	TEMPORARY OUTPUT FAULT	
2	OUTPUT (TRANSISTOR) FAULT	"OF"
3	HIGH DRIVE TEMPERATURE	"AF"
4	FLYING RESTART FAULT	"Rf"
5	HIGH DC BUS VOLTAGE	"HF"
6	LOW DC BUS VOLTAGE	"LF"
7	THERMAL OVERLOAD	"PF"
8	OEM FAULT	"GF"
9	ILLEGAL SETUP	"IL"
10	DYNAMIC BRAKE OVERHEATED	"dF"
11	SINGLE PHASE FAULT	"SF"
12	EXTERNAL	"EF"
13	CONTROL FAULT	"CF"
14	START ERROR	"UF"
15	INCOMPATIBILITY FAULT	"cF"
16	INTERNAL1 (EPM)	"F1"
17	INTERNAL2	"F2"
18	INTERNAL3	"F3"
19	INTERNAL4	"F4"
20	INTERNAL5	"F5"
21	INTERNAL6	"F6"
22	INTERNAL7	"F7"
23	INTERNAL8	"F8"
24	INTERNAL9	"F9"
25	PERSONALITY FAULT	"bF"
26	A/D OFFSET FAULT	"Ad"
27	SERIAL LINK FAULT	"JF"
28	ASSERTION LEVEL CHANGED FAULT	"AL"
29	USER ASSERTION LEVEL FAULT	"A1"
30	OEM ASSERTION LEVEL MIS-MATCH FAULT	"A2"
31	EEPROM CHECKSUM FAULT	"A3"
32	ASSERTION LEVEL HARDWARE FAULT	"A4"



5.4.8 Commanded Rotational Direction - Registers #24 & 29

Table 16 lists the Commanded Rotational Direction (Register #24 byte D6L or Register #29 DL)

Table 16: Commanded Rotational Direction

Setting	Direction
0	FORWARD
1	REVERSE



NOTE 3d - Commanded Rotational Direction

Register NOT used on TCF drives prior to software version 48, revision 7 (4807) and software version 57, revision 3 (5703).

5.5 Motor Volts - Register #30

Output Voltage to the motor expressed as a percentage of nominal drive voltage.

5.6 Keypad Speed - Register #40

This register enables the user to set the keypad speed to 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 and unlocking serial drive control.

5.7 Unlock Commands - Register #48

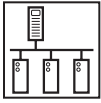
Register #48 (Unlock Commands) unlocks commands by using 0000 for the password. If the correct Programming mode password is entered then the appropriate programming parameters can also be accessed (refer to the full parameter protocol specification if access to programming parameters is required). Enabling 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 #49 was 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 asserted in order to unlock serial control.

5.8 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.

5.9 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 TCF Programming Parameters

6.1 Format



NOTE - Parameter Version

The Parameter List presented in Section 6.2 is valid only for TCF Software, Parameter Version 500. For revisions, refer to appropriate TCF Manual.

Abbreviations:

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

READING:

Message structure for reading 1 word: (most of 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

LEGEND for Parameter List

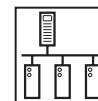
1st Column: **AC Tech Register #** TCF Register # followed by Hex value in parenthesis: 51 (33H)

2nd Column: **Parameter**¹ Drive's programming parameter number

4th Column: **Range of Adjustment** The Modbus values are whole numbers. One decimal place is assumed.

For example, to program a value of 28.2 Hz, the user can program 28.2 into the TCF drive and the drive will display 28.2 but for Modbus communications, the user must input 282. The one decimal place is assumed. If the user wanted a value of 282 Hz, then for Modbus communications he would have to input 2820.

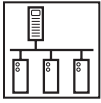
² = Two decimal places assumed (hundredths)



6.2 Parameter List

AC Tech Register Number (hexadecimal representation)	Parameter ¹	Parameter Name	Range of Adjustment Modbus value (decimal value)		Factory Default
51 (33H)	01	Line Voltage	01 - High 02 - Low		01 - High
52 (34H)	02	Carrier Frequency	01 - 2 kHz 02 - 4 kHz 03 - 8 kHz		02 - 4 kHz
53 (35H)	03	Start Method	01 - Normal 02 - Start on Power-up 03 - Start w/DC Brake 04 - Auto Restart w/DC Brake 05 - Flying Restart 1 06 - Flying Restart 2		01 - Normal
54 (36H)	04	Stop Method	01 - Coast 02 - Coast with DC Brake 03 - Ramp 04 - Ramp with DC Brake		01 - Coast
55 (37H)	05	Standard Reference Source	Speed Mode: 01 - Keypad 02 - Preset #1 03 - 0-10 VDC 04 - 4-20 mA	Torque Mode: 01 - Keypad 02 - Keypad 03 - 0-10 VDC 04 - 4-20 mA	01 - Keypad
56 (38H)	06	TB-14 OC Output	01 - None 02 - Run 03 - Fault 04 - Inverse Fault 05 - Fault Lockout 06 - At Set Speed 07 - Above Preset #3 08 - Current Limit 09 - Auto Speed (speed source via terminal strip) 10 - Reverse (rotation direction indication) 11 - Dynamic Braking		01 - None
57 (39H)	07	Bipolar Reference	01 - Disable 02 - Enable		01 - Disable
58 (3AH)	08	TB-30 Analog Output	01 - None 02 - 0-10 VDC Freq 03 - 2-10 VDC Freq 04 - 0-10 VDC %Load 05 - 2-10 VDC %Load 06 - 0-10 VDC Torque 07 - 2-10 VDC Torque		01 - None

¹ = Drive's programming parameter number

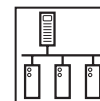


Drive Control & Communication

AC Tech Register Number (hexadecimal representation)	Parameter ¹	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
60 (3CH)	10	TB-13A Input	01 - None 02 - 0-10 VDC 03 - 4-20 mA 04 - Preset Speed #1 05 - Start Forward 06 - Run Reverse 07 - Start Reverse 08 - External Fault 09 - Remote Keypad Control 10 - Dynamic Brake Fault 11 - Auxiliary Stop 12 - Accel / Decel #2	01 - None
61 (3DH)	11	TB-13B Input	01 - None 02 - 0-10 VDC 03 - 4-20 mA 04 - Preset Speed #2 05 - Decrease Freq (MOP) 06 - Jog Forward 07 - Auxiliary Stop	01 - None
62 (3EH)	12	TB-13C Input	01 - None 02 - 0-10 VDC 03 - 4-20 mA 04 - Preset Speed #3 05 - Inc Freq (MOP) 06 - External Fault 07 - Remote Keypad Control 08 - Dynamic Brake Fault 09 - Jog Reverse 10 - Accel / Decel #2	01 - None
63 (3FH)	13	TB-15 OC Output	01 - None 02 - Run 03 - Fault 04 - Inverse Fault 05 - Fault Lockout 06 - At Set Speed 07 - Above Preset #3 08 - Current Limit 09 - Auto Speed (speed source via terminal strip) 10 - Reverse (rotation direction indication) 11 - Dynamic Braking	01 - None
64 (40H)	14	Control	01 - Terminal Strip Only 02 - Remote Keypad Only 03 - Terminal Strip or Remote Keypad	01 - Terminal Strip

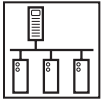
¹ = Drive's programming parameter number

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AC Tech Register Number (hexadecimal representation)	Parameter ¹	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
65 (41H)	15	Serial Link	01 - Disable 02 - 9600, 8, N, 2 with Timer 03 - 9600, 8, N, 2, without Timer 04 - 9600, 8, E, 1 with Timer 05 - 9600, 8, E, 1, without Timer 06 - 9600, 8, O, 1 with Timer 07 - 9600, 8, O, 1, without Timer	02 - 9600, N, 2 w/ Timer
67 (43H)	17	Rotation	01 - Forward Only 02 - Forward and Reverse	01 - Forward Only
68 (44H)	18	Motor Overload Type	01 - Speed Comp 02 - No Comp	01 - Speed Comp
69 (45H)	19	Acceleration Time	1 – 13000 (0.1 sec – 1300.0 sec)	200 (20.0 sec)
70 (46H)	20	Deceleration Time	1 – 13000 (0.1 sec – 1300.0 sec)	200 (20.0 sec)
71 (47H)	21	DC Brake Time	0 – 9999 (0.0 sec – 999.9 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 – Max Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
74 (4AH)	24	Maximum Frequency	Min Frequency – 2400 (0.0 – 240.0 Hz)	600 (60.0 Hz)
75 (4BH)	25	Current Limit	500 – 2000 (50 – 200%)	2000 (200%)
76 (4CH)	26	Motor Overload	300 – 1000 (30 – 100%)	1000 (100%)
77 (4DH)	27	Base Frequency	250 – 5000 (25.0 Hz – 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 (0.0%)
81 (51H)	31	Preset Speed #1	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
82 (52H)	32	Preset Speed #2	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
83 (53H)	33	Preset Speed #3	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
84 (54H)	34	Preset Speed #4	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
85 (55H)	35	Preset Speed #5 / Skip Frequency #1	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
86 (56H)	36	Preset Speed #6 / Skip Frequency #1	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
87 (57H)	37	Preset Speed #7 / Skip Frequency #2	0 – Maximum Frequency (0.0 – 240.0 Hz)	0 (0.0 Hz)
88 (58H)	38	Skip Bandwidth	0 – 100 (0.0 - 10.0 Hz)	0 (0.0 Hz)
89 (59H)	39	Speed Scaling	0 – 65000 (0.0 - 6500.0)	0 (0.0)
90 (5AH)	40	Frequency Scaling	30 – 12000 (3.0 - 1200.0 Hz)	600 (60.0 Hz)
91 (5BH)	41	Load Scaling	100 – 2000 (10 – 200%)	2000 (200%)
92 (5CH)	42	Accel / Decel #2	1 – 13000 (0.1 sec – 1300.0 sec)	200 (20.0 sec)

¹ = Drive's programming parameter number

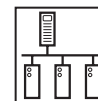


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AC Tech Register Number (hexadecimal representation)	Parameter ¹	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
93 (5DH)	43	Serial Address	1 - 247	1
94 (5EH)	44	Password	000 - 999	225
95 (5FH)	45	Speed at Min Signal	0 - 9990 (0.0 - 999 Hz)	0 (0.0 Hz)
96 (60H)	46	Speed at Max Signal	0 - 9990 (0.0 - 999 Hz)	600 (60.0 Hz)
97 (61H)	47	Clear History	01 - Maintain 02 - Clear	01 - Maintain
98 (62H)	48	Program Selection	01 - User Settings 02 - OEM Settings 03 - Reset OEM 04 - Reset 60 05 - Reset 50 06 - Translate	04 - Reset 60
99 (63H)	49	TB-13D Input	01 - None 02 - 0-10 VDC 03 - 4-20 mA 04 - Preset Speed #1 05 - Start Forward 06 - External Fault 07 - Remote Keypad Control 08 - Dynamic Brake Fault 09 - Auxiliary Stop 10 - Accel / Decel #2	01 - None
Diagnostic – Read Only Parameters! (50# - 60#)				
100 (64H)	50	FAULT HISTORY	Must Read 4 Words (Read Only)	See Note [4]
101 (65H)	51	SOFTWARE VERSION	Must Read 1 or 4 Words (Read Only)	See Note [5]
102 (66H)	52	BUS VOLTAGE [%]	0-250 (MIN 0% MAX 250%)	Read Only
103 (67H)	53	ACTUAL MOTOR VOLTAGE [%]	0-250 (MIN 0% MAX 250%)	Read Only
104 (68H)	54	MOTOR LOAD [%]	0-250 (MIN 0% MAX 250%)	Read Only
105 (69H)	55	0-10VDC analog input [100% = 10VDC]	0-250 (MIN 0% MAX 250%)	Read Only
106 (6AH)	56	4-20mA analog input [100% = 20mA]	0-250 (MIN 0% MAX 250%)	Read Only
107 (6BH)	57	DIGITAL I/O	SERIAL READ - DIGITAL I/O REPRESENTATION	See Note [6]
108 (6CH)	58	DIGITAL I/O	SERIAL READ - DIGITAL I/O REPRESENTATION	See Note [6]
109 (6DH)	59	TB30 OUTPUT	0-250 (MIN 0% MAX 250%)	Read Only
123 (7BH)	73	HEATSINK TEMP	0-255 (degrees C)	Read Only
125 (7DH)	75	INPUT Assertion Level	01 - Low 02 - High	02 - High

¹ = Drive's programming parameter number

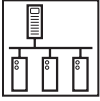
Drive Control & Communication



AC Tech Register Number (hexadecimal representation)	Parameter ¹	Parameter Name	Range of Adjustment Modbus value (decimal value)	Factory Default
130 (82H)	80	Drive Mode	01 - Constant V/Hz 02 - Variable V/Hz 03 - Enhanced Constant V/Hz 04 - Enhanced Variable V/Hz 05 - Vector Speed 06 - Vector Torque	01 - Constant V/Hz
131 (83H)	81	Auto Calibration	00 - Calibration Not Done 01 - Calibration Cycle Enabled 02 - Calibration Complete	00 - Calibration Not Done
132 (84H)	82	Current Loop P Gain	0 - 1600 (0.00 - 16.00)	25 (0.25) ²
133 (85H)	83	Current Loop I Gain	120 - 9990 (12 - 999 msec)	650 (65 msec)
134 (86H)	84	Stator Resistance	0 - 6400 (0.00 - 64.00 ohms) refer to Note 8	0 (0.00 ohms) ²
135 (87H)	85	Motor Rated Speed	3000 - 650000 (300 - 65000 RPM)	17500 (1750 RPM)
136 (88H)	86	Motor Rated Amps	0 - 480 (0.0 - 48.0 amps)	0 (0.0 amps)
137 (89H)	87	Motor Rated Volts	0 - 6000 (0 - 600 VAC)	0 (0 VAC)
138 (8AH)	88	Motor Base Frequency	250 - 5000 (25 - 500 Hz)	600 (60 Hz)
141 (8DH)	91	Motor Cosine Phi	40 - 99 (0.40 - 0.99)	90 (0.90) ²
142 (8EH)	92	Motor Inductance	0 - 20000 (0.0 - 2000 mH) refer to Note 8	0 (0.0 mH)
143 (8FH)	93	Torque Limit	0 - 4000 (0 - 400 %)	1000 (100 %)
144 (90H)	94	Drive Personality	(Read Only) Refer to section 5.3 Drive Size	EPM copy of Drive Index
145 (91H)	95	Motor Current	(Read Only)	N/A
146 (92H)	96	Torque Percent	(Read Only)	N/A

¹ = Drive's programming parameter number

² = Two decimal places assumed (hundredths)



Drive Control & Communication

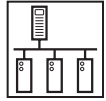


NOTE 4 - AC Tech Register #100, Parameter 50 - Fault History

When parameter #100 is read, the number of registers must 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. Refer to table 17 for clarification.

Table 17: Fault Codes - Register 100

Code	Fault Description	Display
0	NO FAULT	
1	TEMPORARY OUTPUT FAULT	
2	OUTPUT (TRANSISTOR) FAULT	"OF"
3	HIGH DRIVE TEMPERATURE	"AF"
4	FLYING RESTART FAULT	"Rf"
5	HIGH DC BUS VOLTAGE	"HF"
6	LOW DC BUS VOLTAGE	"LF"
7	THERMAL OVERLOAD	"PF"
8	OEM FAULT	"GF"
9	ILLEGAL SETUP FAULT	"IL"
10	DYNAMIC BRAKE OVERHEATED	"dF"
11	SINGLE PHASE FAULT	"SF"
12	EXTERNAL	"EF"
13	CONTROL FAULT	"CF"
14	START ERROR	"UF"
15	INCOMPATIBILITY FAULT	"cF"
16	INTERNAL1 (EPM)	"F1"
17	INTERNAL2	"F2"
18	INTERNAL3	"F3"
19	INTERNAL4	"F4"
20	INTERNAL5	"F5"
21	INTERNAL6	"F6"
22	INTERNAL7	"F7"
23	INTERNAL8	"F8"
24	INTERNAL9	"F9"
25	PERSONALITY FAULT	"bF"
26	A/D OFFSET FAULT	"Ad"
27	SERIAL LINK FAULT	"JF"



NOTE 5 - AC Tech Register #101, Parameter 51 - Software Version

When parameter #101 is read, the number of registers can be either 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: "TF12801". In case of reading one register, received high byte contains software version and low byte revision number. If received word contains hexadecimal number 0x8001 it translates to:

0x80 --> decimal 128 (software version) and

0x01 --> decimal 1 (revision number).



NOTE 6 - AC Tech Registers 107 & 108 - Digital I/O

Table 18 lists the format of AC Tech Register #107, Parameter 57 - TB Strip Status.

Table 19 lists the format of AC Tech Register #108, Parameter 58 - Keypad Status.

Table 18

AC Tech Register #107		
TB Terminal Strip Status		
Data Low Byte	0	Not used
	1	Not used
	2	Protect (pin FAULT3)
	3	FCLIM (pin FAULT4)
	4	STOP
	5	Not used
	6	TB13A
	7	TB13B
Data High Byte	8	TB13C
	9	Open Collector TB14
	10	Open Collector TB15
	11	Charge Relay
	12	TB13D
	13	Not used
	14	Not used
	15	Not used

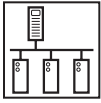
Table 19

AC Tech Register #108		
Keypad Status		
Data Low Byte	0	Not used
	1	Not used
	2	Not used
	3	UP PB
	4	DOWN PB
	5	PROG PB
	6	Not used
	7	FAST CLIM
Data High Byte	8	PROTECTION
	9	Not used
	10	Not used
	11	Not used
	12	Not used
	13	Not used
	14	Not used
	15	Not used



NOTE - AC Tech Registers #134 & 142

Register #134, Parameter 84 (Stator Resistance) and Register #142, Parameter 92 (Motor Inductance) are automatically adjusted when the Auto Calibration function (Parameter 81) is performed. Once the Auto Calibration is complete, the settings should not change.



7 Quick Start Instructions

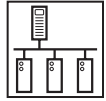
Follow these Quick Start instructions to use ModBus Communications for basic network control of a TCF drive. These instructions are a reprint of Application Note AN0033, *Basic Network Control of the TCF Drive using Modbus™ Communications*. To download the TCF product manual or application note visit the AC Tech Technical Library at <http://www.lenze-actech.com>.

7.1 Initial Settings

1. Set Parameter 14 (P14) to 01 to enable serial communication.
2. Set P43 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. Duplicate addressing on a Modbus network is not allowed. It can lead to conflicts when replacing and commissioning nodes. To avoid this, do not to set the slave address to 1.

3. Set the Modbus master to 9600 baud. No other baud rates are supported by the TCF drive.
4. The TCF series drive has the provision for a watchdog timer to monitor network communications to the drive. The timer is hard coded to a value of 10 seconds. If the drive is under network control and the master does not communicate with the TCF 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:
5. The drive needs to have its network data formatting set the same as the Modbus master.
 - a. If the Modbus master is set to use 8 data bits, no parity and two stop bits and you want the watchdog timer on the TCF drive ENABLED, set P15 to 02.
 - b. If the Modbus master is set to use 8 data bits, no parity and two stop bits and you want the watchdog timer on the TCF drive DISABLED, set P15 to 03.
 - c. If the Modbus master is set to use 8 data bits, even parity and one stop bit and you want the watchdog timer on the TCF drive ENABLED, set P15 to 04.
 - d. If the Modbus master is set to use 8 data bits, even parity and one stop bit and you want the watchdog timer on the TCF drive DISABLED, set P15 to 05.
 - e. If the Modbus master is set to use 8 data bits, odd parity and one stop bit and you want the watchdog timer on the TCF drive ENABLED, set P15 to 06.
 - f. If the Modbus master is set to use 8 data bits, odd parity and one stop bit and you want the watchdog timer on the TCF drive DISABLED, set P15 to 07.



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. Input 1 needs to be asserted in order for the drive to start. If you will not be using start/stop, simply jumper the TB1 input to TB4.
2. Use either Modbus function code 16 with a length of 1 or Modbus function code 06 to perform any writes to the drive.
3. Unlocking the Drive: The first write necessary to the drive to perform any function (start, change speed, change a parameter, etc) needs to be an unlock.

To only control the drive over the network 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 TCF drive is 225.

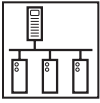
You should only need to send the unlock command once after power up. As long as the communications do not timeout you should not need to write another unlock to the drive before writing any other function.

4. Setting the Drive to Manual Mode: In order for the drive to respond to speed commands written to the keypad speed register 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 P04, 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. P17 must be set to 2 in order for this command to be accepted.
4. To Set Forward direction (the drive powers up with forward direction already selected) write a value of 0080hex to Modbus register 40002.
5. If you want the network to control the speed of the drive, set P05 (Standard Speed Source) to 01 (Keypad) and write the speed to the Keypad Speed Command Register, Modbus register 40041 (AC Tech register 40). Speed is written in 0.1Hz (so 412 would be 41.2 Hz). In this mode the drive's initial speed reference on power up will be the last speed written to the drive.



Drive Control & Communication

7.4 Basic Drive Status

AC Tech register #24 is a 6 word entity containing the drive's status information. To read the entire status block use Modbus function code 3 with a length of 6 to read starting at Modbus register number 40025. The low byte of the third word in this block of data contains the operational status. If this is the only data you want you can use Modbus function code 3 with a length of 1 to read register 40027.

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

Operational Status (Register #24 byte D3L or Register #26 DL)

VALUE*	OPERATIONAL STATE
0	FAULT LOCKOUT
1	FAULT
2	START PENDING
3	IDENTIFICATION NOT DONE
4	STOP
5	LOWER TRANSISTORS SWITCHED ON
6	RUN IDENTIFICATION
7	RUN AT 0Hz
8	RUN
9	ACCEL
10	DECEL
11	DECEL OVERRIDE
12	DC BRAKE
13	FLYING START
14	CURRENT LIMIT

* 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 TCF 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 = TCF parameter number +51

As an example if you wanted to change the acceleration time (P19) of the TCF drive, write the time desired into Modbus register 40070. Note that time is written in 0.1 seconds (so 200 would be 20.0 sec).

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