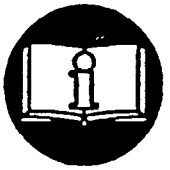
03539954 Form 7114
Edition 3
May, 1997

OPERATION AND MAINTENANCE MANUAL
for
TMAD
DC ELECTRIC TORQUE MANAGEMENT SYSTEMS

This symbol is to alert the user and service personnel to the presence of uninsulated dangerous voltage that will cause a risk of electrical shock.

This symbol is to alert the user and service personnel to the presence of important operating instructions that must be read and understood to prevent personal injury, electrical shock or damage to the equipment.



⚠WARNING

YOU MUST READ THIS MANUAL BEFORE OPERATING THE SYSTEM.

Electrical repairs should be attempted only by authorized trained repairmen. Consult your service center listing for your nearest Ingersoll-Rand authorized service center.

For safe operation the following procedure must be followed.

- **Keep work area clean.**
  Cluttered areas and benches invite injuries.
- **Consider work area environment.**
  Don't expose the Controller to water or moisture. Keep work area well lit.
- **Guard against electric shock.**
  Prevent body contact with grounded surfaces, such as pipes, metal structures or other electrical products.
- **Keep bystanders away.**
  Do not permit unauthorized personnel to operate this Controller.
- **Store idle Controllers.**
  When not in use, the Controller should be stored in a dry, and secure area.
- **Don't abuse cord.**
  Never carry a Controller by its cord or yank the cord of the Controller to disconnect it from a receptacle.
  Keep cord from heat, oil, solvent and sharp edges.
- **Maintain Controller with care.**
  Inspect Controller cord periodically and if damaged, have repaired by authorized service facility.
- **This apparatus must be earth grounded.**
- **The mains plug is considered to be disconnecting device.** Disconnect the appliance from the mains by pulling the plug in order to make it powerless.
- **Every Month:** Test the earth fault protector with the test button.
- **Should the earth fault disconnect the system,** be sure to find the primary reason before you resume operation.
- **Always disconnect the apparatus from the mains, by pulling the plug,** before opening the instrument for installation, service, etc.
- **There are no user serviceable parts inside this unit.** Refer all servicing to qualified service personnel.
- **If the mains cable to this apparatus is damaged** it must be replaced with cable that meets the local electrical safety standards for this type of product.
- **Do not use this product near water,** for example near a washbowl, wet basement or the like.
- The product should be located so that its location is away from heat sources such as radiators or other products that produce heat.
- The instrument should not be subjected to vibration or shock or in close contact with water or other liquids.
- For minimum electrical interference, place the instrument far away from possible sources of electrical noise, e.g. arc welding equipment, etc.

SAVE THESE INSTRUCTIONS

NOTICE

The use of other than genuine Ingersoll-Rand replacement parts may result in safety hazards, decreased tool performance, and increased maintenance, and may invalidate all warranties.

Refer All Communications to the Nearest Ingersoll-Rand Office or Distributor.

Printed in U.S.A.

INGERSOLL-RAND®
PROFESSIONAL TOOLS

NOTICE

Ingersoll-Rand Company makes no warranty or implies any warranty or liabilities due to the misuse or damage resulting from the application of the information supplied by this manual. Liabilities due to errors in the manual are only limited to replacement of the manual. Ingersoll-Rand reserves the right to change information contained in this manual or the program without notice at anytime.

For warranty claims of the equipment contact your nearest Ingersoll-Rand Distributor.

GROUNDING INSTRUCTIONS

⚠WARNING

THE CONTROLLER MUST BE EARTH GROUNDED WHILE IN USE TO PROTECT THE OPERATOR FROM ELECTRIC SHOCK. The Controller is equipped with a three-conductor cord and must be wired by qualified personnel to meet local electrical safety standards for connection to 20A circuit outlet.. The green (or green and yellow)conductor in the cord is the ground wire. Never connect the green (or green and yellow) wire to a live terminal. Your unit is to be used on a 115 VAC, 60 Hz, 3-prong outlet shown. DO NOT use the unit on a 2-prong plug outlet with an adapter. Always check that your ground is operating properly on the outlet by a qualified electrician before using the unit.

EU WIRING

⚠WARNING

THIS APPARATUS MUST BE EARTH GROUNDED

The three conductors of the mains lead attached to this apparatus are identified with color as shown in the table together with the matching terminal on the United Kingdom type power plug. When connecting the mains lead to a plug, be sure to connect each conductor to the correct terminal as indicated.

"This instruction applies to the product for United Kingdom."

MAINS LEAD		PLUG
Conductor	Color	Mark on the matching terminal
Live	Brown	Red or letter L
Neutral	Blue	Black or letter N
Grounding	Green-Yellow	Green, Green-Yellow, letter G or symbol ⏚

⚠WARNING

Use only 3-wire extension cords that have 3-prong grounded-type plugs and 3-pole receptales that accept the Controller's plug. Replace or repair damaged cords.

NOTICE

Cord needs to be braided and grounded at plug end to ensure compliance with GMC requirements.

OPERATION

1. Do not drop or abuse the Controller.
2. Whenever a Controller is not being used, position the Power Switch to the "OFF" position and unplug the power cord.

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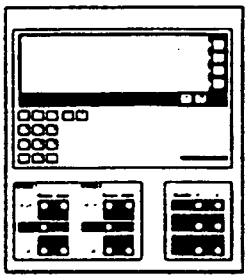
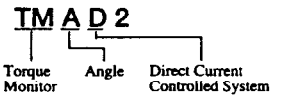
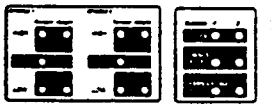
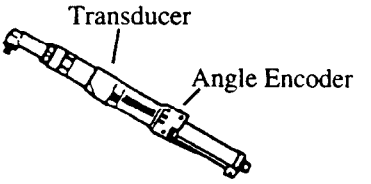
1.0 DC ELECTRIC/TORQUE MANAGEMENT SYSTEM SPECIFICATIONS

Consistent with the great diversity of requirements among products and processes in fastening and assembly, Ingersoll-Rand offers a flexible range of options for torque management with DC Electric tools. In this manner, customers can tailor equipment selections to particular operations without compromise - matching the sophistication of functions to the real-world considerations at hand.






Dual Spindle



Model Numbers:

TMAD1 - For use with one 40 Series tool.
TMAD2 - For use with two 40 Series tools.
TMAD121 - For use with one 120 Series tool.

Options:

- A RS232 Port
- B RS485 Port
- C PLC Interface
- E Tube Nut Drive
- F Push-To-Start or Pistol Tools (TMAD 1/2 only)
- G 230 V Option

Specifications

Note: Always select either A or B option as minimum, e.g., TMAD1-A

Measurement Accuracy:	+/- 0.2% of monitor torque full scale +/- 1 count of angle
Measurement Resolution:	0.05% of monitor torque full scale
Torque Transducer Bridge Excitation:	10 VDC standard
Torque Transducer Zero Offset/Drift Compensation:	+/- 10% (Automatic alert for exceeding offset).
Calibration:	Values entered through front panel. Automatic digital correction.
Frequency Response:	0 - 500 Hz.
Keypad:	User-friendly menu-driven interface for all readings and commands
Display:	LCD supertwist - 0.5 inch character height. 15 feet visibility. Horizontal (floor) viewing angle > 200°. Vertical viewing angle +25° to -50°. 4 lines of 40 characters per line, split into menu window and parameter/variable display window.
Parameter Sets:	8 for one spindle; 4 for two spindle; selectable.
Statistics Data Memory:	10,000 parts of total population on demand. 5,000 parts for torque, angle, and 4 extra variables.
Printer Output Port:	Serial, RS-232-C 7-bit word, 1-stop bit, selectable parity, programmable baud rates of 300 to 9600 baud.
Indicators:	8 high-intensity LED indicators, per spindle.
Control Inputs:	Cycle start, shutdown, shiftdown, configuration #.
Control Outputs:	High, low, pass, reject, cycle complete signals.
Input Power/Consumption:	115 VAC, 50/60 Hz, 10A peak, (TMAD1). 115 VAC, 50/60 Hz, 15A peak, (TMAD2). 115 VAC, 50/60 Hz, 20A peak, (TMAD121). 230 VAC, 50/60 Hz, 10A peak, (option G only).
Input Signal:	2.0 mV/V
Ambient Operating Conditions:	0-50° C temperature, 20-90% non-condensing humidity.
Enclosure:	NEMA-12 type.

2.0 INTRODUCTION

Ingersoll-Rand TMAD Torque Management Systems are easy to use, stand-alone monitoring and control consoles that operate Ingersoll-Rand DC tools and nutrunners.

The IR TMAD units measure applied torque and rotation for single or multiple fastener applications. They utilize a microprocessor-based computing system to monitor, control, and record data from a strain gauge transducer and digital angle encoder. Peak values for each fastening joint and the statistical data for each spindle are stored in the processor. This information is displayed on the screen or can be generated in hard copy format on a printer. The TMAD units can also be polled by a personal computer or other host.

User Friendly Keyboard and Display. The four-line, forty-characters per line window display provides clear, concise readings, as well as prompting messages for the user. The system "asks" for data during the set-up mode and then leads the user through step-by-step diagnostic procedures providing convenient instructions for keypad use.

It enables the user to move through a calibration procedure with ease, and lists all possible print commands for hard copy report. When not in use, it displays the status of the last run - torque, angle, and pass/fail condition.

Complete Data Save Package. All data, including performance parameters, calendar and time of day, and history for approximately the last 5,000 cycles is automatically stored in memory, even during a power failure or interruption.

Printer Interface. Seven different hard copy reports can be generated through the standard serial printer port. Capability for three additional reports can be added as an option.

Multiple Control Parameters. Capable of multiple sets of parameters referred to as "programs" or "configurations", eight for the single sindle system, or the two spindle system set-up as a one machine unit, or 4 each for the two spindle system acting independently.

Memory. System provides 6 month battery back-up for the RAM memory to save data parameters and statistics and a non-volatile (EEPROM) memory for saving serial port baud rate, parity, LCD display viewing angle, volume level of sounder, spindle count and language.

Shut-Down Criteria. Shut-down signals are generated not only when a system health check fails, but also when input parameters are not met or when invalid information is entered into the system.

Control Modes. IR TMAD units accommodate the following control modes:

Torque Control, with or without angle monitoring
Angle Control, indicating the turn of the nut
Pre-Torque Control, which is synchronized in two-spindle units
Combined Torque and Angle Control with Slope Monitor
Tube Nut Control, with indexing capability

Data Entry Security. A password can be required to data entry, if desired. No password is required for displaying performance parameters or data.

Diagnostics. Users can perform fifteen various diagnostic checks to determine proper operation of the keypad, display window, sound alert, calendar/clock, communication ports, external lamps, control inputs, control outputs, internal analog converter, and encoder inputs.

Extensive Logging Capabilities. IR TMAD units log a full range of information and maintain cycle log histories of up to 5,000 cycles for 1 spindle unit or 2500 cycles for 2 spindle units. Logging capabilities include:

End of Cycle Reports, consisting of operation audit trails with time, date, year, run number, and pass/fail information, as well as torque and angle readings. This report can include up to four extra variables that were also measured in the process.

Exception Reports, virtually the same as end of cycle reports, but with only the faulty runs listed.

Statistical Reports, in two variations: one for the total population and another for the programmed cycle size, usually based on the type of X bar - R data desired. The reports contain number of cycles , Sigma, mean range, maximum, mean shift, number of rejects for the high limit, number of rejects for the low limit, hardware faults, and the number of acceptable parts. The data is reported for both torque and angle. If the user has a third variable programmed to qualify the part, the number of rejects based on this variable will also be listed.

Parameter Dump Reports list the values of parameters entered into the TMAD unit by the user, or the TMAD default values. These reports can serve as logs or records of how the unit is configured.

Status Reports are printed every time the TMAD is turned on. These reports record times and dates of use, confirmation of memory retention, calibration for the tool, power failure detection, and other information.

Choice of Five Language Displays. Through a simple, front panel selection process, the TMAD units will display information in any of five languages: English, French, Spanish, Italian or German.

3.0 INSTALLATION (Ref. Figure 3-1)

1. Securely mount unit to wall in a vertical position using 1/4 inch (7 mm) screws, machine bolts or lag bolts in all four positions. For optimal ergonomic viewing of the main display by user, the display should be 4 feet 10 inches floor height.

2. Be sure unit is not near welding equipment or heavy duty electrical equipment - minimum distance recommended is approximately 25 feet (8 meters). Unit should not be plugged into same power line feeding such equipment.

3. Open enclosure by loosening two side clamp screws and rotating clamps downward to allow door to open.

4. Find enclosure key taped to inside bottom panel.

5. Be sure power switch is in off position ("O" side of rocker switch pushed in). Plug female end of cord into cabinet receptacle.

6. Plug male connector end of cord into an approved electrically grounded outlet of at least 15 AMP 115 VAC 60 Hz rating. (20 Amp for TMAD121).

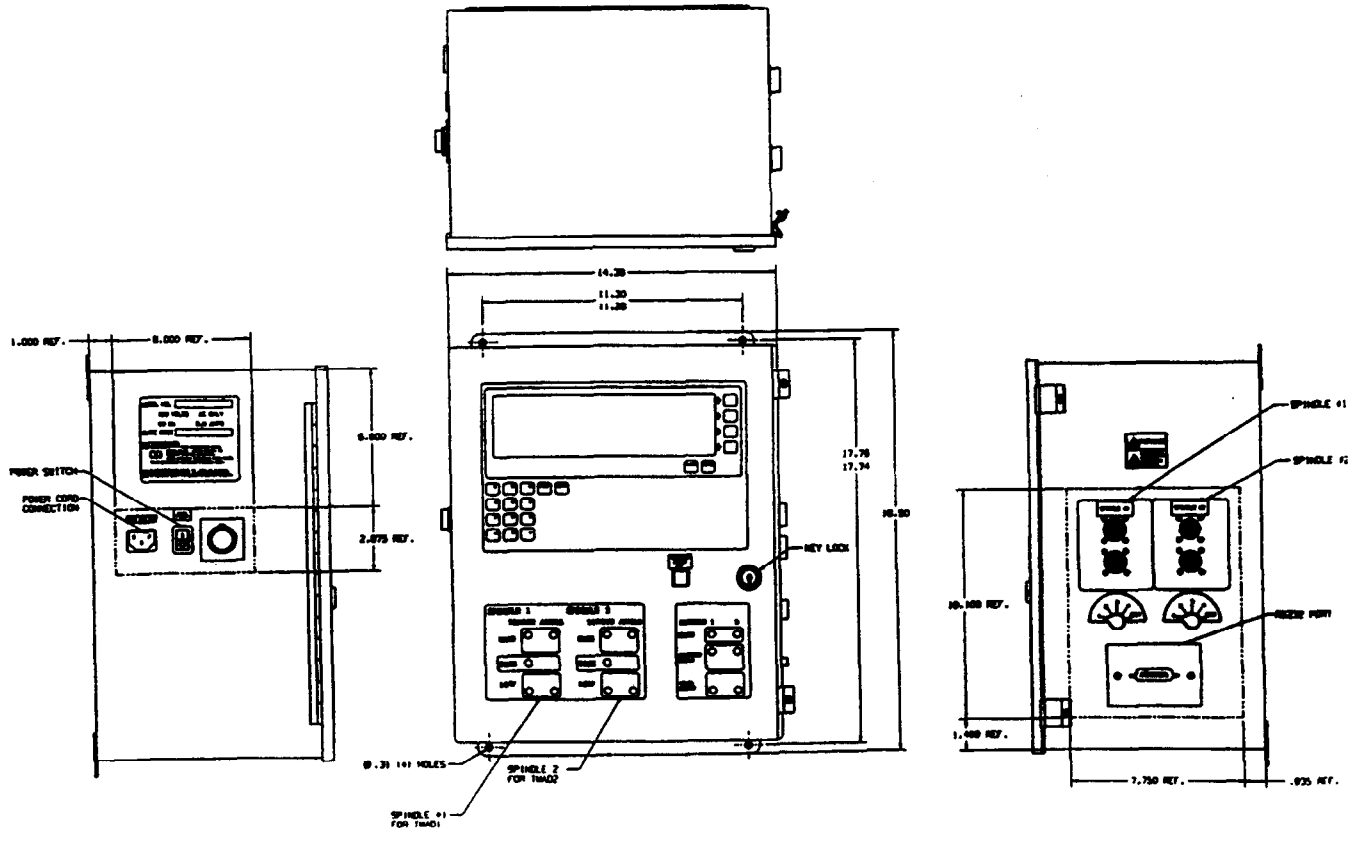
⚠WARNING

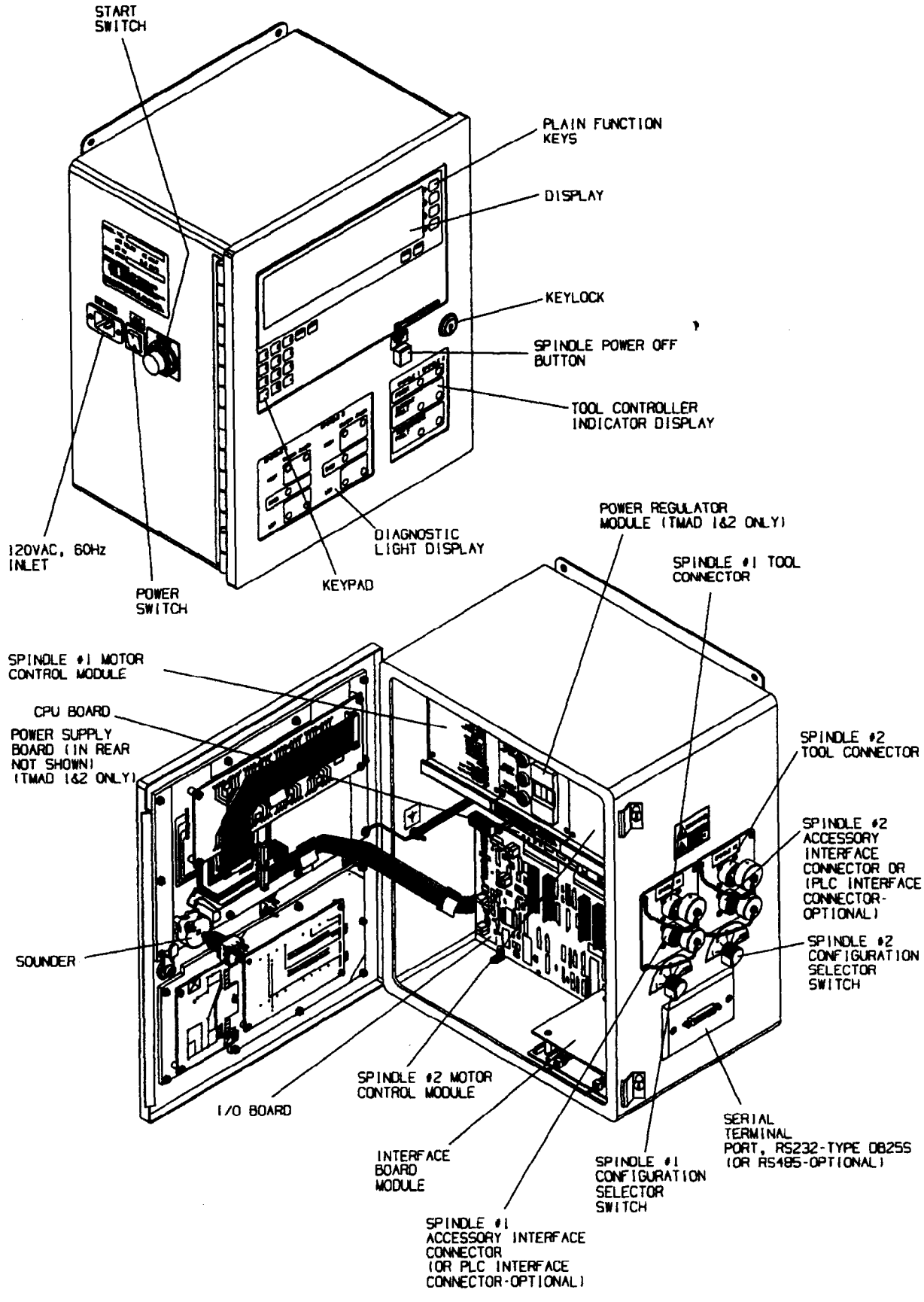
Do not remove ground pin on plug or use an adapter to defeat the plug ground.

7. Connect power tool to one of the available connectors on unit. If extension cable is used, plug male end into connector and female end into tool cable. Maximum recommended total length of extension cable & tool cable approximately 50 feet.

8. Do not turn system on yet - see Section 5.0 for system start-up and basic programming.

TMAD2





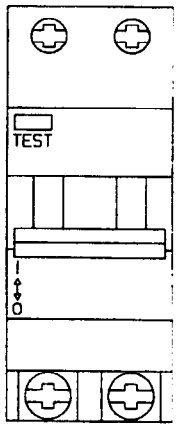
(Dwg. TPA1372)

Figure 3-1.

4.0 OPERATION AND CONTROLS

4.1 POWER REGULATOR MODULE

TMAD121



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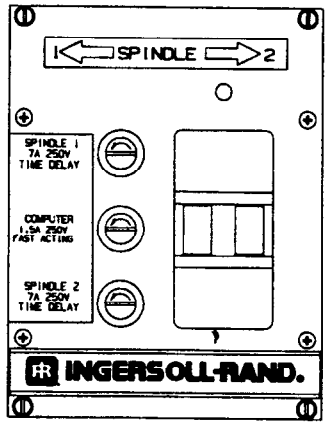


TMAD1/TMAD2

(Dwg. TPD1698)

⚠WARNING

Removal of unit(s) by authorized factory service personnel only.

This module distributes power to the computer and the tool controller. Its functions and features are:

1. Accept 115 VAC, 60 Hz input power from power switch.

2. Deliver 115 VAC, 60 Hz to spindle 1 (tool 1) and spindle 2 (tool 2) through protection fuses (7 Amp, 250 VAC, time delay, BUSS* MDL type or equivalent, 1/4" x 1-1/4").

3. Deliver 115 VAC, 60 Hz to computer through protection fuse (1-1/2 Amp, 250 VAC fast acting, Buss* AGC type or equivalent, 1/4" x 1-1/4").

NOTICE

On TMAD121, all protection is made through one fuse (20 Amp, 250 VAC, time delay,Buss* FNW type or equivalent, 13/32" x 1-1/2") located on the motor controller.

⚠WARNING

Replace only with the proper rated fuse or shock hazard and damage to system and tool can occur.

4. Contains a GFI (Ground Fault Interrupter) to reduce the electrical shock hazard in the computer and tools.

⚠WARNING

This GFI device should be tested at least once a month. Test by pressing in TEST BUTTON with power on to the system. RESET button should immediately pop out. (Note: On TMAD121, the ON/OFF Lever will move down to the off position.) If not, then GFI is defective and must be replaced before operating the system. Replacement to be done only by authorized I-R personnel. To reset for operation press in RESET button until it latches to the in position (Note: On TMAD121, move the ON/OFF Lever up to the ON position.); system is now ready to run.

5. Contains a ground sense circuit which prevents the tools from operating if there is a broken connection in the ground wire from the regulator to the tool. To restart the tools the START button must be pressed.

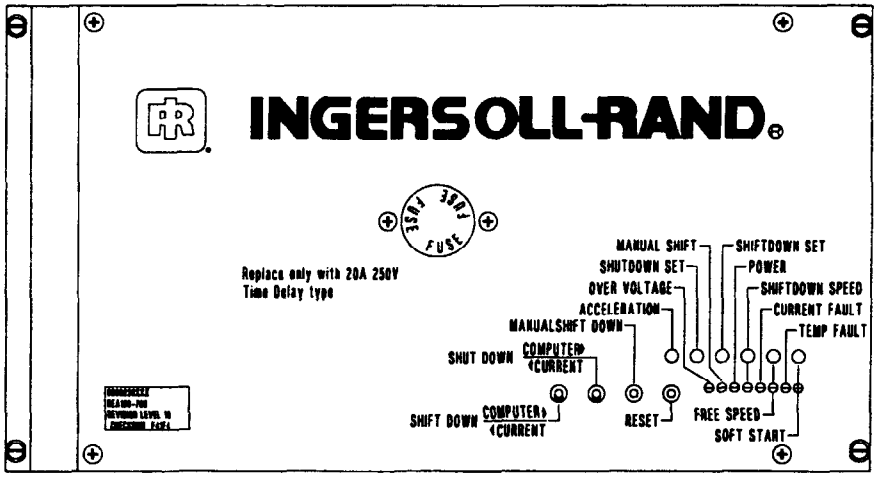
6. Contains a stop system circuit which if the operator or service person wants to shutdown power to the tools, the RED System Stop button on front panel is pressed. When the RED button is pressed, power is disconnected to the tools and the button is illuminated to indicate power was shut down. Note, power still remains on to computer. To restart the tools, the START button must be pressed.

* Registered trade mark of Bussmann Fuse Co.

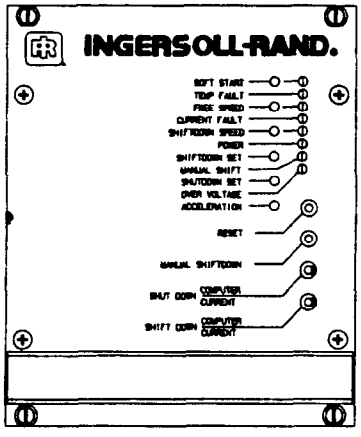
4.2 D.C. TOOL CONTROL MODULE

This unit controls all of the power and drive functions to the DC motor in the tool. All adjustments are to be made only by trained set-up personnel or authorized I-R service technicians.

120 Series



40 Series



(Dwg. TPD1915)

⚠WARNING

Removal of unit by authorized factory service or I-R service personnel only.
Unscrew rack mount fasteners (4 places) before pulling out module from rack.

4.2.1 POTENTIOMETER ADJUSTMENTS

SOFT START	To adjust soft start speed - first speed position on tool throttle, CW = increase speed, CCW = decrease speed
FREE SPEED	To adjust free speed - second speed position on tool throttle, CW = increase speed, CCW = decrease speed
SHIFTDOWN SPEED	To adjust shiftdown speed - used to control mean torque joint shift, CW = increase, CCW = decrease
SHIFTDOWN SET	To set current level for shiftdown speed to be activated (controller in current mode operation only), CW = increase current or torque level, CCW = decrease current or torque level
SHUTDOWN SET	To set current level for tool to shutoff at desired torque (controller in current mode only) CW = increase current or torque level, CCW = decrease current or torque level
ACCELERATION SET	To set rate at which tool comes up to free speed after throttle is fully depressed - used to help operator place socket on fastener or to reduce start up inertia spikes on certain joint applications, CW = increase acceleration rate (faster start up time), CCW = decrease in acceleration rate (slower start up time)

4.2.2 INDICATORS

SOFT START	Green on = soft start speed enabled
TEMP FAULT	Red on = motor temperature too hot - this condition automatically shuts down power to tool - need to press reset button to start tool. Note: after motor cool down period, temp fault light goes out and current fault (general fault) comes on.
FREE SPEED	Green on = free speed enabled
CURRENT FAULT	Red on = Motor Stalled; One Pulse = Temperature Fault; Two Pulses = Motor Shorted; Three Pulses = Encoder Fault; Four Pulses = Overvoltage Fault.
SHIFTDOWN SPEED	Green on = shiftdown speed enabled
POWER	Green on = indicates controller is powered on
MANUAL SHIFT	Green on = indicates controller was put in shiftdown mode manually in order to adjust shiftdown speed - does not come on during normal shiftdown operation
OVERVOLTAGE FAULT	Red on = too high a voltage applied to controller or Too much back emf voltage from motor - this condition automatically shuts down power to tool - need to press reset to start tool. Note: after voltage returns to normal, overvoltage light goes out and current fault (general fault) comes on.

4.2.3 PUSH BUTTONS

MANUAL SHIFTDOWN	Depress tool throttle first then press and release manual shiftdown, enables shiftdown speed for adjustment - to reset, release throttle
RESET	Press and release - resets controller to apply power to tool after a temperature, current or over voltage fault condition occurred

4.2.4 SWITCHES

SHIFTDOWN	COMPUTER CURRENT	Set to computer - tool shiftdown is Controlled by computer settings. Set to current - tool shiftdown is controlled by controller "shiftdown" pot current setting
SHUTDOWN	COMPUTER CURRENT	Set to computer - tool shut-down is controlled by computer settings and fastener strategy set to current - tool shutdown is controlled by controller "shutdown" pot current setting

4.3 COMPUTER CONTROL MODULE

4.3.1 FUNCTION KEYS

0 to 9 are for entering values for parameters in programming and code values for accessing parameters.

plain keys are associated with the particular statement or function that shows up on the screen adjacent to the particular key. There are four of these function keys.

ENTER Enters the numerical data or code number keyed in and shown on screen into computer memory.

CANCEL to change a present list or menu of functions or statements on screen to the first or original menu of statements of a group. Use this key to scan through the various statements or menus.

CLEAR Erases data or code values shown on screen prior to entering with the "ENTER" key.

OTHER to change the screen to list the next set of functions or statements of the menu.

+ & - are used for the proper plus and minus excitation voltage for the torque transducer.

4.3.2 INDICATOR LAMPS

Green shows fastener was ok and acceptable within the programmed limits.
Red shows fastener was high or above programmed limit within torque value and/or angle of rotation.
Yellow shows fastener was low or below programmed limit either in torque and/or angle of rotation.

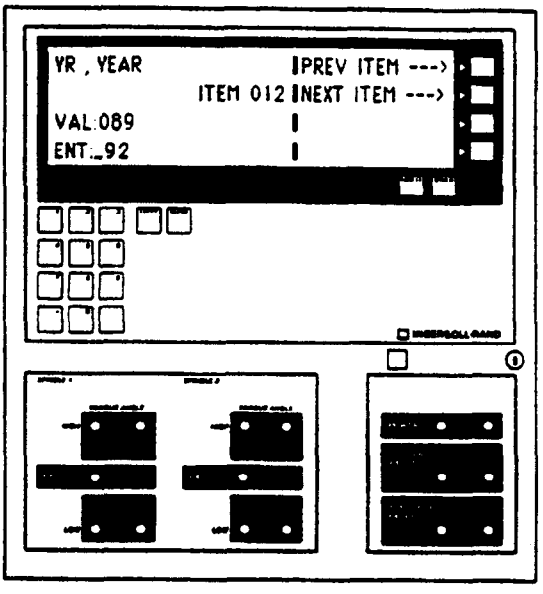


FIGURE 4-3. TMAD DC ELECTRIC SYSTEM

4.3.3 SCREEN

Large liquid crystal display (LCD) which shows menus or statements, reports data, fastener run cycle data, parameters, etc. Viewing angle for clarity can be adjusted.

4.3.4 SOUNDER

Produces an audible "beep" sound. A short "beep" indicates (1) a key was pressed or (2) the data entered was accepted by the computer memory. A long "beep" indicates an error in the keyed data entry which was not accepted by the computer memory.

4.4 INTERFACE BOARD MODULE

The Interface Circuit Board is located in the bottom right hand side of the cabinet.
This board serves the following functions:

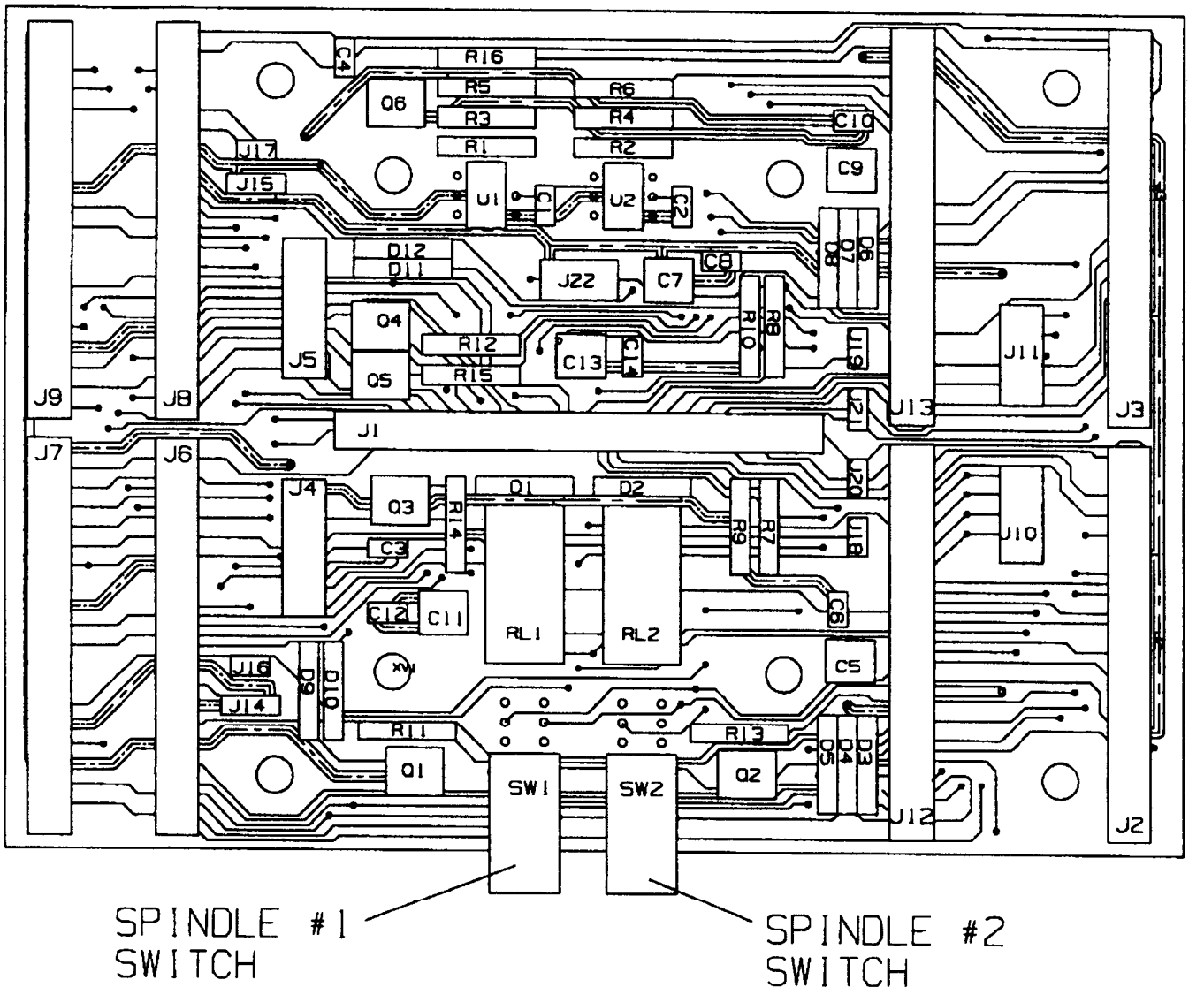
1. Contains controls for
   NORMAL and PRETORQUE fastening strategies.

2. Connections for special and customized outputs such as external lamps, contact switches, signal outputs, signal inputs, etc, (see Section 11.9 Accessory Interface Connector).

4.4.1 NORMAL/PRETORQUE SWITCH

To set operation from normal fastening cycle such as torque control, angle control or torque and angle control, set switch to NORMAL (up) position.

To set operation for pretorque fastening, which pulses the tool twice in one fastening cycle used for stress relaxation type joints like gaskets set switch to PRETORQUE (down) position (see Section 8.5 Pretorque Control). The Pretorque setting is also used for remote start tools (See Section 13.1 Accessory Interface Connector), and for Tube Nut Tools (See Section 13.4 Tube Nut Control).



(Dwg. TPD 1697)

Figure 4-4-1. INTERFACE CIRCUIT BOARD TOP VIEW

Figure 4-4-2. INTERFACE BOARD ASS'Y - PIN OUT LOGIC

LED BOARD

	J4	J5
1	COMMON	COMMON
2	V+	V+
3	TOOL OK 1	TOOL OK 2
4	ANGL LO 1	ANGL LO 2
5	ANGL HI 1	ANGL HI 2
6	TORQ LO 1	TORQ LO 2
7	TORQ HI 1	TORQ HI 2

I/O BOARD

	J6	J8	J7	J9
1	XDUCER SIG+ 1	XDUCER SIG+ 2	COMMON	COMMON
2	XDUCER SIG- 1	XDUCER SIG- 2	CCI 1 / RUN\1	CCI 4 / RUN\2
3	XDUCER EXC+	XDUCER EXC+	TORQ HI 1	TORQ HI 2
4	XDUCER EXC-	XDUCER EXC-	TORQ LO 1	TORQ LO 2
5	XDUCER OUT+ 1	XDUCER OUT+ 2	ANGL HI 1	ANGL HI 2
6	XDUCER OUT- 1	XDUCER OUT- 2	ANGL LO 1	ANGL LO 2
7	COMMON	COMMON	TOOL OK 1	TOOL OK 2
8	+5V	+5V	V+	V+
9	SHIFTDOWN 1	SHIFTDOWN 2	COMMON	COMMON
10	SPARE OUT 1	SPARE OUT 4	CCI 2	CCI 5
11	SPARE OUT 2	SPARE OUT 5	CCI 3	CCI 6
12	+5V	+5V	COMMON	COMMON
13	ENCODR PHS1 1	ENCODR PHS1 2	SHUTDOWN+ 1	SHUTDOWN+ 2
14	COMMON	COMMON	SHUTDOWN- 1	SHUTDOWN- 2
15	ENCODR PHS2 1	ENCODR PHS2 2	+5V	+5V
16	COMMON	COMMON	RESET\	RESET\
17	CONFIG 1	CONFIG 5	COMMON	COMMON
18	CONFIG 2	CONFIG 6	TOOL HI 1	TOOL HI 2
19	CONFIG 3	CONFIG 7	TOOL LO 1	TOOL LO 2
20	CONFIG 4	CONFIG 8	TOOL OK 1	TOOL OK 2

SELECTOR SWITCH

	J10	J11
1	+5V	+5V
2	CONFIG 1	CONFIG 5
3	CONFIG 2	CONFIG 6
4	CONFIG 3	CONFIG 7
5	CONFIG 4	CONFIG 8

AIC

	J12	J13
1	CCI 1 / RUN\1	CCI 4 / RUN\2
2	TOOL HI 1	TOOL HI 2
3	TOOL LO 1	TOOL LO 2
4	REJECT 1	REJECT 2
5	SHUTDOWN\ 1	SHUTDOWN\ 2
6	TOOL OK 1	TOOL OK 2
7	V+-	V+
8	+5V	5V
9	CYCLE COMP 1	CYCLE COMP 2
10	CONFIG 5	CONFIG 1
11	CONFIG 6	CONFIG 2
12	CONFIG 7	CONFIG 3
13	CONFIG 8	CONFIG 4
14	CONFIG 1	CONFIG 5
15	CONFIG 2	CONFIG 6
16	CONFIG 3	CONFIG 7
17	CONFIG 4	CONFIG 8
18	SHIFTDOWN\1	SHIFTDOWN\2
19	COMMON	COMMON
20	N/C	N/C

TOOLS / CONTROLLERS

	J2	J3
1	XDUCER SIG+ 1	XDUCER SIG+ 2
2	XDUCER SIG- 1	XDUCER SIG- 2
3	XDUCER EXC+	XDUCER EXC+
4	XDUCER EXC	XDUCER EXC-
5	+5V CONTROL	+5V CONTROL
6	COMMON	COMMON
7	FREE SP SW 1	FREE SP SW 2
8	SOFT ST SW 1	SOFT ST SW 2
9	FREE SP OUT 1	FREE SP OUT 2
10	SOFT ST OUT 1	SOFT ST OUT 2
11	SHUTDOWN\ 1	SHUTDOWN\ 2
12	TOOL OK OUT 1	TOOL OK OUT 2
13	TOOL LO OUT 1	TOOL LO OUT 2
14	TOOL HI OUT 1	TOOL HI OUT 2
15	COMMON	COMMON
16	ENCODER IN 1	ENCODER IN 2
17	SHIFTDOWN\ 1	SHIFTDOWN\ 2
18	FWD/REV SW 1	FWD/REV SW 2
19	FWD/REV OUT 1	FWD/REV OUT 2
20	I MONITOR 1	I MONITOR 2

EXPANSION

J1		J1	
1	SPARE OUT 2	2	SPARE OUT 5
3	SPARE OUT 3	4	SPARE OUT 6
5	CCI 1 / RUN\1	6	CCI 4 / RUN\2
7	CCI 2	8	CCI 5
9	CCI 3	10	CCI 6
11	TORQ HI 1	12	TORQ HI 2
13	TORQ LO 1	14	TORQ LO 2
15	ANGL HI 1	16	ANGL HI 2
17	ANGL LO 1	18	ANGL LO 2
19	TOOL OK 1	20	TOOL OK 2
21	TOOL HI 1	22	TOOL HI 2
23	TOOL LO 1	24	TOOL LO 2
25	SHUTDOWN- 1	26	SHUTDOWN- 2
27	SHUTDOWN\ 1	28	SHUTDOWN\ 2
29	SHIFTDOWN\ 1	30	SHIFTDOWN\ 2
31	SOFT ST OUT 1	32	SOFT ST OUT 2
33	FREE SP OUT 1	34	FREE SP OUT 2
35	SOFT ST SW 1	36	SOFT ST SW 2
37	FREE SP SW 1	38	FREE SP SW 2
39	FWD/REV OUT 1	40	FWD/REV OUT 2
41	FWD/REV SW 1	42	FWD/REV SW 2
43	I MONITOR 1	44	I MONITOR 2
45	REJECT 1	46	REJECT 2
47	CYCLE COMP 1	48	CYCLE COMP 2
49	N/C	50	N/C

J22		J22	
1	+5V	2	+5V
3	V+-	4	V+
5	COMMON	6	COMMON
7	+5V CONTROL	8	+5V CONTROL

OTHER

	J14	J15
1	+5V	+5V
2	ENCODR PHS1 1	ENCODR PHS1 2
3	COMMON	COMMON

	J16	J17
1	XDUCER OUT+ 1	XDUCER OUT+ 2
2	XDUCER OUT- 1	XDUCER OUT- 2

	J20	J21
1	FWD/REV OUT 1	FWD/REV OUT 2
2	FWD/REV SW 1	FWD/REV SW 2

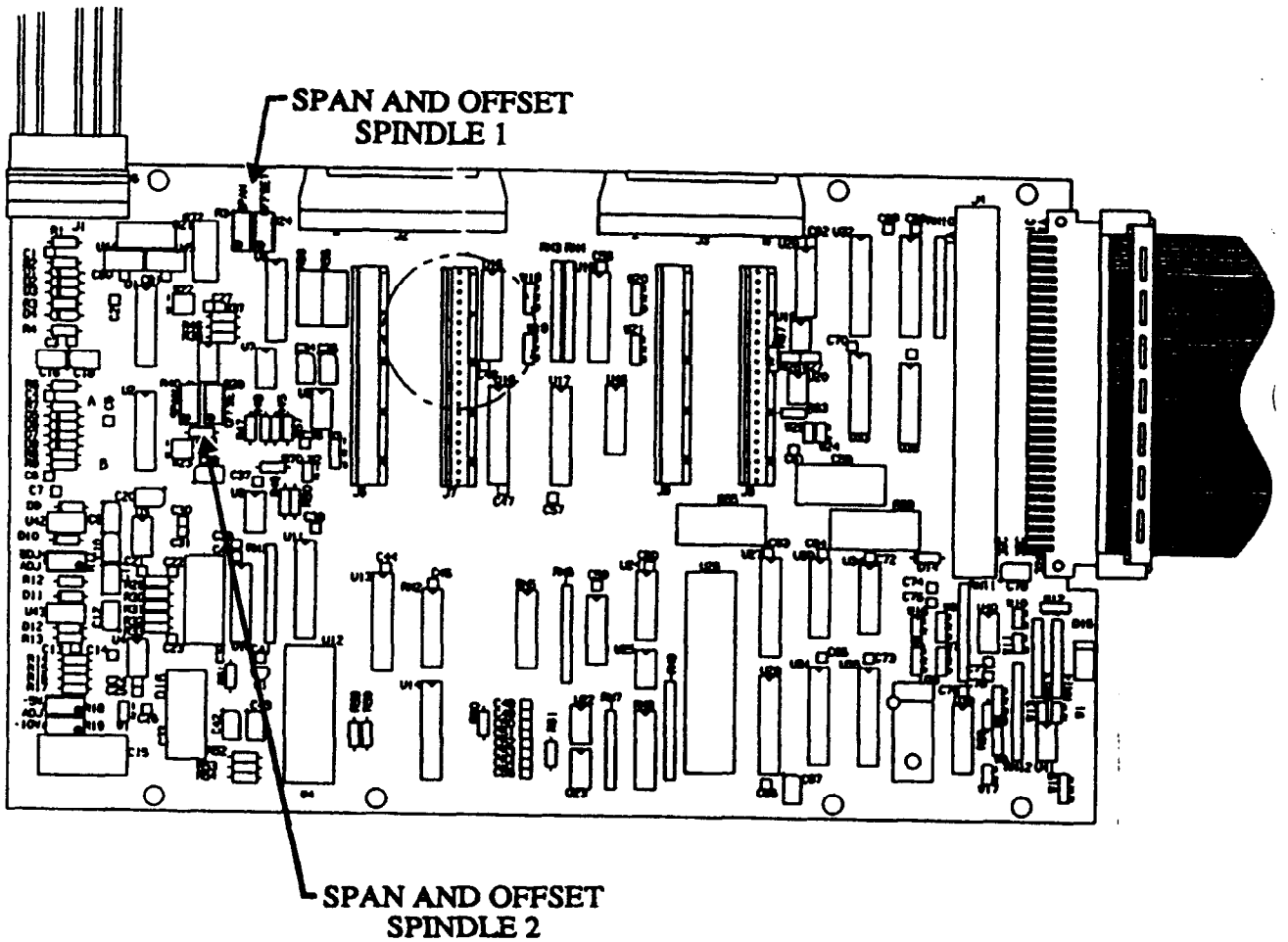
4.5 INPUT/OUTPUT BOARD

This circuit board contains all the electronics to operate the torque transducer, panel lights and accessories as well as condition and calibrate the transducer signal and encoder signal supplied to the microprocessor (CPU Board).

It contains potentiometer (POT) adjustments for the transducer calibration. To adjust the transducer ZERO offset POT, using small bladed plastic screwdriver turn CW to raise zero level (+). To lower zero lever (-), turn CCW. To adjust transducer full scale value (SPAN), using small bladed plastic screwdriver, turn CW to increase span value; turn CCW to lower SPAN value. These adjustments are to be made only by trained set up personnel or authorized service personnel. (See Section 5.3 Computer Control Operation and Start-up Procedure).

⚠WARNING

All other potentiometer adjustments are set at the factory and should be made by authorized I-R service personnel.



(Dwg. TPA1382-TMAD)

FIGURE 4-5

5.0 SYSTEM START-UP AND BASIC PROGRAMMING

This procedure assumes all cabling, power tools and system modules are in proper operating order and computer is NOT locked digitally with code number. If problems occur see Section 12.0 Troubleshooting.

5.1 TURN POWER ON

1. PUSH IN '1' side of rocker switch. For EU models, turn rotary disconnect "Main Switch" CW.

2. PUSH IN "START" BUTTON - This powers up the tool control modules (red system stop switch light goes off and green power lights come on)

5.2 TOOL OPERATION (To be adjusted by trained setup person or service technician only)

Before operating system with computer control, it is best under "cold starts", where system has been idle for awhile or when installing a new system or after repair or a new tool has been connected to check out tool or spindle portion as follows:

1. **Set shiftdown and shutdown switches in "CURRENT" position** - tool control modules override computer - tool will now shiftdown and shutdown under its own control with current sensing.

2. **Fully depress tool throttle lever** and run at free speed (green indicator lamp is on)

3. **Adjust "Free Speed"** - CW increases speed, CCW decreases - use small plastic bladed type screwdriver to adjust "FREE SPEED" potentiometer.

4. **Adjust "Soft Start"** - depress tool throttle only part way until slow or soft start speed is on (observe green indicator light). Adjust soft start pot as you did for free speed (CW for faster, CCW for slower).

5. **Adjust "Acceleration"** - adjust acceleration rate pot CCW (slower start up time) to minimize inertia start-up which could force a premature shutdown. Depress tool throttle all the way to verify acceleration.

6. **Adjust "Shiftdown Speed"** - fully depress throttle for free speed operation then press and release "MANUAL SHIFTDOWN" button - tool is now in shiftdown speed mode - adjust "SHIFTDOWN SPEED" pot as you did for free speed and soft start speed (CW faster, CCW slower).

7. **Adjust "Shutdown Set"** to its lowest setting to prevent damage to fastener or injury to the operator.

⚠CAUTION

DO NOT DEPRESS THROTTLE for this adjustment. CCW for lowest torque (minimum current) shutoff: keep turning pot CCW until you hear it clicking (10 turn rotation).

8. **Adjust "Shiftdown Set"** to its highest setting to eliminate premature shiftdown. CW for highest setting; keep turning pot CW until you hear it clicking (10 turn pot).

5.3 CURRENT CONTROL

1. **Adjust for proper torque shutdown.** This adjustment will tune the tool to a torque value you want on your particular fastener - verify torque with external rotary torque transducer. Put tool socket on fastener, depress throttle - if tool shuts off immediately readjust for higher torque - gradually increase "SHUTDOWN" pot CW direction to increase torque level -depress throttle to check applied torque at various adjustment increments until you reach desired torque.

YOU ARE NOW READY TO RUN TOOL ON JOINTS WITH **CURRENT SENSE** AND CAN NOW SET UP COMPUTER TO CONTROL THE FASTENING STRATEGY.

2. **Shiftdown adjust - (optional)** you may leave at maximum setting and use the computer shiftdown only if you desire (see computer setup instructions) - to adjust for fastener mean joint shift (i.e. reduce applied mean torque disparity between a hard and soft shiftdown set point by turning "SHIFTDOWN POT" CCW. Apply torque to both hard and soft fasteners while observing applied torque with rotating torque transducer. Keep turning pot CCW until the torques between the two joints are close. NOTE: You may also have to reduce the free speed (CCW) and shiftdown speed (CCW) as well in order to reduce the mean shift between joints.

NOTICE

In emergency situations the tool can be operated in current sense without computer control. This feature allows you to run fasteners with a reasonably good torque control without torque readout if the computer or torque transducer fails or until such time as repair can be made to the computer or transducer.

5.4 COMPUTER CONTROL

For computer control:

1. Set SHIFTDOWN and SHUTDOWN switches to "COMPUTER" position.

2. Follow "COMPUTER START-UP" procedure starting on next page.

These instructions are for cold starts, new installations or when computer repairs have been made. If you are familiar with the system operation you can refer to the QUICK SETUP REFERENCE in Appendix B.

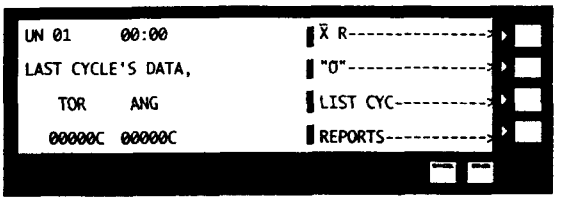
NOTE: For difficult joints which are hard or have a high stiffness where the tool overshoots the torque control point considerably, use the optional TO (Torque Overshoot) control parameter (see Section 6.4), and/or the TDS (Torque Downshift Point) control parameter (see Section 6.5)

5.4.1 COMPUTER START-UP PROCEDURE

OPERATION

1 Keep Pressing until you see the home screen

CANCEL or OTHER

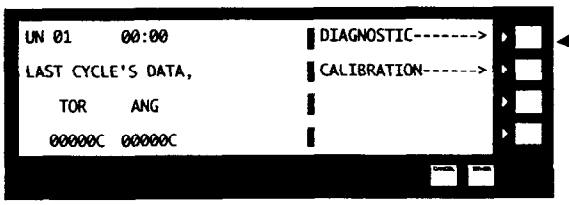


DESCRIPTION OF OPERATION

The following keystrokes will clear memory so that residual data and parameters from previous set-ups and programs will not cause difficulty. NOTE:UN01 indicates this system is designated as No. 1 which can be changed when more than one system is interfaced with a host computer. (see section 10.0)

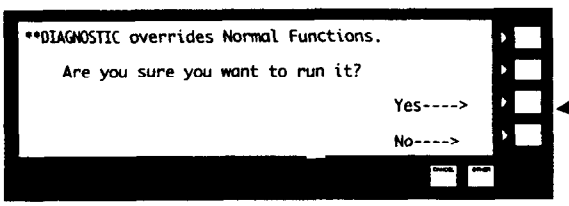
2 Keep Pressing until you see "DIAGNOSTICS" on screen, then select plain key next to it.

OTHER



Pressing key will bring up question for diagnostic menu (See Screen 3)

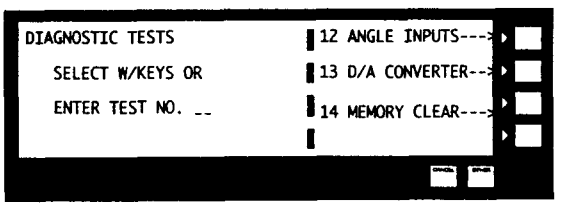
3 Press Plain Key for "YES"



Pressing key will bring up diagnostic menu of statements. (See Screen 4)

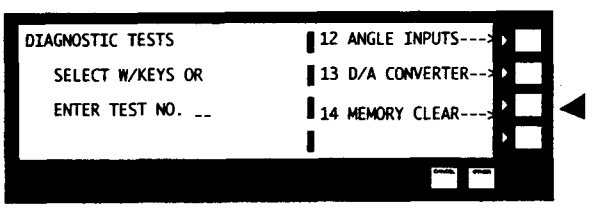
4 Keep Pressing until "14 MEMORY CLEAR" APPEARS

OTHER



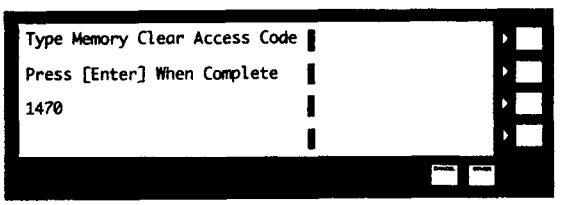
Brings up 14 "MEMORY CLEAR" statement for you to enter in code number that tells computer to clear memory. (See Screen 5)

5 Press Plain Key for "MEMORY CLEAR"



6 Press Numeric Keys for code Number 1470

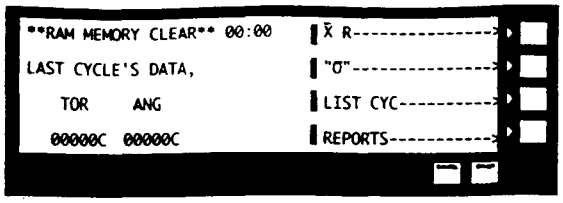
1 4 7 0



Code number 1470 clears the computer memory.

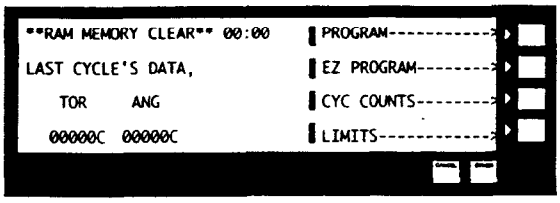
OPERATION | **DESCRIPTION OF OPERATION**

7 Now Press [ENTER]



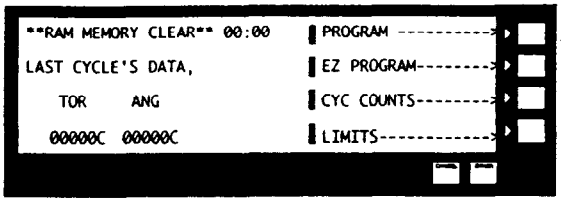
Computer now accepts Code 1470 and memory is cleared. Screen shuttles back and forth with statements UN01 **:** and ** RAM MEMORY CLEAR**

8 Keep Pressing until you see "PROGRAM" on screen [OTHER]



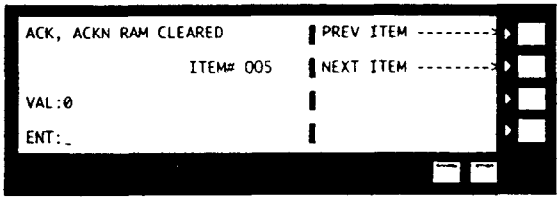
Now that the Random access memory (RAM) is cleared and all previous data (if runs were made) are cleared we must reset the computer.

9 Press Plain Key for "Program"



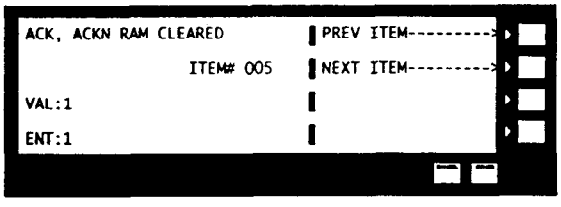
◀ Shuttling statements UN01.. and **RAM.. continue

10 Press Numeric Key [1]



Pressing "PROGRAM" key brings up statement "ACK, ACKN RAM CLEARED" from the program menu with a space after ENT - for you to enter a code number.

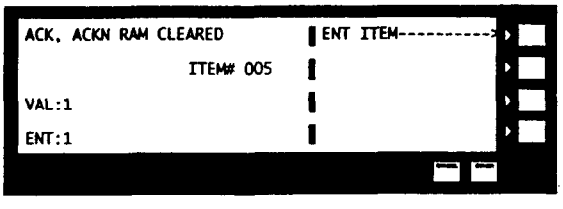
11 Press [ENTER]



By programming a '1' into statement RAM clear ACK. We will reset the computer to be able to run tools and properly record data. More programming will be required however before you can run a tool. Computer is now reset.

Now, you will turn off the "screen display time out," which then will allow the screen to continually display the statements. Otherwise the screen automatically reverts back to display last cycle data after 60 seconds which is inconvenient for programming.

12 Press [OTHER]

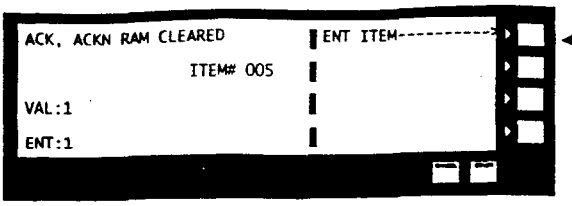


Brings up statement "ENT ITEM" replacing "PREV ITEM" and "NEXT ITEM" statements.

OPERATION

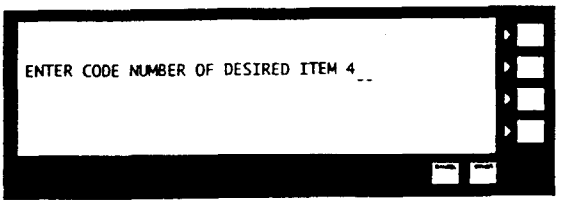
DESCRIPTION OF OPERATION

13 Press Plain Key for "ENT ITEM"



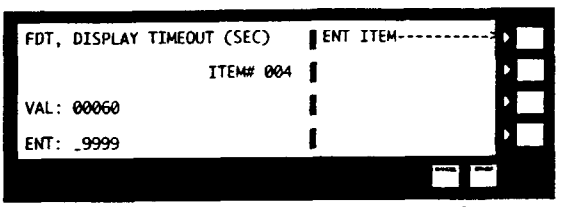
"Brings up "ENTER CODE NUMBER OF ITEM" statement which allows you to call up any of the various program statements in the computer memory. (See Screen 14)

14 Press Numeric Key [4]



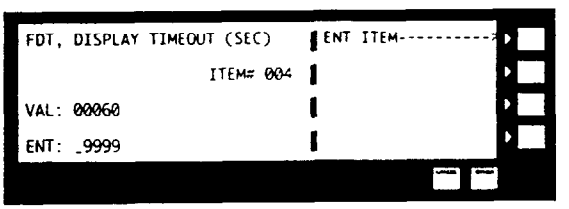
Enters the number 4 into the blank which is the code for the display time value statement.

15 Press [ENTER]



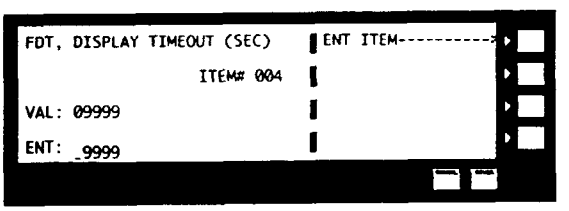
Shows the "FDT DISPLAY TIME OUT" time setting statement; 60 seconds is the preprogrammed (default) value already in the computer memory.

16 Press Numeric Keys [9] [9] [9] [9]



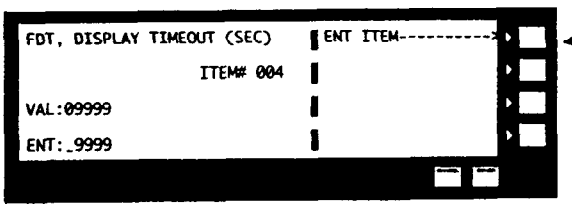
Puts value 9999 into statement which corresponds to 9999 seconds before timeout changes screen back to last cycle data.

17 Press [ENTER]



Computer accepts 9999 seconds. The screen will no longer revert back to the last cycle start for programming convenience.

18 Press Plain Key for ENT ITEM"

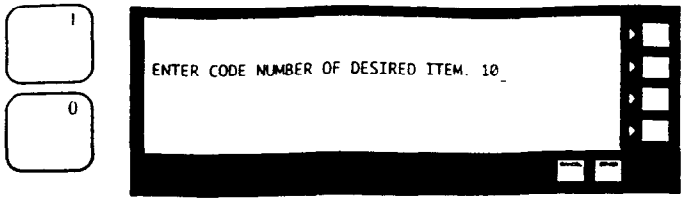


Now you will program in the proper time of day, date and year. The computer will remember these values even when turned off. Useful for time and date on printed reports.

OPERATION

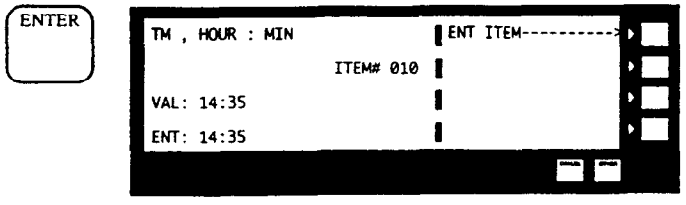
DESCRIPTION OF OPERATION

19 Press Numeric Keys



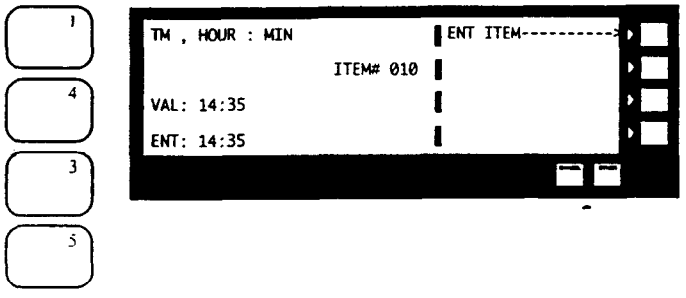
Brings up "ENTER CODE--" statement; input code 10 which is the group of statements for entering time, date and year.

20 Press



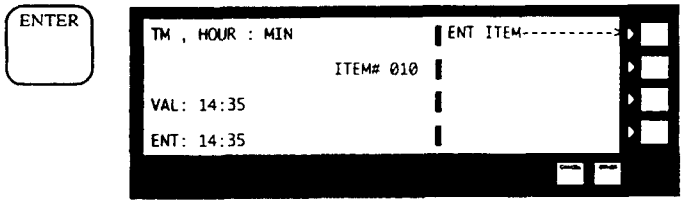
Brings up the time for hour and minutes on the 24 hour system to be programmed.

21 Press Numeric Keys



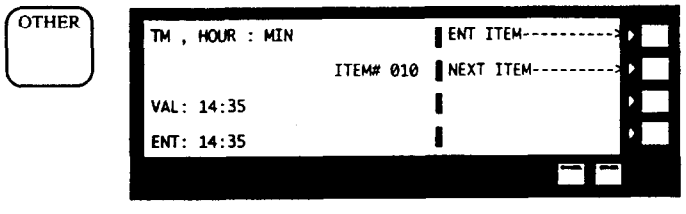
Input present time of day. Ex. 2:35 p.m. or 14:35
*EXAMPLE ONLY, USE CORRECT TIME. *

22 Press



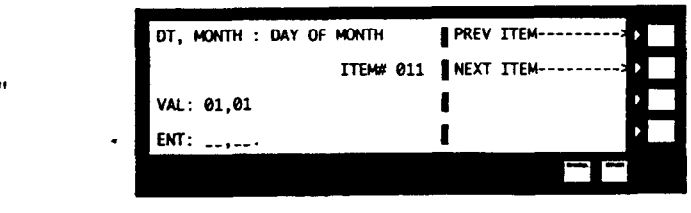
Places time 14:35 into computer memory.

23 Press

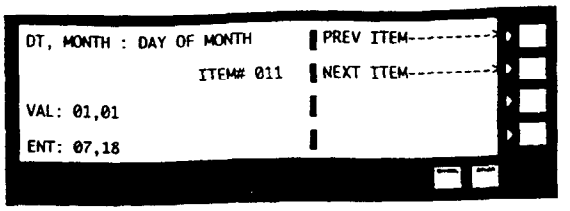
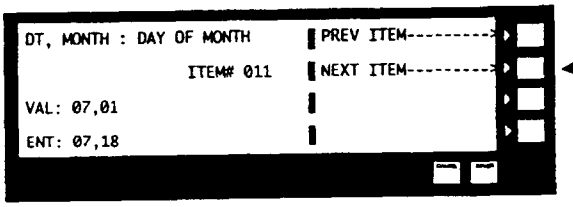
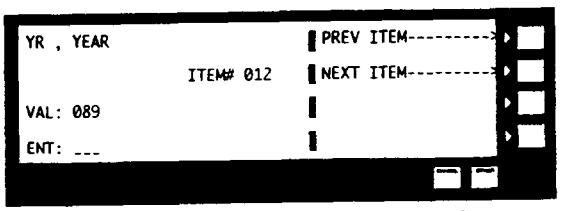
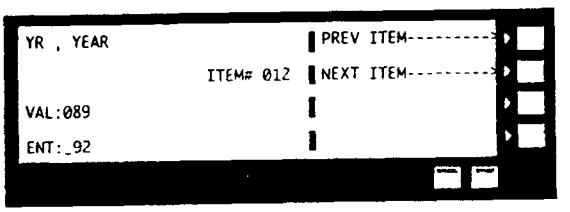
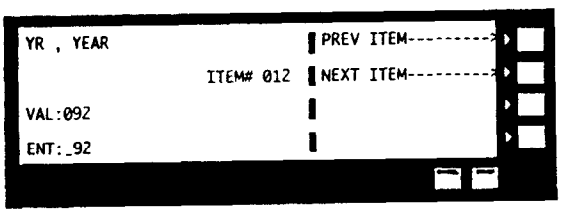
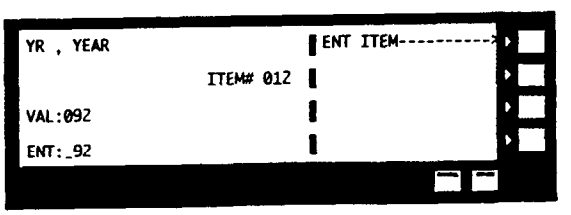


Replaces "ENT ITEM" statement with "PREV ITEM" and "NEXT ITEM" statement.

24 Press Plain Key for "NEXT ITEM" (Screen 23)

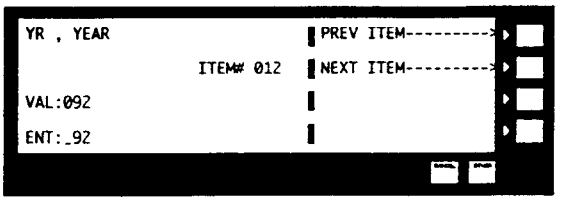
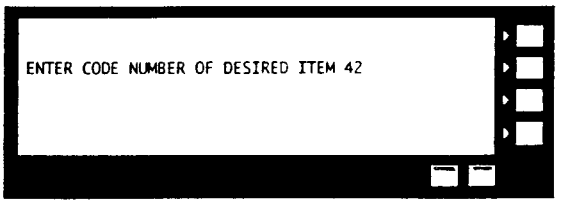
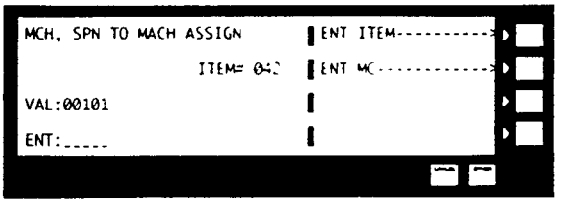
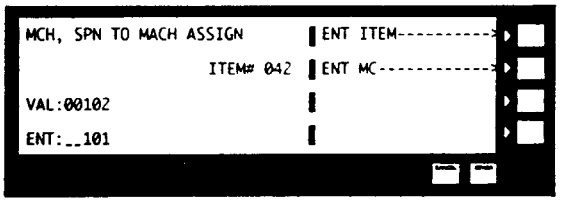
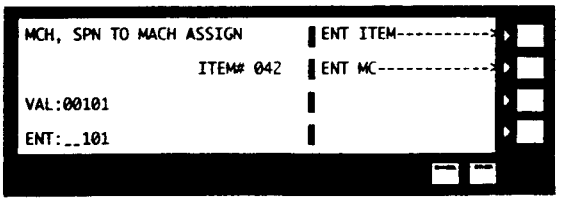


Brings up month and day statement, Item # 11.

OPERATION		DESCRIPTION OF OPERATION
25 Press Numeric Keys	0 7 1 8 	Input month and day in number form to computer's memory. Ex. July, 18 or 7.18 * EXAMPLE ONLY, USE CORRECT MONTH AND DAY. *
26 Press	ENTER 	Computer accepts date.
27 Press Plain Key for "NEXT ITEM" (Screen 26)		Brings up year statement, item # 12.
28 Press Numeric Keys	9 2 	Input year, last 2 digit. Ex. 1992 or 92 * EXAMPLE ONLY, USE CORRECT YEAR. *
29 Press	ENTER 	Computer accepts year
30 Press	OTHER 	Replaces "PREV ITEM" and "NEXT ITEM" statements with "ENT ITEM" statement, ready for the next sequence of programming.

The following is for a one spindle per machine model set-up or a single spindle or one tool set up.

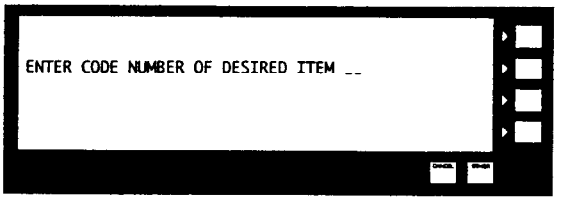
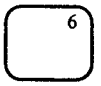
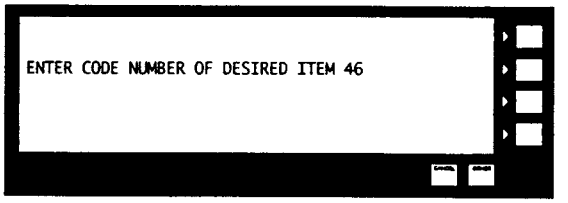
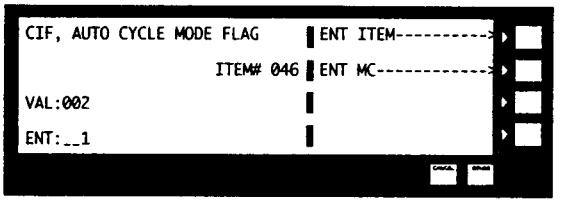
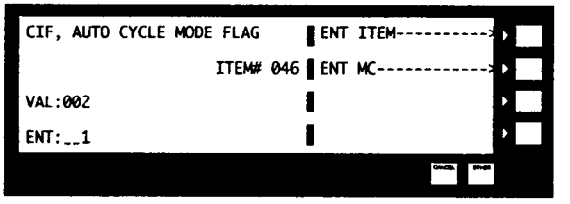
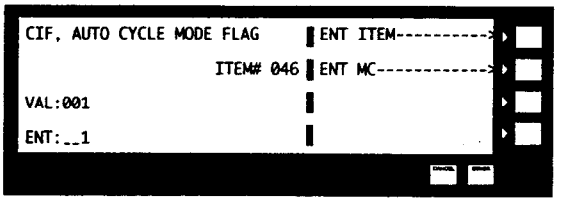
Now you must tell the computer what spindle to control by assigning spindle 1 to machine 1 (i.e., The simplest configuration being only one tool per machine - tool and machine considered to be the same.

OPERATION			DESCRIPTION OF OPERATION
31 Press Plain Key for "ENT ITEM"			Brings up "ENTER CODE--" statement which allows you to access any program statement in the computer memory. (See Screen 32)
32 Press Numeric Keys	4 2		Place code 42 into statement.
33 Press	ENTER		Code 42 statement allows you to assign different spindle configurations to a particular machine i.e., 1 spindle or tool to one machine - tool & machine are the same -for cases where you want to tighten two screws simultaneously with one fixtured control machine; the one machine has 2 tools.
34 Press Numeric Keys	1 0 1		For the simplest set-up assign one spindle or tool to one machine by entering a value of 101 - tool 1 to machine 1. (See also Section 7.0 Two Spindle Operation)
35 Press	ENTER		Now computer accepts the tool - machine configuration 101 as one tool for one machine.

Now you must tell the computer how to reset itself for every fastener cycle, i.e., be ready to run tool and accept data.

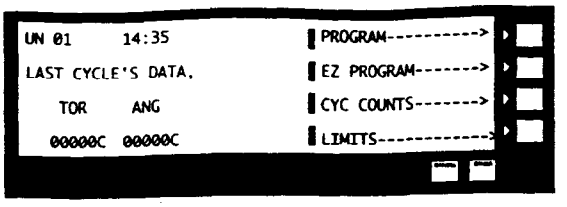
There are several modes of operation to do this:
Mode 0 requires an external contact closure during the entire cycle.
Mode 1 is an automatic cycle and no external switch is necessary to start or stop the cycle.
Mode 2 requires an external switch to start the cycle, and the cycle is ended automatically.

We will use mode 1 which automatically resets the computer after every fastening cycle. This is typical for handheld tools.

OPERATION			DESCRIPTION OF OPERATION
36 Press Plain Key for "ENT ITEM" (Screen 34)			Bring up "ENTER CODE--" statement to be ready for next program sequence.
37 Press Numeric Keys	 		Select auto cycle start for spindle 1/machine 1. Use code #46 to do this.
38 Press			Computer accepts code 46 & brings up statement to assign the type of cycle mode. Computer is preprogrammed for mode 2 (default value).
39 Press Numeric Key			Reassign computer cycle start to mode 1, auto cycle start. Tool automatically is ready for next fastening cycle after the previous cycle completed.
40 Press			Computer is now in auto cycle start mode.

OPERATION

41 Press



DESCRIPTION OF OPERATION

Screen reverts back to the original statement for 'last cycle data.' Now you are ready to program in specific data parameters to run your particular tool and fastener strategy.

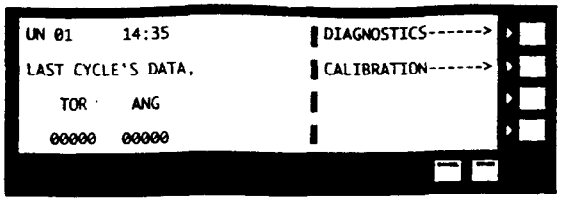
5.5 CALIBRATION

OPERATION

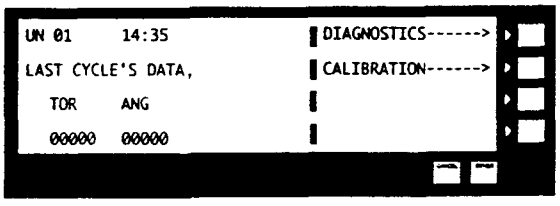
DESCRIPTION OF OPERATION

The following sequence of operations will calibrate the system to the tool transducers. This procedure should be performed whenever a tool is first connected to the system and periodically, thereafter.

1 Keep pressing [OTHER] until "CALIBRATION" appears on right side of screen

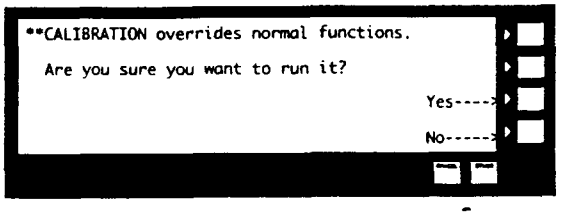


2 Press Plain Key "CALIBRATION"



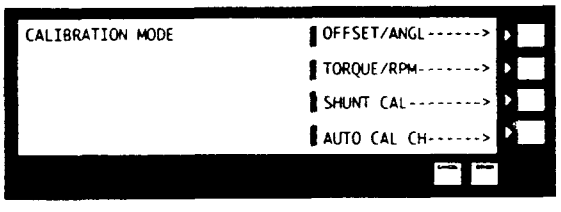
You are now ready to calibrate the tool i.e., adjust torque transducer to read proper torque.

3 Press Plain Key for "YES"



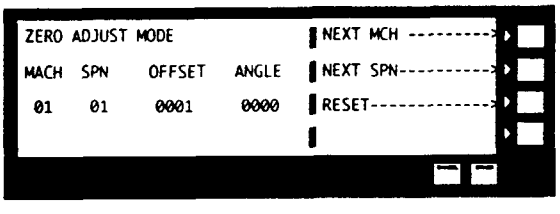
Brings up question asking if you want to calibrate.

4 Press Plain Key for "OFFSET/ANGLE"



Calibration mode menu allows you to call up different functions required to properly adjust torque transducer

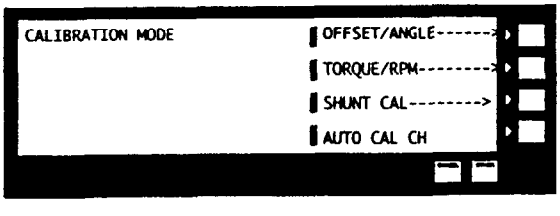
5 Adjust R24 Potentiometer inside cabinet for spindle 1 zero offset by turning pot cw or ccw with small screwdriver until proper value on screen is achieved.



Ref. Fig. 4-5 - Number goes up and down as you slowly turn pot clockwise or counterclockwise respectively. Try to set as close to zero as possible.

This brings up the screen to adjust the transducer for zero offset. (In calibration mode tool solenoid will be shut off) Ideally we want the zero offset to be zero (0000). Ignore angle value. Computer automatically adjusts\zero offset to zero for every fastening cycle up to ±10% of TR(±0007).

6 Press [CANCEL]

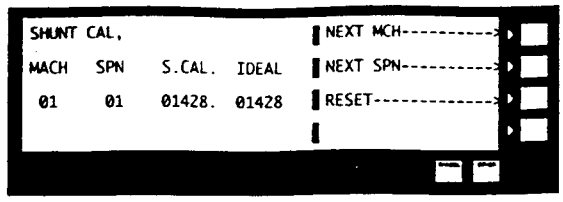


"CANCEL" erases screen and brings back the original menu for calibration.

OPERATION

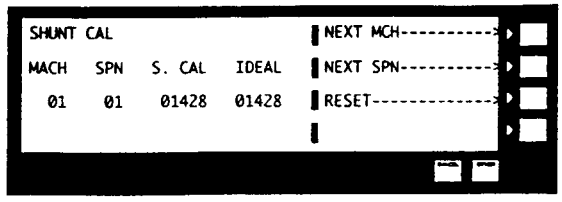
DESCRIPTION OF OPERATION

7 Press Plain Key for "SHUNT CAL" (Screen 71)



Brings up the screen (Shunt cal) to adjust the appropriate full scale value of the torque transducer. For example the transducer will be a common type with 2.0 mv/v sensitivity and 700 ohm bridge resistance. The computer equates these parameters to a particular number, in this case 01428.

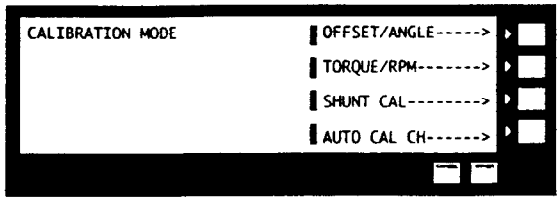
8 Adjust R34 potentiometer inside cabinet for spindle 1 Shunt Cal (SPAN) by turning pot cw or ccw with small screwdriver until proper value on screen is achieved



We must adjust the full scale value (Span) to 01428. The computer will automatically readjust to 1428 after each fastening cycle up to ± 10% (±143).

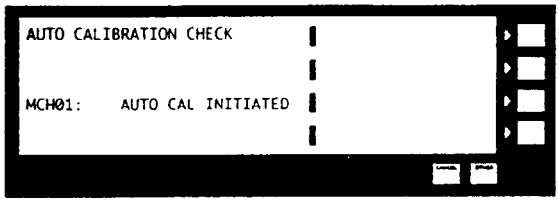
Ref. Fig 4-5 - Number goes up an down as you slowly turn pot clockwise or counterclockwise respectively. Try to set as close to 1428 as possible.

9 Press CANCEL



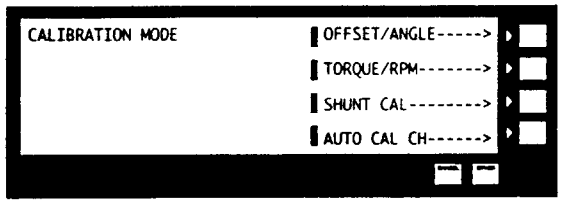
"CANCEL" brings back the original menu for calibration.

10 Press Plain Key for "AUTO CAL CH" (Screen 74)

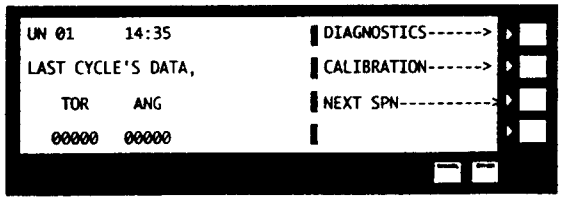


Brings up screen to have computer run through an automatic calibration check of transducer to verify if you calibrated properly. (if both yellow lights come on calibration is OK.) If not redo steps 66 to 74.

11 Press CANCEL



"CANCEL" brings back "LAST CYCLE'S DATA" screen.



You are now ready to run fasteners with the tool.

5.5.1 ADVANCED CALIBRATION (SCT, CTO, GF, GE, XJ, XL)

For applications requiring several cycles in immediate succession, it may be necessary to turn off the automatic calibration that normally occurs at the end of each fastening performed with a handheld tool. To do this, change the Shunt Calibration Timer (SCT - code 89) from the default of 50 milliseconds to 0. Also set the Automatic Calibration Timeout (CTO - code 98) from the default of 0 to the number of minutes of inactivity which will cause a calibration to occur. This allows for a torque transducer "health check" to be performed periodically between jobs or during breaks or shift changes.

In addition to the health check that occurs during calibration, the gain of the transducer is automatically adjusted based upon the offset and shunt calibration readings. The amount of error that has been adjusted for can be viewed as a ratio between the actual and ideal shunt calibration values (GF - code 79) or as a percentage (GE - code 78). Note that this correction is not performed for the system power-up calibration or for those initiated by CTO, but is applied upon manually initiated or cycle end calibrations. The compensation can be disabled at all times by setting XJ (code 149) to 1.

There are three parts to the transducer health check:

- offset must be within +/- 10% of full scale torque
- shunt calibration must be within +/- 5% of the ideal value (IRG)
- shunt calibration adjusted for offset must be less than 123% of full scale torque

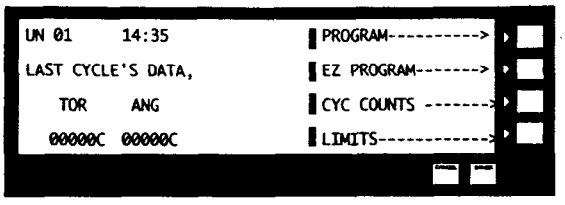
The offset and offset-adjusted shunt calibration checks must be passed by handheld tools or the tool will not be allowed to start, for safety considerations. Failure to pass the raw shunt calibration check will not prevent the tool from starting unless XL (code 151) is changed from it's default of 1 to 0.

6.0 TORQUE CONTROL

OPERATION

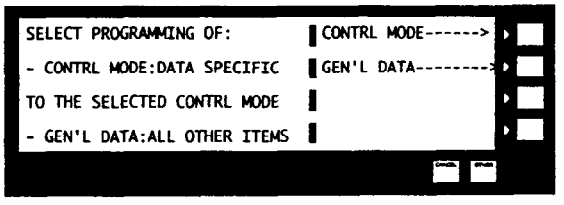
DESCRIPTION OF OPERATION

1 Press Plain Key for "EZ PROGRAM"



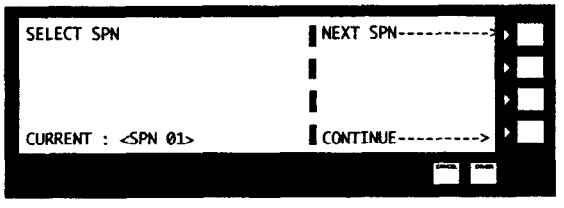
Brings up menu statement for the type of tool control desired. (See Screen 2)

2 Press Plain Key for "CONT'L MODE"



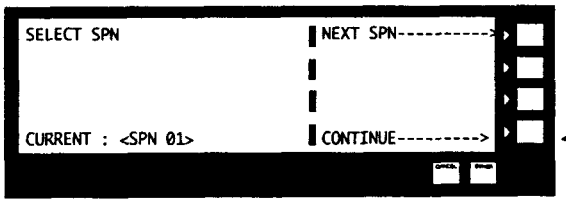
Brings up select spindle statement.

3 Press Plain Key "NEXT SPN" for correct spindle, In this case, we want <SPN01>



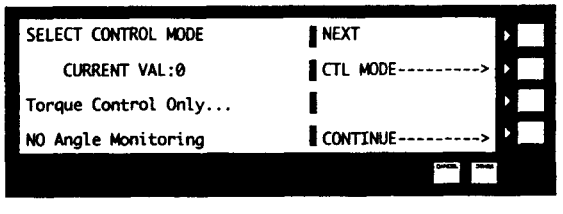
"NEXT SPN" key shuttles screen back and forth between spindle 1 & spindle 2.

4 Press Plain Key "CONTINUE"



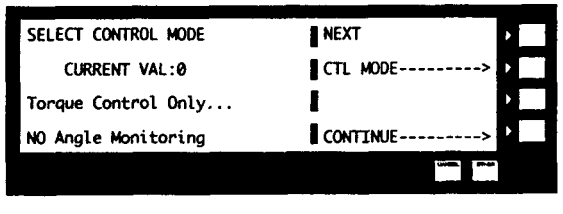
Brings up control selection (Screen 5). There are 4 control modes available:
Mode "0" = Torque monitor and torque control only.
Mode "1" = Torque control and angle monitor.
Mode "2" = Angle control torque monitor
Mode "3" = Torque control and angle control

5 Keep pressing Plain Key CTL mode until '0' appears after "VAL:" You do not need to press enter here, computer already accepts Val:0



Want mode '0', Torque control only.

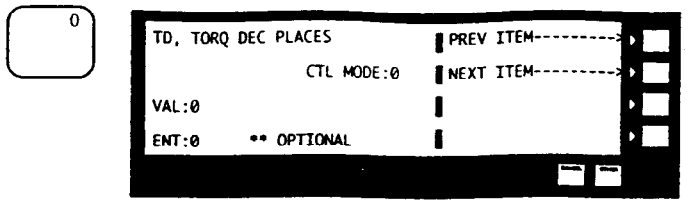
6 Press Plain Key "CONTINUE"



To continue to next programmable statement.

OPERATION | **DESCRIPTION OF OPERATION**

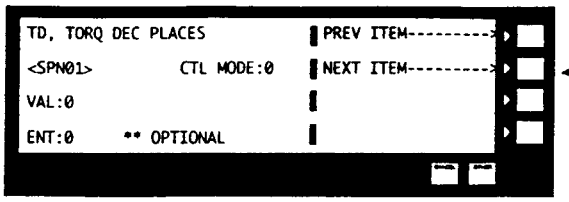
7 Press Numeric Key



Brings up statement to enter the decimal place accuracy desired, i.e., xxxx (Val: 0), xxx.x (Val:1 or xx.xx (Val:2).For this example we will use no decimal place (xxxx - set value to 0).

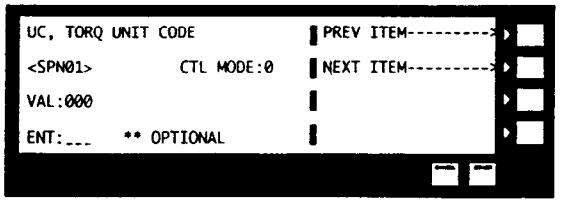
Note the word "** optional" on the screen. This mean that you do not have to enter a value for this code since the computer already has a preprogrammed value (default value).

8 Press ENTER



Enters decimal place accuracy in computer memory.
Val = 0, torque is XXX
Val = 1, torque is XXX.X
Val = 2, torque is XX.XX

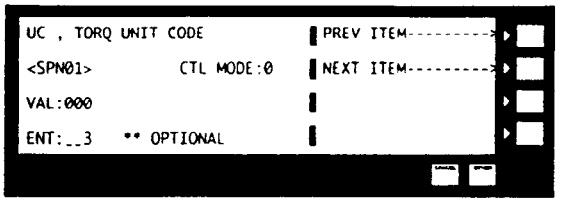
9 Press Plain Key "NEXT ITEM" (Screen 49)



Brings up torque unit code statement.
Code value 0 = no torque units value 1 = ft-lbs.; 2 = in-lbs.; 3 = N-m; 4 = N-cm and 5 = kg-m (Default = 0)

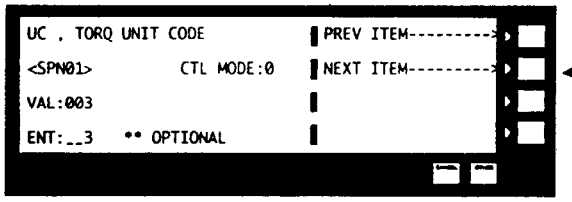
10 Press Numeric Key

3



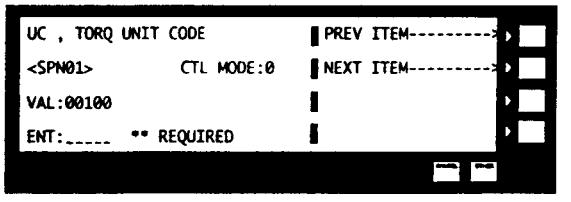
Sets value to 3
* EXAMPLE ONLY, USE YOUR CORRECT PARAMETER VALUES.

11 Press ENTER



Computer accepts value 3 and all torque readings and data will be in n-m units.

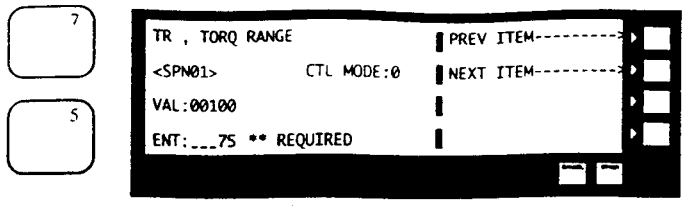
12 Press Plain Key "NEXT ITEM" (Screen 52)



Brings up the torque range of the tool transducer, usually the same as the full scale value of the transducer. See calibration sticker on tool for TR value.

OPERATION | **DESCRIPTION OF OPERATION**

13 Press Numeric Keys

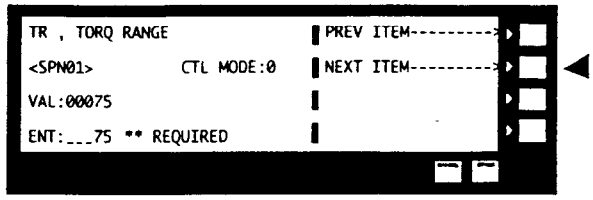


Preprogrammed value (default) is 100. For our example lets use a 75 n-m transducer (full scale value = torque range of 75)
* EXAMPLE ONLY, USE YOUR CORRECT PARAMETER VALUES. *

Caution

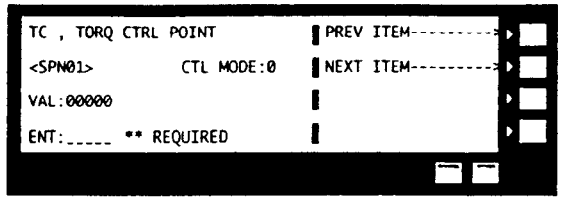
TR is an average value specified by the transducer used in the tool. You may have to adjust this value up or down slightly to fine tune the torque read by the computer to the actual dynamic torque applied as measured by an external lab transducer

14 Press ENTER



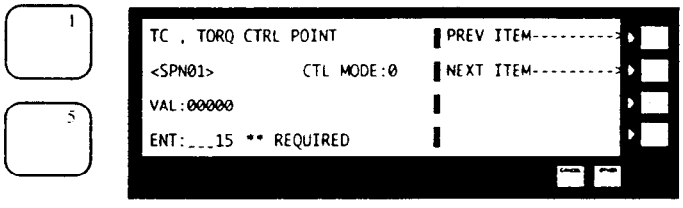
Computer accepts 75

15 Press Plain Key "NEXT ITEM" (Screen 55)



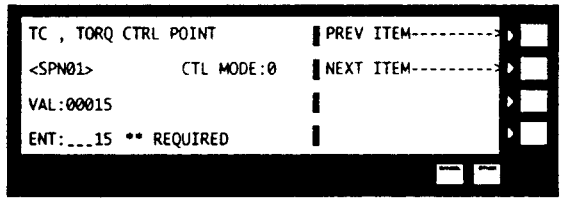
Brings up the torque control point statement which tells computer what you want the statistical data to be based on and also the torque value at which you want the tool to shut off.

16 Press Numeric Keys



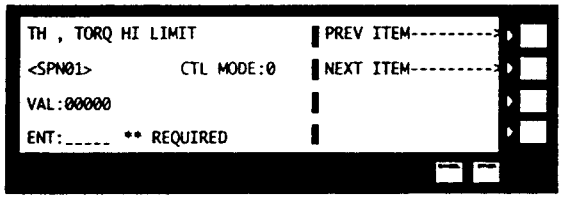
For our example let the desired target torque be 15 n-m. (set TC at 15)
* EXAMPLE ONLY, USE YOUR CORRECT PARAMETER VALUES. *

17 Press ENTER



Computer accepts 15.

18 Press Plain Key "NEXT ITEM" (Screen 58)

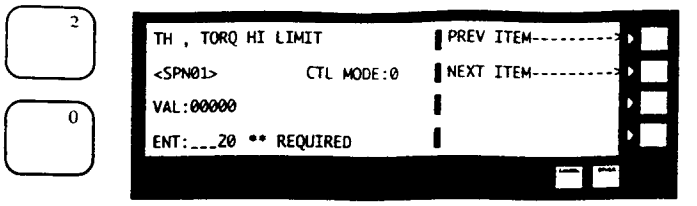


Brings up the torque high limit statement, when tool overtorques beyond this high limit (TH) error signal (red light goes on) and 'H' will appear after torque data.

OPERATION

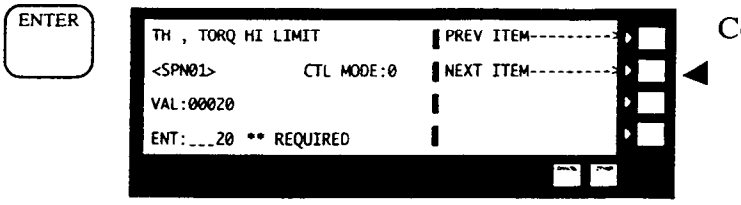
DESCRIPTION OF OPERATION

19 Press Numeric Keys



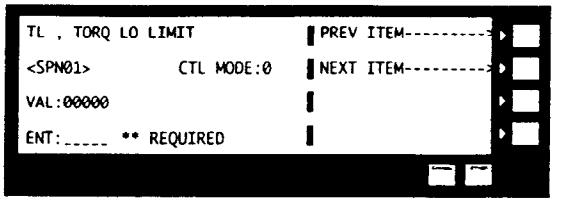
For this example let the highest acceptable torque be 5 n-m above the desired torque TC (TH = 15 + 5 = 20) Set TH at 20.
* EXAMPLE ONLY, USE YOUR CORRECT PARAMETER VALUES. *

20 Press



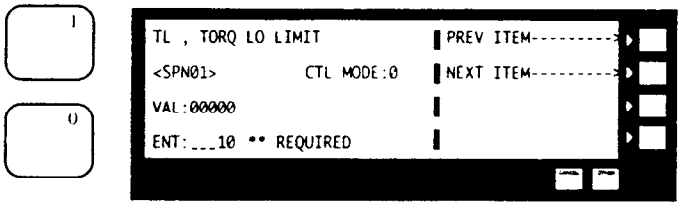
Computer accepts 20.

21 Press Plain Key "NEXT ITEM" (Screen 60)



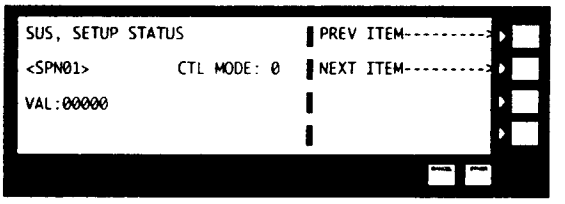
Brings up the torque low limit statement. When tool does not meet this low limit (TL) error signal (yellow lights) and 'L' will appear after torque data.

22 Press Numeric Keys



For this example let the lowest acceptable torque be 5 n-m below the desired torque. (TL = 15 - 5 = 10) Set TL at 10.
* EXAMPLE ONLY, USE YOUR CORRECT PARAMETER VALUES. *

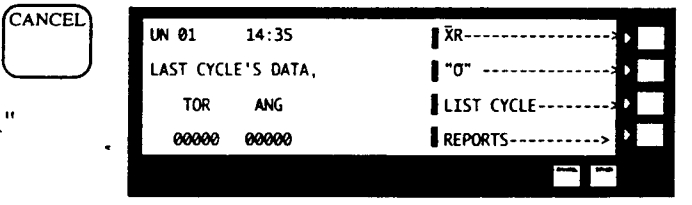
23 Keep pressing Plain Key "NEXT ITEM" until you see "SUS" on screen. If you go past just press the Plain Key,"PREV ITEM" which steps the screen backwards.



Skip all next parameter statements (TT, RTT, TDS) and stop when you see "SUS" (Set up status). This parameter is used to check if all data is entered properly.

Note
If the value of 'SUS' is other than 00000 one or more of the parameters is incorrect.
Recheck Section 6.0 steps 1 to 23 or see "Troubleshooting" Section 12.1.5

24 Keep pressing until "LAST CYCLE DATA" screen appears

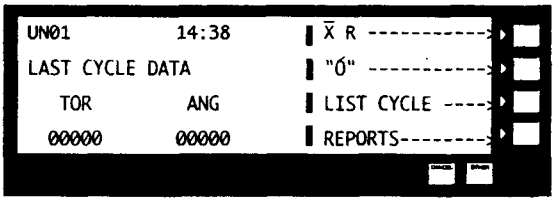


NOTICE

For difficult joints which are hard or have a high rate where the tool overshoots control point considerably, use the optional to (Torque Overshoot) control parameter. (See Section 6.4), and/or the TDS (Torque Downshift Point) control parameter (See Section 6.5)

Now that you have gone through the basic set up and programming steps, you can see how easy it is to call up different menu statements on the screen and scroll through these statements and enter data by using the CANCEL, OTHER and PLAIN keys. From here on we will abridge the programming steps and describe only the types of parameters you need to know. Not every key stroke or screen will be presented; you are expected to know the basic operation of the keyboard and screen. If not, please review all of Section 5.4.1.

REMEMBER. Anytime you want to pull up on the screen a specific code or parameter statement keep pressing CANCEL key until the home screen is displayed



then press PLAIN key for **program**, then press OTHER until **ENTER ITEM** is shown, then press PLAIN key for **ENTER ITEM** to enter parameter statement you wish to view or change.

NOTICE

Always clear memory of previous runs data before reprogramming computer. WE DO NOT need to completely erase the computer memory and start from the beginning since the time, date and tool configuration for one spindle has already been done. We must however, reset or clear the memory of any data run previously in order for the computer to accept new program parameters. The computer does this to protect the existing tool configuration data from being diluted with different results thereby effecting the statistical data in the memory. If you do not clear memory the computer will not allow certain parameters such as TR to be changed - an error message will come up on screen "HAS STATS" with loud beep (i.e. computer has statistics in memory). See Section 9.5 for more information.

To clear memory of past statistical data, call up Code #103 (RPS - Erase Stats for Spindle).

ENTER 1 This clears or flushes statistical data from memory for spindle 1 without reporting to a printer or host computer.

OR

ENTER 2 This flushes the statistics for spindle 2.

⚠CAUTION

If you want to change to another control mode strategy such as going from 3 to 1, be sure to clear all unnecessary parameters to prevent program malfunction. It is best to start with a clean slate and set all parameters TC, TH, TL, TT, AC, AH and AL to zero before reprogramming. If there are other values such as time functions, default values, etc, that have been re-programmed and you are not sure what they are, or what has been altered, you may consider clearing the entire RAM (Random Access Memory) and start from scratch (i.e., set item 17 Memory Clear to Code 1470 - see Section 5.4.1 item #6).

6.1 TORQUE CONTROL WITH ANGLE MONITOR

Now let's program the computer for torque control with angle monitor fastening. Here we want to control torque and also see how many degrees of rotation the fastener moved after seating to achieving full torque.

6.1.1 Clear memory of past statistical data, Codes #103, 91 and 92. (See Section 9.5).

6.1.2 SEQUENCE OF OPERATIONS:

1. **Keep pressing CANCEL key until "PROGRAM" comes on screen.**
2. **Press PLAIN key for "EZ PROGRAM".**
3. **Press PLAIN key for "CONTROL MODE".**
4. **Keep pressing PLAIN** key for control mode until statement shows CURRENT VALUE = 1.
5. **Press PLAIN key for "CONTINUE"** - brings up "NEXT ITEM" on screen.
6. **Keep pressing PLAIN key for "NEXT ITEM"** (i.e., scroll through items TD, TR, TC, TH, TC) **until you come to TT**, threshold torque, which is torque value when angle count begins.

NOTICE

All previous items TD to TC have been entered from Section 6.0.

7. Enter torque value for TT (Torque Threshold) - usually the snug or seating torque when the computer starts to count angle in degrees. **DO NOT** set TT below your expected fastener rundown torque ripple or the computer will start counting angle of rotation too soon resulting in an erroneous large angle value.

   For our previous example of TC =15, TL = 10 and TH = 20, let's assume maximum rundown torque ripple is 3 n-m. To be safe set TT = 5 n-m.

8. **Press PLAIN key for "NEXT ITEM" - brings up ASC** (Angle Scale Factor - which is the angle encoder resolution factor for a particular tool).
9. Enter value for ASC - Check ASC value on calibration sticker on tool or Appendix B.

NOTICE

The computer only accepts the inverted value (degrees of spindle rotation per encoder pulse).
Let our example be 406 encoder pulses per one spindle revolution (360°) or ASC = 360÷406 = .8867 degrees/pulse.

10. **Press PLAIN key for "NEXT ITEM" - brings up AH** (Angle High Limit).
11. Enter value for AH - any final angle number over this limit gives a red light on front panel as a rejection. Let our example be AH = 150°.
12. **Press PLAIN key for "NEXT ITEM" - brings up AL** (Angle Low Limit).
13. Enter value for AL - any final angle number below this limit gives a yellow light on front panel as a rejection. Let our example be AL = 50°.
14. **Keep pressing the PLAIN key for "NEXT ITEM" until you come to 'SUS'** (Setup Status - this value should be 00000. If not, then one or more of the parameters is incorrect; see "Troubleshooting" Section).

NOW WE MUST CHECK THE CALIBRATION OF THE ANGLE ENCODER LIKE WE DID FOR THE TORQUE TRANSDUCER.

15. **Press CANCEL key until "CALIBRATION" comes on screen.**

16. **Press PLAIN key for CALIBRATION** - brings up calibration menu.

17. **Press PLAIN key for YES** - brings up calibration menu

18. **Press PLAIN key for "OFFSET/ANGLE"** - now computer is in torque transducer zero offset and angle resolution calibration mode - THE COMPUTER SHUTS OFF TOOL IN THIS MODE FOR SAFETY PURPOSES.

19. **FIRST put a mark** on the tool spindle or socket.

20. **NEXT carefully and slowly rotate** the tool spindle clockwise one revolution. The final angle displayed should be approximately 360 degrees.

21. **Press PLAIN key for "RESET"** - repeat step 21 - if angle is off correct the ASC value (step #10).

ALTERNATE: You can also verify the appropriate angle setting using speed.

22. Return to CALIBRATION mode and press PLAIN key for "TORQUE/RPM" - the computer **maintains power** to the tool for it to run for speed check.

23. Run tool at the free speed and observe RPM reading on screen. Verify with tachometer at spindle - correct the ASC value (step #10) if speed value is incorrect.

24. **Keep pressing the CANCEL** key to return screen to the original display of **LAST CYCLE'S DATA.** You are now ready to run torque monitor or control with angle monitor.

⚠CAUTION

The computer will automatically shut off tool if AH (Angle High Limit) is exceeded even though TC (Torque Control Point) has not been reached. This is a safety feature to help prevent damage to fastener or tool.

6.2 ANGLE CONTROL WITH TORQUE MONITOR:

Now we will program the computer for angle control with torque monitor (sometimes referred to as "turn-of-the-nut"). Here, we want to achieve proper bolt tension by rotating the fastener a predetermined number of degrees after the fastener is snug or seated (TT, Torque Threshold Value).

6.2.1 Clear memory of past statistical data, Codes 103, 91 & 92 (See Section 9.5)

6.2.2 SEQUENCE OF OPERATIONS:

1. **Keep pressing CANCEL until "PROGRAM" comes on screen.**

2. **Press PLAIN key for "EZ PROGRAM".**

3. **Press PLAIN key for "CONTROL MODE".**

4. **Keep pressing PLAIN key for control mode until statement shows current value = 2.**

5. **Press PLAIN key for "CONTINUE".**

6. **Keep pressing PLAIN key for NEXT ITEM until you come to AC** (Angle Control) This is the angle value in degrees at which the computer will stop the tool from the snug point, i.e., angle count starts at TT torque value. It is also the angle value you want the statistical data to be based on.

NOTICE

All previous items TD to AL have been entered from Sections 6.0 and 6.1.

7. Enter value for AC in degrees - for our example, let the target or control point be AC = 100°.

NOTICE

Torque transducer and angle encoder have been calibrated per Sections 5.5, 6.0 and 6.1.

8. **Keep pressing PLAIN key for NEXT ITEM until you come to 'SUS'** - SUS should be 00000, if not then see "Troubleshooting" section.

9. **Keep pressing CANCEL** key to return screen to original display of **LAST CYCLE'S DATA.**

YOU ARE NOW READY TO RUN ANGLE CONTROL WITH TORQUE MONITOR.

⚠CAUTION

The computer will automatically shutoff tool if TH (Torque High Limit) is exceeded even though the AC (Angle Control Point) has not been reached. This is a safety feature to help prevent damage to fastener or tool.

NOTICE

For difficult joints which are hard or have a high rate where the tool overshoots the Angle Control Point considerably, use the optional AO (Angle Overshoot) control parameter. (see Section 6.4).

6.3 COMBINED TORQUE CONTROL AND ANGLE CONTROL

Some fastening strategies require the control or target of both a torque value and an angle of rotation, i.e., the computer shuts off tool either on achieving the TC (Torque Control Point) or the AC (Angle Control Point), whichever comes first during rundown.

6.3.1 CLEAR MEMORY OF PAST STATISTICAL DATA (Codes 103, 91 and 92 (See Section 9.5))

6.3.2 SEQUENCE OF OPERATIONS:

1. **Keep pressing CANCEL until "PROGRAM" comes on screen**

2. **Press PLAIN key for "EZ PROGRAM"**

3. **Press PLAIN key for "CONTROL MODE"**

4. Keep pressing PLAIN key for control mode until statement shows current value = 3

5. **Press PLAIN key for "CONTINUE"**

6. **Keep pressing PLAIN key for NEXT ITEM to scroll through all parameters** - NOTE TC and AC have already been assigned from our previous example so we will let TC remain at 15 n-m and AC remain at 100°.

7. **Keep pressing PLAIN key for NEXT ITEM until you come to 'SUS'** - SUS should be 00000. if not then see "Troubleshooting" section

8. **Keep pressing CANCEL key** to return screen to original display of **LAST CYCLE'S DATA.**

YOU ARE NOW READY TO RUN TORQUE AND ANGLE CONTROL.

6.4 TORQUE AND ANGLE OVERSHOOT

The programmable setpoints TC and AC should be thought of as the "desired target points" TC and AC are used by the statistical functions as reference values. Hence the TO (or AO when applicable) overshoot value should be set so that TC (or AC) defines the desired torque (or angle). The "shutdown condition" is useful even in a monitor only configuration, since it defines the torque vs. time and slope measurements. In a "torque monitor" application TC should be set to the desired torque. A recommended setting for TO in a monitor application would be such that the "shutoff point" (TC-TO) would be the torque low limit (TL). This guarantees a valid "torque rise time" measurement whenever the torque has reached the minimum permissible value. TO and AO can also be programmed to negative values for use in control mode 3 to effectively turn off one of the two shutdown conditions, but leave TC or AC at a value which defines a desired "target".

Example: Let TC = 15 n-m. Tool consistently generates an overshoot of up to 18 n-m. Therefore set TO to 3 n-m. The resultant torque will be closer to the target of 15. (i.e., shut off signal occurs at TC-TO or 15-3 = 12 n-m. which compensates for the 3 n-m overshoot).

6.5 TORQUE DOWNSHIFT POINT

To further control overshoot on hard or high torque rate joints, use a torque downshift setpoint. Enter a value in torque units less than the TC (Torque Control Point) into code 173 (TDS Torque Downshift Point) to enable this feature. The tool will slow to "Shiftdown Speed" upon reaching this value, in order to improve controllability at desired target point. Enter a value greater than TR (Code 20) .to disable this feature.

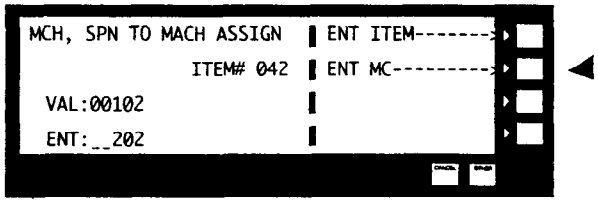
7.0 TWO SPINDLE OPERATION (SPN)

Now we will program the computer to run a second tool or spindle by using the **ENTER ITEM** statement as described in Section 6.0. The number of spindles to be controlled by the system can be varied between 1 and 2 by changing SPN (Code 40).

7.1 ASSIGNING SPINDLES TO MACHINES (MCH)

The two-spindle unit provides for flexible machine configurations. This is facilitated by programming the spindle to machine assignment (code 42 = MCH). The available options are two single-spindle "machines", or one two-spindle machine. To set up the unit to control a two-spindle machine, the spindle count must be two, and machine #1 must be programmed to indicate the use of spindles 1 thru 2 with the entry 0102. For two hand-held one-spindle tools, set machine #1 to 0101 and machine #2 to 0202. The machine assignment data entry is prohibited if any of the spindles are presently in cycle (response Err: In Cycle), one of the machines is in calibration mode (Err: Ent Inapprop), or statistical data was not flushed (Err: Has Stats). With the two spindle per machine case, a torquing cycle is initiated for both spindles simultaneously. For example, in the auto-cycle-start mode (CIF = 1) the "machine" will begin a cycle when torque is greater than MST % of full scale for either of the two channels. The cycle will not end until torque remains below one half of MST % for both of the spindle channels for the required time. This machine assignment is accessible in the CTL MISC group of EZ PROGRAM.

Program the computer to configure two spindles as follows:



1. Enter item 42 - brings up "MCH, SPN to MACH ASSIG"

2. Keep pressing PLAIN key "ENT MC" until <MCH02> is displayed.

   This statement assigns different spindle configurations to a particular machine i.e., 1 spindle or tool to one machine or 2 tools per one machine for cases where you want to tighten two fasteners simultaneously with one fixtured control machine (the one machine has 2 tools or spindles).

3. Now enter 0202 for value as shown above. This sets up the computer to recognize one tool is one machine or spindle <MCH0101> and the second tool as the second machine or spindle <MCH 0202>.

4. Now you can program the second tool **totally independent** from the first tool the same way you did the first tool after plugging in tool #2 to output connector labeled SPINDLE 2.

NOTICE

that during programming you must press the PLAIN key that ask for "ENT MC" or "NEXT MCH" so that you are programming the correct tool (keep pressing PLAIN key which will shuttle screen back and forth between MCH 01 and MCH 02).

For those parameters that are common to machine or tool 1 and machine or tool 2, the computer doesn't ask for you to choose which machine you want (i.e., time, date, year, etc.).

7.2 TWO SPINDLES AND MULTIPLE CONFIGURATIONS (CFU)

If a two-spindle unit is set up for multiple configurations and two separate machines, additional set up is required. This is the item "number of configurations used" (CFU, code = 017). The primary purpose of CFU is to provide independence between "machines" for the number of available configurations, the CSM = 1 automatic rollover and a safety against illegal selections of configuration if CSM=2. For example, consider a case with CFM = 4 (maximum configurations) and CSM = 2 (discretly selected inputs) for both machines. However, only two operations will be performed with tool #1, while four will be performed with tool #2. By programming CFU (for machine #1) to 2, only two inputs, will be used for machine #1. CFU will be set to 4 for machine #2, and it will use four inputs.

With CSM = 1, CFU will determine when the present configuration is reset to #1. For example, if CFU = 3, the program will automatically reset to configuration #1 upon completion of the cycle for configuration #3. See Section 8.2 for more information about configurations.

8.0 ADVANCED PROGRAMMING

8.1 REPROGRAMMING OF REJECT VARIABLES

The TMAD unit has the capability of defining items other than torque and angle for "reject" tests.

8.1.1 REASSIGNING THE "SECOND" DISPLAY VARIABLE (AFD, ADH, ADL, ADC)

The parameter "Item number for second display variable" (code 037 = AFD) defines the code # of the item displayed as the second item on the front panel after a torquing cycle, as well as the value passed on to the statistics computations. This item code must be one of those listed in Table 8-1.

If this variable is set to an item which is not an angle value, a separate set of limits must be programmed namely "Second Display Item Low Limit" (code 115 = ADL) and "Second Display Item High Limit" (code 114 = ADH).

Also, if the statistical information is of value, the second display item "target point" (code 111 = ADC) should be programmed. This simply defines the statistical target point for the second item.

These parameters are accessible in the REPORTING group of EZ PROGRAM/GEN'L DATA. If the item assigned to AFD is outside of these limits, the Angle Fault Indicators would be lit accordingly. It should be noted that for some of the items applicable to this function (e.g. slope), angle monitoring is required. In control applications set up in this manner, it is necessary to properly program the angle high limit in addition to "ADH" and "ADL". This will provide for a "fail safe" shutdown in case a programmed torque control shutdown condition is never satisfied and will be flagged as an "unusual condition" by the program.

NOTICE

Prior to changing AFD, the statistics must be flushed using RPS (Code 103). See Section 9.5 for more information. When the AFD parameter is changed, the data on the front panel will not be updated until after the next torquing cycle.

8.1.2 THIRD VARIABLE REJECT CONDITIONS (LVA, LAH, LAL)

If there is a valid item assigned to logged variable A (LVA, code 107), reject indications can be generated by simply programming a pair of reject limits, namely "LVA High Limit" (LAH, code 112) and "LVA Low Limit" (LAL, code 113). The limit variables must be set to a non-zero value to be active. For example, if the high limit is 0, a fault can be flagged only if the value is below the low limit.

If the item assigned to LVA is outside its limits AND there were no other faults (torque or angle) detected, then the reject indicators "Torq Hi", "Angle Hi", and "Angle Lo" are turned on. Counts of these faults appear in the statistical reports.

Note that it is not recommended to assign either speed or any of the calibration items (OFF, ARG, or RRG) to either AFD or LVA with the purpose of performing reject checks, since there are health checks built in for these items.

Table 8-1. Items Available for Extra Logged Variable Operator

Code	Id	Description
50	AF	Final Angle (TT to AT)
51	AS	Shutdown Angle (TT to Shutdown)
52	PPK	Peak Torque At Pretorque Shutdown
53	RDT	Prevailing Torque (Average Of Samples)
54	RPM	Peak Motor Speed
55	TCT	Total Cycle Time
56	PTT	Pretorque Time (Cycle Start to TP)
57	FTT	Fastening Time (Cycle Start to Shutdown)
58	RT	Torque Rise Time (TT to Shutdown)
59	RFT	Torque Rise And Fall Time (TT to AT)
60	AN	Net Angle (TT to Cycle End)
61	ANF	Net Angle - Final Angle (AT to Cycle End)
73	RDD	Prevailing Torque Sample Difference
116	SLP	Slope (TT to Shutdown)
117	FT	Torque Fall Time (Shutdown to AT)
118	SA	Slope Before Threshold (TT to TTS)
119	SB	Slope After Threshold (TTS To Shutdown)
130	OFF	Amplifier Offset
131	RRG	Raw Shunt Calibration
132	ARG	Actual Shunt Calibration (RRG-OFF)
145	XF	Shunt Calibration Fault Code
146	XG	Shutdown Cause Code
178	GCC	Gang Count Current

Note that the items above can be accessed from the STATUS VARS group of EZ PROGRAM/GEN'L DATA.

8.2 MULTIPLE CONFIGURATIONS (CFM, CSM)

In some instances, it is desirable to perform more than one tightening operation with a single tool (or group of tools). In this situation there would be separate sets of limits, control setpoints, etc. for each operation. With the TMAD unit, the data for these different operations is referred to as "configurations". Programmable parameters define the number of configurations actually used, the means by which a configuration is selected for a particular torquing cycle, and which configuration is accessed by data entry and display.

By default, the TMAD is set up for a single configuration. To set up the unit for multiple configurations, the "maximum number of configurations" (code 041 = CFM) must be programmed. It is accessible in the CTL MISC data group of "EZ PROGRAM/GEN'L DATA". The largest value for CFM is 8 (4 each for 2 spindles). Note that this entry will be rejected if statistical data is NOT flushed (response "Err: Has Stats"). This is because the program will divide memory into sets according to the CFM settings.

The "NEXT CFG" or "ENT CF" function keys select the parameter configuration which is accessed by the data entry and display software. When CFM is greater than 1, the present configuration is provided to the operator whenever entering or displaying a parameter which has the multiple configurations structure. Such parameters are only those which define the monitoring/control strategy. Hardware dependent items such as "Torque Range" are not included in the multiple configuration structure.

The means for selecting which configuration is used for a particular torquing cycle is determined by the "Configuration Selection Mode" (code 018 = CSM) accessed in CTL MISC. There are two modes available the first mode increments the configuration automatically after cycle end, resetting the configuration to number one upon detection of a momentary reset contact closure (CSM = 1); and the second mode uses eight individual contact closure inputs to select one of eight configurations (CSM = 2). The configuration which is presently selected will be displayed on the top line of the front panel, in the format "CFG nn".
Note: Set CSM=2 to allow use of the Configuration Selection Switches on the right side of the cabinet (See Figure 3-1) to select configuration through the AIC (Section 11.9 Accessory Interface Connector), or to use a socket tray.

NOTICE

If using a socket tray, or seleting a configuration through the AIC Connector, the configuration selection switches must be in the remote position.

8.2.1 CONFIGURATION SELECTION, 1 OF 8 INPUTS

If CSM = 2, up to eight inputs are used for selecting configurations. If input is active (and only input #n), then configuration #n is selected. If more than one or none of the contacts are closed, the program will declare the input an invalid setup condition and the front panel display will show "CFG = Invalid". If the tool is run when in this state, the cycle will be flagged and"invalid setup fault". One application of this philosophy is a repair center, where the operators choice of one of eight sockets from a rack causes a contact to be closed when a socket is removed.

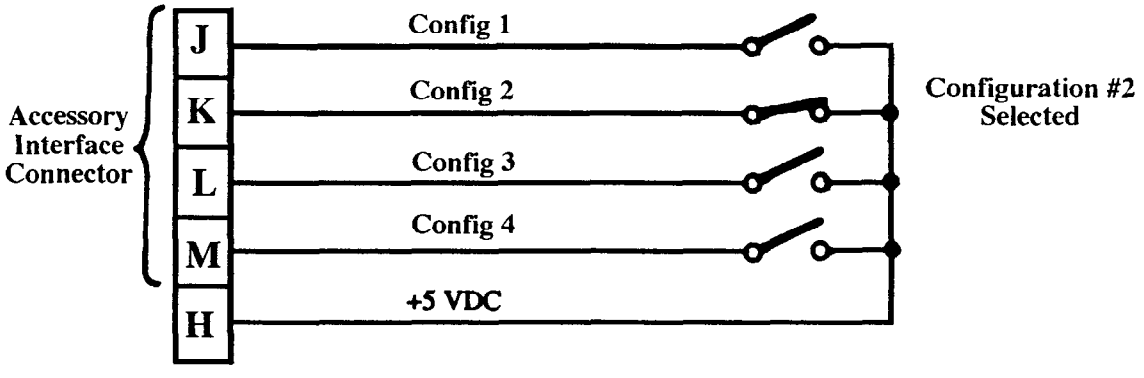
NOTICE

For two spindle unit (TMAD2) programmed to run two tools you can only select 1 of 4 inputs per spindle or tool.

Table 8-2. CSM=2 Input States

#1	#2	#3	#4	#5	#6	#7	#8	Program
open	open	open	open	open	open	open	open	Invalid
closed	open	open	open	open	open	open	open	1
open	closed	open	open	open	open	open	open	2
open	open	closed	open	open	open	open	open	3
open	open	open	closed	open	open	open	open	4
open	open	open	open	closed	open	open	open	5
open	open	open	open	open	closed	open	open	6
open	open	open	open	open	open	closed	open	7
open	open	open	open	open	open	open	closed	8
closed	closed	open	open	open	open	open	open	Invalid

Example of selection by closure of "1 of n" inputs for spindle #1



For the above:

For a one-spindle unit, CSM = 2, CFM = 4

For mach. #1 of a two-spindle unit, CFU(1) = 4. CFM = 4, CSM(1) = 2

8.2.2 CONFIGURATION SELECTION, AUTO-INCREMENT

If CSM = 1, the program will automatically increment the configuration upon completion of a torquing cycle. When the incremented configuration number would exceed CFM, the configuration is reset to number one. The configuration number will also be reset to number one upon detection of a reset CCI. The CCI assignment function designates this input. When this input is detected (a momentary closure of about 0.1 second), the configuration selected is reset to 1.

Example: Two spindle unit with 3 program strategies for tool #1 only. Torque control, no angle monitor: 18 NM for fastener 1, 18 NM for fastener 2, 30 NM for fastener 3, then reset automatically back to fastener strategy 1 (config. 1) which is 18 NM.

set CSM = 1 (automatic sequencing)
set CFM = 3 (3 strategies for tool 1)
set CFU = 3 (for 2 spindle units only - TMAD 2)
set TC = 18 NM for configuration 1
set TC = 18 NM for configuration 2
set TC = 30 NM for configuration 3

NOTICE

See Section 13.3 Gang Counting to setup multiple cycles per configuration

8.3 MONITORING RUN DOWN TORQUE (RTT, AR, TMR)

The program has capability of monitoring the "prevailing torque" during fastener run down. The function requires an appropriate setting of the "Prevailing Torque Threshold" (code 64 = RTT). If angle monitoring is enabled(control mode setting non-zero), the "Prevailing Torque Angle Interval" (code 039 = AR) must be programmed appropriately. If angle monitoring is not enabled, the "Prevailing Torque Time Interval (code 069 = TMR) must be programmed. The program measures torque at AR degrees or TMR time after a torque greater than or equal to RTT is detected and again after an additional AR degrees/TMR time interval. The prevailing torque is the average of these two measurements. These variables are defined graphically in Figure 8-3 below and are accessible using the EZ PROGRAM / CONTROL MODE option. The Program will prompt for entry of AR or TMR according to the selected control mode when using EZ PROGRAM.

There are three limitations to this function. First, the time from the detection of RTT until the second sample must be at least 60 milliseconds in either the angle or time modes of operation. Secondly, when using a fastener which has a significant prevailing torque, and the unit is set up in auto-cycle start mode (CIF = 1), the torque for cycle start should be less than the prevailing torque, or the speed for cycle start should be programmed in order to have the process be "in cycle" thereby allowing the torque to be evaluated. Third, this process must be completed before the rise in torque caused by the fastening.

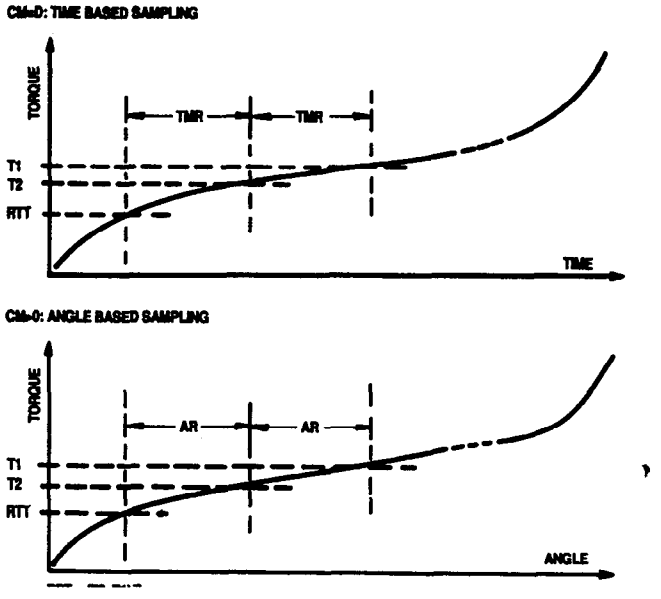


Figure 8-3. Run Down (Prevailing) Torque Monitoring

8.4 SLOPE MONITORING (TTS)

The program calculates torque vs. angle slope when angle monitoring is enabled (CM non-zero). The value is computed from the change in torque from threshold (TT) until a control shutoff point is reached and the change in angle over the same period. The value is not defined in cases where threshold is not reached, or when invalid setup, encoder fault, or transducer fault conditions are flagged. When control mode 3 is selected, the capability to break up the slope into two parts, TT to TTS and TTS to shutdown, is added. Thus TTS must be set between TT and TC. See Figure 8-4, which illustrates these measurements.

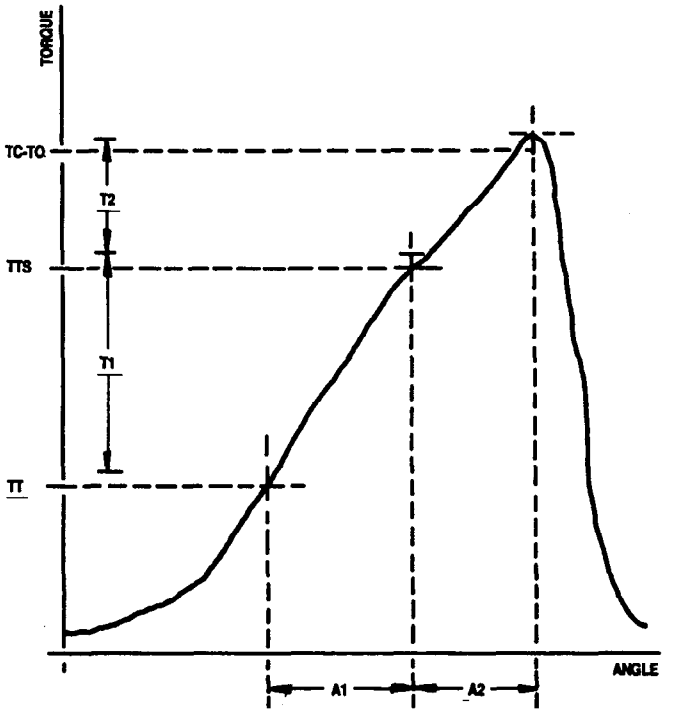


Figure 8-4. Slope Monitoring

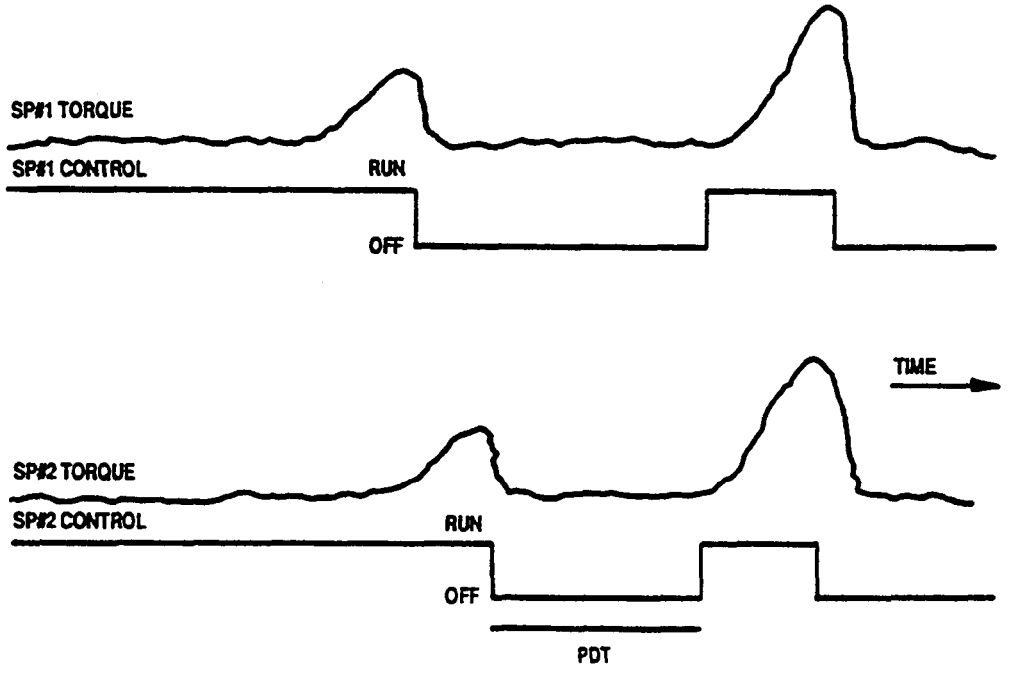
8.5 PRETORQUE CONTROL (TP, PDT)

For some applications, it may be desirable to have a control shutdown at a point well below the desired setpoint, so that the part can properly seat itself. This is accommodated by programming the Pretorque Control Setpoint (code 29 = TP). This pretorque shutdown occurs only if TP is set to a non-zero value. The feature is intended primarily for multiple-spindle control applications. The pretorque switch (See Section 4.4.1) must be in the down position.

The program will synchronize spindles assigned to the same machine, in that the final rundown will not begin until pretorque shutdown is detected for both of the spindles in the machine (see Figure 8-5). The control outputs will be held in the shutdown state for at least the Pretorque Shutdown Time (PDT, code 65) after both spindles in the machine have detected pretorque, have shutdown, and torque decay has been detected. Note that the setting of CTA must define a time considerably greater than PDT, or the end of cycle condition could be satisfied at pretorque shutdown. Note that this is exactly what would happen if a bolt was missing. Also, for handheld tools, CTB should be set long enough to allow the operator to release the throttle at the end of the complete cycle, without another cycle being started.

Some special fault conditions will override this pretorque control logic. If a transducer, encoder, or setup fault is detected on any of the spindles in the machine, the pretorque complete condition will never be satisfied. Hence, the cycle will end CTA seconds after all have shutdown, with appropriate reject indications (special fault on one spindle, low torque and angle on the others).

EXAMPLE OF PRETORQUE CONTROL WITH A TWO SPINDLE MACHINE



8.6 CYCLE TIMING (CIF, MST, MSS, CTA, CTB, SDT, RTO)

There are three modes in which the system can be operated, as selected by the Cycle Initiation Flag (CIF - code 46). Two of the modes apply to fixtured tools only, with the third for handheld tools.

The default of CIF to 1 is used for all handheld tools. In this mode, a cycle begins automatically when the torque reaches the Minimum Cycle Start Torque (MST - code 25). This setting is entered as a percentage of full scale torque, and the default is 5%. Alternatively, the cycle can be initiated upon a Minimum Cycle Start Speed (MSS - code 44), which defaults to 9999 RPMs (disabled). The cycle ends automatically when torque falls below MST / 2 for a time set by the Cycle End Timers (CTA - code 66 and CTB - code 67). If the control point has not been reached, CTA is used to end the cycle, and CTB is used if tool shutdown occurred. CTA may need to be increased from the default of 1 second if Pretorque Control is employed (see section 8.5) or if there is a high start-up torque long before the fastener is snug, in order to prevent false cycles. CTB also may need to be increased for the default of 0.1 seconds for Pretorque Control, in order to allow enough time for the operator to release the trigger at the end of the complete cycle. Note that a calibration begins immediately following the CTB timer, and lasts for twice the SCT timer. This calibration may be

Control, in order to allow enough time for the operator to release the trigger at the end of the complete cycle. Note that a calibration begins immediately following the CTB timer, and lasts for twice the SCT timer. This calibration may be disabled (see section 5.6.1), in which case the Shutdown Duration Timer (SDT - code 85) determines the time until the next cycle may be run. The Rundown Timeout setting (RTO - code 93) determines an absolute maximum time a cycle is allowed to continue, and the default is 20 seconds.

For fixtured tools, CIF is usually set to 2. The Run command at pin A of the AIC or PLC Interface Connector (see section 13.1 or 13.2) will initiate a cycle, starting with an automatic calibration, and the cycle will end as described above for handheld tools (without the calibration at the end of the cycle). If the ability to reverse a fixtured tool is needed or the tool needs to be seated onto the part (see section 8.8 - Jog Timer), CIF should be set to 0. In this mode, a cycle is started as for CIF set to 2, but the Run signal must be maintained throughout the fastening. If the Run command is removed before the control setpoint is reached, the tool will be shutdown immediately and the cycle will end in CTA seconds. If the fastening was completed, the cycle will end in CTB seconds. Normally, the Complete signal can be monitored to determine when the Run command can be used, but for the reverse and jog operations the command must be timed or otherwise determined.

8.7 SETTING THE MINIMUM ALLOWABLE SPEED CHECK (ES)

A speed check can be performed each cycle, if desired. This function is enabled by programming the Minimum Allowable Speed (code 038 = ES, units of RPM). The check operates by simply performing a peak-hold of spindle speed during fastener rundown and comparing the peak-held value to ES when the programmed torque threshold (TT) is reached. A fault is flagged if the maximum measured speed is less than the ES setting. The fault indication is both the angle high and angle low indicators lit. ES has a default value of 0. A small value will ensure that faults due to an open circuit in the encoder wiring would be flagged. To truly get an accurate check, ES should be set to about 90 % of the expected speed.

This parameter can be used to flag any variation that causes the motor speed to appear to be reduced, such as: motor degradation, cross threaded bolt, actual encoder fault, improper lubrication in the joint, or a poorly threaded hole.

There are limitations on this function. For a low speed setting (ES = 15), at least 1/2 turn is required prior to detecting significant torque (to prevent flagging of a false fault). If setting ES to 90% of expected speed, as much as two full turns may be required.

8.8 JOG TIMER (JT)

For fixtured tools with CIF set to 0, data for short cycles used to seat the tool on the part may be kept out of the statistics and logs. This is accomplished by programming the Jog Timer (JT - code 47) to a value in seconds longer than the maximum time needed to seat the tool. If the torque during the cycle is greater than MST, or the Run command is longer than JT, the cycle will be handled normally.

8.9 CHANGING THE TORQUE FOR ANGLE STOP (AT)

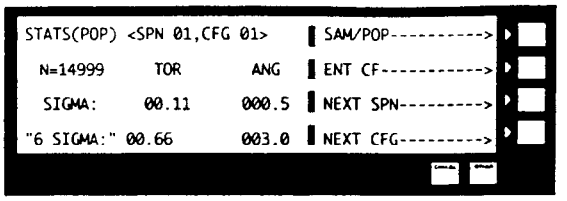
The Torque Used For Angle Stop parameter (AT - code 27) determines the end point for angle counting during a cycle. The value programmed into this code is in torque units and must be less than TC. After shutdown occurs, angle continues to be tracked until the torque decays to this value.

When left at the default of 0, AT is effectively set to MST / 2. For most applications, no change is necessary, but for joints with high relaxation AT is usually set to be the same as TL, the minimum acceptable torque value.

9.0 STATISTICS: This section describes the TMAD built in statistics.

9.1 Sigma

This function displays standard deviation data in the following format:



Display Fields

STATS : Title

(POP) : Indicates group of torquing cycles for which data is being displayed. "POP" means entire population; "SAM" indicates sample-size group.

<CFG 01> : Configuration #'s of displayed data. Appears only if >1 config.

N=14999 : Number of data points in currently-displayed statistics group.

TOR
SIG: 00.11
"6sig" 012.7

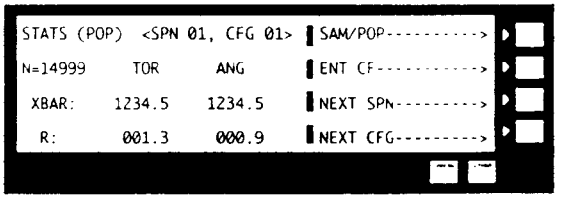
: Standard deviation ("sigma") for peak torque value. (Standard deviation is calculated using N-1 as the divisor.) The "six sigma" is simply six times sigma.

ANG
SIG: 00.00
"6sig" 000.0

: Standard deviation data for the "angle" value, i.e. value specified by "Angle For Display" (AFD) parameter. Heading will be "ANG" if the item is angle related, otherwise another 3-char item code will be displayed.

9.2 XBAR R

This function displays mean and range for torquing cycle data in the following format:



Display Fields

STATS : Title

(POP) : Indicates group of torquing cycles for which data is being displayed. "POP" means entire population ; "SAM" indicates sample-size group.

<CFG 01> : Configuration #'s of displayed data. Appears only if >1 config.

N=14999 : Number of data points in currently-displayed statistics group.

TOR
XBAR: 1234.5
R: 001.3

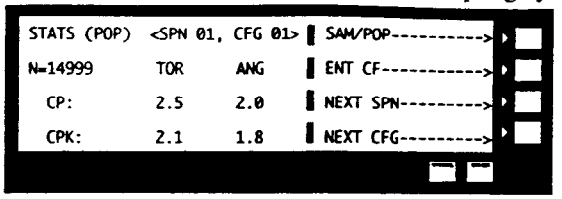
: Mean and range for peak torque value.

ANG
XBAR: 1234.5
R: 000.9

: Mean and range for "angle" value, i.e. value specified by "Angle For Display" (AFD) parameter. Heading will be "ANG" if item is angle-related, otherwise 3-char item code will be used.

9.3 CP and CPK

This function displays CP and CPK for torquing cycle data in the following format:



Display Fields

STATS	: Title
(POP)	: Indicates group of torquing cycles for which data is being displayed. "POP" means entire population ; "SAM" indicates sample-size group.
<CFG 01>	: Configuration #'s of displayed data. Appears only if >1 config.
N=14999	: Number of data points in currently-displayed statistics group.
CPK	: A measure of distribution position. Astatistical indicator of how centered the distribution is within the tolerance zone. USL = Upper Spec Limit. LSL = Lower Spec Limit.
CP	: Process spread
CPK	: Lesser of $\frac{(USL - XBAR)}{3\ Sigma}$ $\frac{(XBAR - LSL)}{3\ Sigma}$
CP	: Capability of machine or process. A measure of distribution width.
CPK	: Capability Index
CP	: $\frac{(USL - LSL)}{6\ Sigma}$

9.4 STATISTICS MANAGEMENT (SSZ, SIG)

The TMAD maintains statistics for the torquing results in two separate data bases. One provides data for a user-defined sample size (code 70 = SSZ). There is memory available for up to 5000 total samples. Based on the number of data set (spindle/configuration set), this memory is divided and the storage area for each data set is calculated. For example, if the unit is configured for one spindle and one configuration set, the maximum number of parts that can be stored is 5000. For two spindles and one configuration (i.e., two data sets), the maximum part number for each data set is 2500/ For two spindles and two configurations (i.e., four data sets), this number will be set to 1250 for each data set.

The second provides data for the entire "population ", i.e., data is accumulated for all cycles since the last time the data was reset (by user command). Note that discrete data values are maintained only for the maximum possible sample size. Information entered into the population and sample statistics is determined by the setting of the Statistics Update Mode (SIG, code 090). If SIG = 0, data from all torquing cycles without regard to fault flags is included. If SIG = 1, then data for acceptable cycles only is included. If SIG = 2, then data for all cycles except gross failures is included. The default setting is SIG = 1. Note that SSZ and SIG are accessible in the STATS CTL group of EZ PROGRAM/ GEN'L DATA.

Control parameters TC (code 21), and AC (code 31), or ADC (code 111) are used by the statistical data set (determined by spindle and configuration) are determined by the setpoint values at the time statistical data is flushed. If one of these setpoints change, the target will be changed ONLY if there is no statistical data accumulated (for the relevant data set). The TARGET SHIFT for torque is defined as torque mean value - torque target value. The TARGET SHIFT for the second variable is the mean value - target value, where the target is determined by AC if "AFD" is assigned to angle, or ADC if AFD is not assigned to angle. These target points are also used for accumulating standard deviation data. The program determines SIGMA (standard Deviation) from the SIGMA of the deviation of the actual measured values from the target point. Hence, proper programming of the target points would tend to minimize rounding error in the SIGMA calculations. Note that the use of these target values in the SIGMA calculations should be transparent to the user.

9.5 RESETTING (FLUSHING) STATISTICS (RP, RS, RPS)

To reset (flush) the population statistics, enter a non-zero value into the "population stat. reset" flag (RP, code 091). Similarly, to flush the sample statistics, enter a non-zero value into the "Sample Stat. Reset" flag (RS, code 092). A report is printed out BEFORE the flush operation is carried out. In some instances it is undesirable to flush data for all data sets. This is particularly true when changing a tool. Scale factors (ASC and TR) for a spindle can not be changed if there is statistical data for that spindle. The "Spindle Population and Sample Data Reset" function (code 103 = RPS) enables flushing data for an individual spindle channel without generating a report. This operation is performed by programming RPS to a valid spindle number. A message is printed to acknowledge this operation. Recall that the cycle counter is cleared when population data is flushed. If RPS is used to flush data, only the cycle counters for all configurations for the selected spindle will be cleared. Note that the data is automatically flushed if data for 16000 cycles has been accumulated (for any data set). The message "Stat Mem Near Full" is displayed and an exception log is printed if data for more than 15900 cycles is accumulated.

NOTICE

The statistics must be flushed before making changes to AFD (Code 37 - Second Display Variable) or SPN (Code 40-Number of Spindles).

10.0 EXTERNAL PRINTER AND COMPUTER OPERATION

10.1 SERIAL TERMINAL PORT FOR CONNECTING PRINTERS AND PC'S (POL, BTA, PTA)

The system is equipped with a terminal port (RS232 type DB25S designated as port 'A') which through the various logging functions produce their reports. If a keyboard¬equipped terminal is attached, this port can also be used for programming the system using the command syntax described in the Appendix below. By default, this port operates at 2400 BAUD, even parity. The BAUD rate can be changed by data entry to the "BAUD for Terminal" parameter (code #135, = BTA). Parity can be changed through the "Parity for Terminal" parameter (code #138 = PTA). Any changes in these parameters are stored in the system's EEPROM so that they will not be lost on subsequent "cold starts".

Data transmission is at 7 data bits, 1 stop bit and selectable parity . Your printer or PC should be set for this. Also the TMAD should be set to operate port 'A' by setting code # 16 = POL to zero. To match different baud rates and parity.

set: code 135 (BTA) to 300, 1200, 2400...or 9600
code 138 (PTA) to 0 = NO PARITY, 1 = ODD, 2 = EVEN, 3 = SPACE

Following is the pinout for the terminal-port connector, DB25S, on the outside of the unit:

1 = SHIELD GROUND
2 = SERIAL DATA IN
3 = SERIAL DATA OUT
4 = CTS, Clear-To-Send, Optional output, high when data input is allowed.
5 = RTS, Request-To-Send, Optional input, must be open or high
7 = COMMON

10.1.1 SERIAL PRINTER

To hook the terminal port to a typical **serial printer** the cable wiring should be as follows:

TMAD **Serial printer (See Printer Manual)**

2 2
3 3
7 7
ALL OTHER PINS NOT USED

10.1.2 PARALLEL PRINTERS

To hook the terminal port to a typical **parallel printer** use a serial/parallel converter between TMAD and printer (See Your Converter and Printer Manual). Cable wiring can be the same between TMAD and converter as shown above for the serial printer.

10.1.3 PC TERMINAL

To hook the terminal port to a typical terminal use the PC **serial port** and cable wiring should be as follows:

TMAD Pin #	**PC (see PC Manual) Pin #**
2 (Serial Data In)	3 (Serial Data Out)
3 (Serial Data Out)	2 (Serial Data In)
4 (Clear to Send)	7 (Request to Send)
5 (Request to Send)	8 (Clear to Send)
7 (Common)	5 (Signal Ground or Common)

To properly operate the communication between TMAD and PC, you must program the PC to function as a terminal or use a commercially available program to do so, such as "PROCOMM" * to configure the PC as a terminal.

* Registered software name of Datastorm Technologies, Inc.

10.1.4 HOST INTERFACE (POL, BH, PH, ADR)

The TMAD has a built-in Host Communication Capability. On the standard system, the Host comm function shares the single serial port with the terminal-oriented logging and programming functions described above. On the initial start-up of the system, the port is assigned to the terminal functions. The operator can switch the port over to Host Comm by setting the "Host Polling Enable Flag" (code 016 = POL) to 1. The system has separate Baud rate and parity parameters for each mode of the port. The parameter associated with the sharing of the port can be summarized as follows:

MODE OF PORT	POL	BAUD AND PARITY
Terminal Functions	0	(Code 135 = BTA) & (Code 138 = PTA)
Host Comm Functions	1	(Code 134 = BH) & (Code 137 = PH)

The Host function is intended to work in a multi-drop RS485 network of TMAD's, each with its own unique address. This address, also referred to as the "unit number" is set through a system parameter (Code #013 = ADR). The unit number is also displayed on the TMAD's main display screen. The RS485 connector is available with option "B" instead of "A" (See Section 1.0 Specification).

The mating connector is a Bendix part number PT065E-10-65(SR) or equivalent. Shielded two-twisted pairs cable should be used to "daisy-chain" up to 32 systems and the host computer comprising the network.

Pin outs are as follows:

Pin	Function
2	Tx+
3	Tx-
4	Rx+
5	Rx-

10.1.5 HOST MODE PROTOCOL

The Host Communications function can be used to poll for torque and angle samples as well as for performing terminal-oriented logging and display/entry.

The format of the polling request to be initiated by the Host computer is:

AA0S<CR><LF>

where "AA" is the 2 digit address of the TMAD system (ADR - code 13), <CR> is a carriage return or CTRL-M and <LF> is a line feed or CTRL-J. "S" is the data set number organized as follows for a dual spindle system:

Data Set Number	Spindle	Configuration
1	1	1
2	2	1
3	1	2
4	2	2
5	1	3
6	2	3
7	1	4
8	2	4

For a single spindle system, the data set number is simply the configuration number. If the system address is invalid, there will be no response from any system. Of the polling message contains an invalid data set number, the response will be AA<NAK><CR><LF>. The TMAD will respond with AA@@@@<CR><LF> if there is no data to be transferred. Otherwise, the response is:

AASSMMDDYYHHMM<data>CCcc<CR><LF>

where "MMDDYY" is the date, "HHMM" is the time, "CC" is the cycle number and "cc" is an ASCII hex checksum mod 256. The data itself is in the form:

SSTTT.TtAAAAa

where "t" is the torque status flag and "a" is the angle status flag (see section 12.1.2). To advance the cycle pointer for the next data request, the host must immediately respond with an <ACK> or CTRL-F.
The Terminal mode may be temporarily entered for any one system on the network by sending:

AA#TERMINAL<CR><LF>

The "E" and "D" commands may then be used as described in the next section. To resume polling, send:

#NORMAL<CR>

10.2 PROGRAMMING THROUGH TERMINAL PORT VIA PC KEYBOARD

10.2.1 DATA ENTRY OPERATIONS

Data entry operations can be performed via the terminal port, using the following protocol:

E <index range> [space] <item> [space] <value> [Carr Ret]

where:

E = ASCII character E, initiates data entry

<index range> = Specifies an inclusive range of spindles or machines to be referenced, in the form "x" or "x-y". Not required for scalar values.

[space] = ASCII space (space bar on a terminal)

<item> = three digit item code number or 2 or 3 character mnemonic code

<value> = 1 to 5 digit value.

[Carr Ret] = ASCII carriage return = <CTRL> M for terminal keystrokes.

In response to an "E" command, the program will output either "** good" or "** Ernn", where nn is an error code. These codes are listed in Section 10.2.3. The "Escape" key may be used to abort a requested report.

Examples:

The following would enter a torque high limit (TH) of 30 into spindles 1 and 2:

E1-2 [space] TH [space] 30 [Carr Ret]

The following would enter a time of day (TM) of 10:30:

E [space] TM [space] 1030 [Carr Ret]

Similarly, the syntax for displaying data is as follows:

D <index range> [space] <item> [Carr Ret]

D initiates the display operation, the rest is the same as for the "E" command. The system responds with either "** Ernn" (defined as above) or the request value(s) in the format:

ii (c) vvvvv [ii (c) vvvvv] ...

where

ii = Index # (If tabular item)
(c) = configuration # where relevant (Always equal to CFG)
vvvvv = Data item's current value, with the decimal point in proper position.

Because this syntax provides for only a single tool or spindle configuration, a special mechanism is provided for terminal-port entry of data indexed by both Spindle and Configuration. The operator must pre-set the configuration to be used for terminal port data access by using the parameter CFG (Code #19). Once CFG is set to a given configuration #, that number will be assumed whenever accessing any multi-configuration items through the terminal port. Note that the CFG is programmed as a global parameter, even though each spindle channel has separate control parameter values for each configuration.

10.2.2 TERMINAL PORT CODES

In addition to the programming codes defined in this manual, the following codes are available for use via the terminal port.

Code	ID	Description
0	ULK	Data Entry Unlock
1	LK	Data Entry Lock
8	DMP	Dump Parameters Flag
14	MEM	Memory Flush Required Code
15	CLR	Memory Flush Start Code
19	CFG	Configurations for Terminal Entry/Display
43	CAL	Calibration Mode
94	LP	Population Log Flag
95	LS	Sample Log Flag
102	PTR	Torque Trace Print Flag
104	LC	Cycle Log Reprint Flag
105	LE	Exception Log Recall Flag
106	LST	List Samples Request
169	LCT	Total Cycles for Outputs
170	PLT	Plot Data Request
174	CFO	Configuration Override
176	SIN	Configuration Inputs Status

10.2.3 ERROR CODES FOR TERMINAL ENTRY AND DISPLAY

Er01	Entry Locked
Er02	Invalid unlock combination
Er03	Command incomplete
Er04	Index range invalid
Er05	Invalid item code # or ID
Er11	Attempted entry on non-entry item
Er12	Entry value out of limit
Er13	Entry disallowed when spindle in cycle
Er14	Attempted display of non-display item
Er15	Entry inappropriate, depends on specific item
Er16	Stats must be flushed before entry allowed

10.3 CYCLE LOG FORM FEED CONTROL

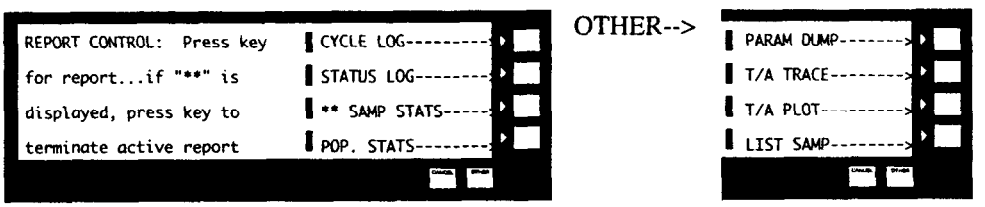
The number of lines or fastening cycles printed out on your printer or PC terminal before a new heading is printed is determined by the programmed Cycle Log Form Feed count (CFF = code #097). The parameter is named as such because an ASCII Form Feed precedes the heading text. The default value for CFF is 8. This item is also accessible in the REPORTING group of EZ PROGRAM/GEN'L DATA.

10.4 REPORTING TO A PRINTER OR PC

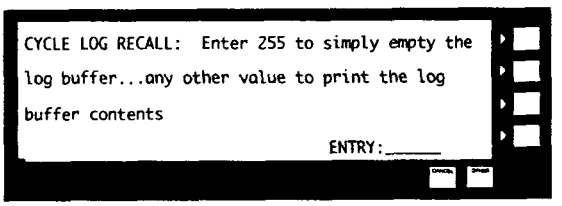
10.4.1 REPORTS

To print a report press CANCEL or OTHER until you see REPORTS. Then press REPORTS. Follow the instructions on the display screen to print the desired report.
Press OTHER for more selections
Press CANCEL to return to the main screen.

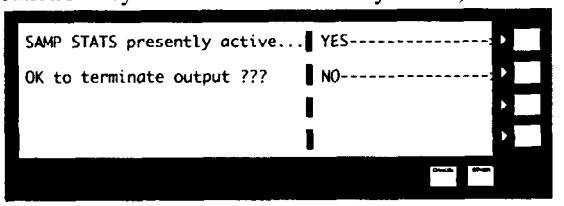
This function allows the user to start reports to be output to the terminal port.



If a report isn't already active, pressing its key will either activate the report (SAMP STATS, POP STATS), or bring up a request for a special command entry, e.g.



Pressing a key for an active report will provide the option to terminate its output ("**" to the left of a report's function key means that it is already active). The display response will be:



Function Keys

CYCLE LOG	: Starts "recall" print of cycle logs
STATUS LOG	: Starts "recall" print of system status logs
SAMP STATS	: Starts log of Sample-buffer statistics.
POP. STATS	: Starts log of Population statistics.
PARAM DUMP	: Starts dump log. The operator will be requested to enter a code which selects the data items to be printed.
T/A TRACE	: Prints the actual torque/angle samples taken during the previous cycle if the trace function was enabled.
T/A PLOT	: Prints the torque/angle samples of the previous cycle in the "PLOT" format. These data are the same as the data for the trace function except that each pair of torque and angle is output on a separate line (Carriage and Linefeed appended).
LIST SAMP	: Prints the number of cycles specified for the selected spindle, configuration data set.

10.4.2 CYCLE LOGS (LM)

The most recent cycle logs can be recalled by selecting the CYCLE LOG option in the REPORT CONTROL menu. This is particularly useful when the system is configured to log on rejects only. A total of 120 logs can be recalled with this command. The buffer for log recall will be erased by entering a value of 255 into LC or as a response to the entry request when selecting CYCLE LOG from REPORT CONTROL. A message will be printed to acknowledge this action.

By default, the TMAD will generate logs for ALL torquing cycles. To generate logs for REJECT cycles only, simply set the Logging Mode Flag (code 096, = LM) to a non-zero value. LM is accessible in the REPORTING group of EZ PROGRAM/GEN'L DATA. The format for the data output is as follows:

	S,C	CYC	TORQ	ANGL
[date & time]	s,c,	CCC,	TTT.Tt,	AAAAa,

Where s = spindle number, c = configuration number used for the cycle, ccc = cycle count modulo 1000, TTT.T = torque, t = torque fault flag, AAAA = angle, a = angle fault flag.

Torque fault flag		**Angle Fault Flag**
S = invalid setup		S = Invalid setup
X = transducer fault		X = Encoder Fault
U = Torque < TT or > TR		U = Angle > 9999 or Angle > AH when AFD <> 50
H = Torque > TH	*	H = Angle > AH
L = Torque < TL	*	L = Angle < AL
space = within limits		space = within limits

* Actually, the item assigned to "the second display variable".

Note that these correspond to the fault characters provided in the LAST CYCLE'S DATA on the front panel. Note that on the front panel, an additional status character "C" is provided. this character is displayed upon exit from calibration mode if a cal. fault was cleared, or there was no previous cycle data to display.

10.4.3 ASSIGNING EXTRA LOGGED VARIABLES (LVA, LVB, LVC, LVD)

If extra logged variables are programmed (codes 107 to 110, = LVA, LVB, LVC, and LVD), up to four more variables are printed along with torque and angle in the cycle log. The entered value for any of these parameters is one of the code numbers for the variables listed in Table 8-1, Sec. 8.0. The three letter data entry/display identifier of the selected item(s) is used for the heading on the printout. As these parameters are each set to a valid code, an additional column of data is added to the output (in addition to torque and angle). These are all accessible using the REPORTING group of EZ PROGRAM/GEN'L DATA.

10.4.4 STATUS LOG PRINTOUT

Messages are generated for such conditions as power up, power down, memory loss, acknowledgement of memory loss, exit from diagnostic mode, power down during a torquing cycle, bypass mode activated/deactivated, and data entry lock/unlock. These logs can be "recalled" at any time by selecting STATUS LOG in REPORT CONTROL. Note that up to 30 such logs can be recalled. The buffer for log recall will be flushed by entering 255 as response to the entry request in REPORT CONTROL. Note that if the data entry lockout feature is fully utilized (by always entering the lock flag or by appropriately programming the "auto lock timer" code LKT, see Section 11.1) this exception log recall feature provides an "audit trail" of system activity. The output would determine if and when data parameters may have changed, calibration was checked, diagnostic mode was entered, or power was turned off.

10.4.5 PRINTING STATISTICS

To generate a hard copy of the population statistics information (without flushing the data), select POP. STATS from REPORT CONTROL. Similarly, a hard copy of the sample stat. information can be generated by selecting SAMP STATS in REPORT CONTROL. The Sample Stat. log is the same except that "machine accepts" and "1st Cycle Date/Time" are not included, and the SAMPLE SIZE is given in the heading. The items logged are listed below.

1ST CYCLE DATE	! : Date of first cycle after last flush
1ST CYCLE TIME	! : Time of first cycle after last flush
TOTAL CYC	: # of non-jog cycles since last reset
N FOR SIGMA	: # of cycles included in mean, sigma, range, and maximum calculations. A given cycle is included or excluded depending on the setting of the statistics update mode flag (CODE 090 = SIG).
HW REJECTS	: # of cycles rejected on the basis of hardware faults (transducer or encoder faults), spindle in bypass, "unusual" torque or angle condition or invalid set-up of control parameters.
MEAN	: Mean of samples.
RANGE	: Maximum value - minimum value
MAXIMUM	: Maximum
TARGET	: Statistical target (TC, AC or ADC)
MEAN SHIFT	: MEAN-target for torque, MEAN-target for angle
SIGMA	: Std deviation (using N-1 as divisor).
6 SIGMA	: 6 times SIGMA
HI REJECTS	: # of cycles rejected as over high limit.
LO REJECTS	: # of cycles rejected as below low limit.
MACHINE ACCEPTS	: # of AOK cycles for each machine, organized by configurations.

! "****" is printed in lieu of time/date if TOTAL CYC IS 0
For example see Figure 1, Appendix A

10.4.6 PARAMETER DUMP LOG

The user may also request a dump of current system data parameters through the printer channel. To request this dump, the user will enter a non-zero value as response to the entry request after selection of PARAM DUMP from the REPORT CONTROL menu. The entry defines the output as follows:

Entry value		LOG OUTPUT
1		Dump spindle #1 control parameters and status data
2	**	Dump spindle #2 control parameters and status data
10		General System data
11		General System data plus spindle #1 control parameters and status data
12	**	General System data plus spindle #2 control parameters and status data
21		Spindle #1 status data only
22		Spindle #2 status data only
99		All parameters

** Applicable only to a two-spindle unit

Example of report - See Figure 2, Appendix A.

10.4.7 TORQUE AND ANGLE TRACE AND PLOT FUNCTIONS (ITR, DAS)

The TMAD program provides capability to trace the torque and angle samples for a particular fastening operation. The capability is available to store up to 500 individual torque angle samples. If it would take more samples to trace the entire cycle, the "sample interval for trace" (ITR, code 101) should be set to a value greater than 1. This is applicable to very slow, soft joints. ITR defines the number of actual torque samples for each trace buffer sample. The tracing is enabled the same time "D/A Converter Angle Output" (DAS, code 36) is enabled (by programming DAS to a valid non-zero spindle number). Note that this is not operational in control mode 0. Both ITR and DAS are accessible in the CTL MISC group in EZ PROGRAM/GEN'L DATA.

The trace data may be output in either the "TRACE" format for printer reports or in the "PLOT" format for plotting with a personal computer program. The data is printed in "TRACE" format by selecting T/A TRACE from REPORT CONTROL. The plot format of data may be generated by selecting T/A PLOT from REPORT CONTROL. For example see Figure 3 and 4, Appendix A.

10.4.8 SAMPLE (CYCLE) LIST PRINTOUT

The TMAD program provides capability to print a specified number of results for a data set (spindle/ configuration combination) upon demand. This report may be generated by selecting LIST SAMP in REPORT CONTROL. Two data entry screens will be brought up, the first one for the number of sample lists to be output. If set to "0" all the sample lists in the buffer will be printed.

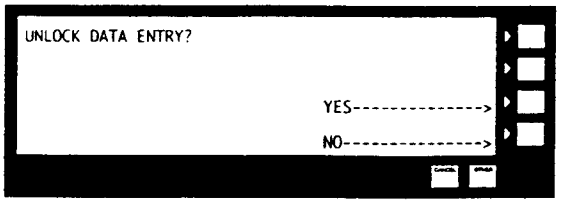
The format for the second entry is "ccss", where "cc" = configuration number and "ss" = spindle number. If "cc" is omitted, configuration number one is assumed. If there is no data to be printed, or "ccss" specifies an invalid set, an appropriate message is printed in lieu of any data. Example output is given in Fig. 5, Appendix A. Note that if the cycle log is set up for printing all parts, this function could be considered redundant. However, since printing data for all cycles could generate and undesirable amount of paper, it is advisable to set logging mode up for rejects only, and use this cycle list report to extract individual torquing cycle results.

11.0 DISPLAY OPTIONS

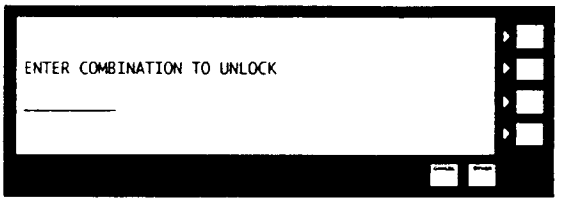
This section includes special programming and interface features.

11.1 DATA ENTRY LOCK (COM, LKT, XO)

The system provides a locking mechanism to prevent unauthorized changes to data parameters. By default, this mechanism is disabled. To activate the lock, the user must change the 4-character combination to something different than the initial value of "0000". The combination must be 4 characters long with '0'..'9' and '-' as valid character. The combination is available in the SYSTEM INIT group (COM=Code# 002). The current value of the **combination** is never displayed; "****" appears in the 'VAL" field. * **BE SURE TO REMEMBER COMBINATION # ONCE YOU HAVE ENTERED IT.** When the lock is active, the program will check its status before entering any programming mode. If unlocked, it will proceed directly to the programming function; otherwise it will first give the operator a chance to unlock as shown below. Code #003 = LKT programs the time in mitures for automatic lockout to occur.

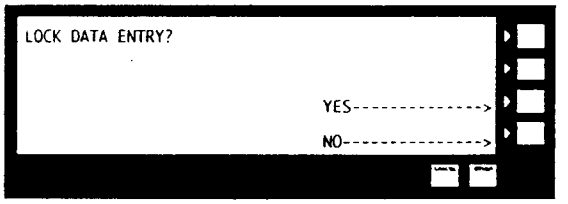


If NO, then the system proceeds directly to the programming function. Otherwise, it prompts with:



As the combination is keyed in, it is echoed with "*"s. If the correct combination is entered, the system proceeds to the programming function. Otherwise, an error message is displayed.

If data entry is unlocked upon exiting the programming function, the system will give the user the chance to lock it by displaying:



Either response will exit the programming function, but a "YES" response will first first lock data entry. A No response would be ueful if subsequent entry into either CALIBRATION or DIAGNOSTIC mode is desired.

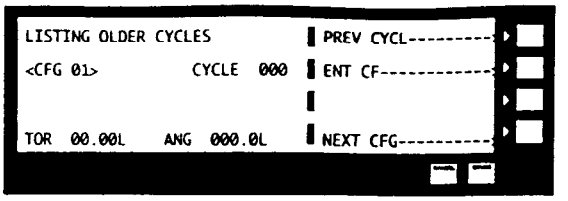
* NOTE: If you forget the unlock combination enter code #154 (XO - Unlock Combination) which will tell you what the "COM" is.

11.2 MULTI-LANGUAGE CAPABILITY

The TMC program provides a capability to display the operating information in multiple languages. The current language parameter LNG (Code 172) is available to specify the desired language. The user may set this parameter to 0 for English, 1 for Spanish, 2 for German, 3 for French and 4 for Italian. This parameter will be set to 0 by default for English language. Any changes made to this parameter will be stored in the system's EEPROM so that it can be retrieved for the system "cold start".

11.3 LIST CYCLES

This function provides for displaying individual samples in the sample buffer for each "configuration" combination. When the function is initiated, the display is as follows:



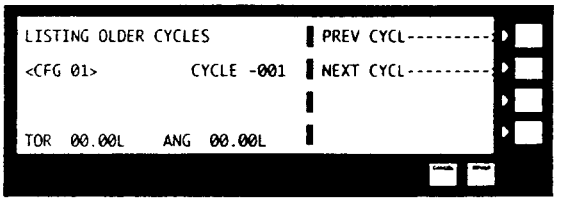
Display Fields

LISTING OLDER CYCLES	: Title
<CFG 01>	: Configuration set whose sample buffer is being displayed. This label appears only if >1 config.
CYCLE 000	: Cycle # currently being displayed, starts with #000, the most recent. Pressing "PREV CYCL" changes the display format (see below).
TOR 00.00L	: Peak torque value with status character.
ANG 000.0L	: "Angle" value with status character. "Angle" value is specified by "Angle For Display" (AFD) parameter. Label is "ANG" if AFD is angle-related, otherwise it is the 3-character code for the item.

Function and Other Keys

PREV CYCL : Initiates stepping back to the previous (next oldest) cycle in Sample buffer (see below);

When PREV CYCL is pressed, the display changes the function key format to:

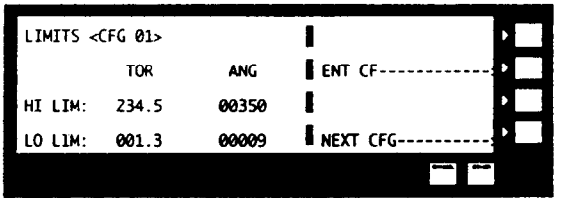


PREV CYCL : Displays the data for the "previous" cycle in the sample buffer, i.e., CYCLE is decremented. Pressing the key after the oldest data is reached, resets the "CYCLE 000" display.

NEXT CYCLE : Brings up the data for the "next" cycle in the sample buffer. The initial display is brought up if "NEXT" brings up CYCLE 000.

11.4 LIMITS

This function provides quick access to the torque and "angle" (2nd variable) qualification limits as follows:



	TOR	: High and low torque rejection limits. (TH, TL)
HI LIM:	234.5	
LO LIM:	001.3	
	ANG	: High and low "angle" rejection limits. "Angle" qualifier is as specified by "Angle For Display"
HI LIM:	00350	(AFD)parameter. AFD is actually angle, limits are AH and AL. Otherwise, limits are ADH and
LO LIM:	00009	ADL.

12. TROUBLESHOOTING

This section is divided into hardware and software troubleshooting hints. The computer can diagnose numerous software and programming errors, as well as some hardware problems associated with the computer and the tool.

12.1 SOFTWARE AND PROGRAMMING ERRORS

12.1.1 ON-LINE SYSTEM ERROR CONDITIONS

The following are the system error conditions which the software can detect and display on the top line of the main display. The displayed messages are shown below.

Messages	Fatal	Reason
PROM Err Page xxxx	Yes	PROM fault detected in PROM memory page xxx.
RAM Memory Clear	No	RAM memory was cleared at start up due to an error in a RAM copy of PROM checksum data or in the parameter area of RAM Fault cleared by entering a non-zero value into RAM Clear Ack (CODE 005 = ACK).
RAM Error: Param	Yes	Error detected in parameter area during normal operation.
RAM Error: Gen'l	Yes	Error detected in RAM copy of a PROM checksum during normal operation.
Battery Failure	No	Battery Fault
Clock Failure	No	Clock Failure
Stat Mem Near Full	No	Population stats near overflow.

12.1.2 CYCLE STATUS ERRORS

Torque fault flag	Angle Fault Flag
S = invalid setup	S = Invalid setup
X = transducer fault	X = Encoder Fault
U = Torque < TT or Torque > TR	U = Angle > 9999
H = Torque > TH	H = Angle > AH
L = Torque < TL	L = Angle < AL
space = within limits	space = within limits

Note that these correspond to the fault characters provided in the LAST CYCLE'S DATA on the front panel. Note that on the front panel, an additional status character "C" is provided. This character is displayed upon exit from calibration mode if a cal. fault was cleared, or there was no previous cycle data to display.

12.1.3 PROGRAM ERRORS PREVENTING RUN OR FURTHER DATA ENTRY

ERR: BAD INDEX	Your selection of MCH, CFG, or SPN is out of range
ERR: ENT INAPPR	Invalid entry. Try again.
ERR: HAS STATS	Statistics must be cleared before the value will be entered. To clear statistics press: CANCEL or OTHER until you see "PROGRAM" PROGRAM ENT ITEM # 103 ENTER 1 ENTER (clears stats for spindle 1) CLEAR 2 ENTER (clears stats for spindle 2)
ERR: IN CYCLE	You can't enter parameters when the TMAD is in torque cycle.
ERR: NO VALUE	ENTER was pressed before any numeric key was pressed.
ERR: OUT OF LIM	You have tried to enter a value that is too large or too small. If this message appears when entering a torque value, you may have to lower the value of TD. Torque and angle values are limited to four digits.

12.1.4 FAULT INDICATIONS / RECOVERY

The table below shows the meaning of some special combinations of Lamp & Screen indicators and the means of recovering from the condition flagged. (NOTE: in the chart below, TH = Torque Hi indicator, TL = Torque Low, AH = Angle Hi, and AL = Angle Low). For lights on the tool, the TH and AH condition are combined for the RED indicator, and TL and Al are combined for the amber indicator.

Special Indications

LAMP Indication	**Condition**	**Comments**
TH, TL BOTH ON	Shunt Cal. Fault	Check calibration of transducer inputs. Would also have an AL indication if angle monitoring is enabled. See if the tool is disconnected or a wire is broken.
TH,TL,AH,AL ALL ON	Invalid Setup, No ACK	Make sure all torque parameters are less than 125% of torque range. This indication also appears when spindle is not assigned to a machine. Indication will be cleared the first cycle after machines are properly set up. The same indication also occurs if a torquing cycle occurs after a memory loss and prior to programming ACK (code 5).
TH,TL,AH ALL ON	Cal.Mode	Upon exit from Cal. Mode, the indicators are restored to their state when cal. mode was entered.
AH, AL BOTH ON	Angle Check Failure	Improper process fault such as cross thread, encoder failure, or improper lubrication. This would most likely be accompanied by a TL indication when using shutdown control
AH, AL, THE ALL ON	Third Var. Reject	The variable assigned to LVA was outside of its programmed limits, and the torque and angle were within their respective limits. This indication is also possible if angle check failure and torque was greater than the high limit.
TH, AL ALL OFF	Cal. passed Diagnostic Mode, or IN CYCLE	Calibration check passed.

12.1.5 SET-UP STATUS ERRORS

If the parameter SUS has a value other than 0000, this means that there is a problem with one or more of the parameters. The value displayed for SUS is the weight of the error. Each parameter is given a weight as below. To find the bad parameters separate the total weight into its components.

For example, if SUS = 128 then the angle high limit AH is incorrect. If SUS = 33, then TH and TL are incorrect (32 + 1).

Parameter	**Weight**
Invalid TH	1
Invalid TP	2
Invalid TC	4
Invalid TT	8
No MCH	16
Invalid TL	32
Invalid AT	64
Invalid AH	128
Memory error	256
No ACK	512 Set ACK = 1
Bad CCI	1024
Invalid CFG	4096

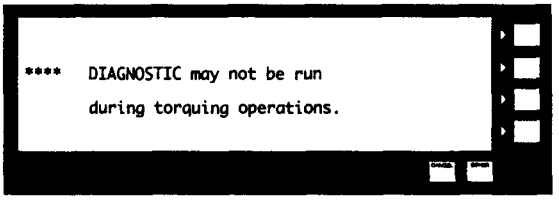
12.1.6 CALIBRATION FAULT CODES

Upon Calibration Fault, XF (Code 145) provides information about what failed the health check.

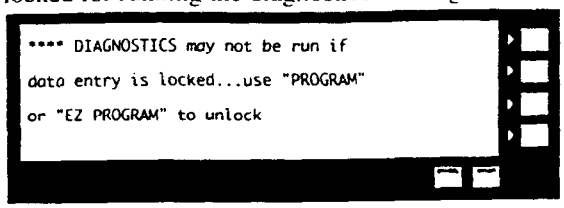
Error	Weight
Offset not +/- 10% full scale	1
Shunt Cal. not +/- 5% of ideal value (IRG)	2
Offset Adjusted Shunt Cal > 123% full scale	4

12.1.7 DIAGNOSTIC MODE

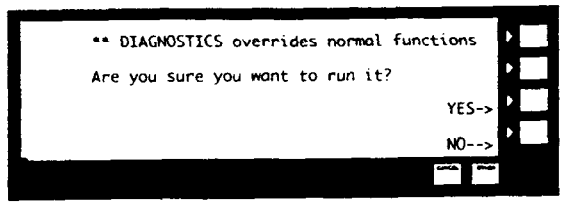
Diagnostic mode is entered by pressing the DIAGNOSTIC key from the main display. Since the diagnostic function completely takes over the system hardware, it can disrupt any active control cycles. If the operator attempts to enter the diagnostics during a torquing cycle, the program will bring up the following:



Pressing <CANCEL> returns the operator to the main display. The program also requires that data entry be unlocked for running the diagnostics. If diagnostics are selected with data entry locked, the following is displayed:

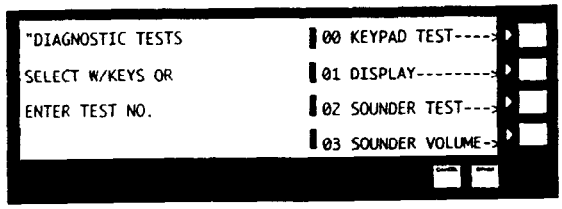


Pressing <CANCEL> will return the operator to the main display at which point he may select a "PROGRAM" function to access the unlocking mechanism. If the above condition does not inhibit entry to diagnostics, the program brings up the following additional warning message:

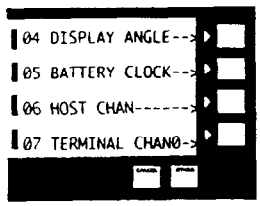


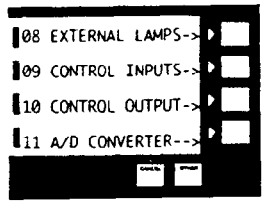
If the user selects "YES" the program will then bring up the main diagnostics menu. This extra step will prevent accidental entry to the diagnostics.

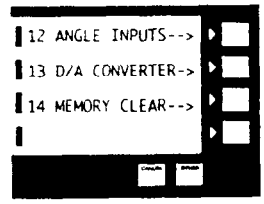
Once diagnostics mode has been entered, the program displays:



<Other> selections are:







* NOTE: Check your I-R authorized service center for availability of this option.

Description of diagnostic tests

To enter a diagnostic test, simply press the selection key next to the corresponding test name, or enter the test number at the "ENTER TEST NO." prompt. To exit a diagnostic test, simply press <Cancel>.

00 **Keypad Test**

On entrance to this test, the display will be as follows:

When the user presses a key, the value will be displayed on the display.

01 Display Test

On entrance to this test, the program will display the letters <block>, "D", "I", "S", "P", "L", "A", "Y", <space>, "T", "E", "S", "T", one at a time, each filling the screen when displayed. The exception to this is when <block> is displayed; it is displayed one line at a time from top to bottom. After a number of cycles as above a display will occur where groups of eight "D"s followed by eight "I"s etc. will cycle through the screen.

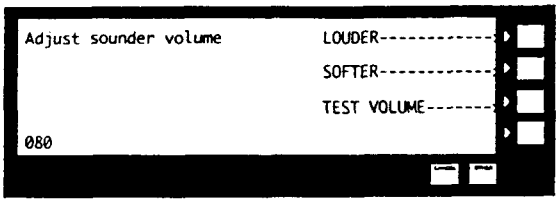
02 Sounder Test

On entrance to this test, the initial display is as follows:

This gives the user the option of turning the sounder on and off.

03 Sounder Volume

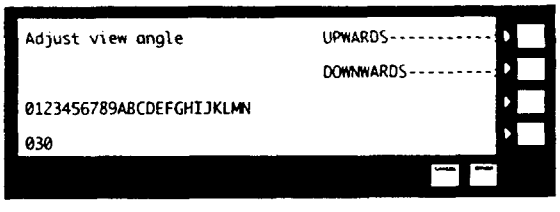
On entrance to this test, the initial display is as follows:



The user can increment and decrement and test the sound level by pressing the appropriate selection keys. Displayed in the lower left corner of the display is a relative sound level, which varies from 0 to 100H. The test will put up a message indicating when minimum or maximum level has been reached.

04 Display Angle

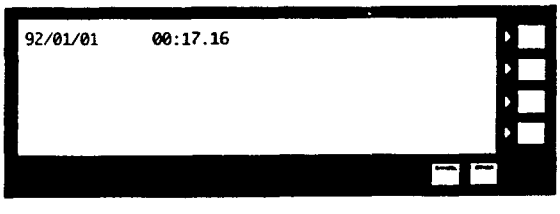
On entrance to this test, the initial display is as follows:



The user can adjust the view angle by pressing the appropriate selection keys. Displayed in the lower left corner of the display is a relative display angle value, which varies from 0 to 100H. The sequence 0-N is displayed for visual help in selecting the proper view angle.

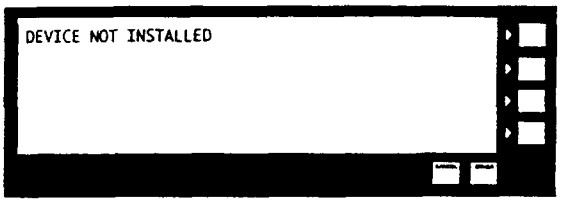
05 Battery Clock

This test displays the current time and date contained in the real time clock. An example display is as follows:



06 **Host Communications Channel**

The display will look like this:

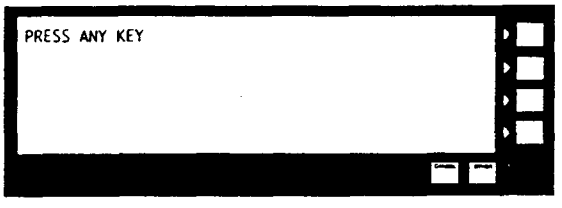


NOTICE

This screen in not functional.

07 **Terminal Channel A**

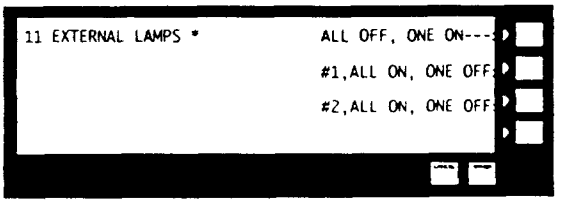
This is the RS232 port. The initial display will look like this:



and upon receipt of a character from the terminal, the program will display "Character received <char>" and send the message "Character sent <char>" to the terminal. Upon the user pressing a key on the keypad, the program will send the message "Character received <char>" to the terminal, and will display "Character sent <char>" on the display.

08 **External Lamps**

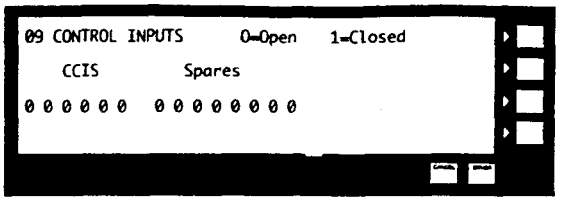
This test provides the capability to test the operation of the external hi, lo lamps/leds and AOKs. On entrance to this test, the display is as shown:



The test lights one lamp or AOK at a time for 0.5 seconds each. This sequence repeats itself until the operator terminated the test. All the external HI/LO and AOK lamps are turned off at this time. If the F2 or F3 key is pressed, the test will have all lamps initially on (for selected group) and turn lamps off one at a time. If F1 is pressed, the initial test is restored, i.e., all off initially, with lamps turned on one at a time.

09 Control Inputs

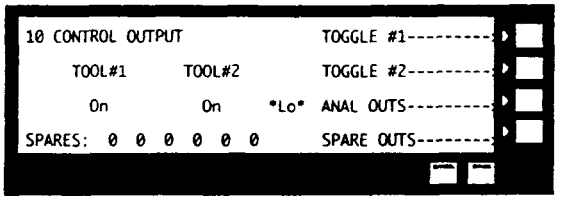
This test provides capability to test the hardware for the optically coupled or logic level inputs. On entrance to this test, the display is as follows:



The display is used to indicate the state of the inputs. Each display bit (0 or 1) on the left corresponds to the state of one of the six optically coupled contact closure inputs (rightmost of the 6th contact closure is #1). The display bits on the right correspond to one of eight of the spare inputs. A contact closure on any input should produce a 1 indication on the display.

10 Control Outputs

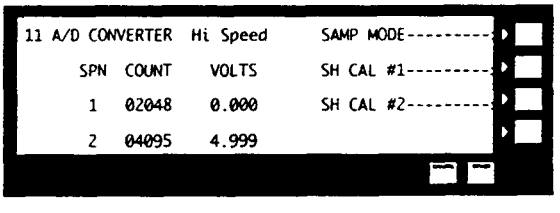
This test provides capability to test the hardware for the control shutdown outputs. The initial display is as follows:



The display is used to echo the state of the outputs. F1 and F2 toggle the state of the motor control (shutdown) outputs, F1 controlling channel 1 etc. Whether the tool is allowed to run (or not) is shown by an "On" or "Off" indication under the appropriate "TOOL #x" label. F3 toggles the state of the shunt cal. switch for testing external hardware (e.g. and electric motor controller) which uses the torque amplifier output for control. Pressing F3 simply toggles the shunt cal. state of the two input channels. The corresponding indication is "*Lo" or "*Hi". F4 will modify the state of the spare outputs, walking a 1 or 0 thru each position. Downshift may be tested using the spare outputs, the right most bit for spindle #1, and the 3rd bit from the left for spindle #2.

11 A/D Converter

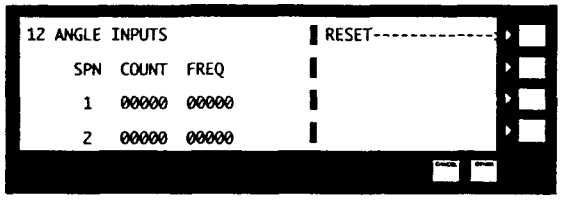
This test provides the capability to verify operation of the A/D inputs and associated circuitry. The initial display is as follows:



The test operates by, depending on input, closing or opening the shunt cal switch for the channels displayed. The display will show the A/D count and corresponding voltage for the spindle for display. Key F1 selects the origin of the A/D data, either the high speed sample routine or explicit read of the A/D converter. Keys F2 and F3 toggles the state of the shunt cal switch for spindle 1 and 2 respectively.

12 Angle Inputs

This test provides the capability to verify the proper operation of angle encoder inputs. The initial display is as follows:



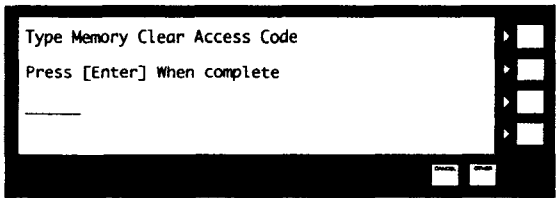
This test displays the present angle counter value (MOD 10000) and the frequency (hz) of the input signal. Pressing RESET zeroes the angle count and initializes the frequency measurement.

13 D/A Converter

This option is not used.

14 Memory Flush

The TMAD program has an operator initiated memory flush. There are two means of activating this. First, if option 14 in diagnostic mode is selected, the operator will be requested to enter a code as follows:



Entering the valid code number 1470 will initiate the memory flush.

12.1.8 AUTO DISPLAY ADJUST

On some rare occasions, such as when subjecting the unit to environmental extremes, the heat sensitive LCD may not be visible. If this is the case, it is difficult to enter diagnostic mode to perform the necessary adjustment. An auto adjust mode can be entered by pressing CANCEL a minimum of 10 times within 5 seconds, followed by two seconds of no key inputs. The program will print a message "..System Alarm: Auto Display Adjust" and begin changing the view angle automatically every second. When the display is visible, the message "Auto Display Adj" will alternate with the normal information of the top line.

⚠WARNING

Any electronic or electrical repairs are to be done by authorized trained service personnel only.

12.2 HARDWARE PROBLEMS

CONDITION	POSSIBLE CAUSE	ACTION
Transducer fault ("X" displayed next to last torque reading)	- Computer not calibrated to match transducer	- Recalibrate Computer (See Section 5.3 Computer Control Operation and Start-up Procedure)
	- Short or open circuit (computer will not calibrate or erratic reading	- Check all wires and connectors
	- Bad transducer (computer will not calibrate or erratic reading)	- Replace transducer or tool
Tool will not run	- Transducer fault	- See above
	- Current fault (front panel lamp lit)	- Reset control module (see Section 4.2 DC Tool Control Module)
	- Temperature fault (front panel lamp lit)	- Allow tool to cool before attempting use
	- Incorrect normal pretorque switch setting	- Correct switch setting (See Section 4.4.1 Normal/Pretorque switch)
	- No power to motor control module	- See below
Consistantly high or low cycles	- Incorrect setting of shutdown control switch on motor control module (typically should be set to "computer" mode)	- Correct switch setting (See Section 4.2 D.C. Tool Control Module)
No power to motor control module (Power lamp off)	- Cabinet just powered up or "SYSTEM STOP" button pushed	- Press Start Switch
	- Blown Fuse	- Check and replace fuse for appropriate control module (See Section 4.1 Power Regulation Module)
	- Ground Fault Interruptor (GFI) tripped out	- Press "RESET" button on GFI (See Section 4.1 Power Regulation Module)
	- Bad Connection	- Reseat control module and power regulator modules (See Section 4.0 Operation and Controls)
	- Tool not connected	- ConnectTool

13.0 HARDWARE INTERFACING

The standard TMAD system is supplied with an Accessory Interface Connector. This is typically used in conjunction with Socket Trays, Remote Alarm Boxes and Reset Stations, all of which are available as optional equipment. Alternatively, option "C" (see section 1.0 - Specifications) changes the AIC to a PLC Interface Connector. In this case, all outputs are dry contact to be driven with the PLC's own supply, and a Reverse input is made available for use with fixtured tools.

13.1 ACCESSORY INTERFACE CONNECTOR

PIN #	I/O	SPINDLE #1	SPINDLE #2	USE W/ PIN(S)
A	I	RUN\1	RUN\2	F
B	O	TOOL HI 1	TOOL HI 2	F
C	O	TOOL LO 1	TOOL LO 2	F
D	O	TOOL OK 1	TOOL OK 2	F
E	I	SHUTDOWN\1	SHUTDOWN\2	F
F	O	COMMON	COMMON	A-E, N-R
G	O	V+	V+	-
H	O	+5 VDC	+5 VDC	J-M, S-V
J	I	CONFIG 1	CONFIG 5	H
K	I	CONFIG 2	CONFIG 6	H
L	I	CONFIG 3	CONFIG 7	H
M	I	CONFIG 4	CONFIG 8	H
N	I	SHUTDOWN\1	SHUTDOWN\2	F
P	O	REJECT 1	REJECT 2	F
R	O	CYCLE COMPLETE 1	CYCLE COMPLETE 2	F
S	I	CONFIG 5	CONFIG 1	H
T	I	CONFIG 6	CONFIG 2	H
U	I	CONFIG 7	CONFIG 3	H
V	I	CONFIG 8	CONFIG 4	H

Figure 13-1. Standard AIC Accessory Interface Connections

RUN\ (A): To make use of the remote cycle start feature for fixtured tools only, put the appropriate Interface Board switch into the "Pre-Torque" (down) position, and set code 46 (CIF) to 2. If using a lever start tool, tie the throttle down. Each cycle is started by momentarily shorting RUN\ (A) to COMMON (F). Emergency stop could then be accomplished by using SHUTDOWN\ (E) if necessary. Alternately, code 46 (CIF) could be set to 0. The cycle would then run for the duration of RUN\ (A) being shorted to COMMON (F). Emergency Stop could thus easily be accomplished by removing the short at any time. However, in this mode there is no indication of the result (hi, low, ok, reject or cycle complete outputs) until the cycle is ended, so the short must be applied for a period longer than the longest conceivable valid fastening cycle to ensure that the tool is not stopped in mid-rundown.

TOOL HI (B): This pin provides around 9VDC whenever a red LED (torq or angle high) is active on the front panel. Avoid connecting to this pin with much less than 500 ohms impedance (or a current draw of much more than 20mA) as this will drop the voltage output.

TOOL LO (C): This pin provides around 9VDC whenever a yellow LED (torq or angle low) is active on the front panel. Avoid connecting to this pin with much less than 500 ohms impedance (or a current draw of much more than 20mA) as this will drop the voltage output.

TOOL OK (D): This pin provides around 9VDC whenever the green LED (torq and angle OK) is active on the front panel. Avoid connecting to this pin with much less than 500 ohms impedance (or a current draw of much more than 20mA) as this will drop the voltage output.

SHUTDOWN\ (E): Short this pin to COMMON (F) to stop the tool immediately (in the forward direction only). This function can be used as an Emergency Stop (for fixtured tools) or as a reject interlock (for handhelds), perhaps coupled with a palm switch reset.

COMMON (F): This pin is the return for all outputs and may be shorted to the RUN\ (A), SHUTDOWN\ (E), and SHIFTDOWN\ (N) pins.

V+ (G): This pin is used for logic power with standard accessories only.

+5 VDC (H): This pin may be shorted to the CONFIG 1-8 (J-M, S-V) pins.

CONFIG 1-8 (J-M,S-V): Pull the appropriate pin to +5 VDC (H) to select a configuration. The Selector Switch on the side of the cabinet must be in the REMOTE position, and code 18 (CSM) must be set to 2. Configurations 5-8 are equivalent to configurations 1-4 for the second spindle in a two spindle system.

SHIFTDOWN\ (N): Momentarily short this pin to COMMON (F) during rundown to cause the tool to slow into the shiftdown speed.

REJECT (P): This pin provides around 9VDC whenever a red or yellow LED (torq or angle) is active on the front panel. Avoid connecting to this pin with much less than 500 ohms impedance (or a current draw of much more than 20mA) as this will drop the voltage output.

CYCLE COMPLETE (R): This pin provides around 9VDC whenever a green, red or yellow LED (torq or angle) is active on the front panel. Avoid connecting to this pin with much less than 500 ohms impedance (or a current draw of much more than 20mA) as this will drop the voltage output.

13.2 PLC INTERFACE CONNECTOR

PIN #	I/O	SPINDLE #1	SPINDLE #2	USE W/ PIN(S)
A	I	RUN\ OR RESET\1	RUN\ OR RESET\2	F
B	O	TOOL HI 1	TOOL HI 2	N
C	O	TOOL LO 1	TOOL LO 2	N
D	O	TOOL OK 1	TOOL OK 2	N
E	I	SHUTDOWN\1	SHUTDOWN\2	F
F	O	COMMON	COMMON	A, E, G
G	I	SHUTDOWN\1	SHUTDOWN\1	F
H	O	+5 VDC	+5 VDC	J-M, P, S-V
J	I	CONFIG 1	CONFIG 5	H
K	I	CONFIG 2	CONFIG 6	H
L	I	CONFIG 3	CONFIG 7	H
M	I	CONFIG 4	CONFIG 8	H
N	I	EXTERNAL SOURCE	EXTERNAL SOURCE	B-D, R
P	I	REVERSE 1	REVERSE 2	H
R	O	CYCLE COMPLETE 1	CYCLE COMPLETE 2	N
S	I	CONFIG 5	CONFIG 1	H
T	I	CONFIG 6	CONFIG 2	H
U	I	CONFIG 7	CONFIG 3	H
V	I	CONFIG 8	CONFIG 4	H

Figure 13-2. Optional PLC Interface Connections

RUN\ or CONFIG RESET (A): To make use of the remote cycle start feature for fixtured tools only, put the appropriate Interface Board switch into the "Pre-Torque" (down) position, and set code 46 (CIF) to 2. If using a lever start tool, tie the throttle down. Each cycle is started by momentarily shorting RUN\ (A) to COMMON (F). Emergency Stop

could then be accomplished by using SHUTDOWN\ (E) if necessary. If reversing capability is needed, code 46 (CIF) must be set to 0. The cycle would then run for the duration of RUN\ (A) being shorted to COMMON (F). Emergency Stop could thus easily be accomplished by removing the short at any time. The CYCLE COMPLETE (R) output should then be used to determine when the RUN\ command could be removed after the rundown has been completed. For handheld tools, a sequential configuration mode could be used by setting code 18 (CSM) to a 1. The system would then automatically increment the configuration number after every cycle, and reset to the first configuration when this pin is momentarily shorted to COMMON (F). If the Gang Counter option is activated (see section 13.3), this pin may be used to reset the count to zero.

TOOL HI (B): This pin will act as a contact closure to the EXTERNAL SOURCE (N) pin whenever a red LED (torq or angle high) is active on the front panel. It may be connected to TOOL LO (C) to create a Reject output.

TOOL LO (C): This pin will act as a contact closure to the EXTERNAL SOURCE (N) pin whenever a yellow LED (torq or angle low) is active on the front panel. It may be connected to TOOL HI (B) to create a Reject output.

TOOL OK (D): This pin will act as a contact closure to the EXTERNAL SOURCE (N) pin whenever the green LED (torq and angle OK) is active on the front panel.

SHUTDOWN\ (E): Short this pin to COMMON (F) to stop the tool immediately (in the forward direction only). This function can be used as an Emergency Stop (for fixtured tools) or as a reject interlock (for handhelds), perhaps coupled with a palm switch reset.

COMMON (F): This pin may be shorted to the RUN\ (A), SHUTDOWN\ (E), and SHIFTDOWN\ (G) pins.

SHIFTDOWN\ (G): Momentarily short this pin to COMMON (F) during rundown to cause the tool to slow into the shiftdown speed.

+5 VDC (H): This pin may be shorted to the CONFIG 1-8 (J-M, S-V) and REVERSE (P) pins.

CONFIG 1-8 (J-M,S-V): Pull the appropriate pin to +5 VDC (H) to select a configuration. The Selector Switch on the side of the cabinet must be in the REMOTE position, and code 18 (CSM) must be set to 2. Configurations 5-8 are equivalent to configurations 1-4 for the second spindle in a two spindle system.

EXTERNAL SOURCE (N): This pin can be connected to a source of up to 24VDC, and is used with the dry contact outputs of TOOL HI (B), TOOL LO (C), TOOL OK (D), and CYCLE COMPLETE (R).

REVERSE (P): Pull this pin to +5 VDC (G) before starting a cycle using RUN\ (A) to reverse a fixtured tool. Code 46 (CIF) must be set to a 0 to allow the RUN\ signal to control the start and stop of the tool, as SHUTDOWN\ (E) does not function in reverse.

CYCLE COMPLETE (R): This pin will act as a contact closure to the EXTERNAL SOURCE (N) pin whenever the system disables the tool, as it does for a programmable period following any cycle. This output could be used to determine when it is proper to remove the RUN\ (A) short when code 46 (CIF) is set to 0, and the cycle time is under remote control. If the Gang Counter option is activated (see section 13.3), this output will be active only when the total count of valid cycles is reached.

13.3 GANG COUNTING (GCT)

When the PLC Interface option "C" is added to the system (see section 1.0 - Specifications) an output becomes available to signal that a pre designated number of good cycles have bee completed (see section 13.2 - PLC Interface Connector). The number of cycles desired for each configuration should be entered into the Gang Count Setting (GCT - code 177). The present count can be viewed at the Home screen (see section 8.1.2 Third Variable Programming). Also from the Home screen, the running count can be reset by entering a "1" for the first tool or a "2" for the second tool. An external reset button may also be wired into the PLC Interface Connector. The default setting of 0 in GCT will permit the Cycle Complete signal to activate at the end of every cycle, good or rejected. A setting of 1-99 changes this output to the Gang Complete signal. Also, the Gang Counter feature may be combined with sequential configurations (see section 8.2.2) to allow multiple rundowns at each configuration.

13.4 TUBE NUT CONTROL (TBN)

When the Tube Nut option "E" is installed on the system (see section 1.0 - Specifications), the Tube Nut Mode flag must also be set to 1. This allows the reverse action to continue at slow speed until the indexing position of the tube nut tool is reached. Two adjustments can be made to allow for minimum indexing time without overshooting or premature shutoff. Soft Start controls speed (see section 4.2.1 - Potentiometer Adjustments) and MST (code 86) controls the shutdown point. To disable this mode, set TBN to 0. Note that the forward cycle is not affected by the state of TBN.

APPENDIX A
EXAMPLE REPORTS AND PRINTOUTS
Figure 1. Population Statistics Report Format

POPULATION STATISTICS

12/15/87 11:42:22

<SP, CFG> -->	S1,C1	S1,C2	S1,C3	S1,C4	S1,C5	S1,C6	S1,C7	S1,C8
1ST CYCL DATE	12/15	12/15	12/15	12/15	12/15	*****	12/15	12/15
1ST CYCL TIME	11:31	11:31	11:31	11:31	11:31	*****	11:36	11:36
TOTAL CYC	00074	00074	00084	00084	00084	00000	00065	00065
N FOR SIGMA	00074	00074	00084	00084	00084	00000	00065	00065
ACCEPT CYC	00074	00074	00084	00084	00084	00000	00065	00065
HW REJECTS	0000	0000	0000	0000	0000	0000	0000	0000
TORQUE								
MEAN	0056.5	0063.4	0063.7	0061.4	0062.7	0000.0	0056.5	0063.6
RANGE	0000.3	0000.3	0000.5	0006.2	0000.6	0000.1	0000.2	0000.0
MAXIMUM	0056.6	0063.6	0063.9	0063.3	0063.0	-000.0	0056.6	0063.6
TARGET	0055.0	0062.0	0062.0	0062.0	0062.0	0012.0	0062.0	0062.0
MEAN SHIFT	0001.5	0001.4	0001.7	-000.6	0000.7	-012.0	-005.5	0001.6
SIGMA	000.08	000.07	000.11	001.78	000.12	000.00	000.07	000.00
6*SIGMA	000.47	000.45	000.68	010.69	000.72	000.00	000.43	000.00
HI REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
LO REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
ANGLE								
MEAN	00020.	00010.	00011.	00008.	00009.	00000.	00120.	00109.
RANGE	00006.	00005.	00006.	00006.	00007.	00001.	00001.	00001.
MAXIMUM	00023.	00012.	00013.	00010.	00013.	-0000.	00120.	00110.
TARGET	00000.	00000.	00000.	00000.	00000.	00000.	00100.	00100.
MEAN SHIFT	00020.	00010.	00011.	00008.	00009.	00000.	00020.	00009.
SIGMA	0001.7	0001.8	0002.0	0001.7	0002.5	0000.0	0000.5	0000.3
6*SIGMA	0010.3	0010.7	0011.9	0010.5	0015.1	0000.0	0002.9	0001.6
HI REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
LO REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
RFT								
HI REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
LO REJECTS	00000	00000	00000	00000	00000	00000	00000	00000
MACHINE ACCEPTS								
M01,C01: 00074;	M01,C02: 00074;		M01,C03: 00084;		M01,C04: 00084;			
M01,C05: 00084;	M01,C06: 00000;		M01,C07: 00065;		M01,C08: 00065;			

APPENDIX A
EXAMPLE REPORTS AND PRINTOUTS
Figure 2. Parameter Dump Listing

TMC PARAMETER DUMP

03/11/88 11:39:13 CONTROL CONFIGURATION

SPN, NO. OF SPNS= 01; CFM, MAXIMUM CONFIG NUMBER= 02

CONTACT CLOSURE INPUTS:
CCI(01)= UNUSED , CCI(02)= UNUSED, CCI(03)= UNUSED, CCI(04)= UNUSED,
CCI(05)= UNUSED, CCI(06)= UNUSED,
XTRA INPUTS:
XIN(01)= M01 PSELA, XIN(02)= UNUSED, XIN(03)= UNUSED, XIN(04)= UNUSED,
XIN(05)= UNUSED, XIN(06)= UNUSED, XIN(07)= UNUSED, XIN(08)= UNUSED,

MACHINE OUTPUTS:
OUT(01)= UNUSED, OUT(02)= UNUSED, OUT(03)= UNUSED, OUT(04)= UNUSED,
OUT(05)= UNUSED, OUT(06)= UNUSED,

SPINDLE #01, ASSIGNED TO MACHINE #01
MACHINE #01 DATA:
CIF= 00001., JT= 0000.0, CTA= 001.00, CTB= 001.00, RTO= 00020.,
CSM= 00000.,

03/11/88 11:39:14 SPINDLE #01 PARAMETERS, TORQUE UNITS: ******

CONFIG #1:
CM = 00000., TC = 00000., TH = 00000., TL = 00000., TT = 00000.,
AT = 00000., TP = 00000., AC = 00000., AH = 00000., AL = 00000.,
ES = 00015., AR = 00000., RTT= 00000., TTS= 00000., TO = 00000.,
AO - 00000., SCT= 00050., LAH= 00000., LAL= 00000., ADH= 00000.,
ADL= 00000., ADC= 00000., TMR= 00.000, CYC= 00000.,
CONFIG #2:
CM = 00000., TC = 00000., TH = 00000., TL = 00000., TT = 00000.,
AT = 00000., TP = 00000., AC = 00000., AH = 00000., AL = 00000.,
ES = 00015., AR = 00000., RTT= 00000., TTS= 00000., TO = 00000.,
AO = 00000., SCT= 00050., LAH= 00000., LAL= 00000., ADH= 00000.,
ADL= 00000., ADC= 00000., TMR= 00.000, CYC= 00000.,
COMMON TO ALL CONFIGS:
TR = 00100., MST= 00005., TD = 00000., UC = 00000., ASC= 00.508,
BYP= 00000., JT = 0000.0, SDT= 001.50, XFS= 0040.0, BHI= 00010.,
BLO= 00010., RB = 00700., RSC= 00100., MSS= 09999., PDT= 001.50,

03/11/88 11:39:15 SPINDLE #01 STATUS INFO

TPK= 00000., AF = 00000., IRG= 01428., AS = 00000., PPK= 00000.,
RDT= 00006., RPM= 00000., SLP= 000.00, TCT= 000.00, PTT= 000.00,
FTT= 00000, RT = 00.000, RFT= 00.000, AN = 00000., ANF= 00000.,
FT = 00000, SA = 000.00, SB = 000.00, OFF= 00002., RRG= 01379.,
ARG= 01377., GE = 0000.0, GF = 01.000, XG = 00000., SUS= 00000.,
RDD= 00007.,

03/11/88 11:39:16 GENERAL SYSTEM PARAMETERS

SS2= 00005., LKT = 00000., FDT= 00060., ALK = 00001., LM= 00000.,
SIG= 00001., AFD= 00050., CTO= 00000., LVA= 00000., LVB= 00000.,
LVC= 00000., LVD = 00.000, ITR= 00001., BH = 09600., BTA= 02400.,
PH = 00003., PTA = 00003., DAS = 00001.

03/11/88 11:39:17 GENERAL SYSTEM STATUS INFO

ADR = 00001., PN= 93979599.R15

APPENDIX A

Figure 3. Torque/Angle Trace Output in "TRACE" Format

TMC JOINT TRACE DATA (TTTT AAAA), SP #01, SAMPLE PERIOD = 0.67 MILLISEC

005.0	00000,	005.1	00003,	005.3	00006,	005.4	00009,	005.4	00011,
005.4	00014,	006.0	00017,	006.0	00020,	006.2	00022,	006.4	00025,
006.3	00028,	007.2	00030,	006.5	00033,	006.7	00036,	007.2	00038

Figure 4. Torque/Angle Trace Output in "PLOT" Format

TMC JOINT TRACE DATA (TTTT AAAA), SP #01, SAMPLE PERIOD = 0.67 MILLISEC

005.0 00000
005.1 00003
005.3 00006
005.4 00009
005.4 00011
005.4 00014
006.0 00017
006.0 00020
006.2 00022
006.4 00025
006.3 00028
007.2 00030
006.5 00033
006.7 00036
007.2 00038

Figure 5. Data Set List Printout

07/15/87 11:41:40 LAST 100 FOR SPINDLE #01, CONFIG #01 (TTT.T AAAA)

07/15 11:31 --> 062.7 0008 , 062.6 0006 , 062.9 0012 , 062.7 0006,
07/15 11:31 --> 062.8 0009 , 062.7 0008 , 062.7 0009 , 062.8 0013,
07/15 11:31 --> 062.8 0008 , 062.6 0013 , 062.6 0006 , 062.5 0006,
07/15 11:32 --> 062.7 0009 , 062.8 0013 , 062.9 0013 , 062.8 0009,
07/15 11:32 --> 062.9 0008 , 062.8 0009 , 062.7 0006 , 062.9 0008,
07/15 11:32 --> 062.8 0009 , 062.7 0010 , 062.6 0006 , 062.7 0008,
07/15 11:32 --> 062.7 0009 , 062.6 0009 , 062.4 0006 , 062.8 0009,
07/15 11:33 --> 062.7 0009 , 062.6 0006 , 062.8 0013 , 062.7 0008,
07/15 11:33 --> 062.7 0006 , 062.7 0006 , 062.7 0006 , 062.7 0006,
07/15 11:33 --> 062.7 0006 , 062.7 0006 , 062.8 0006 , 062.8 0013,
07/15 11:33 --> 062.8 0010 , 062.6 0006 , 062.7 0009 , 062.7 0010,
07/15 11:34 --> 062.8 0006 , 062.7 0013 , 062.5 0006 , 062.7 0010,
07/15 11:34 --> 062.5 0006 , 062.7 0010 , 063.0 0013 , 062.9 0013,
07/15 11:34 --> 062.8 0013 , 062.7 0006 , 062.8 0006 , 062.8 0013,
07/15 11:35 --> 062.7 0010 , 062.5 0006 , 062.7 0010 , 062.7 0006,

APPENDIX B

EZ PROGRAM PROCEDURES

TORQUE CONTROL

045 (CM) CONTROL MODE = 0
028 (TD) TORQUE DECIMAL = SEE BELOW
026 (UC) TORQUE UNIT CODE = SEE BELOW
020 (TR) TORQUE RANGE = SEE TABLE, PG. B-4
021 (TC) TORQUE CONTROL POINT
022 (TH) TORQUE HIGH LIMIT
023 (TL) TORQUE LOW LIMIT
024 (TT) TORQUE THRESHOLD = OPTIONAL
064 (RTT) PREV. TORQ. THRES. = OPTIONAL
173 (TDS) TORQUE DOWN SHIFT
049 (SUS) SETUP STATUS = 00000

ANGLE CONTROL TORQUE MONITOR

045 (CM) CONTROL MODE = 2
028 (TD) TORQUE DECIMAL = SEE BELOW
026 (UC) TORQUE UNIT CODE = SEE BELOW
020 (TR) TORQUE RANGE = SEE TABLE, PG. B-4
022 (TH) TORQUE HIGH LIMIT
023 (TL) TORQUE LOW LIMIT
024 (TT) TORQUE THRESHOLD
021 (TC) TORQUE CONTROL POINT = OPTIONAL
030 (ASC) ANGLE SCALE FACTOR = SEE TABLE, PG. B-4
031 (AC) ANGLE CONTROL POINT
032 (AH) ANGLE HIGH LIMIT
033 (AL) ANGLE LOW LIMIT
038 (ES) MIN. SPEED QUALIFIER = OPTIONAL
039 (AR) ANGLE THRESHOLD = OPTIONAL
064 (RTT) PREV. TORQ. THRES. = OPTIONAL
173 (TDS) TORQUE DOWN SHIFT
049 (SUS) SETUP STATUS = 00000

(TD) 0 = 0 1 = 0.0 2 = 0.00 3 = 0.000
(UC) 1 = FT-LBS. 2 = IN-LBS. 3 = N-m 4 = N-cm 5 = Kg-m

STANDARD SETUP PROCEDURES

1) Plug in cabinet to 115 VAC or 220 VAC as applicable.
2) Turn on unit and allow to power up.
3) Verify transducer calibration. If the letter (C) appears next to last torque on the screen, unit is calibrated, otherwise adjust offset and span inside cabinet.
4) Press the START switch on cabinet to power spindle up.
5) Verify the POWER light on the controller and cabinet door are lit.
6) If not, check fuses to determine if blown.
7) Verify the controller is set in computer mode on the shiftdown and shutdown switches located at bottom of controller.
8) Verify the toggle switch on the interface board is set to normal operation.
9) If programming new strategy, it is recommended to clear entire memory first.
10) Select torque strategy and program as stated in easy program located on reverse.

TORQUE CONTROL ANGLE MONITOR

045 (CM) CONTROL MODE = 1
028 (TD) TORQUE DECIMAL = SEE BELOW
026 (UC) TORQUE UNIT CODE = SEE BELOW
020 (TR) TORQUE RANGE = SEE TABLE, PG. B-4
021 (TC) TORQUE CONTROL POINT
022 (TH) TORQUE HIGH LIMIT
023 (TL) TORQUE LOW LIMIT
024 (TT) TORQUE THRESHOLD
030 (ASC) ANGLE SCALE FACTOR = SEE TABLE, PG. B-4
032 (AH) ANGLE HIGH LIMIT
033 (AL) ANGLE LOW LIMIT
031 (AC) ANGLE CONTROL POINT = OPTIONAL
038 (ES) ENC CHK MIN SPEED = OPTIONAL
039 (AR) ANGLE THRESHOLD = OPTIONAL
064 (RTT) PREV. TORQ. THRES. = OPTIONAL
173 (TDS) TORQUE DOWN SHIFT
049 (SUS) SETUP STATUS = 00000

TORQUE & ANGLE CONTROL

045 (CM) CONTROL MODE = 3
028 (TD) TORQUE DECIMAL = SEE BELOW
026 (UC) TORQUE UNIT CODE = SEE BELOW
020 (TR) TORQUE RANGE = SEE TABLE, PG. B-4
021 (TC) TORQUE CONTROL POINT
022 (TH) TORQUE HIGH LIMIT
023 (TL) TORQUE LOW LIMIT
024 (TT) TORQUE THRESHOLD
030 (ASC) ANGLE SCALE FACTOR = SEE TABLE, PG. B-4
032 (AH) ANGLE HIGH LIMIT
033 (AL) ANGLE LOW LIMIT
038 (ES) MIN. SPEED QUALIFIER = OPTIONAL
031 (AC) ANGLE CONTROL POINT
039 (AR) ANGLE THRESHOLD = OPTIONAL
064 (RTT) PREV. TORQ. THRES. = OPTIONAL
068 (TTS) TORQUE MIDPOINT SLOPE = OPTIONAL
173 (TDS) TORQUE DOWN SHIFT
049 (SUS) SETUP STATUS = 00000

SETUP STATUS ERROR CODES

PARAMETER	WEIGHT
INVALID TH	1
INVALID TD	2
INVALID TC	4
INVALID TT	8
NO MCH	16
INVALID TL	32
INVALID AT	64
INVALID AH	128
MEMORY ERROR	256
NO ACK	512
BAD CCI	1024
UNUSED	2048
INVALID CFG	4096

Note: Weight may be an addition of more than one parameter value.

VARIABLES FOR DISPLAY TABLE

CODE	ID	DESCRIPTION
50	AF	Final Angle, angle from TT until torque decays to 5% after a control shutoff point reached
51	AS	Shutdown Angle, angle from TT until first time a control setpoint is reached
52	PPK	Peak torque during pretorque control state
53	RDT	Run down torque
54	RPM	Peak-held speed
55	TCT	Total Cycle Time (accurate to .01 sec.)
56	PTT	Time from cycle start to pretorque shutdown
57	FTT	Time from cycle start to control setpoint
58	RT	Torque Rise time
59	RFT	Torque Rise and Fall time
60	AN	Net Angle (from threshold until cycle end)
61	ANF	AN - AF (Net - Final)
73	RDD	Deviation between run down torque samples
116	SLP	Slope (Torque Units/degree)
117	FT	Torque Fall Time
118	SA	Slope (torque/deg) from TT to TTS
119	SB	Slope from TTS to control setpoint
130	OFF	Torque Offset Compensation
131	RRG	Torque Input During Shunt Calibration
132	ARG	RRG - OFF
145	XF	Shunt Calibration Fault Code
146	XG	Control Shutdown Code
178	GCC	Gang Count

CURRENT FAULT CODE DESCRIPTIONS

NUMBER OF SEQUENTIAL PULSES	FAULT INDICATION	DESCRIPTION
Steady - No Pulse	Stall Fault	Tool Stall
One Pulse	PTC Fault	Motor Overtemp
Two Pulses	Phase to Phase Fault	Cable Short
Three Pulses	Hall Signal Fault	Encoder Fault
Four Pulses	Overvoltage Fault	AC Input > 140VAC

SHUTDOWN CAUSE CODES

Parameter Code 146 (XG)

CODE (XG)	REASON FOR SHUTDOWN
1	Pretorque Reached
2	Torque > TH
3	Angle > AC
4	Torque > TC
5	Calibration Fault
6	Setup Status Error
8	Loss of cycle run input
9	Minimum speed not reached
10	Cycle time > RTO seconds
11	Angle> AH
12	Angle>AH after a previous shutdown condition
13	Torque>TH after a previous shutdown condition
14	Power fail detected during a control cycle

TORQUE FAULT FLAG	ANGLE FAULT FLAG
S = INVALID SETUP	S = INVALID SETUP
X = TRANSDUCER FAULT	X = TRANSDUCER FAULT
U = TORQUE < TT OR > TR	U = ANGLE > 9999
H = TORQUE > TH	H = ANGLE > AH
L = TORQUE < TL	L = ANGLE < AL

RAM MEMORY CLEAR ERROR

To perform a RAM MEMORY CLEAR enter the DIAGNOSTICS screen:

- System asks if you want to enter mode because normal functions are overridden
- Press pad next to YES
- Press OTHER until MEMORY CLEAR (code 14) appears
- Press the pad by the MEMORY CLEAR option
- Press the numeric keys for code number "1470" and then press ENTER
- Press OTHER until PROGRAM is displayed
- Press the pad by PROGRAM to bring up the statement ACKN RAM CLEARED (code 5)
- Press the numeric keypad for "1" and press ENTER
- See Section 5.3 of the "Operation and Maintenance Manual" for programming setup parameters

APPENDIX B

FREQUENTLY USED PROGRAMMING PARAMETERS

CODE		DESCRIPTION	RECOMMENDATION
002	COM	4 Digit Combination Lock	4 digit number chosen by mgt. if necessary
004	FDT	Display Time Out	60 seconds
005	ACK	Ram Clear Acknowledgment	Enter 1
009	PN	Program Number	Revision of software - Non-programmable
010	TM	Time of Day	Military time (EX: for 1:23 pm enter 1323)
011	DT	Date (Month/Day)	(EX: for March 27 enter 0327)
012	YR	Year	Last two digits of year (EX: 97 for 1997)
016	POL	Host Poll Enable Flag	0 = Terminal/Printer, 1 = Host
018	CSM	Mode for Selecting Configurations	2 (1 of 8 spare inputs)
020	TR	Full Scale Torque Range	See TR values
021	TC	Torque Control Point	Application dependent
022	TH	Torque High Limit	Application dependent
023	TL	Torque Low Limit	Application dependent
024	TT	Torque Threshold (Snug)	Application dependent - Appx. 1/3 of TC value
025	MST	Minimum Cycle Start Torque	5 to 7 (% of TR)
026	UC	Unit Code	1 = ft-lbs, 2 = in-lbs, 3 = Nm, 4 = Ncm, 5 = kgm
028	TD	Torque Decimal Places	Enter this value before all torque settings
029	TP	Pretorque Control Point	O = Off
030	ASC	Angle Scale Factor	See ASC values
031	AC	Angle Control Point	If CM = 1 then AC = 0 If CM = 2 then AC is application dependent
032	AH	Angle High Limit	If limits are unknown, use 9999
033	AL	Angle Low Limit	If limits are unknown, use 0000
040	SPN	No. of Spindles Being Monitored	1 or 2
041	CFM	Maximum Number of Configurations	1 to 8
042	MCH	Spindles Assigned to Machine	101 = 1 MCH, 1 SPN 102 = 1 MCH, 2 SPN 202 = 2 MCH, 2 SPN
046	CIF	Cycle Mode	1 = Hand Held (automatic) 0 = Run (for remote start) 2 = Start (for remote start)
049	SUS	Setup Status	See Status Error Codes
066	CTA	Control Timer A	1.00 sec (Cycle time-out pre shut down)
067	CTB	Control Timer B	0.5 sec (Cycle time-out post shut down)
070	SSZ	Statistics Sample Size	25 minimum for statistics
087	TO	Torque Overshoot	Application dependent (lowers shut down point)
089	SCT	Shunt Cal Settling Time	50ms (0 to disable)
090	SIG	Parts Recorded for Statistics	0 = all, 1 = good, 2 = exclude faults
103	RPS	Flush Statistics	Enter 1 to flush stats
107	LVA	Extra Logged Variable	See Variables for Display Table
134	BH	Baud Rate for Host Port	9600
135	BTO	Baud Rate for Terminal Port	9600
137	PH	Parity for Host Port	0 (no parity), 1 = odd, 2 = even
138	PTO	Parity for Terminal Port	0 (no parity), 1 = odd, 2 = even
151	XL	Shunt Cal Fault Shutdown Flag	1 (Gross faults will shut down tool)
173	TDS	Torque Downshift Point	Application dependent -- generally ≥ 50% of TC
175	TBN	Tube Nut Mode	0 = Normal, 1 = Tube Nut Mode
177	GCT	Gang Counter Setpoint	0-99

TOOL PERFORMANCE AND CALIBRATION DATA

MODEL NUMBER	TRANSDUCER	FULL SCALE (Nm)	GEAR CASE	LABEL	GEAR CASE RATIO	OUTPUT	OUTPUT RATIO	TOTAL RATIO	AVG. SPEED (RPM)	MAX. TORQUE (Nm)	TR (Nm)	ASC
40 SERIES ANGLES												
DEA OR DEF8NMT2S4	DEA40-A756-25	25	DEM8-M37	BT	8.000:1	DAA2S4A	1.50:1	12.000:1	1250	11	37.5	2.5
DEA OR DEF15NMT2S6	DEA40-A756-25	25	DEM15-M37	CT	14.999:1	DAA2S6A	1.50:1	22.499:1	666	20	37.5	1.333
DEA OR DEF23NMT3S6	DEA40-A756-25	25	DEM23-M37	ET	23.064:1	DAA4S6	1.50:1	34.596:1	434	30	37.5	0.867
DEA OR DEF31NMT3S6	DEA40-A756-50	50	DEM31-M37	FT	31.128:1	DAA4S6	1.50:1	46.692:1	321	40	75	0.643
DEA OR DEF40NMT3S6	DEA40-A756-50	50	DEM40-M37	GT	40.670:1	DAA4S6	1.50:1	61.005:1	246	55	75	0.492
40 SERIES STRAIGHTS												
DEA OR DEF8NMTE—	DEA40-A756-25	25	DEM15-M37	CT	14.999:1	120E—	1.0:1	14.999:1	1000	11	25	2
DEA OR DEF15NMTE—	DEA40-A756-25	25	DEM23-M37	ET	23.064:1	120E—	1.0:1	23.064:1	650	20	25	1.3
DEA OR DEF23NMTE—	DEA40-A756-25	25	DEM31-M37	FT	31.128:1	120E—	1.0:1	31.128:1	482	30	25	0.964
DEA OR DEF31NMTE—	DEA40-A756-50	50	DEM40-M37	GT	40.670:1	120E—	1.0:1	40.670:1	369	40	50	0.738
DEA OR DEF40NMTE—	DEA40-A756-50	50	DEM60-M37	HT	59.070:1	120E—	1.0:1	59.070:1	254	55	50	0.508
120 SERIES ANGLES												
DEA OR DEM55N5S8	DEA120-A756-50	50	DEA55-M37	A	13.573:1	DAA5S8	1.75:1	23.753:1	635	55	87.5	1.263
DEA OR DEM70N5S8	DEA120-A756-50	50	DEA70-M37	B	14.737:1	DAA5S8	1.75:1	25.790:1	585	70	87.5	1.163
DEA OR DEM90N5S8	DEA120-A756-70	70	DEA90-M37	C	19.342:1	DAA5S8	1.75:1	33.849:1	450	90	122.5	0.886
DEA OR DEM120N6S8	DEA120-A756-70	70	DEA120-M37	D	24.561:1	DAA6S8	1.75:1	42.982:1	355	120	122.5	0.698
120 SERIES STRAIGHTS												
DEA OR DEM55NE—	DEA120-A756-50	50	DEA90-M37	C	19.342:1	120E—	1.0:1	19.342:1	780	55	50	1.551
DEA OR DEM70NE—	DEA120-A756-70	70	DEA120-M37	D	24.561:1	120E—	1.0:1	24.561:1	620	70	70	1.221
DEA OR DEM90NE—	DEA120-A756-120	120	DEA150-M37	E	30.952:1	120E—	1.0:1	30.952:1	450	90	120	097
DEA OR DEM120NE—	DEA120-A756-120	120	DEA200-M37	F	41.568:1	120E—	1.0:1	41.568:1	355	120	120	0.722
30 SERIES TITAN PISTOL												
DEP 3N—	DEP30-A756-30	30	—	—	3.333:1	—	1.0:1	3.333:1	4500	3	30	9
DEP 5N—	DEP30-A756-30	30	—	—	5.667:1	—	1.0:1	5.667:1	2650	5.4	30	5.294
DEP 9N—	DEP30-A756-30	30	—	—	11.111:1	—	1.0:1	11.111:1	1350	9	03	2.7
DEP 15N—	DEP30-A756-30	30	—	—	15.000:1	—	1.0:1	15.000:1	1000	15	30	2
DEP 20N—	DEP30-A756-30	30	—	—	21.530:1	—	1.0:1	21.530:1	700	20	30	1.393
DEP 25N—	DEP30-A756-30	30	—	—	25.500:1	—	1.0:1	25.500:1	590	25	30	1.176
DEP 30N—	DEP30-A756-30	30	—	—	32.115:1	—	1.0:1	32.115:1	470	30	30	0.934

PROGRAMMING CODES IN LOGICAL GROUPS

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
			GENERAL SYSTEM				
2	COM	-	Unlock Combination Entry	0000	-	0000=disable,0001-9999	11.1
3	LKT	-	Auto Entry Lockout Timer	00000	minutes	0=disabled,1-500	11.1
4	FDT	-	Display Timeout	00060	seconds	0=disabled,1-9999	5.4
5	ACK	-	Acknowledge RAM Clear	0	-	set to 1=Acknowledge	5.4
10	TM	-	Time	00.00	hour.minute	00.00-23.59	5.4
11	DT	-	Date	01.01	month.day	01.01-12.31	5.4
12	YR	-	Year	089	year	0-99	5.4
154	XO	-	Unlock Combination	0000	-	READ ONLY	11.1
172	LNG	-	Current Language Code	000	-	0=English,1=Spanish,2=German,3=French,4=Italian	11.2
			DIAGNOSTICS				
9	PN	-	Program Revision Number	-	-	READ ONLY	-
36	DAS	-	Trace / Plot Output Spindle Selection	000	-	0=none,1=sp1,2=sp2	10.4
37	AFD	-	Second Display Variable Code	050	-	SEE CHART	8.1
49	SUS	S	Setup Status	00000	-	READ ONLY	6.0,12.1
78	GE	S	Gain Percent Error On Shunt Calibration	0000.0	%	READ ONLY	5.5
79	GF	S	Gain Factor (Actual / Ideal Shunt Cal)	01.000	-	READ ONLY	5.5
101	ITR	-	Torque Trace Sample Interval	001	-	0-255	10.4
107	LVA	-	Extra Logged Variable A	000	-	SEE CHART	8.1,10.4
112	LAH	C	Extra Logged Variable A High Limit	00000	-	0=disable,-9999-32000	8.1
113	LAL	C	Extra Logged Variable A Low Limit	00000	-	0=disable,-9999-32000	8.1
114	ADH	C	AFD Item High Limit	00000	-	0=disable,-9999-32000	8.1
115	ADL	C	AFD Item Low Limit	00000	-	0=disable,-9999-32000	8.1
133	IRG	S	Ideal Shunt Calibration	01428	A/D counts	READ ONLY	5.5
			CYCLE CONTROL				
17	CFU	M	Configurations Actually Used	008	-	1-8	7.2
18	CSM	M	Configuration Selection Mode	002	-	0=binary,1=auto increment,2=1 of 8 inputs	7.2,8.2
25	MST	S	Minimum Start Torque (% of TR)	00005	%	1-25	8.6
40	SPN	-	Number Of Spindles	001	-	1-2	7.0
41	CFM	-	Maximum Configuration Number	008	-	4,8	8.2,8.4
42	MCH	M	Spindle To Machine Assignment	101	-	101=sp1 to mch1,202=sp2 to mch2,102=both to mch1	5.4,7.1

PROGRAMMING CODES IN LOGICAL GROUPS

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
44	MSS	S	Minimum Cycle Start Speed	09999	RPM	0-9999	8.6
45	CM	C	Control Mode	000	-	0=torque without angle monitor,1=torque,2=angle,3=both	6.0-6.3
46	CIF	M	Auto Cycle Mode Flag	001	-	0=run,1=auto,2=start	5.4,8.6
66	CTA	M	Cycle End Time Before Shutdown	001.00	seconds	.10-30.00	8.5,8.6
67	CTB	M	Cycle End TIme After Shutdown	000.10	seconds	.10-5.00	8.5,8.6
85	SDT	S	Shutdown Duration Timer	001.50	seconds	.1-100.00	8.6
89	SCT	C	Shunt Calibration Settling Time	00050	milliseconds	50=normal,0= off,10-2500	5.5,8.6
93	RTO	M	Auto Cycle Run Timeout	00020	seconds	2-60	8.6
98	CTO	-	Auto Cal Time	00000	minutes	0-9999	5.5
149	XJ	-	Override Gain Compensation	00000	-	0=normal,1=disable shunt cal gain correction	5.5
151	XL	-	Shunt Calibration Fault Shutdown Flag	1	-	0=shutdown on all faults,1=shutdown only on gross faults	5.5
			TORQUE CONTROL				
20	TR	S	Torque Range	0075.0	UC	0-999.9	6.0
21	TC	C	Torque Control Point	0000.0	UC	0-999.9	6.0,9.4
22	TH	C	Torque High Limit	0000.0	UC	0-999.9	6.0
23	TL	C	Torque Low Limit	0000.0	UC	0-999.9	6.0
26	UC	S	Torque Unit Code	003	-	0=no units,1=ft-lbs,2=in-lbs,3=Nm,4=Ncm,5=Kgm	6.0
28	TD	S	Torque Decimal Places	1	-	0-2	6.0
87	TO	C	Torque Control Overshoot	0000.0	UC	0-999.9	6.4
173	TDS	C	Torque Shiftdown	0999.9	UC	0-999.9	6.5
			ANGLE CONTROL				
24	TT	C	Torque Threshold	0000.0	UC	0-999.9	6.1
27	AT	C	Torque For Angle Stop	0000.0	UC	0=MST/2,0.1-999.9	8.9
30	ASC	S	Angle Scale Factor	00.001	degrees/pulse	0.001-9.999	6.1
31	AC	C	Angle Control Point	00000	degrees	0-9999	6.2,9.4
32	AH	C	Angle High Limit	00000	degrees	0-9999	6.1
33	AL	C	Angle Low Limit	00000	degrees	0-9999	6.1
88	AO	C	Angle Control Overshoot	00000	degrees	0-9999	6.4

PROGRAMMING CODES IN LOGICAL GROUPS

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
			SERIAL INTERFACE				
13	ADR	-	Unit Number For Network Communication	001	-	1-32	10.1
16	POL	-	Host Poll Enable Flag	0	-	0=Terminal,1=Host,2=FTS-NET	10.1
134	BH	S	Host Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
135	BTA	-	Terminal Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
137	PH	-	Host Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
138	PTA	-	Terminal Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
			SPECIAL MODES				
29	TP	C	Pretorque Control Point	0000.0	UC	0=disabled,0.1-999.9	8.5
38	ES	C	Encoder Check Minimum Speed	00000	RPM	0-9999	8.7
39	AR	C	Prevailing Torque Angle Interval	00000	degrees	0-9999	8.3
47	JT	M	Jog Timer	0000.0	seconds	0-10.0	8.8
64	RTT	C	Prevailing Torque Threshold	0000.0	UC	0-999.9	8.3
65	PDT	S	Pretorque Shutdown Time	001.50	seconds	.10-5.00	8.5
68	TTS	C	Torque Threshold For Slope	0000.0	UC	0-999.9	8.4
69	TMR	C	Prevailing Torque Time Interval	00.000	seconds	0-2.500	8.3
175	TBN	S	Tube Nut Mode	0	-	0=Normal,1=Tube Nut	13.4
177	GCT	C	Gang Count Set	0	cycles	0-99	13.3
			STATISTICS / REPORTS				
70	SSZ	-	Statistics Sample Size	00005	samples	2-562	9.4
90	SIG	-	Statistics Update Mode	1	-	0=all samples,1=good only,2=all except faults	9.4
91	RP	-	Population Statistics Flush	0	-	set to 1=flush	9.5
92	RS	-	Sample Statistics Flush	0	-	set to 1=flush	9.5
96	LM	-	Log Mode	0	-	0=log all cycles,1=log rejects only	10.4
97	CFF	-	Cycle Form Feed Count	050	logs/page	0-255	10.3
103	RPS	-	Erase Statistics For Spindle	000	-	set to 1=erase spindle 1 stats,2=erase spindle 2 stats	6.1,9.5
108	LVB	-	Extra Logged Variable B	000	-	SEE CHART	10.4
109	LVC	-	Extra Logged Variable C	000	-	SEE CHART	10.4
110	LVD	-	Extra Logged Variable D	000	-	SEE CHART	10.4
111	ADC	C	Statistics Target For Second Variable	00000	-	-32768-32767	8.1,9.4

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
AC	31	C	Angle Control Point	00000	degrees	0-9999	6.2,9.4
ACK	5	-	Acknowledge RAM Clear	0	-	set to 1=Acknowledge	5.4
ADC	111	C	Statistics Target For Second Variable	00000	-	-32768-32767	8.1,9.4
ADH	114	C	AFD Item High Limit	00000	-	0=disable,-9999-32000	8.1
ADL	115	C	AFD Item Low Limit	00000	-	0=disable,-9999-32000	8.1
ADR	13	-	Unit Number For Network Communication	001	-	1-32	10.1
AF	50	S	Final Angle (TT to AT)	00000	degrees	READ ONLY	8.1
AFD	37	-	Second Display Variable Code	050	-	SEE CHART	8.1
AH	32	C	Angle High Limit	00000	degrees	0-9999	6.1
AL	33	C	Angle Low Limit	00000	degrees	0-9999	6.1
AN	60	S	Net Angle (TT to Cycle End)	00000	degrees	READ ONLY	8.1
ANF	61	S	Net Angle - Final Angle (AT to Cycle End)	00000	degrees	READ ONLY	8.1
AO	88	C	Angle Control Overshoot	00000	degrees	0-9999	6.4
AOK	86	M	Spare Output Functions	0	-	READ ONLY	-
AR	39	C	Prevailing Torque Angle Interval	00000	degrees	0-9999	8.3
ARG	132	S	Actual Shunt Calibration (RRG-OFF)	00000	A/D counts	READ ONLY	8.1
AS	51	S	Shutdown Angle (TT to Shutdown)	00000	degrees	READ ONLY	8.1
ASC	30	S	Angle Scale Factor	00.001	degrees/pulse	0.001-9.999	6.1
AT	27	C	Torque For Angle Stop	0000.0	UC	0=MST/2,0.1-999.9	8.9
ATC	127	S	A/D Counts For AT	00000	A/D counts	READ ONLY	-
BH	134	S	Host Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
BHI	81	S	Bridge High Excitation	00005	V	5,10	-
BLO	82	S	Bridge Low Excitation	-00005	V	-10,-5,0	-
BTA	135	-	Terminal Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
BYP	48	S	Spindle Bypass Flag	000	-	0=normal,1=bypass spindle	-
CAL	43	M	Calibration Mode	000	-	set to 1=zero,2=dynamic,3=shunt cal,4=auto cal	10.2
CCI	71	-	Contact Closure Input Functions	UNUSED	-	READ ONLY	-
CFF	97	-	Cycle Form Feed Count	050	logs/page	0-255	10.3
CFG	19	-	Configs For Terminal Entry / Display	001	-	1-8	10.2
CFM	41	-	Maximum Configuration Number	008	-	4,8	8.2,8.4
CFO	174	M	Configuration Override	000	-	0-8	10.2
CFU	17	M	Configurations Actually Used	008	-	1-8	7.2

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
CHG	181	-	Change Code	000	-	0-255	-
CIF	46	M	Auto Cycle Mode Flag	001	-	0=run,1=auto,2=start	5.4,8.6
CLR	15	-	Memory Flush Start Code	00000	-	set to 9630 within 15 seconds of setting MEM	10.2
CM	45	C	Control Mode	000	-	0=torque without angle monitor,1=torque,2=angle,3=both	6.0-6.3
COM	2	-	Unlock Combination Entry	0000	-	0000=disable,0001-9999	11.1
CSM	18	M	Configuration Selection Mode	002	-	0=binary,1=auto increment,2=1 of 8 inputs	7.2,8.2
CTA	66	M	Cycle End Time Before Shutdown	001.00	seconds	.10-30.00	8.5,8.6
CTB	67	M	Cycle End TIme After Shutdown	000.10	seconds	.10-5.00	8.5,8.6
CTO	98	-	Auto Cal Time	00000	minutes	0-9999	5.5
CYC	155	C	Cycle Count For Log	00000	-	0-9999	-
CYH	156	C	Cycle Count For Host	00000	-	0-9999	-
DAS	36	-	Trace / Plot Output Spindle Selection	000	-	0=none,1=sp1,2=sp2	10.4
DAV	35	-	DAC Scale	0000.0	V/degree	READ ONLY	-
DMP	8	-	Dump Parameters Flag	000	-	set to 1-2=spindle,10=misc,11-12=spindle+misc,99=all	10.2
DOA	34	-	DAC Offset	00010	mV	0-3000	-
DT	11	-	Date	01.01	month.day	01.01-12.31	5.4
ES	38	C	Encoder Check Minimum Speed	00000	RPM	0-9999	8.7
FDT	4	-	Display Timeout	00060	seconds	0=disabled,1-9999	5.4
FT	117	S	Torque Fall Time (Shutdown to AT)	00.000	seconds	READ ONLY	8.1
FTT	57	S	Fastening Time (Cycle Start to Shutdown)	000.00	seconds	READ ONLY	8.1
GCC	178	S	Gang Count Current	000	cycles	READ ONLY	8.1
GCT	177	C	Gang Count Set	0	cycles	0-99	13.3
GE	78	S	Gain Percent Error On Shunt Calibration	0000.0	%	READ ONLY	5.5
GF	79	S	Gain Factor (Actual / Ideal Shunt Cal)	01.000	-	READ ONLY	5.5
IRG	133	S	Ideal Shunt Calibration	01428	A/D counts	READ ONLY	5.5
ITR	101	-	Torque Trace Sample Interval	001	-	0-255	10.4
JT	47	M	Jog Timer	0000.0	seconds	0-10.0	8.8
LAH	112	C	Extra Logged Variable A High Limit	00000	-	0=disable,-9999-32000	8.1
LAL	113	C	Extra Logged Variable A Low Limit	00000	-	0=disable,-9999-32000	8.1
LC	104	-	Cycle Log Reprint Flag	000	-	set to 1-120=copy of 1-120 cycles,255=flush	10.2
LCT	169	-	Total Cycles For Outputs	00000	cycles	0=all samples,or 1-32767 then set LST	10.2
LE	105	-	Exception Log Recall Flag	000	-	set to 1=copy,255=flush	10.2

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
LK	1	-	Data Entry Lock	-	-	READ ONLY	10.2
LKT	3	-	Auto Entry Lockout Timer	00000	minutes	0=disabled,1-500	11.1
LM	96	-	Log Mode	0	-	0=log all cycles,1=log rejects only	10.4
LNG	172	-	Current Language Code	000	-	0=English,1=Spanish,2=German,3=French,4=Italian	11.2
LP	94	-	Population Log Flag	0	-	set to 1=copy	10.2
LS	95	-	Sample Log Flag	0	-	set to 1=copy	10.2
LST	106	-	List Samples Request	00000	-	set to 0C0S=config C of spindle S after setting LCT	10.2
LVA	107	-	Extra Logged Variable A	000	-	SEE CHART	8.1,10.4
LVB	108	-	Extra Logged Variable B	000	-	SEE CHART	10.4
LVC	109	-	Extra Logged Variable C	000	-	SEE CHART	10.4
LVD	110	-	Extra Logged Variable D	000	-	SEE CHART	10.4
MCH	42	M	Spindle To Machine Assignment	101	-	101=sp1 to mch1,202=sp2 to mch2,102=both to mch1	5.4,7.1
MEM	14	-	Memory Flush Required Code	00000	-	set to 1470, then set CLR within 15 seconds	10.2
MSC	125	S	A/D Counts For MST	00000	A/D counts	READ ONLY	-
MSS	44	S	Minimum Cycle Start Speed	09999	RPM	0-9999	8.6
MST	25	S	Minimum Start Torque (% of TR)	00005	%	1-25	8.6
MTA	62	M	Spare Out A On Time	000.00	seconds	READ ONLY	-
MTB	63	M	Spare Out B On Time	000.00	seconds	READ ONLY	-
MTC	74	M	Spare Output C On Time	000.00	seconds	READ ONLY	-
OFF	130	S	Amplifier Offset	00.000	-	READ ONLY	8.1
OUT	72	-	Extra Output Functions	UNUSED	-	READ ONLY	-
PDT	65	S	Pretorque Shutdown Time	001.50	seconds	.10-5.00	8.5
PH	137	-	Host Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
PLT	170	-	Plot Data Request	000	-	set to 1=copy	10.2
PN	9	-	Program Revision Number	-	-	READ ONLY	-
POL	16	-	Host Poll Enable Flag	0	-	0=Terminal,1=Host,2=FTS-NET	10.1
PPK	52	S	Peak Torque At Pretorque Shutdown	0000.0	UC	READ ONLY	8.1
PTA	138	-	Terminal Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
PTR	102	-	Torque Trace Print Flag	0	-	set to 1=copy	10.2
PTT	56	S	Pretorque Time (Cycle Start to TP)	000.00	seconds	READ ONLY	8.1
RB	83	S	Bridge Resistance	00700	ohms	100-10000	-
RDD	73	S	Prevailing Torque Sample Difference	0000.0	UC/degrees	READ ONLY	8.1

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
RDT	53	S	Prevailing Torque (Average Of Samples)	0000.0	UC	READ ONLY	8.1
RFT	59	S	Torque Rise And Fall Time (TT to AT)	00.000	seconds	READ ONLY	8.1
RP	91	-	Population Statistics Flush	0	-	set to 1=flush	9.5
RPM	54	S	Peak Motor Speed	00000	RPM	READ ONLY	8.1
RPS	103	-	Erase Statistics For Spindle	000	-	set to 1=erase spindle 1 stats,2=erase spindle 2 stats	6.1,9.5
RRG	131	S	Raw Shunt Calibration	00000	A/D counts	READ ONLY	8.1
RS	92	-	Sample Statistics Flush	0	-	set to 1=flush	9.5
RSC	77	S	Shunt Calibration Resistor	00100	k ohms	43,87,100,175,350	-
RT	58	S	Torque Rise Time (TT to Shutdown)	00.000	seconds	READ ONLY	8.1
RTC	126	S	A/D Counts For RTT	00000	A/D counts	READ ONLY	-
RTO	93	M	Auto Cycle Run Timeout	00020	seconds	2-60	8.6
RTT	64	C	Prevailing Torque Threshold	0000.0	UC	0-999.9	8.3
SA	118	S	Slope Before Threshold (TT to TTS)	00.000	UC/degrees	READ ONLY	8.1
SB	119	S	Slope After Threshold (TTS To Shutdown)	00.000	UC/degrees	READ ONLY	8.1
SCT	89	C	Shunt Calibration Settling Time	00050	milliseconds	50=normal,0= off,10-2500	5.5,8.6
SDS	84	S	Shutdown Sense	001	-	1=normal,0=inverted	-
SDT	85	S	Shutdown Duration Timer	001.50	seconds	.1-100.00	8.6
SIG	90	-	Statistics Update Mode	1	-	0=all samples,1=good only,2=all except faults	9.4
SIN	176	-	Configuration Inputs Status	00000	-	READ ONLY	10.2
SLP	116	S	Slope (TT to Shutdown)	00.000	UC/degrees	READ ONLY	8.1
SPN	40	-	Number Of Spindles	001	-	1-2	7.0
SSZ	70	-	Statistics Sample Size	00005	samples	2-562	9.4
STC	128	S	A/D Counts For TTS	00000	A/D counts	READ ONLY	-
SUS	49	S	Setup Status	00000	-	READ ONLY	6.0,12.1
TBN	175	S	Tube Nut Mode	0	-	0=Normal,1=Tube Nut	13.4
TBS	179	S	Tube Nut State	0	-	READ ONLY	-
TC	21	C	Torque Control Point	0000.0	UC	0-999.9	6.0,9.4
TCC	121	S	A/D Counts For TC	00000	A/D counts	READ ONLY	-
TCT	55	S	Total Cycle Time	000.00	seconds	READ ONLY	8.1
TD	28	S	Torque Decimal Places	1	-	0-2	6.0
TDS	173	C	Torque Shiftdown	0999.9	UC	0-999.9	6.5
TH	22	C	Torque High Limit	0000.0	UC	0-999.9	6.0

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
THC	122	S	A/D Counts For TH	00000	A/D counts	READ ONLY	-
TL	23	C	Torque Low Limit	0000.0	UC	0-999.9	6.0
TLC	123	S	A/D Counts For TL	00000	A/D counts	READ ONLY	-
TM	10	-	Time	00.00	hour.minute	00.00-23.59	5.4
TMR	69	C	Prevailing Torque Time Interval	00.000	seconds	0-2.500	8.3
TO	87	C	Torque Control Overshoot	0000.0	UC	0-999.9	6.4
TP	29	C	Pretorque Control Point	0000.0	UC	0=disabled,0.1-999.9	8.5
TPC	129	S	A/D Counts For TP	00000	A/D counts	READ ONLY	-
TPK	76	S	Peak Torque	0000.0	UC	READ ONLY	-
TR	20	S	Torque Range	0075.0	UC	0-999.9	6.0
TRC	120	S	A/D Counts For TR	00000	A/D counts	READ ONLY	-
TT	24	C	Torque Threshold	0000.0	UC	0-999.9	6.1
TTC	124	S	A/D Counts For TT	00000	A/D counts	READ ONLY	-
TTS	68	C	Torque Threshold For Slope	0000.0	UC	0-999.9	8.4
UC	26	S	Torque Unit Code	003	-	0=no units,1=ft-lbs,2=in-lbs,3=Nm,4=Ncm,5=Kgm	6.0
ULK	0	-	Data Entry Unlock	-	-	READ ONLY	10.2
XA	140	-	Number Of Executive Passes In Last Sec	00000	-	-32768-32767	-
XB	141	-	Minimum Number Of Executive Passes	00000	-	0-9999	-
XC	142	-	Maximum Number Of Executive Passes	00000	-	READ ONLY	-
XD	143	-	Number Of 8259-Generated Interrupt 7's	00000	-	0-9999	-
XE	144	-	Population Stats Overflow	00000	-	0-9999	-
XF	145	S	Shunt Calibration Fault Code	000	-	READ ONLY	8.1
XFS	80	S	Transducer Full Scale Output	0020.0	mV	1.0-500.0	-
XG	146	S	Shutdown Cause Code	000	-	READ ONLY	8.1
XH	147	-	Cycle Log Queue Overflow	00000	-	0-9999	-
XI	148	-	Extra Data Item I	00000	-	-32768-32767	-
XIN	75	-	Extra Contact Closure Input Functions	UNUSED	-	READ ONLY	-
XJ	149	-	Override Gain Compensation	00000	-	0=normal,1=disable shunt cal gain correction	5.5
XK	150	-	Extra Data Item K	00000	-	-32768-32767	-
XL	151	-	Shunt Calibration Fault Shutdown Flag	1	-	0=shutdown on all faults,1=shutdown only on gross faults	5.5
XM	152	-	120 Hz Clocks for CTB	00000	-	READ ONLY	-
XN	153	-	120 Hz Clocks for CTA	00000	-	READ ONLY	-

PROGRAMMING CODES IN ALPHABETICAL ORDER

NAME	CODE	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
XO	154	-	Unlock Combination	0000	-	READ ONLY	11.1
YR	12	-	Year	089	year	0-99	5.4
ZAD	7	-	Unit Number For Network Communication	001	-	1-32	-

PROGRAMMING CODES IN NUMERICAL ORDER

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
0	ULK	-	Data Entry Unlock	-	-	READ ONLY	10.2
1	LK	-	Data Entry Lock	-	-	READ ONLY	10.2
2	COM	-	Unlock Combination Entry	0000	-	0000=disable,0001-9999	11.1
3	LKT	-	Auto Entry Lockout Timer	00000	minutes	0=disabled,1-500	11.1
4	FDT	-	Display Timeout	00060	seconds	0=disabled,1-9999	5.4
5	ACK	-	Acknowledge RAM Clear	0	-	set to 1=Acknowledge	5.4
7	ZAD	-	Unit Number For Network Communication	001	-	1-32	-
8	DMP	-	Dump Parameters Flag	000	-	set to 1-2=spindle,10=misc,11-12=spindle+misc,99=all	10.2
9	PN	-	Program Revision Number	-	-	READ ONLY	-
10	TM	-	Time	00.00	hour.minute	00.00-23.59	5.4
11	DT	-	Date	01.01	month.day	01.01-12.31	5.4
12	YR	-	Year	089	year	0-99	5.4
13	ADR	-	Unit Number For Network Communication	001	-	1-32	10.1
14	MEM	-	Memory Flush Required Code	00000	-	set to 1470, then set CLR within 15 seconds	10.2
15	CLR	-	Memory Flush Start Code	00000	-	set to 9630 within 15 seconds of setting MEM	10.2
16	POL	-	Host Poll Enable Flag	0	-	0=Terminal,1=Host,2=FTS-NET	10.1
17	CFU	M	Configurations Actually Used	008	-	1-8	7.2
18	CSM	M	Configuration Selection Mode	002	-	0=binary,1=auto increment,2=1 of 8 inputs	7.2,8.2
19	CFG	-	Configs For Terminal Entry / Display	001	-	1-8	10.2
20	TR	S	Torque Range	0075.0	UC	0-999.9	6.0
21	TC	C	Torque Control Point	0000.0	UC	0-999.9	6.0,9.4
22	TH	C	Torque High Limit	0000.0	UC	0-999.9	6.0
23	TL	C	Torque Low Limit	0000.0	UC	0-999.9	6.0
24	TT	C	Torque Threshold	0000.0	UC	0-999.9	6.1
25	MST	S	Minimum Start Torque (% of TR)	00005	%	1-25	8.6
26	UC	S	Torque Unit Code	003	-	0=no units,1=ft-lbs,2=in-lbs,3=Nm,4=Ncm,5=Kgm	6.0
27	AT	C	Torque For Angle Stop	0000.0	UC	0=MST/2,0.1-999.9	8.9
28	TD	S	Torque Decimal Places	1	-	0-2	6.0
29	TP	C	Pretorque Control Point	0000.0	UC	0=disabled,0.1-999.9	8.5
30	ASC	S	Angle Scale Factor	00.001	degrees/pulse	0.001-9.999	6.1
31	AC	C	Angle Control Point	00000	degrees	0-9999	6.2,9.4
32	AH	C	Angle High Limit	00000	degrees	0-9999	6.1

PROGRAMMING CODES IN NUMERICAL ORDER

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
33	AL	C	Angle Low Limit	00000	degrees	0-9999	6.1
34	DOA	-	DAC Offset	00010	mV	0-3000	-
35	DAV	-	DAC Scale	0000.0	V/degree	READ ONLY	-
36	DAS	-	Trace / Plot Output Spindle Selection	000	-	0=none,1=sp1,2=sp2	10.4
37	AFD	-	Second Display Variable Code	050	-	SEE CHART	8.1
38	ES	C	Encoder Check Minimum Speed	00000	RPM	0-9999	8.7
39	AR	C	Prevailing Torque Angle Interval	00000	degrees	0-9999	8.3
40	SPN	-	Number Of Spindles	001	-	1-2	7.0
41	CFM	-	Maximum Configuration Number	008	-	4,8	8.2,8.4
42	MCH	M	Spindle To Machine Assignment	101	-	101=sp1 to mch1,202=sp2 to mch2,102=both to mch1	5.4,7.1
43	CAL	M	Calibration Mode	000	-	set to 1=zero,2=dynamic,3=shunt cal,4=auto cal	10.2
44	MSS	S	Minimum Cycle Start Speed	09999	RPM	0-9999	8.6
45	CM	C	Control Mode	000	-	0=torque without angle monitor,1=torque,2=angle,3=both	6.0-6.3
46	CIF	M	Auto Cycle Mode Flag	001	-	0=run,1=auto,2=start	5.4,8.6
47	JT	M	Jog Timer	0000.0	seconds	0-10.0	8.8
48	BYP	S	Spindle Bypass Flag	000	-	0=normal,1=bypass spindle	-
49	SUS	S	Setup Status	00000	-	READ ONLY	6.0,12.1
50	AF	S	Final Angle (TT to AT)	00000	degrees	READ ONLY	8.1
51	AS	S	Shutdown Angle (TT to Shutdown)	00000	degrees	READ ONLY	8.1
52	PPK	S	Peak Torque At Pretorque Shutdown	0000.0	UC	READ ONLY	8.1
53	RDT	S	Prevailing Torque (Average Of Samples)	0000.0	UC	READ ONLY	8.1
54	RPM	S	Peak Motor Speed	00000	RPM	READ ONLY	8.1
55	TCT	S	Total Cycle Time	000.00	seconds	READ ONLY	8.1
56	PTT	S	Pretorque Time (Cycle Start to TP)	000.00	seconds	READ ONLY	8.1
57	FTT	S	Fastening Time (Cycle Start to Shutdown)	000.00	seconds	READ ONLY	8.1
58	RT	S	Torque Rise Time (TT to Shutdown)	00.000	seconds	READ ONLY	8.1
59	RFT	S	Torque Rise And Fall Time (TT to AT)	00.000	seconds	READ ONLY	8.1
60	AN	S	Net Angle (TT to Cycle End)	00000	degrees	READ ONLY	8.1
61	ANF	S	Net Angle - Final Angle (AT to Cycle End)	00000	degrees	READ ONLY	8.1
62	MTA	M	Spare Out A On Time	000.00	seconds	READ ONLY	-
63	MTB	M	Spare Out B On Time	000.00	seconds	READ ONLY	-
64	RTT	C	Prevailing Torque Threshold	0000.0	UC	0-999.9	8.3

PROGRAMMING CODES IN NUMERICAL ORDER

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
65	PDT	S	Pretorque Shutdown Time	001.50	seconds	.10-5.00	8.5
66	CTA	M	Cycle End Time Before Shutdown	001.00	seconds	.10-30.00	8.5,8.6
67	CTB	M	Cycle End TIme After Shutdown	000.10	seconds	.10-5.00	8.5,8.6
68	TTS	C	Torque Threshold For Slope	0000.0	UC	0-999.9	8.4
69	TMR	C	Prevailing Torque Time Interval	00.000	seconds	0-2.500	8.3
70	SSZ	-	Statistics Sample Size	00005	samples	2-562	9.4
71	CCI	-	Contact Closure Input Functions	UNUSED	-	READ ONLY	-
72	OUT	-	Extra Output Functions	UNUSED	-	READ ONLY	-
73	RDD	S	Prevailing Torque Sample Difference	0000.0	UC/degrees	READ ONLY	8.1
74	MTC	M	Spare Output C On Time	000.00	seconds	READ ONLY	-
75	XIN	-	Extra Contact Closure Input Functions	UNUSED	-	READ ONLY	-
76	TPK	S	Peak Torque	0000.0	UC	READ ONLY	-
77	RSC	S	Shunt Calibration Resistor	00100	k ohms	43,87,100,175,350	-
78	GE	S	Gain Percent Error On Shunt Calibration	0000.0	%	READ ONLY	5.5
79	GF	S	Gain Factor (Actual / Ideal Shunt Cal)	01.000	-	READ ONLY	5.5
80	XFS	S	Transducer Full Scale Output	0020.0	mV	1.0-500.0	-
81	BHI	S	Bridge High Excitation	00005	V	5,10	-
82	BLO	S	Bridge Low Excitation	-00005	V	-10,-5,0	-
83	RB	S	Bridge Resistance	00700	ohms	100-10000	-
84	SDS	S	Shutdown Sense	001	-	1=normal,0=inverted	-
85	SDT	S	Shutdown Duration Timer	001.50	seconds	.1-100.00	8.6
86	AOK	M	Spare Output Functions	0	-	READ ONLY	-
87	TO	C	Torque Control Overshoot	0000.0	UC	0-999.9	6.4
88	AO	C	Angle Control Overshoot	00000	degrees	0-9999	6.4
89	SCT	C	Shunt Calibration Settling Time	00050	milliseconds	50=normal,0= off,10-2500	5.5,8.6
90	SIG	-	Statistics Update Mode	1	-	0=all samples,1=good only,2=all except faults	9.4
91	RP	-	Population Statistics Flush	0	-	set to 1=flush	9.5
92	RS	-	Sample Statistics Flush	0	-	set to 1=flush	9.5
93	RTO	M	Auto Cycle Run Timeout	00020	seconds	2-60	8.6
94	LP	-	Population Log Flag	0	-	set to 1=copy	10.2
95	LS	-	Sample Log Flag	0	-	set to 1=copy	10.2
96	LM	-	Log Mode	0	-	0=log all cycles,1=log rejects only	10.4

PROGRAMMING CODES IN NUMERICAL ORDER

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
97	CFF	-	Cycle Form Feed Count	050	logs/page	0-255	10.3
98	CTO	-	Auto Cal Time	00000	minutes	0-9999	5.5
101	ITR	-	Torque Trace Sample Interval	001	-	0-255	10.4
102	PTR	-	Torque Trace Print Flag	0	-	set to 1=copy	10.2
103	RPS	-	Erase Statistics For Spindle	000	-	set to 1=erase spindle 1 stats,2=erase spindle 2 stats	6.1,9.5
104	LC	-	Cycle Log Reprint Flag	000	-	set to 1-120=copy of 1-120 cycles,255=flush	10.2
105	LE	-	Exception Log Recall Flag	000	-	set to 1=copy,255=flush	10.2
106	LST	-	List Samples Request	00000	-	set to 0C0S=config C of spindle S after setting LCT	10.2
107	LVA	-	Extra Logged Variable A	000	-	SEE CHART	8.1,10.4
108	LVB	-	Extra Logged Variable B	000	-	SEE CHART	10.4
109	LVC	-	Extra Logged Variable C	000	-	SEE CHART	10.4
110	LVD	-	Extra Logged Variable D	000	-	SEE CHART	10.4
111	ADC	C	Statistics Target For Second Variable	00000	-	-32768-32767	8.1,9.4
112	LAH	C	Extra Logged Variable A High Limit	00000	-	0=disable,-9999-32000	8.1
113	LAL	C	Extra Logged Variable A Low Limit	00000	-	0=disable,-9999-32000	8.1
114	ADH	C	AFD Item High Limit	00000	-	0=disable,-9999-32000	8.1
115	ADL	C	AFD Item Low Limit	00000	-	0=disable,-9999-32000	8.1
116	SLP	S	Slope (TT to Shutdown)	00.000	UC/degrees	READ ONLY	8.1
117	FT	S	Torque Fall Time (Shutdown to AT)	00.000	seconds	READ ONLY	8.1
118	SA	S	Slope Before Threshold (TT to TTS)	00.000	UC/degrees	READ ONLY	8.1
119	SB	S	Slope After Threshold (TTS To Shutdown)	00.000	UC/degrees	READ ONLY	8.1
120	TRC	S	A/D Counts For TR	00000	A/D counts	READ ONLY	-
121	TCC	S	A/D Counts For TC	00000	A/D counts	READ ONLY	-
122	THC	S	A/D Counts For TH	00000	A/D counts	READ ONLY	-
123	TLC	S	A/D Counts For TL	00000	A/D counts	READ ONLY	-
124	TTC	S	A/D Counts For TT	00000	A/D counts	READ ONLY	-
125	MSC	S	A/D Counts For MST	00000	A/D counts	READ ONLY	-
126	RTC	S	A/D Counts For RTT	00000	A/D counts	READ ONLY	-
127	ATC	S	A/D Counts For AT	00000	A/D counts	READ ONLY	-
128	STC	S	A/D Counts For TTS	00000	A/D counts	READ ONLY	-
129	TPC	S	A/D Counts For TP	00000	A/D counts	READ ONLY	-
130	OFF	S	Amplifier Offset	00.000	-	READ ONLY	8.1

PROGRAMMING CODES IN NUMERICAL ORDER

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
131	RRG	S	Raw Shunt Calibration	00000	A/D counts	READ ONLY	8.1
132	ARG	S	Actual Shunt Calibration (RRG-OFF)	00000	A/D counts	READ ONLY	8.1
133	IRG	S	Ideal Shunt Calibration	01428	A/D counts	READ ONLY	5.5
134	BH	S	Host Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
135	BTA	-	Terminal Mode Baud Rate	09600	baud	300,1200,2400,4800,9600	10.1
137	PH	-	Host Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
138	PTA	-	Terminal Mode Parity	0	-	0=none, 1=odd, 2=even, 3=space	10.1
140	XA	-	Number Of Executive Passes In Last Sec	00000	-	-32768-32767	-
141	XB	-	Minimum Number Of Executive Passes	00000	-	0-9999	-
142	XC	-	Maximum Number Of Executive Passes	00000	-	READ ONLY	-
143	XD	-	Number Of 8259-Generated Interrupt 7's	00000	-	0-9999	-
144	XE	-	Population Stats Overflow	00000	-	0-9999	-
145	XF	S	Shunt Calibration Fault Code	000	-	READ ONLY	8.1
146	XG	S	Shutdown Cause Code	000	-	READ ONLY	8.1
147	XH	-	Cycle Log Queue Overflow	00000	-	0-9999	-
148	XI	-	Extra Data Item I	00000	-	-32768-32767	-
149	XJ	-	Override Gain Compensation	00000	-	0=normal,1=disable shunt cal gain correction	5.5
150	XK	-	Extra Data Item K	00000	-	-32768-32767	-
151	XL	-	Shunt Calibration Fault Shutdown Flag	1	-	0=shutdown on all faults,1=shutdown only on gross faults	5.5
152	XM	-	120 Hz Clocks for CTB	00000	-	READ ONLY	-
153	XN	-	120 Hz Clocks for CTA	00000	-	READ ONLY	-
154	XO	-	Unlock Combination	0000	-	READ ONLY	11.1
155	CYC	C	Cycle Count For Log	00000	-	0-9999	-
156	CYH	C	Cycle Count For Host	00000	-	0-9999	-
169	LCT	-	Total Cycles For Outputs	00000	cycles	0=all samples,or 1-32767 then set LST	10.2
170	PLT	-	Plot Data Request	000	-	set to 1=copy	10.2
172	LNG	-	Current Language Code	000	-	0=English,1=Spanish,2=German,3=French,4=Italian	11.2
173	TDS	C	Torque Shiftdown	0999.9	UC	0-999.9	6.5
174	CFO	M	Configuration Override	000	-	0-8	10.2
175	TBN	S	Tube Nut Mode	0	-	0=Normal,1=Tube Nut	13.4
176	SIN	-	Configuration Inputs Status	00000	-	READ ONLY	10.2
177	GCT	C	Gang Count Set	0	cycles	0-99	13.3

CODE	NAME	INDEX	DESCRIPTION	DEFAULT	UNITS	RANGE	SECTION
178	GCC	S	Gang Count Current	000	cycles	READ ONLY	8.1
179	TBS	S	Tube Nut State	0	-	READ ONLY	-
181	CHG	-	Change Code	000	-	0-255	-