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COOPER Tools

Programming Manual
PL12-1300 12/00

Cleco®

Electric Tool Control
TME-100 Series



Reference Document: PL12-1400 Parts Manual
For additional product information visit our website at http://www.coopertools.com

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1 Getting Started

1.1 Safe Work Practices Symbol



The signal word "Warning" identifies all notes on safe work practices in this operating instruction, alerting to hazards for life and health of people. Observe these notes and proceed with special care in the cases described. Pass all safety instructions on to other operators. In addition to the safety instructions in this operating instruction, the general local safety and accident prevention rules must be observed.

CAUTION!

The signal word "Caution!" identifies all portions of this operating instruction meriting special attention to ensure that guidelines, rules, hints and the correct work procedures are observed; and, to prevent damage to and destruction of the machine and/or parts.

1.2 Checking Your Unit

Take the time to ensure you have the required peripheral equipment and cables necessary to setup and run your unit. If you do not have all the necessary items, contact your distributor.

Refer to “Attachment A.1” on page 9 for illustration of your unit.

1.3 Software

Your unit has been pre-loaded with version 1.0 software and requires no additional software to begin your fastening process. If you are interfacing your unit with an external computer, interfacing software is required. Contact your distributor for the interfacing software.

1.4 Installing Unit

1.4.1 General



It is mandatory that national, state and local safety and wiring standards be followed during installation. These standards would take precedence over any information presented in this section.

To avoid the hazard of electrical shock or burn, the following instructions must be adhered to. Failure to follow these instructions may also cause damage to your unit and void existing warranties.

- **Do not energize the unit until all connections have been properly made.**
- **Equipment must be properly grounded before applying power. Units energized by cord and plug must be connected to an approved and properly grounded receptacle.**
- **All units must be energized by an isolated line.**
- **The unit door must always be closed and secured prior to energizing the unit.**
- **Ensure the power switch is in the "off" position prior to connecting the power cord.**

CAUTION!

Though it is not mandatory, the following instructions are highly recommended for the protected operation of your unit.

- **Use an isolation transformer and surge arrestor on the incoming isolated line.**
- **Use oversized feeder lines to reduce electrical noise and voltage drop.**

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1.4.2 Mounting

Each unit is used primarily as a single tool process/controller/monitor installed in a work station or work area. It may be wall mounted, table mounted, beam mounted, suspended overhead, pedestal mounted or used without mounting. Always choose a stable location to avoid the possibility of unit damage and/or operator injury through hitting, falling, vibration or inconvenient mounting. All cables attached to the unit should be located and secured in a manner to avoid potential operator and passer-by injury. As with all electrical equipment, the unit will produce some heat and should be located so that ambient air can freely circulate around the box.

Refer to Illustration Q of the parts manual, PL12-1400 for mounting hole dimensions.

1.4.3 Location Considerations

Your unit should be located to allow access to the front panel and connectors. The unit should be installed for unrestricted and comfortable viewing of the LCD & LED's by the operator. The LCD menu screen, key pad and side door connectors must be readily accessible for the setup. Dependent on the peripheral equipment purchased, the unit may be located in a remote position but should still be accessible.

Attachment of accessories and tools should also be considered with the installation locations. Items to be considered are:

- Location of printer (10 ft. cable maximum for the parallel interface).
- Attachment of a data collection unit, if desired.
- Attachment of redundant master transducers (less than 50 ft. is desirable).
- Attachment of remote annunciators, socket nest, or remote parameter select.
- Attachment of the unit in a network to a computer.
- Operation convenience/safety - keep cables off the floor or dangling in operator areas.

1.4.4 Source Power

Your unit, which is used as the process control and power supply for the Cleco DC electric tools, requires a power line with 10 amp capacity at 220-240 Volts AC (50/60 Hz) for the TME-111-30. The TME-111-15 requires a power line with 15 amp capacity at 110-130 Volts AC (50/60 Hz).

1.5 Connecting Unit

1.5.1 General

Connect all equipment to the correct input and output connectors. Refer to “Attachment A.1” on page 9 for proper port locations.



To avoid the hazard of electrical shock or burn the following instructions must be adhered to. Failure to follow these instructions may also cause damage to your unit and void existing warranties.

- **Ensure the power switch is in the "off" position and that the box cover is properly secured prior to connecting power cord.**
- **Ensure equipment has been properly grounded before applying power.**

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1.6 Energizing Unit

To avoid the hazard of electrical shock or burn the following instructions must be adhered to. Failure to follow these instructions may also cause damage to your unit and void existing warranties.

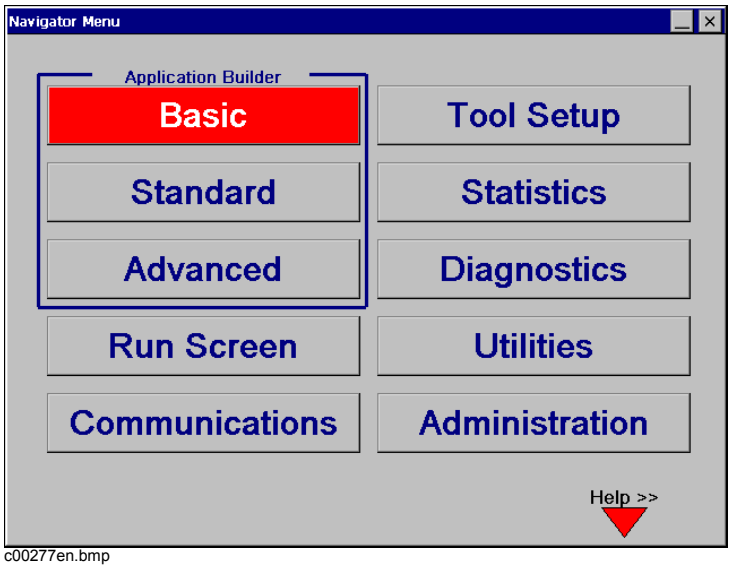
Upon application of power, the unit will initiate a self test. The initialization takes approximately 45 seconds.

The introduction screen shown below will be displayed for approximately 10 seconds and then the navigator menu will be displayed.



c00276de.bmp

Fig. 1-1: Introduction Screen



c00277en.bmp

Fig. 1-2: Navigator Menu

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After the Navigator Menu is displayed, verify the Tool Memory by entering Tool Setup. If Tool Memory is not active then select a tool using the Tool Library. Press the ship's wheel to return to the Navigator Menu.

Once Tool Setup is complete the application needs to be programmed. To do this, go to Basic Application Builder. From this screen torque, angle, and speed parameters must be entered for the selected application. Press the ship's wheel to return to the Navigator Menu.

The controller is now ready to begin fastening cycles. The torque and angle data can be viewed by pressing the Run Key. Tool and controller indicator lights will illuminate according to the results.

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Attachment A.1

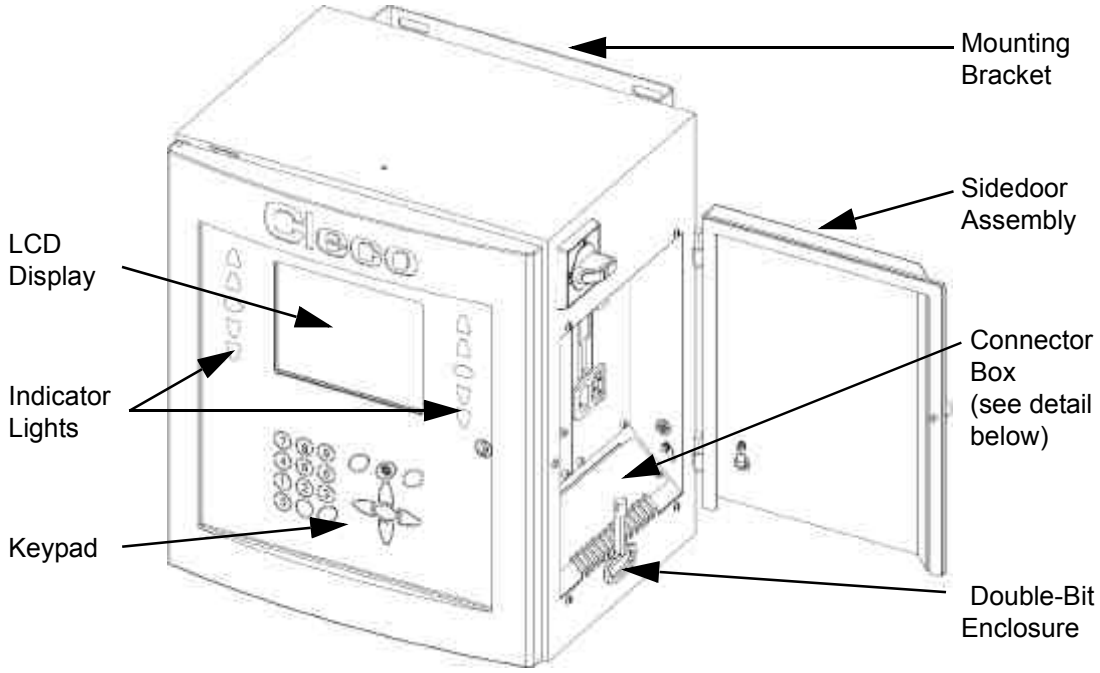


Fig. 1-3: Controller

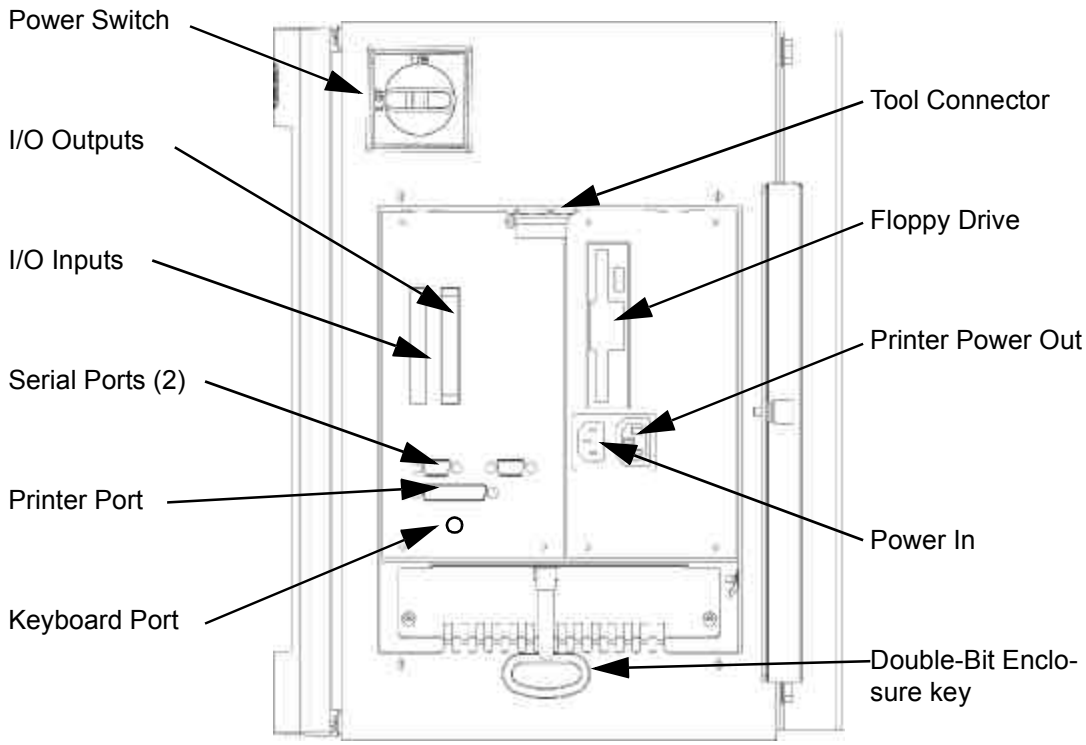


Fig. 1-4: Connector Box Detail

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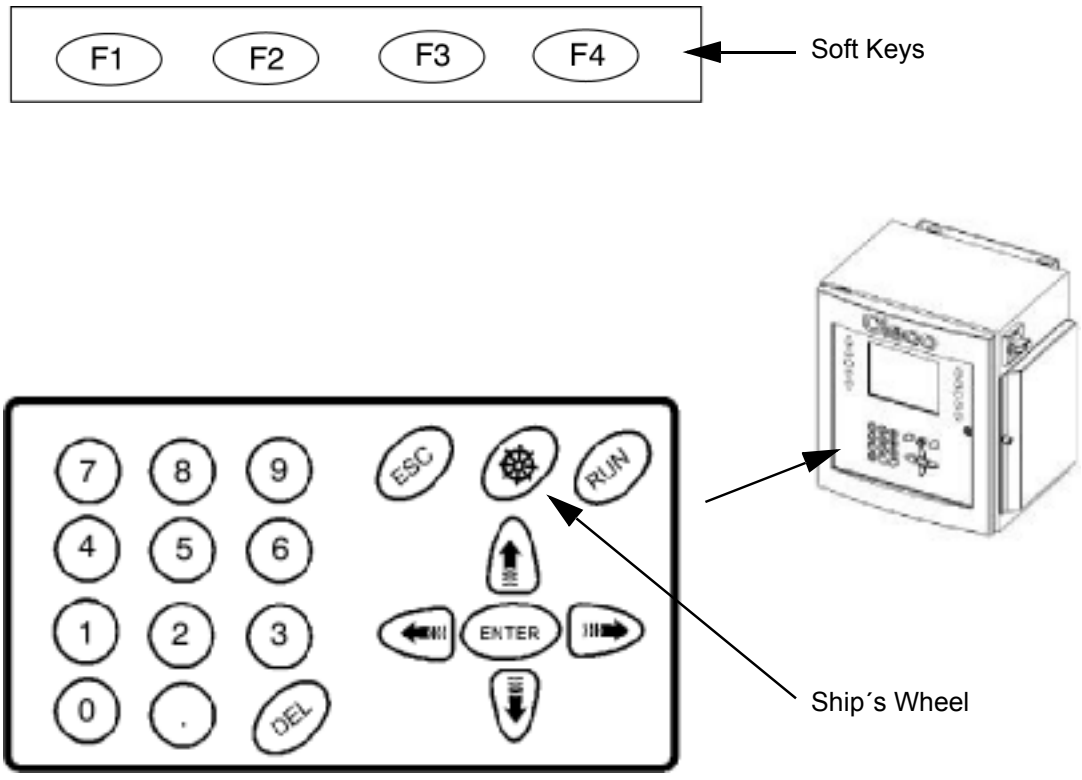
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2 Controller Specifications

2.1 Understanding the Keypad

The following is a brief explanation of the keypad keys. You will need to become familiar with these keys so you can smoothly program your unit.

Soft Keys (F1-F4)	- used to select functions based on the screen displayed.
ESC Key	- used at any time to return back one screen or exit the edit mode.
DEL Key	- used to delete a numerical value on the LCD screen.
Arrow Keys	- used to move the orange highlight around the screen.
ENTER Key	- used to accept an answer/value on the LCD screen.
Ships Wheel	- used at any time to return to the navigator menu.
Run	- used at any time to return to Run Screen.



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2.2 Specifications

2.2.1 Enclosure

Model	Weight*		Width		Height		Depth	
	lb	kg	in	mm	in	mm	in	mm
TME-111	80	36.4	16.5	419.1	17.5	444.5	12.3	312.4

* Mounting plate adds weight of 7 lbs / 3.2 kg and depth of 1.62 in / 41.1 mm

- Designed for NEMA 13/IP54 rating
- Lockable front door for customer specific key requirements
- Lockable 3-phase power switch
- Side door for connector/cable protection
- Removable Mounting Plate
- Removable, fully operational internal chassis
- Conductive front door gasket and lip to meet EMI regulations
- Orange textured powder coat

2.2.2 Display

- 7.7 in Passive Matrix Color LCD Module
- 640 x 480 resolution
- CCFT backlight
- Contrast and Brightness control

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2.2.3 Keypad Overlay

Key Definitions	
Key	**Description**
0-9	Numbers 0-9
.	Decimal point
DEL	Delete
ESC	Escape
	Navigator Menu
RUN	Run Screen
	Up Arrow
	Down Arrow
	Left Arrow
	Right Arrow
ENTER	Enter
Orange Border	4 Soft Keys

2.2.4 Indicators

5 Highly visible indicators

- 2 red groupings
- 1 green grouping
- 2 amber groupings
- Each grouping contains 12 high intensity LED´s @ 30 mcd each

2.2.5 CPU with PC/104

Minimum Requirements

- Pentium 133 Mhz
- 32 MB DRAM
- 16 MB DiskonChip
- 4 serial ports
- 1 parallel port
- Ethernet 100-Base T
- PC Keyboard input
- PC/104 Bus
- Floppy interface
- LCD/Flat Panel controller

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Arcnet PC/104 board

- Arcnet communication
- 4 +24 V inputs
- 12 +24 V outputs
- 24-position keypad decoder
- Battery-Backed SRAM, 1 MB

External I/O PC/104 board

- 8 optically isolated inputs
- 8 relay outputs
- Switching levels to meet IEC-1131-2

2.2.6 Internal AC Input Power

- Selectable 115 VAC @15 A or 230 VAC @ 10 A, +/-5% on all voltages
- Internal fuse
- Fault current circuit-breaker (10 mA)
- Isolation Transformer 4.5 kVA peak, meets VDA 0570 norm

2.2.7 Inernal DC Power

- Input: 85 VAC-264 VAC
- Output: +5 VDC @ 5 A, +12 VDC @ 1 A, +24 VDC @ 3 A, +/-5% on all voltages
- 110 W capability without a fan
- MTBF->20,000 hours

2.2.8 Input / Output Connectors

Tool Connector	Matrix MS83723R/2028N
Serial (2)	9-pin Male D-Shell
Parallel	25-pin Female D-Shell
Keyboard	Mini 6-DIN
Inputs (+24 V)	Phoenix MSTBV 2,5/12-GF-5,08 Order No. 1777170
Outputs	Phoenix ICV 2,5/12-GF-5,08 Order No. 1825792
Floppy	3.5in 1.44 MB
AC Power Input	Standard male receptacle
AC Power Output	Standard female receptacle

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Tool		
Pin #	**Description**	**Value**
1	+Excitation	+12 V +/- .05 V
2	-Excitation	0 V
3	Drehmomentsignal	0 to +5 V
4	0 V Drehmomentsignal	0 V
5	Tool Memory TXD -	-3 V to +3 V
6	Tool Memory TXD +	-3 V to +3 V
7	Tool Memory RXD -	-3 V to +3 V
8	Tool Memory RXD +	-3 V to +3 V
9	Resolver Carrier R1	7 VAC
10	Resolver Carrier R2	0 VAC
11	Resolver Cosine S1	7 VAC
12	Red LED	0 to +24 V
13	Signal GND	0 V
14	Yellow LED	0 to +24 V
15	Motor PE	0 V
16	Start Switch	0 to +24 V
17	Reverse Switch	0 to +24 V
18	+24V	+24 V
19	Motor Phase C	0 to 300 V
20	Transducer Calibration	0 to +5 V
21	Temperature Sensor +	0 to +5 V
22	Temperature Sensor -	0 to +5 V
23	Motor Phase B	0 to 300 V
24	Resolver Sine + S2	7 VAC
25	Resolver Cosine S3	0 VAC
26	Resolver Sine S4	0 VAC
27	Motor Phase A	0 to 300 V
28	Green LED	0 to +24 V
Housing	PE	0 V

Serial		
Pin #	**Description**	**Value**
1	DCD	-25 V to +25 V
2	RxD	-25 V to +25 V
3	TxD	-25 V to +25 V
4	DTR	-25 V to +25 V
5	GND	0 V
6	DSR	-25 V to +25 V
7	RTS	-25 V to +25 V

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Serial		
8	CTS	-25 V to +25 V
9	RI	-25 V to +25 V

Parallel		
Pin #	**Description**	**Value**
1	Strobe	0 to +5 V
2	Data 0	0 to +5 V
3	Data 1	0 to +5 V
4	Data 2	0 to +5 V
5	Data 3	0 to +5 V
6	Data 4	0 to +5 V
7	Data 5	0 to +5 V
8	Data 6	0 to +5 V
9	Data 7	0 to +5 V
10	Acknowledge	0 to +5 V
11	Busy	0 to +5 V
12	Paper Out	0 to +5 V
13	Select Out	0 to +5 V
14	Auto Feed	0 to +5 V
15	Error	0 to +5 V
16	Initialize	0 to +5 V
17	Select In	0 to +5 V
18	Gnd	0 V
19	Gnd	0 V
20	Gnd	0 V
21	Gnd	0 V
22	Gnd	0 V
23	Gnd	0 V
24	Gnd	0 V
25	Gnd	0 V

Keyboard		
Pin #	**Description**	**Value**
1	Data	0 to +5 V
2	N/C	N/A
3	Gnd	0 V
4	Power	0 to +5 V
5	Clock	0 to +5 V

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Inputs		
Pin #	**Description**	**Value**
1	+24 V (Output)	+24 VDC
2	Input 0	0 to +24 V
3	Input 1	0 to +24 V
4	Input 2	0 to +24 V
5	Input 3	0 to +24 V
6	Input 4	0 to +24 V
7	Input 5	0 to +24 V
8	Input 6	0 to +24 V
9	Input 7	0 to +24 V
10	Input Common (Input)	0 V
11	Signal Gnd (Output)	0 V
12	Spare	N/A

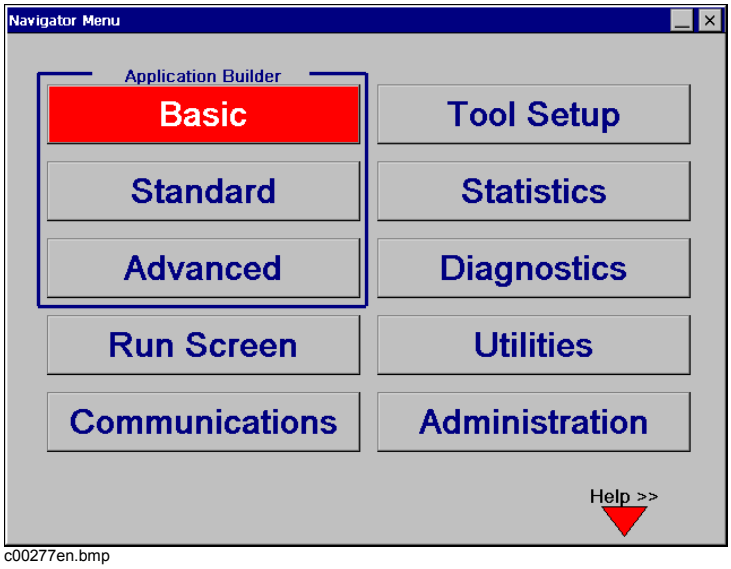
Outputs		
Pin #	**Description**	**Value**
1	+24 V (Output)	+24 VDC
2	Output Common (Output)	0 to 30 V
3	Output 0	0 to 30 V
4	Output 1	0 to 30 V
5	Output 2	0 to 30 V
6	Output 3	0 to 30 V
7	Output 4	0 to 30 V
8	Output 5	0 to 30 V
9	Output 6	0 to 30 V
10	Output 7	0 to 30 V
11	Signal Gnd (Output)	0 V
12	Spare	N/A

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3 Programming

3.1 Navigator Menu



c00277en.bmp

Fig. 3-1: Navigator Menu

3.1.1 Basic Navigation Instructions

Each field in a screen is selectable with an orange highlight using the 4 arrow keys and Enter. Upon entering a screen the top left most field is always highlighted. The Navigator key (ship's wheel) will always return the user to the Navigator Menu. At the bottom of the screen 4 soft keys are available. These functions will change from screen to screen. In some cases the screen label will contain the (>>) character to indicate more functions are available when the key is pressed.

To edit a textbox the user can use 0-9 or the DEL keys. To exit the edit mode the user can press the arrow keys to move the highlight or press the ESC key. The ESC key will return the original value.

In order to describe the soft key functions the left soft key is referred to as F1, center left soft key F2, center right soft key F3 and right soft key F4. They are located in the orange display border. F4 always functions as Help for that screen.

Applications are selectable 1-8.

Stages are selectable 1-6.

3.1.2 Password Function

If the user exits a section with programmable data (Basic, Standard, Advanced, Communications, Tool Setup) that has been changed, then the password entry dialog will be displayed. If no password is activated, then only the confirm entry in the password dialog is displayed. Once the password has been entered, it must be entered each time an appropriate screen is exited.

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3.1.3 Navigator Menu

Basic Application Builder

Basic Application Builder allows the user to graphically select and program a two-stage rundown for Torque Control/Angle Monitor (Sequence 11/Sequence 30) or Angle Control/Torque Monitor (Sequence11/Sequence 50) for any of the 8 Applications. The user only enters Torque, Angle, and Speed Setpoints in one screen. Other parameters such as timers, etc are automatically defaulted to pre-determined values.

Standard Application Builder

Standard Application Builder allows the user to program up to a 6-stage rundown for any of the 8 Applications. Once the fastening sequences are selected for each stage, the associated Torque, Angle, Speed, and Advanced parameters can be programmed.

Advanced Application Builder

Advanced Application Builder allows the user to View and Edit all 8 Application setups at once, and perform I/O Mapping. The Application Matrix shows an overview of Application and Stage programming by displaying the selected Fastening Sequence for each stage. Stages can be copied from one to the other or programmed directly from the Parameter soft key. I/O Mapping lets the user select from a list of functions and assign that function to a given input or output.

RUN Screen

The Run Screen button takes the user directly to the display for Torque, Angle, and Status Indicator Labels. The Oscilloscope function used for diagnosing torque traces is also located in the Run Screen.

Communications

The Communications Setup allows the user to configure all communications for the Printer and Serial Data Transmission. Appropriate communications settings for protocol, port, baud rate, etc can be set in this screen.

Tool Setup

The Tool Setup displays the Tool Memory Data and allows the user to modify this information by changing it directly or selecting from the Tool Library. The user can also create and save custom tool setups under new model numbers.

Statistics

Chronological History and associated statistics are viewable from this screen. Data can be erased and printed as well.

Diagnostics

The System Diagnostics contains screens to determine if the system is functioning properly. There are diagnostics for I/O, Arcnet, Tool and Tightening Module, Serial Communications, and Transducer Calibration.

Utilities

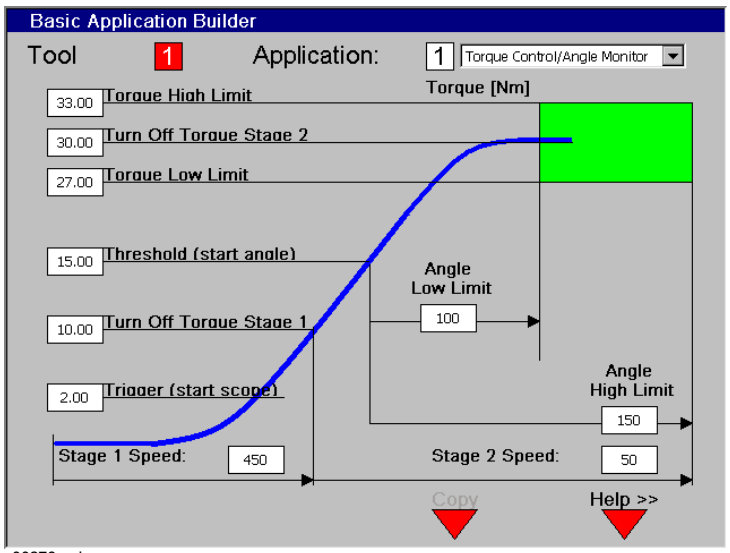
Utilities contains functions for upgrading or changing the system software. From the Utilities screen the user can update the TME-100 application software from the floppy, install a new firmware version in the Tightening Module from the floppy, or set the application software language (English, German, Spanish, Portuguese).

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Administration

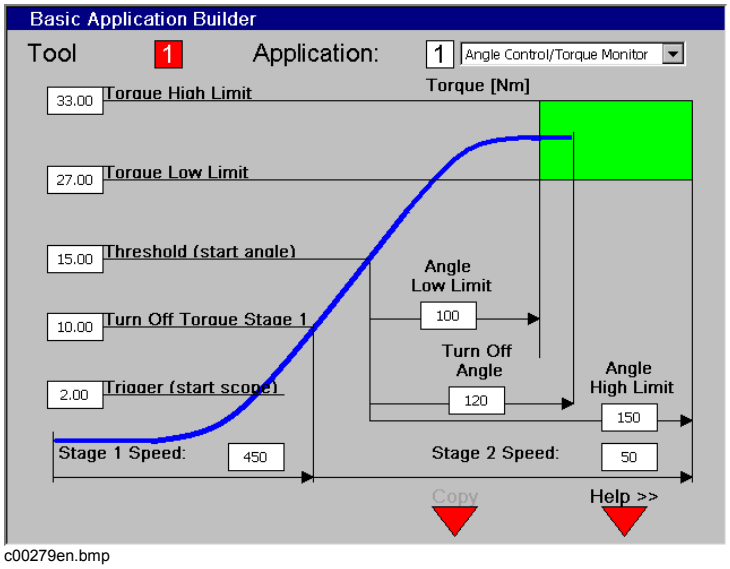
From the Administration screen the user can load, save and configure system information. Administration functions include loading and saving the system parameters to a diskette, setting date and time, setting password protection, and printing the system parameters.

3.2 Basic Application Builder



c00278en.bmp

Fig. 3-2: Torque Control / Angle Monitor



c00279en.bmp

Fig. 3-3: Angle Control / Torque Monitor

The Basic Application Builder allows the user to select a typical two-stage rundown where the first stage is a high speed rundown and the second stage is a lower speed rundown that controls on either torque or angle.

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Fastening Strategies Torque Control/Angle Monitoring (Sequence 11/Sequence 30) or Angle Control/Torque Monitoring (Sequence 11/Sequence 50) are selectable from the dropdown list-box in the upper right hand corner of the screen. Once a Strategy is selected, the appropriate Parameters will be displayed for programming.

3.2.1 Basic Parameters for Torque Control / Angle Monitor

- Trigger Torque [Nm] - Torque to start collecting oscilloscope data.
- Turnoff Torque Stage 1 [Nm] - Torque to change from stage 1 to stage 2.
- Threshold Torque [Nm] - Torque to begin counting angle in stage 2.
- Torque Low Limit [Nm] - Minimum acceptable torque.
- Turnoff Torque Stage 2 [Nm] - Torque to turnoff the tool.
- Torque High Limit [Nm] - Maximum acceptable torque.
- Angle Low Limit [Deg] - Minimum acceptable angle.
- Angle High Limit [Deg] - Maximum acceptable angle.

3.2.2 Basic Parameters for Angle Control / Torque Monitor

- Turnoff Angle [Deg] - Angle to turnoff the tool.
- The rest of the Parameters are the same as Torque Control/Angle Monitor except Turnoff Torque Stage 2 is eliminated.

Below are the acceptable ranges for each Parameter and its default value. For initial programming, the Parameters automatically use the default values.

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3.2.3 Basic Application Builder Parameters

Parameter Name	Range	Default
Fastening Strategy	Torque Control/Angle Monitor Angle Control/Torque Monitor	Torque Control/Angle Monitor
Trigger Torque [Nm]	0 to Tool Max	0.0
Turnoff Torque Stage 1 [Nm]	0 to Tool Max	0.0
Threshold Torque [Nm]	0 to Tool Max	0.0
Torque Low Limit [Nm]	Threshold to Tool Max	0.0
Turnoff Torque Stage 2 [Nm]	Low Limit to Tool Max	0.0
Torque High Limit [Nm]	Turnoff to 1.2 TQ-Cal. value	0.0
Angle Low Limit [Deg]	0 to 9999	0.0
Turnoff Angle [Deg]	Low Limit to 9999	0.0
Angle High Limit	Turnoff to 9999	0.0
Speed Stage 1 [RPM]	0 to Tool Max	80% of Tool Max
Speed Stage 2 [RPM]	0 to Tool Max	50

In the Basic Application Builder some parameters are not programmable and are also set to default values. These values are located in the Standard Application Builder under Advanced Parameters. However, if the parameters are changed using the Standard Application Builder, then the Basic Application Builder does not reset them back to the default values.

3.2.4 Advanced Parameter Default Values

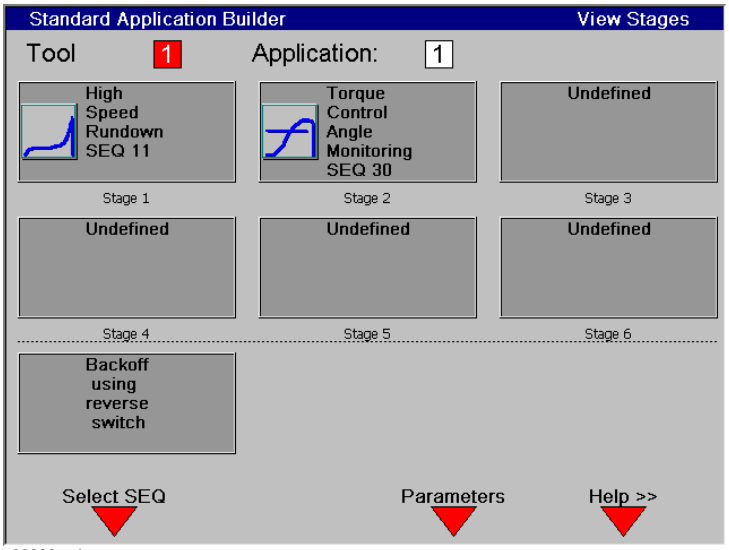
Parameter Name	Stage 1	Stage 2
Start delay time [mS]	0	0
Start spike time [mS]	0	0
Max. Fastening time [mS]	10000	10000
End delay time [mS]	0	30
Torque Filter Factor	1	1
If NOK go to stage	Stop	Stop
Print	None	All

If an Application with more than two stages is required, or if a different Fastening Strategy has previously been selected for the Application than described above, the Standard Application Builder must be used.

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3.3 Standard Application Builder

3.3.1 Standard Application Builder / View Stages



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Fig. 3-4: View Stages

From View Stages, Stages 1-6 and a Backoff Stage are programmable for a given tool and application.

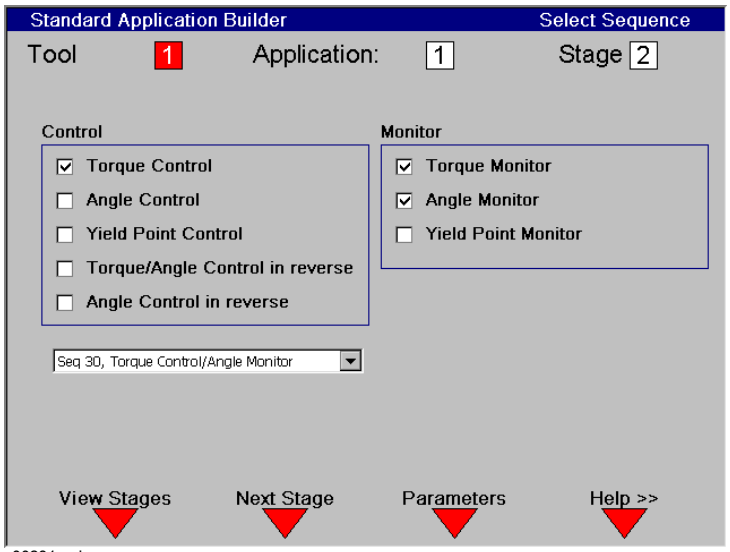
When the tool is started, each Stage having a programmed Fastening Sequence will be run in succession based on the results from the previous stage. The Backoff Stage is used when the tool is run in back-off direction or with the reverse button activated.

If a sequence has not been selected for a stage, then N/A is displayed for that stage. Otherwise the Sequence number, description and icon are displayed. Sequences can be selected or changed using the Select Seq (F1) soft key. This key is only valid when stages 1-6 are highlighted. The Fastening Sequence for the Backoff Stage is selected automatically.

The parameters for any stage can be programmed using the Parameters (F3) soft key. This key is only valid when a Sequence has been selected for a given Stage.

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3.3.2 Standard Application Builder / Select Sequence



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Fig. 3-5: Select Sequence

Fastening Sequences are selectable for a given Tool, Application and Stage by using the Control and Monitor check boxes or selecting a Fastening Sequence directly from the dropdown listbox.

The following Fastening Sequences or Fastening Strategies are available:

Sequence 11	High Speed Rundown
Sequence 30	Torque Control/Angle Monitor
Sequence 50	Angle Control/Torque Monitor
Sequence 41	Angle Controlled Backoff

When a Sequence is selected the Control and Monitor check boxes and Fastening Sequence listbox will both display the appropriate settings for the selected Sequence. An icon portraying the selected Sequence is also displayed in the bottom right-hand corner.

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The following table shows a matrix of the Control and Monitor schemes for each Sequence:

	Sequence 11	Sequence 30	Sequence 50	Sequence 41
Control				
Torque Control	X	X		
Angle Control			X	
Yield Control				
Torque Control Reverse				
Angle Control Reverse				X
Monitor				
Torque Monitor		X	X	
Angle Monitor		X	X	X
Yield Monitor				

The Parameters (F3) soft key allows the user to program all associated control parameters for the selected Sequence. It is only valid when a Sequence has been selected.

The following is a detailed description of each Fastening Sequence:

Sequence 11
High Speed Rundown

This tightening method is generally used as a fast pre-tightening stage. The torque transducer integrated into the nutrunner measures the torque during the tightening. The value is processed by the control system. When the defined Turnoff Torque is reached the nutrunner is shut off. Thereafter the peak torque is measured during a dwell time and is then processed as the tightening torque of the bolt in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. When the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

Sequence 30
Torque Control with Torque and Angle Monitoring

This tightening stage is normally preceded by a fast pre-tightening stage. The transducer integrated into the nutrunner measures the torque and the resolver measures the angle during the tightening. The values are processed by the control system. When the threshold torque is reached the angle count starts. When the Turnoff Torque is reached the nutrunner is shut off. Thereafter the peak torque is measured during a dwell time and is then processed as the tightening torque of the bolt together with the evaluation of the rundown in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. When the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

Sequence 50
Angle Controlled Tightening with Angle and Torque Monitoring

This tightening sequence is generally preceded by a fast pre-tightening cycle. The transducer integrated into the nutrunner measures the torque and the resolver measures the angle during the rundown. The values are processed by the control system. When the Turnoff angle is reached the nutrunner is shut off. Thereafter the final angle and the peak torque are measured during a dwell time, and these tightening values for the bolt are then processed together with the evaluation of the rundown in the control system. These values are displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communica-

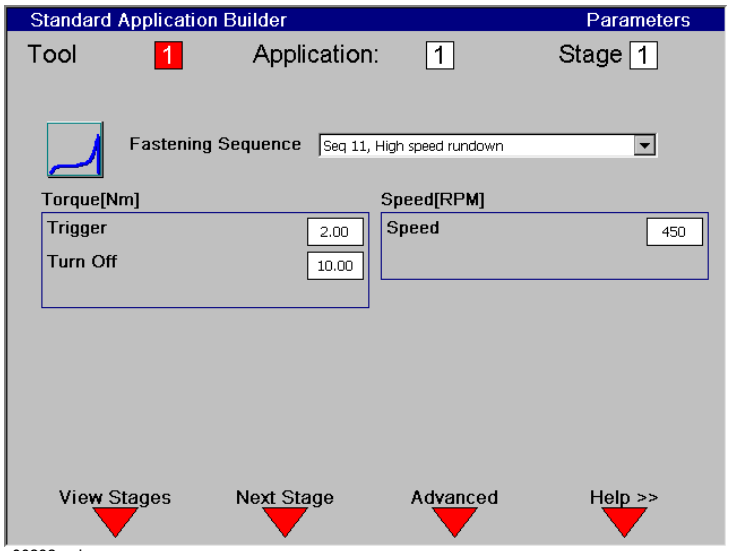
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tion. When the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

Sequence 41
Angle Controlled Back-off with Angle Monitoring

This fastening sequence is generally used to loosen a bolt a specified number of degrees. The resolver integrated into the nutrunner measures the angle during the untightening. The value is processed by the control system. When the Turnoff angle is reached the nutrunner is shut off. Thereafter the final angle is measured during a dwell time and is then processed as the back-off angle of the bolt together with the evaluation of the untightening in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. In this stage the oscilloscope funktion is not supported.

3.3.3 Standard Application Builder / Parameters



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Fig. 3-6: Parameters

Parameters are programmable for a given Tool, Application and Stage based on the selected Fastening Sequence and only the appropriate parameters are displayed for the selected Fastening Sequence.

The Next Stage (F2) key will increment to the next stage until it reaches the last stage having a selected Sequence. It will then rollover to the first stage. In order to add a stage without a selected Sequence the user must highlight the stage field and enter a number 1-6.

The following is a detailed description of each Fastening Sequence and associated Parameters:

Sequence 11
High Speed Rundown

This tightening method is generally used as a fast pre-tightening stage. The torque transducer integrated into the nutrunner measures the torque during the tightening. The value is processed by the control system. When the defined Turnoff Torque is reached the nutrunner is shut off. Thereafter the peak torque is measured during a dwell time and is then processed as the tightening torque of the bolt in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. When

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the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

The following parameters are programmable from the Standard Application Builder:

- Fastening Sequence = 11
- Trigger Torque (Nm) = trigger torque, beginning of measurement for the graphic display.
- Turnoff Torque (Nm) = turnoff torque for the pre-tightening stage.
- Speed = max speed of the nutrunner during the pre-tightening stage.

Parameter Name	Range	Default
Fastening Strategy	Sequence 11	High Speed Rundown
Trigger Torque [Nm]	0 to Tool Max	0.0
Turnoff Torque [Nm]	Trigger to Tool Max	0.0
Speed Stage 1 [RPM]	0 to Tool Max	80% of Tool Max

Sequence 30
Torque Control with Torque and Angle Monitoring

This tightening stage is normally preceded by a fast pre-tightening stage. The transducer integrated into the nutrunner measures the torque and the resolver measures the angle during the tightening. The values are processed by the control system. When the threshold torque is reached the angle count starts. When the Turnoff Torque is reached the nutrunner is shut off. Thereafter the peak torque is measured during a dwell time and is then processed as the tightening torque of the bolt together with the evaluation of the rundown in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. When the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

The following parameters are programmable in the Standard Application Builder:

- Sequence input value = 30
- Trigger Torque (Nm) = trigger torque, beginning of measurement for the graphic display.
- Threshold Torque (Nm) = threshold torque, beginning of angle counting
- Turnoff Torque (Nm) = shut-off torque for the stage.
- Torque High Limit (Nm) = max torque, high limit for torque reached.
- Torque Low Limit (Nm) = min torque, low limit for torque reached.
- Angle High Limit (deg) = maximum angle, high limit for angle reached. The nutrunner will stop if this value is exceeded
- Angle Low Limit (deg) = minimum angle, low limit for angle reached.
- Speed = max speed of the nutrunner during the tightening stage.

Parameter Name	Range	Default
Fastening Strategy	Sequence 30	Torque Control/ Angle Monitor
Trigger Torque [Nm]	0 to Tool Max	0.0
Threshold Torque [Nm]	0 to Tool Max	0.0
Torque Low Limit [Nm]	0 to Tool Max	0.0

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Parameter Name	Range	Default
Turnoff Torque [Nm]	Low Limit to Tool Max	0.0
Torque High Limit [Nm]	Turnoff to 9999	0.0
Angle Low Limit [Deg]	0 to 9999	0.0
Angle High Limit	Low Limit to 9999	0.0
Speed [RPM]	0 to Tool Max	50

Sequence 50
Angle Controlled Tightening with Angle and Torque Monitoring

This tightening sequence is generally preceded by a fast pre-tightening cycle. The transducer integrated into the nutrunner measures the torque and the resolver measures the angle during the rundown. The values are processed by the control system. When the Turnoff angle is reached the nutrunner is shut off. Thereafter the final angle and the peak torque are measured during a dwell time, and these tightening values for the bolt are then processed together with the evaluation of the rundown in the control system. These values are displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. When the trigger torque is reached the torque curve is recorded and can be viewed and evaluated using the oscilloscope function.

The following parameters are programmable in the Standard Application Builder:

- Sequence input value = 50
- Trigger Torque (Nm) = trigger torque, beginning of measurement for the graphic display
- Threshold Torque (Nm) = threshold torque, beginning of angle counting
- Turnoff Angle (deg) = shut-off angle for the stage
- Angle High Limit (deg) = maximum angle, high limit for angle reached
- Angle Low Limit (deg) = minimum angle, low limit for angle reached
- Torque High Limit (Nm) = max torque, high limit for torque reached and safety shut-off
- Torque Low Limit (Nm) = min torque, low limit for torque reached
- Speed = max speed of the nutrunner during the tightening stage

Parameter Name	Range	Default
Fastening Strategy	Sequence 50	Angle Control/ Torque Monitor
Trigger Torque [Nm]	0 to Tool Max	0.0
Threshold Torque [Nm]	0 to Tool Max	0.0
Torque Low Limit [Nm]	0 to Tool Max	0.0
Torque High Limit [Nm]	Low Limit to Tool Max.	0.0
Angle Low Limit [Deg]	0 to 9999	0.0
Turnoff Angle [Deg]	Low Limit to 9999	0.0
Angle High Limit	Turnoff angle to 9999	0.0
Speed Stage [RPM]	0 to Tool Max	50

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Sequence 41
Angle Controlled Back-off with Angle Monitoring

This fastening sequence is generally used to loosen a bolt a specified number of degrees. The resolver integrated into the nutrunner measures the angle during the untightening. The value is processed by the control system. When the Turnoff angle is reached the nutrunner is shut off. Thereafter the final angle is measured during a dwell time and is then processed as the back-off angle of the bolt together with the evaluation of the untightening in the control system. This value is displayed on the Run Screen and can be output to a printer or transmitted to other system components by data communication. In this stage the oscilloscope function is not supported.

The following parameters are programmable in the Standard Application Builder:

- Sequence input value = 41
- Turnoff Angle (deg) = shut-off angle, back-off angle
- Angle High Limit (deg) = maximum angle, high limit for angle reached.
- Angle Low Limit (deg) = minimum angle, low limit for angle reached.
- Speed = max speed of the nutrunner during the back-off stage.

Parameter Name	Range	Default
Fastening Strategy	Sequence 41	Angle Control in Reverse
Angle Low Limit [Deg]	0 to 9999	0.0
Turnoff Angle [Deg]	Low Limit to 9999	0.0
Angle High Limit	Turnoff angle to 9999	0.0
Speed Stage [RPM]	0 to Tool Max	500

Backoff Using Reverse Switch (Sequence 41 or Sequence 46)

The Backoff stage is automatically set to Sequence 46 for a tubenut tool and Sequence 41 for all others. The automatic selection of a tube nut tool depends on a "T" in the tool model number. That means, if a "T" appears in the model number a tube nut tool is expected. This fastening sequence is selected when the tool is run in the reverse or untighten direction. It is also automatically used to return a tubenut tool to the home position on every other trigger pull. The resolver integrated into the nutrunner measures the angle during the untightening. The measured angle value is processed by the control system. When the Turnoff angle is reached the nutrunner is shut off. For a tubenut tool, the Turnoff angle is programmed so that the attachment will always turn far enough to reach the home position and stop based on the torque reaction against the pawl.

The following parameters are programmable in the Standard Application Builder:

- Speed [rpm] = Max speed of the nutrunner during the backoff stage.
- LED flashing in reverse = If yes, the tool LED's will blink when the tool is in reverse.
- NOK after reverse = If yes, the controller will report an NOK if the tool is run in reverse.

Parameter Name	Range	Default
Speed Stage [RPM]	0 to Tool Max	500 or 30% of Tool Max (tubenut)
LED flashing in reverse	Yes/No	No
NOK after reverse	Yes/No	No

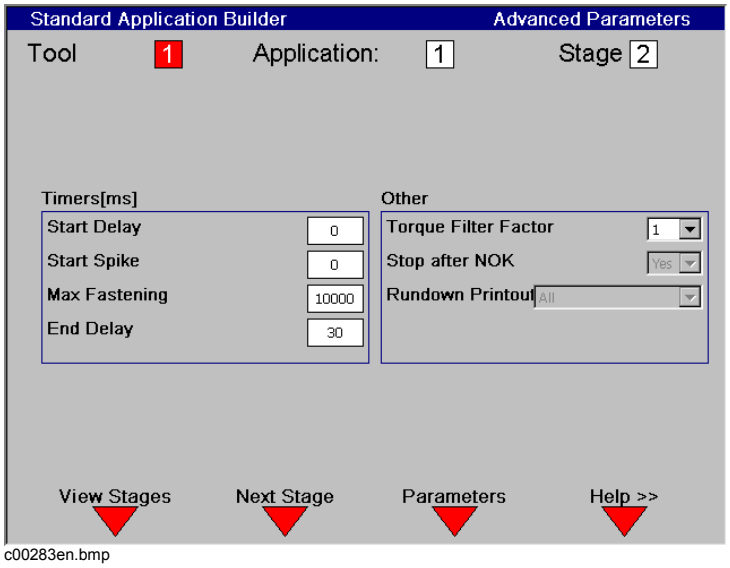
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The backoff parameters that are not displayed are set to values as in the table below.

Parameter Name	Sequence 41	Sequence 46
Start delay time [mS]	0	0
Start spike time [mS]	0	0
Max. Fastening time [mS]	10000	10000
End delay time [mS]	30	30
Torque Filter Factor	1	1
Torque Target	---	3,5% of Tool max. Torque
Torque High Limit	---	10% of Tool max. Torque
Angle Low Limit	0	0
Angle Target	9999	370
Angle High Limit	9999	380

For at tube nut tool the maximum speed for backoff ist 30% of Tool Max Speed. It is not possible to enter a higher value.

3.3.4 Standard Application Builder / Advanced Parameters



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Fig. 3-7: Advanced Parameters

The user can enter the Advanced Parameters using the Advanced (F3) soft key from the Parameter screen. These parameters are identical regardless of the selected Fastening Sequence.

The Next Stage (F2) key will increment to the next stage until it reaches the last stage with a selected Sequence. It will then rollover to the first stage. In order to add a stage without a selected Sequence the user must highlight the stage field and enter a number 1-6.

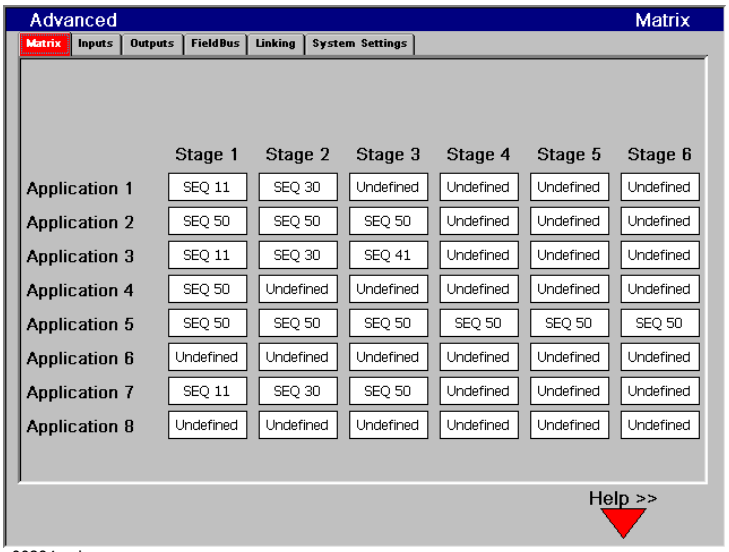
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Advanced Parameters

- Start delay time [mS] = time delay before the stage will start.
- Start spike time [mS] = time delay for the control system to start measuring torque after the stage starts.
- Max. Fastening time [mS] = max time for the tool to run during the stage.
- End delay time [mS] = time delay from tool turnoff until shut-off of measured value recording.
- Torque Filter Factor = used for torque averaging.
- If NOK go to stage = gives the control system direction if the stage is NOK.
- Rundown Printout = gives the control system direction for when to print.

Advanced Parameters	Default	Range of Values
Start delay time [mS]	0	0 - 999
Start spike time [mS]	0	0 - 999
Max. Fastening time [mS]	10000	1 - 60000
End delay time [mS]	30	0 - 999
Torque Filter Factor	1	1, 2, 4, 8, 16, 32
If NOK go to stage	Stop	Next; Error; Stop; 1; 2; 3; 4; 5; 6
Rundown Printout	None	OK; NOK; All; None

3.3.5 Advanced Application Builder / Application Matrix



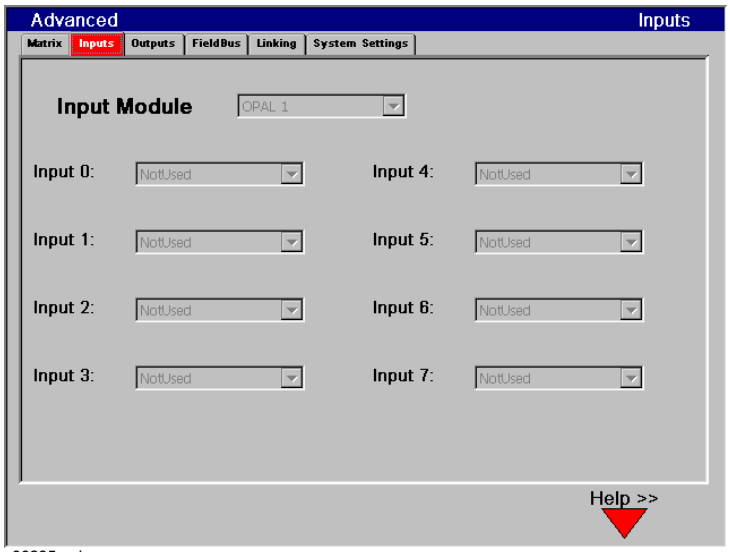
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Fig. 3-8: Application Matrix

The Application Matrix is a display matrix of 8 Applications vs. 6 Stages showing the selected Sequence number for each stage. It gives the user an overview of controller programming in a single screen.

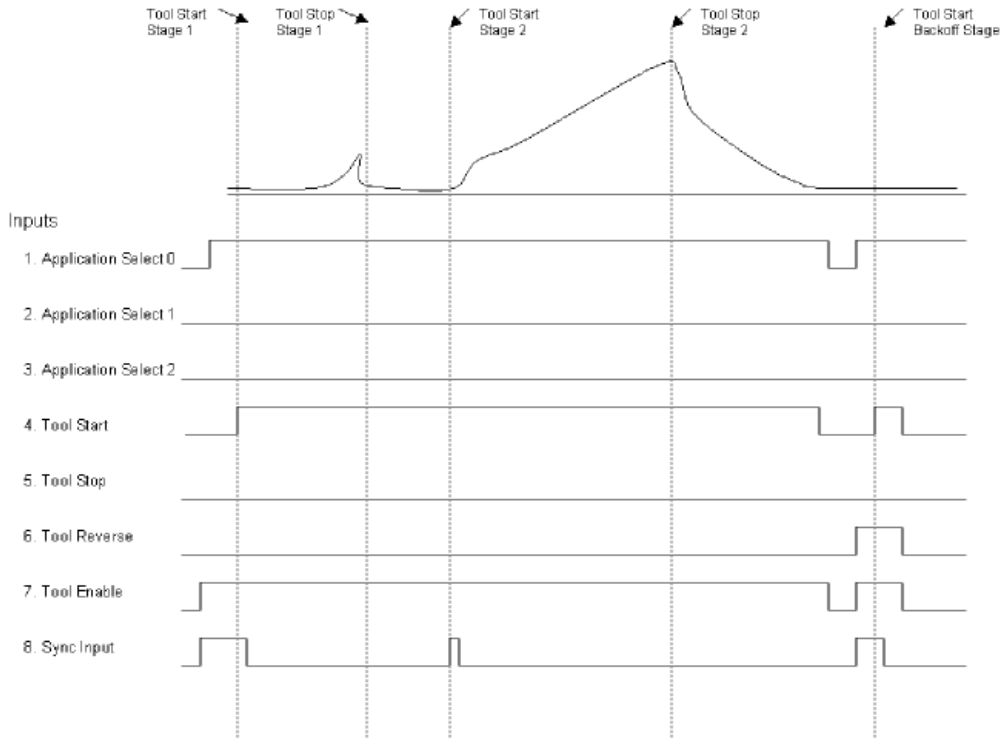
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3.3.6 Advanced Application Builder / Inputs



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Fig. 3-9: Inputs



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Fig. 3-10: Input Timing Diagram

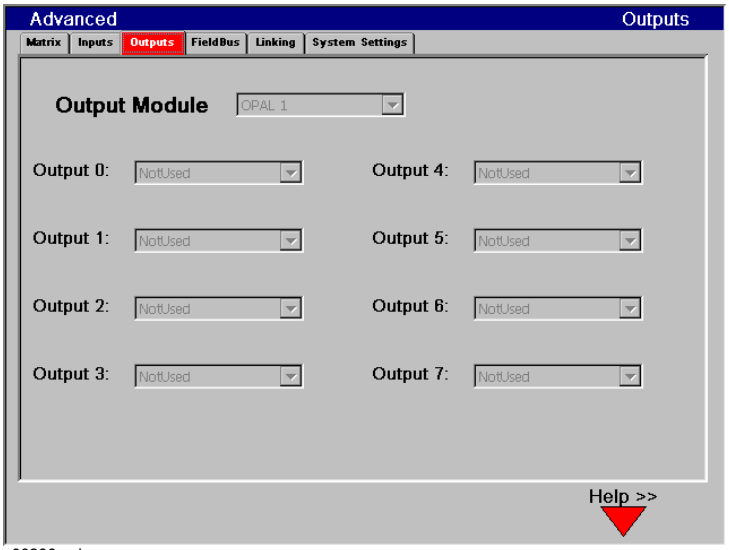
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Eight optically isolated, +24V inputs are available at the Phoenix input connector under the right side door and are defined as follows:

Inputs 0-2	Application Select 0-2: Application Selects 0-2 are used to select Applications 1-8 using a binary count of 0-7 where Applicaton Select 0 is the least significant bit. This feature overrides application changes from the keypad.
Input 3	Tool Start (LCD and Outputs also clear): Starts the tool. Works in parallel with the tool start switch.
Input 4	Activates the inputs I0 to I2 and I6.
Input 5	Tool Reverse: When active prior to tool start, the tool will run counter-clockwise using the Backoff Strategy. Works in parallel with the tool reverse actuator.
Input 6	Tool Enable: When active allows the tool to start in conjunction with Tool Start.
Input 7	Synchronization Input: When active allows the tool to start from stage to stage in conjunction with Tool Start.

All inputs are active high. They are referenced to an isolated Input Common (pin 10). When using the internal +24V (pin 1) to activate these inputs, you must connect Input Common (pin 10) and GND (pin 11).

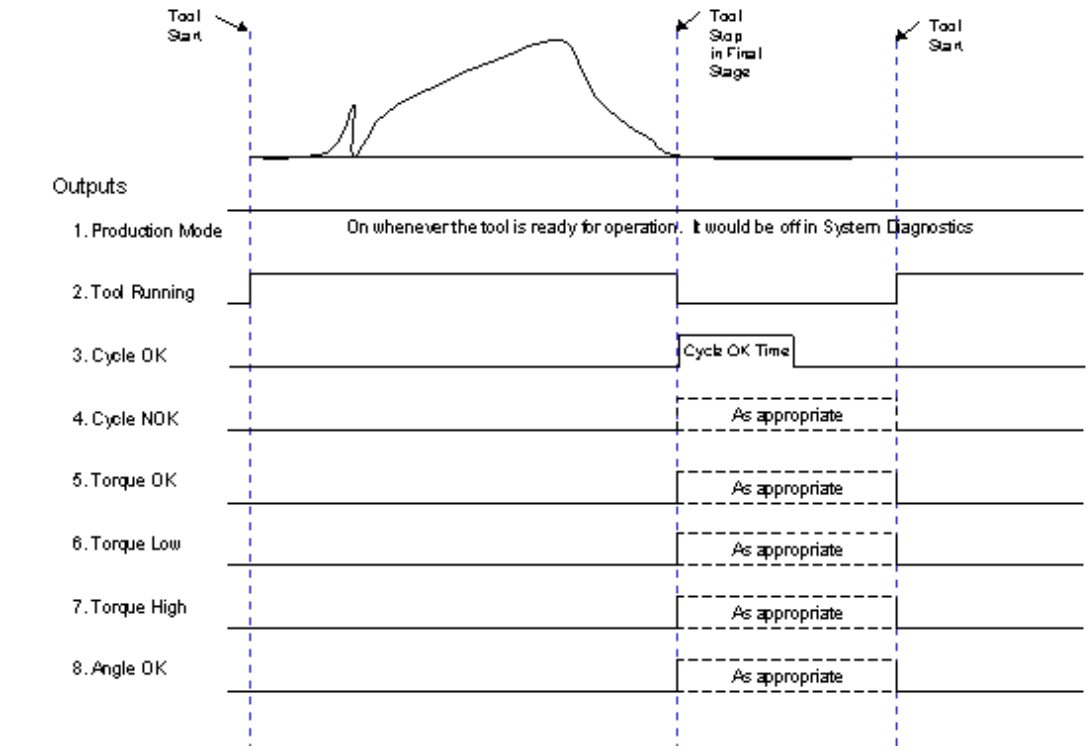
3.3.7 Advanced Application Builder / Outputs



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Fig. 3-11: Outputs

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Fig. 3-12: Output Timing Diagram

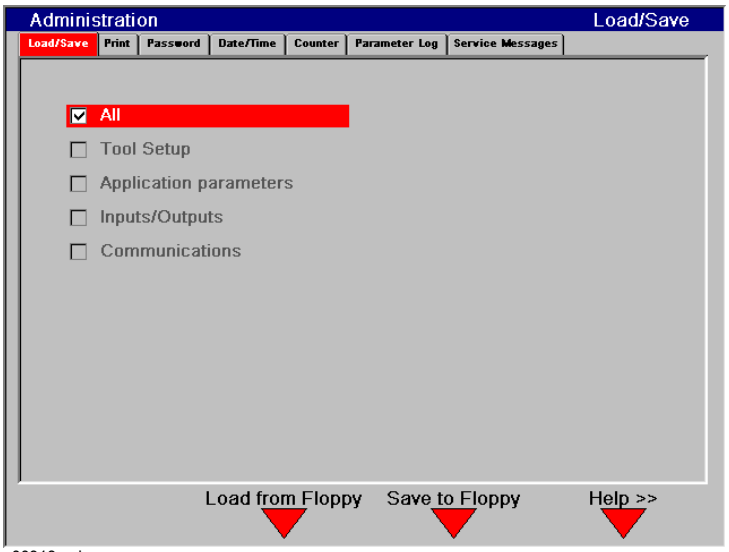
Eight relay outputs are availiable at the Phoenix output connector under the right side door and are defined as follows:

Output 0	Cycle OK: Active if Torque/Angle/Yield are within programmed limits.
Output 1	Cycle NOK: Active if Torque/Angle/Yield are outside limits or some other error has occurred.
Output 2	Torque Low: Active if Peak Torque < Torque Low Limit
Output 3	Torque High: Active if Peak Torque > Torque High Limit
Output 4	Angle Low: Active if Final Angle < Angle Low Limit
Output 5	Angle High: Active if Final Angle > Angle High Limit
Output 6	Cycle Complete: Active whenever the fastening sequence is complete
Output 7	Synchronization Output: Active at the end of each stage to signal a stage is complete.

All relay outputs are active high. One side of all of the relay contacts is tied to a common supply voltage point called Output Common (pin 2). When using the internal +24V (pin 1) as a source for these outputs, you must connect Output Common (pin 2) and +24V (pin 1). The outputs will then be referenced to GND (pin 11).

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3.3.8 Advanced / System Settings



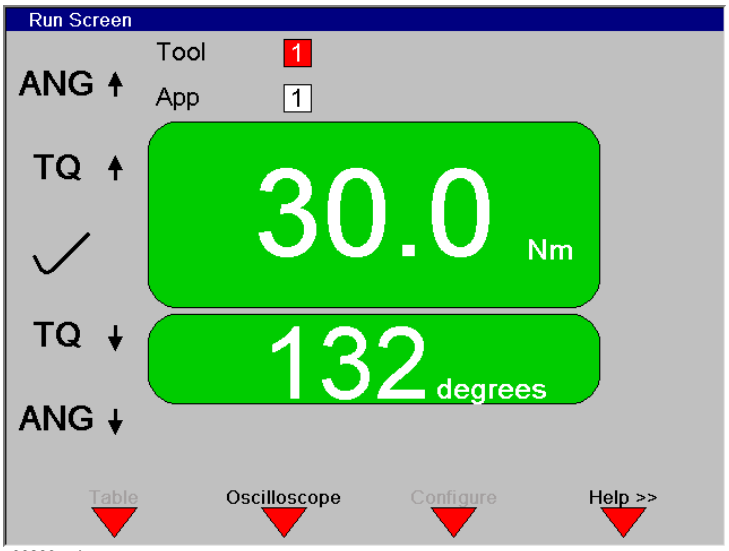
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Fig. 3-13: System Settings

The System Settings allows the user to assign the System a name and number as well as change the system torque units.

The torque units can be set to Nm, Ft-Lb, In-Lb, or Kg-cm. When the units are changed, all torque values are immediately changed to the new units.

3.4 RUN Screen



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Fig. 3-14: Run Screen

From the Run Screen the user can see rundown data as it occurs. The Torque and Angle readings are displayed with a background color corresponding to the status of each. The background

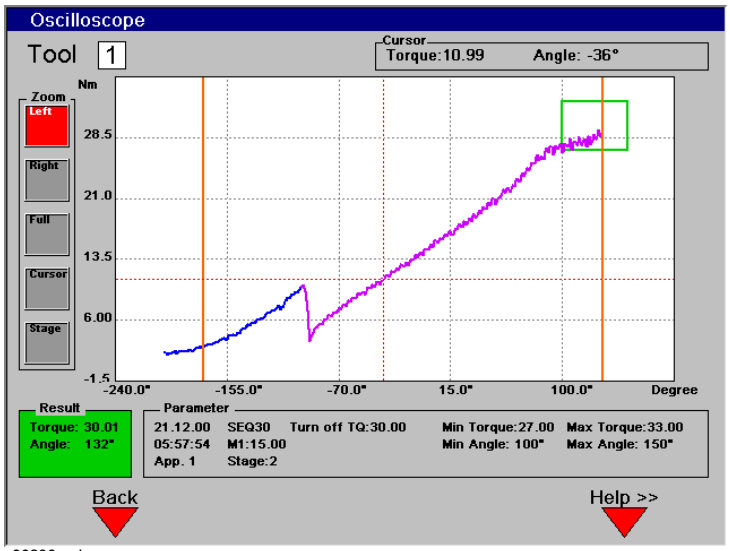
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will be red if the value is too high, yellow if it is too low, and green if it is within limits. The current tool model number, application name, and indicator labels are also displayed.

The desired Application (1-8) is selectable using the keypad.

The Oscilloscope (F2) soft key will display the Oscilloscope function for evaluating Torque and Angle curves. It is automatically updated after each cycle.

3.5 Oscilloscope



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Fig. 3-15: Oscilloscope Operation

The Oscillosope funktion displays a Torque vs. Angle curve after each complete rundown in the tightening direction. The curve is colored in alternating blue and pink lines to indicate the different stages. A green box is also displayed on the trace to indicate the torque and angle limits. There is a data point for each degree of angle rotation.

Zoom

Using the Zoom indicators on the left side of the display, a specific area of the torque trace can be enlarged. Using the up/down arrow keys, highlight the "Left" zoom indicator. Using the left/right arrow keys set the orange vertical line to the left extent of the desired zoom window. Then highlight the "Right" zoom indicator and set the right extent ot the desired zoom window. Once the window extents are set, pressing "Enter" will enlarge the trace to the desired zoom window. Highlight the "Full" zoom indicator and press "Enter" to return the trace to the original unzoomed size.

Cursor

The cursor (red cross-hatch) can be moved along the torque trace using the left and right arrow keys. The actual torque and angle values of the cursor position are shown at the top ot the display.

Stage

The Stage softkey allows to select the corresponding stage by input of a stage number (0 to 6). If you enter "0", the entire rundown is shown.

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Rundown Indicator

At the bottom left of the display is the rundown indicator. The final torque and angle values are displayed on either a green (OK) background or red (NOK) background.

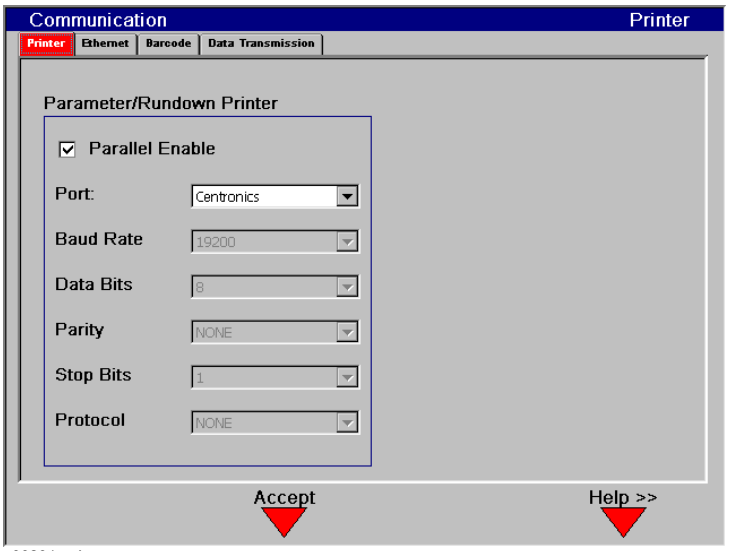
Parameters

At the bottom of the display is a summary of the parameter settings for the rundown.

The Save softkey (F2) lets you print a hardcopy.

3.6 Communication

3.6.1 Communications / Printer



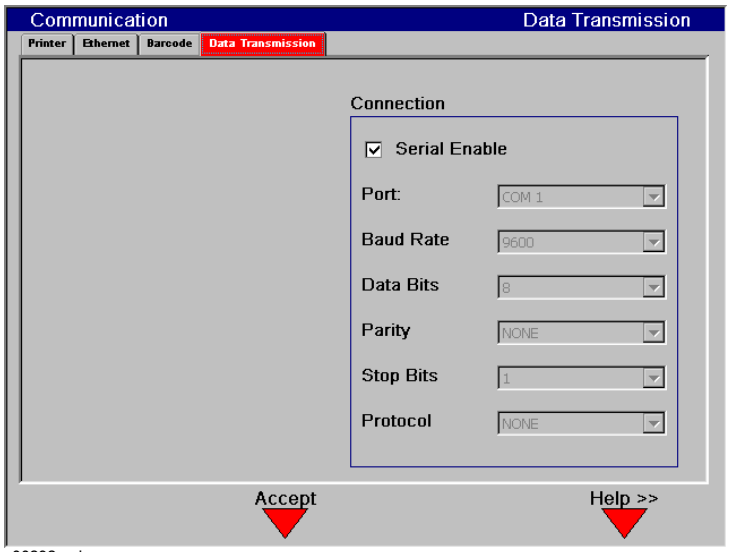
c00291en.bmp

Fig. 3-16: Printer

From this screen the user can configure the setup for the Parameter/Rundown Printer. The Basic settings are Port, Baud rate, Data bits, Stop bits, Parity, and Protocol. In case a Centronics Port is selected for the Printer all other fields are inactive.

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3.6.2 Communications / Serial Data Transmission



c00292en.bmp

Fig. 3-17: Data Transmission

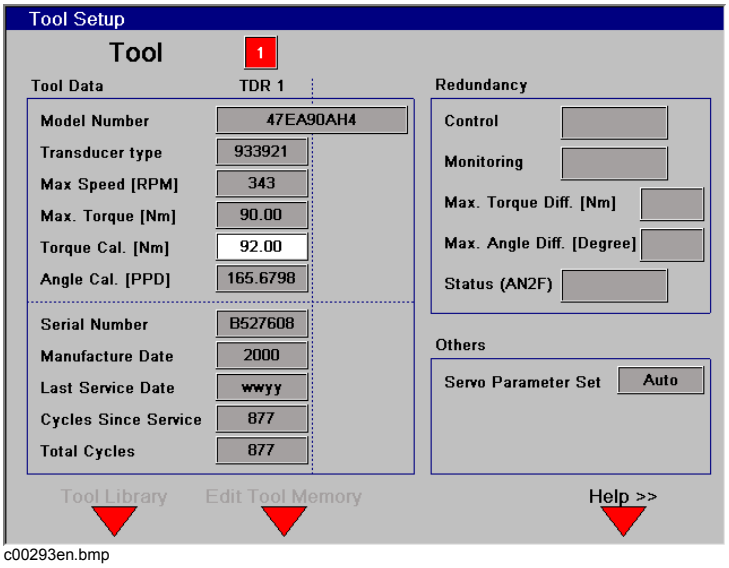
The Serial Data Transmission is sent after each cycle to the programmed COM port. The Basic settings are Port, Baud rate, Data bits, Stop bits, Parity, and Protocol. The following table details the transmission data:

Start	End	Length or Value	Description
1	1	42 hex	B
2	3	2 Digit ASCII	Tool Number
4	5	2 Digit ASCII	Parameter Set
6	17	12 Char ASCII	Date and Time (YYMMDDHHMMSS)
18	24	7 Digit ASCII	Peak Torque
25	31	7 Digit ASCII	Low Torque Limit
32	38	7 Digit ASCII	High Torque Limit
39	39	1 Char ASCII Status	Torque Status Flag L = low A = accept H = high
40	46	7 Digit ASCII	Final Angle
47	53	7 Digit ASCII	Low Angle Limit
54	60	7 Digit ASCII	High Angle Limit
61	61	1 Char ASCII Status	Angle Status Flag L = low A = accept H = high

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Start	End	Length or Value	Description
62	62	1 Char ASCII Status	Overall Status Flag A = accept R = reject
63	64	2 Digit ASCII	Batch Count
			(Only for Batch Count)
65	66	2 Digit ASCII	Batch Size (User programmable) (Advances only on ACCEPT)
67	67	0D hex	CR (carriage return)
68	68	0A hex	LF (line feed)

3.7 Tool Setup



c00293en.bmp

Fig. 3-18: Tool Memory

The Tool memory data is displayed for the selected tool and redundancy. Only the Field Torque Calibration (+/- 20% of nominal) is editable. If no Tool memory is available, then all data is programmable.

To change the tool memory the (F2) soft key must be pressed and a warning message will be displayed. Then all fields are programmable except Serial number, Manufacture date, and Total Cycles. When the tool memory is changed, the user name is also written to the tool memory for traceability.

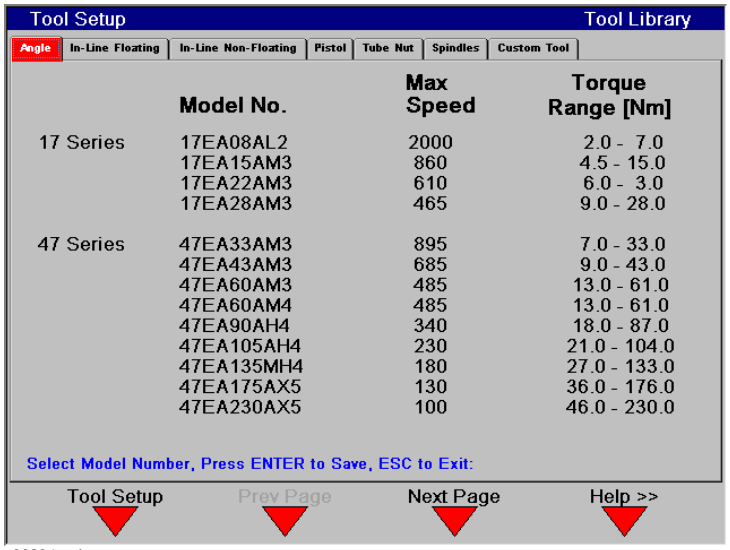
In case a tool with memory is changed to another tool with memory of the same type the tool will continue to work without any necessary changes. In case the tool is changed to a tool without memory or to a different type, then after power on or when pressing the start switch a message is displayed which prompts the user to verify the Tool Setup.

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Pressing the Tool Library (F1) key will allow the user to select from a library of predefined tools. This library can be used to program the tool parameters when tool memory is not available or to change the existing tool memory values.

3.8 Tool Library

3.8.1 Tool Library



c00294en.bmp

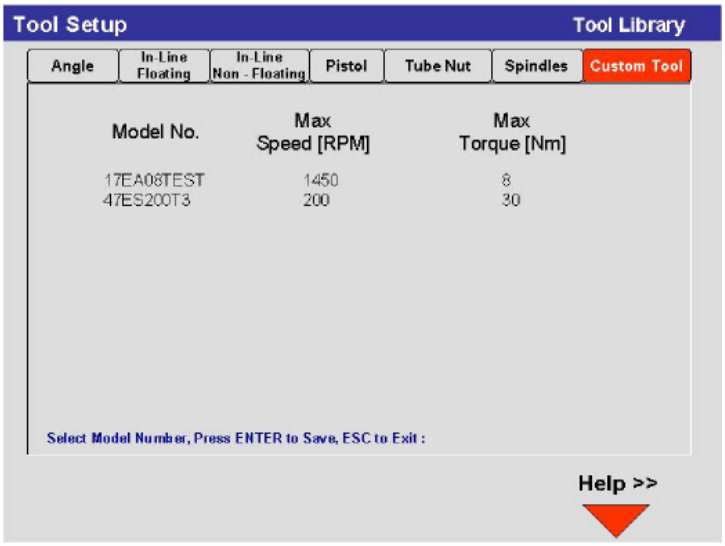
Fig. 3-19: Tool Library

Using the arrow keys, move the orange highlight to the desired tool. Press ENTER to select that model or ESC to exit. If a model is selected these new parameters will be used as the tool parameters. Note that it is extremely important that the correct model is chosen to avoid damage to the tool or injury to the worker.

Use Page Up (F2) and Page Down (F3) when appropriate to view more tool models.

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3.8.2 Tool Library / Custom



c00295en.bmp

Fig. 3-20: Custom Tool

Tools will be added to the Custom Tool Library when a tool that does not exist in the Tool Library is used. Anytime data is entered in the Tool Setup screen that does not match data in the Standard Tool Library, the new tool will be added to the Custom Tool Library.

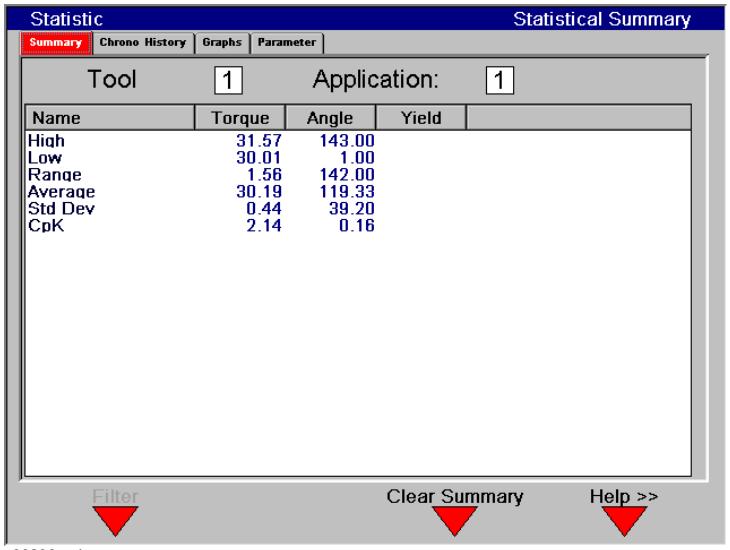
Using the arrow keys, move the orange highlight to the desired tool. Press ENTER to select that model or ESC to exit. When a model is selected these new parameters will be used as the tool parameters. Note that it is extremely important that the correct model is chosen to avoid damage to the tool or injury to the worker.

Use Page Up (F2) and Page Down (F3) when appropriate to view more tool models.

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3.9 Statistics

3.9.1 Statistics / Summary



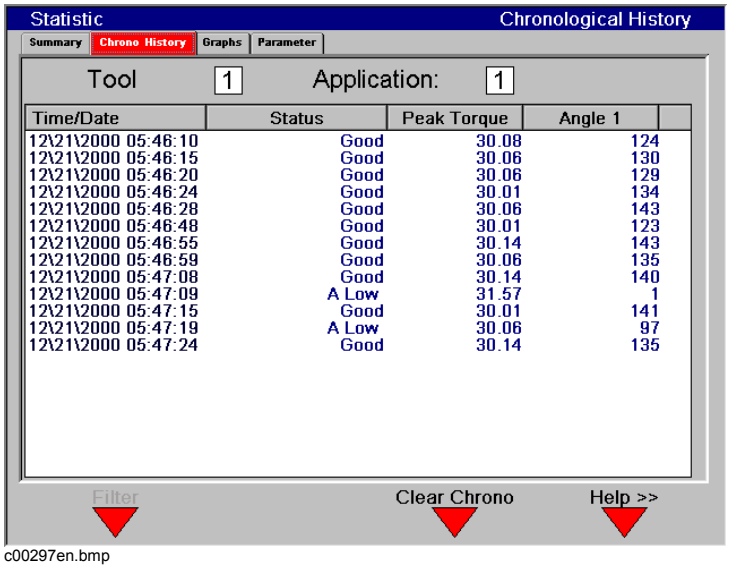
c00296en.bmp

Fig. 3-21: Statistical Summary

The user can view the Statistical Summary for the selected rundowns of any Tool or Application. This summary includes high value, low value, range, average, standard deviation, and CpK for Torque and Angle.

The Clear Summary (F3) soft key allows the user to delete the Statistics.

3.9.2 Statistics / Chronological History



c00297en.bmp

Fig. 3-22: Chronological History

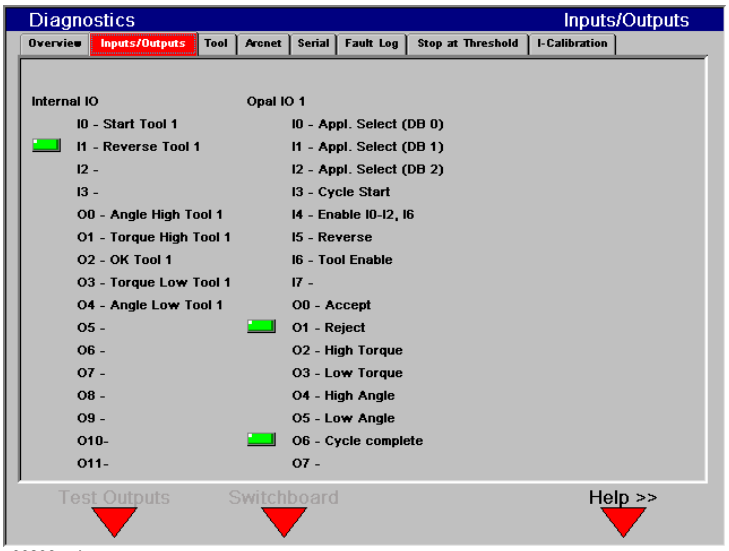
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The user can view the Chronological History for the selected rundowns of any Tool or Application. This history includes time, date, status, torque, and angle.

The Clear Chrono (F3) soft key allows the user to delete all rundowns.

3.10 Diagnostics

3.10.1 Inputs / Outputs



c00298en.bmp

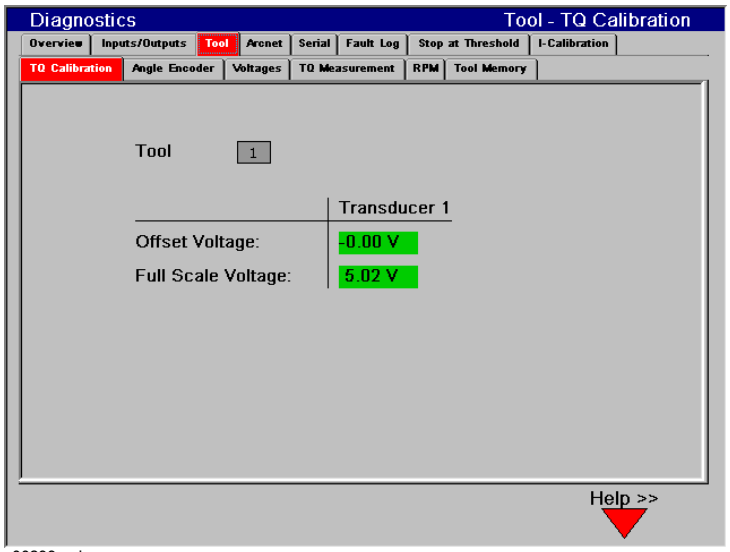
Fig. 3-23: Inputs / Outputs

Inputs and Outputs are divided into Internal and External I/O. The Internal I/O displayed on the left side is used for tool start, direction, and Led outputs. The External I/O displayed on the right side can be reached at the Phoenix connectors located under the side door. This screen will give a live update of all system I/O. If a green box is shown next to the I/O description, then it is active.

Otherwise the space next to the I/O description will be blank indicating it is inactive.

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3.10.2 Tool / Calibration



c00299en.bmp

Fig. 3-24: Tool / Calibration

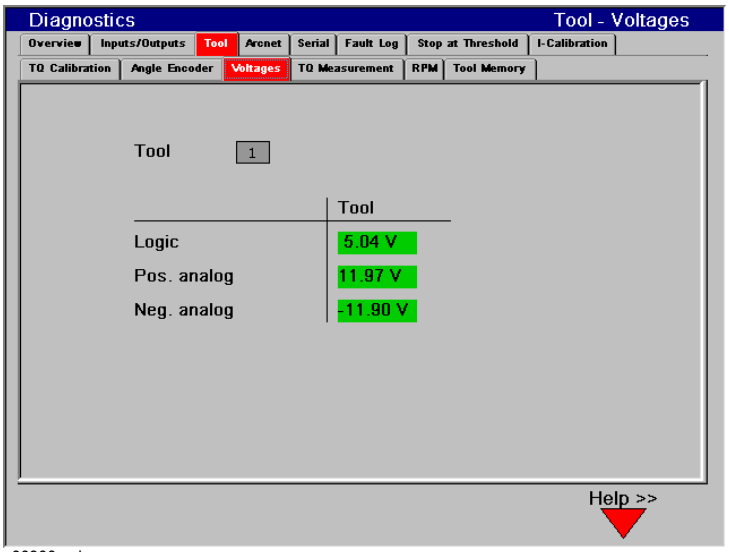
This test function cyclically recalibrates the system with the values used immediately before the start of a rundown. The must be released for this function! The values "Calibration offset" and "Calibration voltage" of the torque transducer are displayed. If redundancy is activated, the values of the second transducer are displayed. If a value is out of tolerance, it is shown in red.

Rated values and tolerances:

Value	Rated value	Tolerance
Calibration offset:	0 V	+/-200 mV
Calibration voltage:	5 V	+/-150 mV

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3.10.3 Tool / Voltages



c00300en.bmp

Fig. 3-25: Tool / Voltages

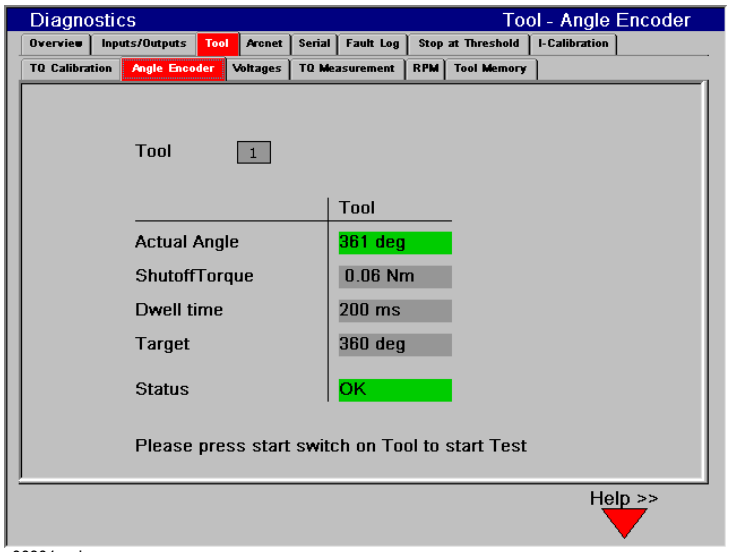
The table displays the measured voltages of a channel.

These are the most important supply voltages on the measuring board, required for proper torque and angle measurement. Therefore, these must be monitored continuously. If a voltage is out of tolerance, it is shown in red.

Designation voltage	Rated value	Tolerance
Logic voltage:	+5 V	+250 mV/-400 mV
Pos. analog Positive analog voltage	+12 V	±600 mV
Neg. analog Negative analog voltage	-12 V	±600 mV

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3.10.4 Tool / Angle Encoder



c00301en.bmp

Fig. 3-26: Tool / Angle Encoder

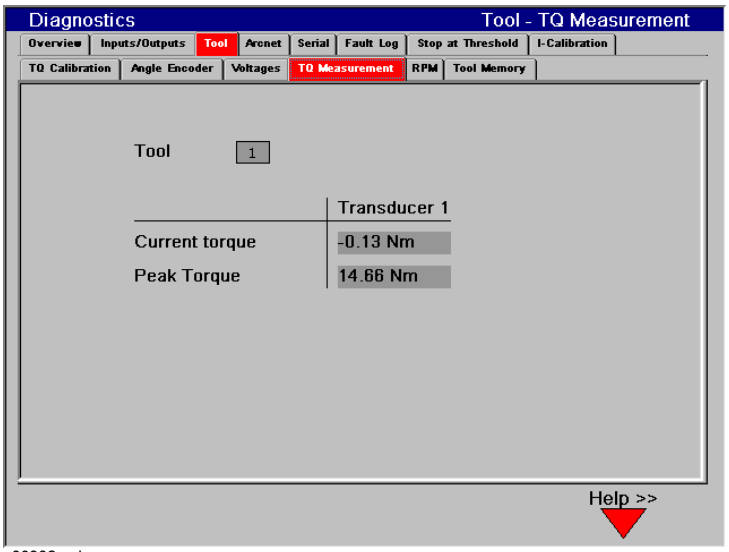
The tool start switch starts the spindle with a speed of 30 % of the maximum. After one revolution of the output shaft (set angle 360 deg), measured with the tool resolver, it is stopped. During a permanently adjusted dwell time of 200 ms any further angle pulses occurring are traced. The total result is shown as "Actual Angle". The "Shut-off Torque" displayed is the torque prevailing at shut-off or the maximum value reached during the dwell time if that value is higher than the torque at shut-off.

If the test run is not terminated by a monitoring criterion, the total result equals or is higher than 360 degrees and is evaluated as okay ("OK"). Monitoring criteria are the torque of transducer 1 and a monitoring time. If the torque of transducer 1 exceeds 15 % of its calibration value (even during the dwell time), or if the monitoring time of 5 seconds is elapsed, the test run is terminated with "NOK".

The user must check himself, if the output shaft has actually turned by the value indicated (e. g. put mark on the spindle). If the angle reached by the output shaft does not agree with the value displayed, either the angle factor is or the resolver is defective.

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3.10.5 Tool / TQ Measurement

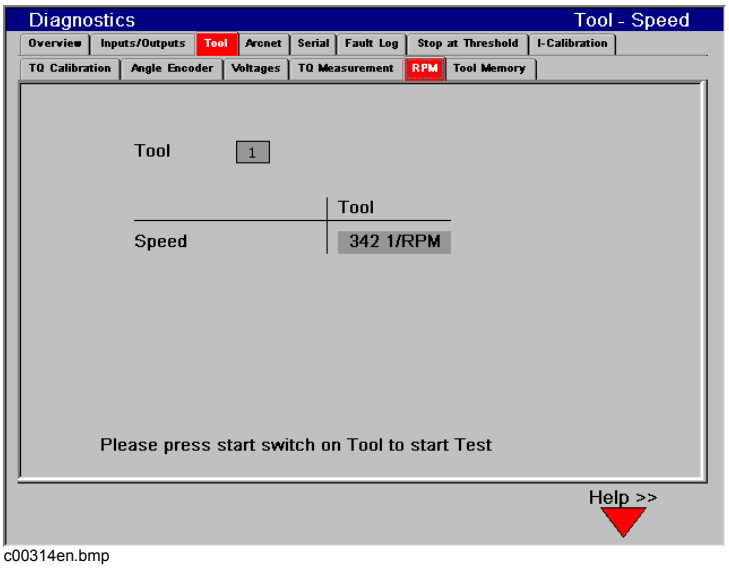


c00302en.bmp

Fig. 3-27: Tool / TQ Measurement

This test function recalibrates the system with the values used immediately before the start of a rundown. The spindle must therefore be released still when this function is called up! Then the tool is started at zero speed and the torque is continuously measured and displayed. The field "Current torque" displays the current torque, "Peak torque" displays the highest value measured since the start of the function. If "Redundancy" is activated, the values of the second transducer are also displayed.

3.10.6 Tool / Speed



c00314en.bmp

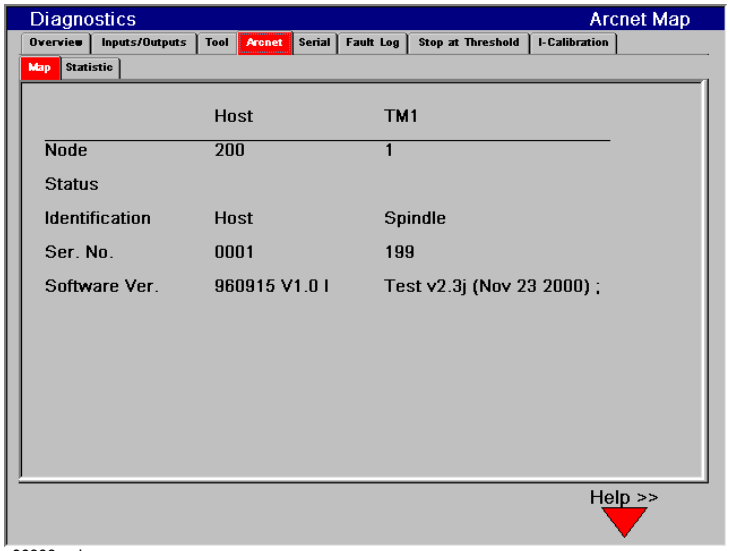
Fig. 3-28: Tool - Speed

When you press the tool start switch, the spindle starts with maximum speed. The current output shaft speed is displayed. To achieve this, the angle factor must have been entered correctly,

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since the integrated speed measurement is derived from the resolver signals. When you release the start switch the spindle stops. As a safety function the torque is monitored by the tool transducer. If it exceeds 15 % of its calibrated value, the tachometer function is terminated.

3.10.7 Arcnet / Map



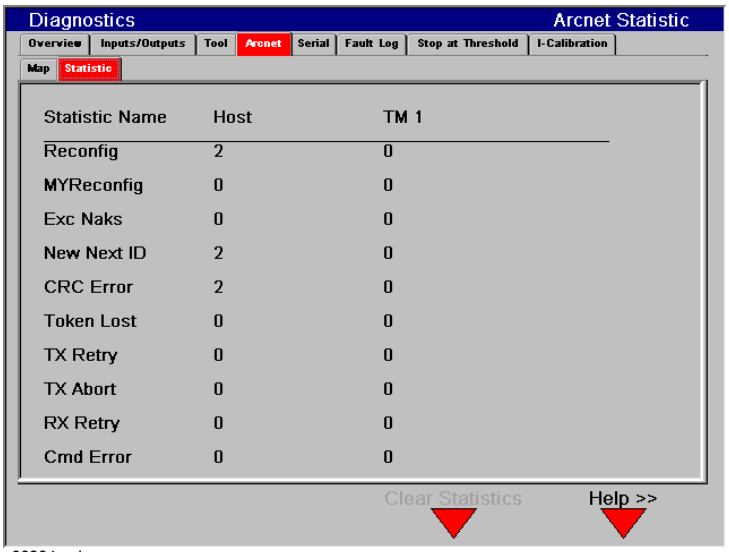
c00303en.bmp

Fig. 3-29: Arcnet / Map

The ARCNET map displays information on the current number of participants in the network, their ARCNET-ID, status, serial and software number and identification. The display is continuously updated, e. g. if the connection with a participant is interrupted, it is removed from the table, or if a new participant is added, it is added to the ARCNET table.

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3.10.8 Arcnet / Statistic



c00304en.bmp

Fig. 3-30: Arcnet / Statistic

The ARCNET statistics allow to check the stability of the field bus system. There are two different statistics:

- For all external hardware components (bridges, TMs)
- For the station controller

The following is a description of the parameters required for stable operation.

TM Bridge	
Description	
Reconfigurations	Change upon each reset of a participant
Own reconfigurations	Change upon each reset or severe failure
Excessive NAK	Should be stable
New next ID	Change upon switsch-off/on of downstream participant
CRC error	Should be stable
Lost Token	Should be stable
Send repetitions	Should be stable
Send termination	Should be stable
Receive terminations	Should be stable
Command errors	Should be stable
Unassignable ACKs	Should be stable
ACKs with Bit 14/15-Packets without CPT protocol	Should be stable
Input queue overflow	Should be stable
Packet not assigned by node	Should be stable
Discarded input packets	Should be stable

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Host Driver Statistics

Reconfiguration	Change upon each reset of a participant
Host reconfiguration	Change upon each reset or severe failure
CRC error	Should be stable
Outbound packets - Inbound packets - Next ID	Change upon switch-off/on of downstream participant
Excessive NAK	Should be stable
Lost Token	Should be stable

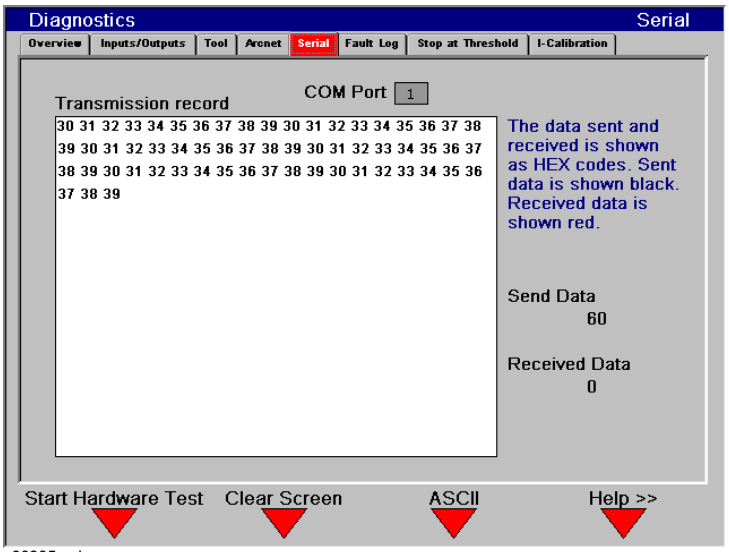
Statistics of ARCNET Manager

Broadcasts received -
Synochronous starts -
Stopped synchronous starts -

CRC error	Should be stable
Timeout A	Should be stable
Timeout B	Should be stable
Wrong ARCNET ID received	Should be stable
Packets not for host	Should be stable
ACKs in READY status	
ACKs in ERROR status	Should be stable
Unassignable ACK	Should be stable
ACKs with Bit 14/15	
Packets without CPT protocol	Should be stable
Input queue overflow	Should be stable
Packet not assigned by node	Should be stable
Discarded input packets	Should be stable

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3.10.9 Serial



c00305en.bmp

Fig. 3-31: Serial Port Diagnostics

The serial diagnostics allows the user to test the selected COM port by displaying sent (blue text) and received data (red text).

The Start Hardware Test (F1) soft key will send ten bytes and toggle the TXD line. It will read back the bytes based on the RXD signal. For this test an external Adapter with shorted pins is necessary.

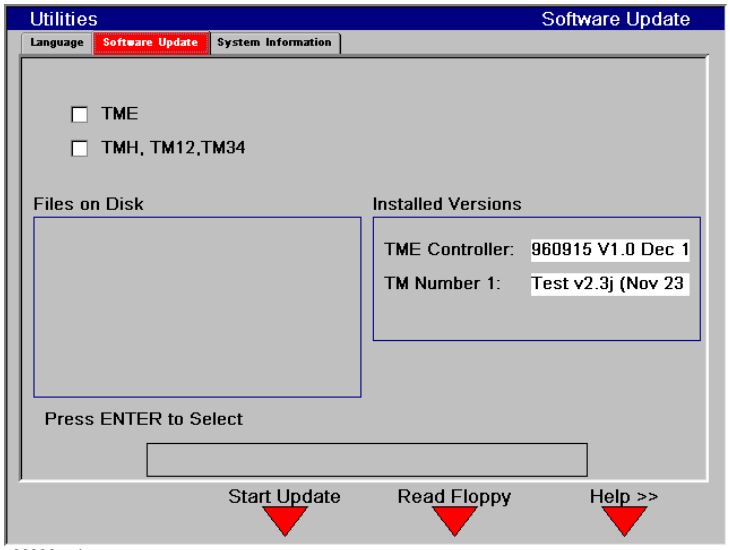
The Clear Screen (F2) soft key will clear the displayed bytes.

The ASCII (F3) soft key allows to toggle between hexadecimal and ASCII format.

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3.11 Utilities

3.11.1 Utilities / Update Software



c00306en.bmp

Fig. 3-32: Update Controller Software

Using the radio buttons the user can select either the TME or just the Tightening Module itself. The current installed versions are listed for each module. As the software is updated a progress bar will be displayed.

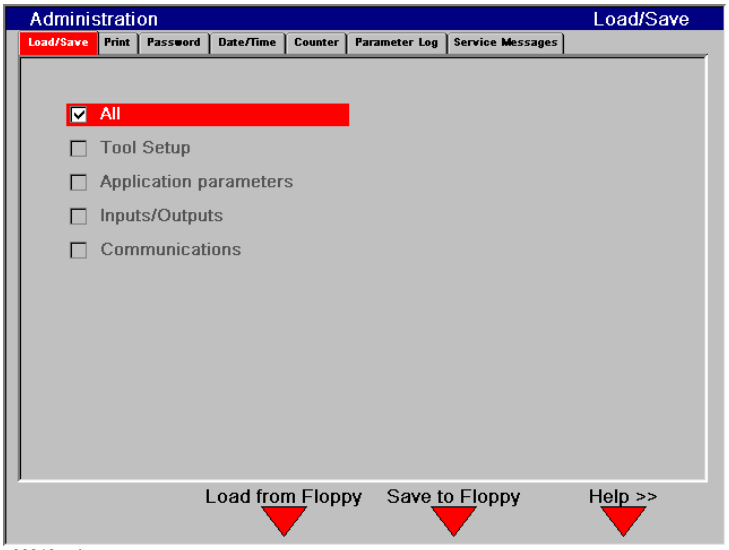
The Start Update (F2) soft key will load the selected file into the selected module.

The Read Floppy (F3) soft key will read the floppy and display the contents.

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3.12 Administration

3.12.1 Administration / Load/Save



c00313en.bmp

Fig. 3-33: Load / Save

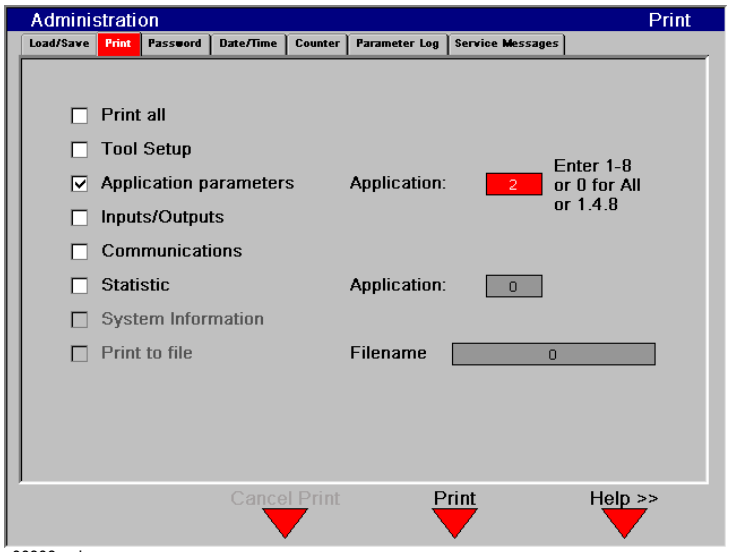
Using the check boxes, the user can select the parameters to load or save to the floppy diskette.

The Load from Floppy (F2) soft key will search the floppy for the selected parameters and update them accordingly.

The Save to Floppy (F3) soft key will save the selected parameters to the floppy diskette.

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3.12.2 Administration / Print



c00308en.bmp

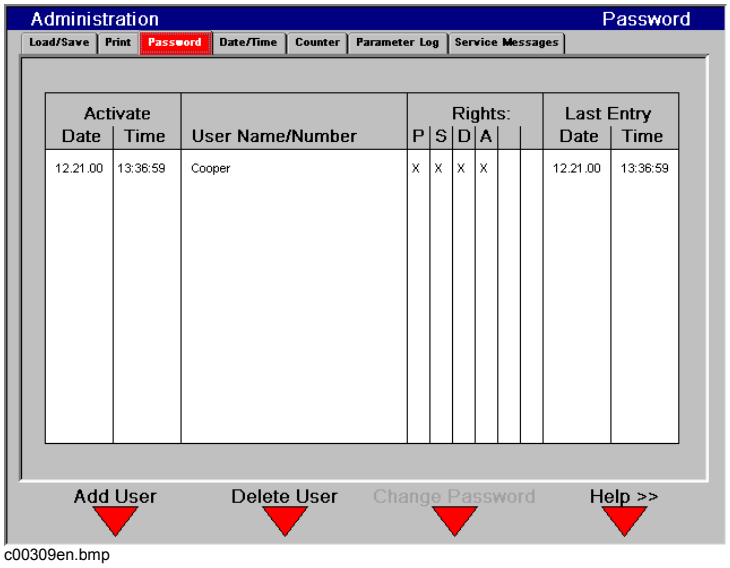
Fig. 3-34: Print

Using the check boxes, the user can select the parameters to print. These will be sent to the printer defined in the Communications setup or to a file on the floppy diskette if selected.

The Cancel Print (F2) soft key will cancel the print job immediately.

The Print (F3) soft key will start printing. Upon printing a message will be displayed to show the number of pages being printed.

3.12.3 Administration / Password



c00309en.bmp

Fig. 3-35: Password

The Password displays the active users and corresponding rights. There are different rights available for Programming, Statistics, Diagnostics and Administration. The date and time of the

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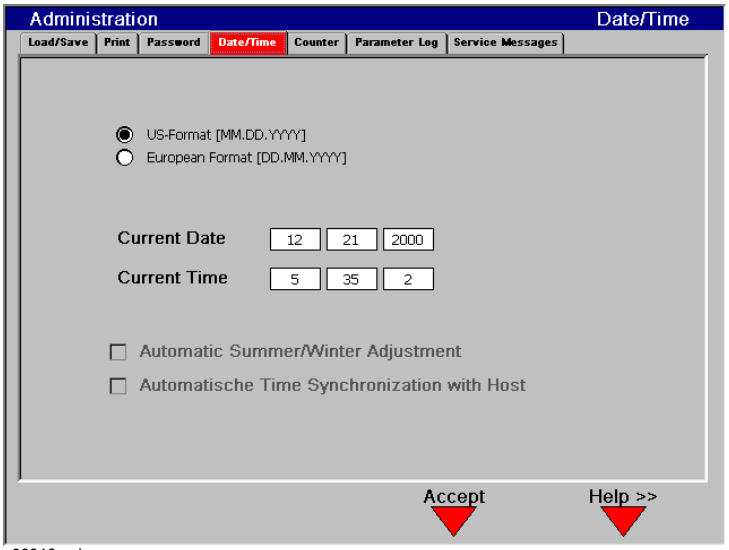
last entry changes automatically when parameters are changed. The Password function supports up to ten different users plus a master password.

Pressing Add User (F1) it is possible to add a new user. If the first user does not activate the "Administration" rights he will get them automatically.

Pressing Delete User (F2) it is possible to delete a user. If the last user does not have the "Administration" rights he will get them automatically.

Pressing Change Password (F3) it is possible to change the password or rights of an existing user.

3.12.4 Administration / Date & Time



c00310en.bmp

Fig. 3-36: Date & Time

Enter the appropriate settings for time and date.

Using the radio buttons the user can select European or US format for time and date.

The Checkbox for Winter/Summer will account for Daylight Savings Time.

The Time Synchronization Checkbox is only valid if Ethernet is available and will allow for the time and date to be synchronized from an external device.

The System Time and date will be updated when the Accept (F3) soft key is pressed.

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4 Statistics

4.1 Understanding Statistics

Your unit provides a wide array of statistical and data reports (charts) for the control of manufacturing processes. The following provides a description of the control chart for variables and an outline of the procedure for its use. Known as the $\bar{x}$-R chart (pronounced X-bar-R), the chart for variables can be used whenever a quality characteristic can be measured and expressed by a numerical value. When properly used, it can bring substantial improvement in product quality and a reduction of scrap and rework.

When we control a process, we monitor the variation of the characteristics that are important to the product. During production, samples from the process are measured. By plotting the results of these measurements on the control chart, we are able to see if the process is operating in a stable manner (in a state of statistical control), or if the pattern has been disturbed by an event that drives the process out of control. In other words, the control chart tells us what the process is doing - when to take action and when to leave it alone.

Although it is a powerful tool, the $\bar{x}$-R Control Chart is easy to use. Only an understanding of a few basic statistical concepts and the use of simple arithmetic is needed.

4.1.1 The Nature of Variation

Variations in measured product are always present because of random fluctuations and inconsistencies in machines, material, and operator performance. No two items produced are exactly alike.

When variation is random and stable, the process is in a state of statistical control (see graph 4-1a). The process has an identity, and its performance is predictable. The stable pattern of variation is caused by conditions that are inherent to the manufacturing system, such as spindle run out, bearing clearances, differences in material properties, accuracy of measuring equipment, and operator performance. We call this "common cause" variation.

When variation is sporadic and unstable, the process is out of statistical control (see graph 4-1b). The process loses its identity and is no longer predictable. The unstable pattern is caused by such events as tool breakage, tool wear, bad material, and operator error. This is called "special cause" variation.

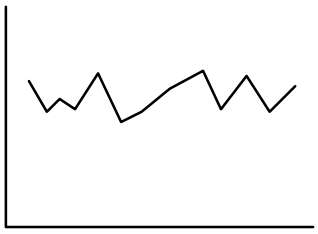


Fig. 4-1: a) Common Cause Variation

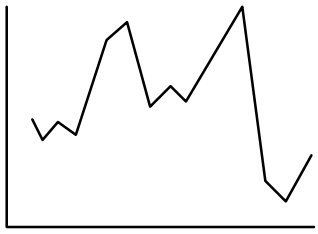


Fig. 4-1: b) Special Cause Variation

4.1.2 The Normal Curve

Most processes in statistical control have a fixed pattern of variation. The mathematical curve that describes this pattern is known as the normal curve (see graph 4-2a). The normal curve is symmetrical about the average. It is high in the middle and becomes smaller as the distance

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from the average increases. Since the shape resembles a bell, it is sometimes referred to as a bell curve.

The normal curve is defined by two conditions - the average of all items produced, and the amount of variation from the average. We can think of these as the center and width of the bell, respectively. The center is the arithmetic average of all items produced. The width is expressed in terms of the standard deviation which is a statistical calculation for the amount of variation from the average. The standard deviation, represented by the Greek letter sigma (σ), holds a fixed relationship to the normal curve, as follows (see graph 4-2b):

- 68% of all items produced will be within +1σ of the average (two sigma spread).
- 95% will be within +2σ of the average (four sigma spread).
- 99.7% will be within +3σ of the average (six sigma spread).

These two characteristics - the average and the standard deviation - provide the foundation for statistical process control. By taking sample measurements during production, we can predict the average value and the amount of variation for all items produced.

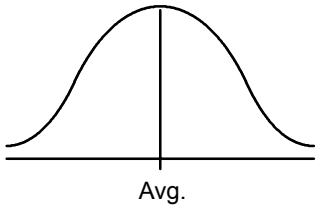


Fig. 4-2: a) The Normal Curve

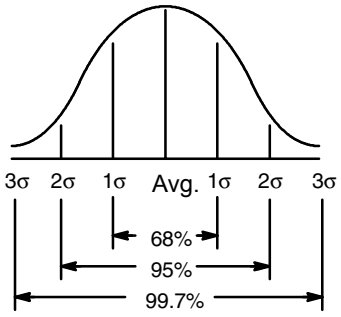


Fig. 4-2: b) Areas Under The Normal Curve

4.1.3 The Procedure

The procedure for establishing a statistical process control program consists of three phases. The first is to obtain statistical control - a state of random and stable variation. The second is to establish process capability. A state of statistical control in itself does not assure that the process is capable of meeting the specification. The limits of variation must be equal to or less than the total specification tolerance. The third is to monitor the process throughout production using the control chart, to detect and correct conditions that upset the stable pattern of variation.

Use of the $\bar{x}$-R Control Chart includes the following steps:

1. Select the Characteristic

Since a separate chart is required for each characteristic, practical considerations limit use to selected requirements. A good candidate is a characteristic that is important to the function of the item. Others include those that are causing a high cost loss because of scrap or rework, and those that require evaluation by destructive testing.

2. Designate the Sample Size

It is usually desirable to keep the sample size small so that variation within the sample is at a minimum, but not so small that statistical validity is lost. The control chart described in this document is structured for a sample size of five units. If a sample other than five is selected, the manufacturing or quality engineer can provide alternate factors for use in calculating the control limits and standard deviation (Steps 8 and 10).

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3. Designate the Sample Frequency

Selection of the sample frequency should be based on economic considerations for the cost of measurements and the potential loss that may occur if samples are not taken often enough. Early in the production run, samples should be taken more frequently and then extended after satisfactory control is verified. The frequency may be expressed as a time interval or as a portion of quantities produced.

4. Assure Measurement Accuracy

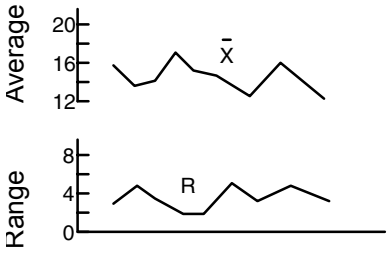
Measurement accuracy is mandatory for successful statistical control. Measuring and test equipment must be of a type suitable for the characteristic being evaluated, and must be calibrated and properly used. Decisions resulting from the analysis of a control chart will be no better than the measurement data.

5. Complete the Data Sheet Headings

It is important that all heading entries on the data sheet be completed. They include the part number and description, the operation performed, the name of the operator, the machine or equipment used, and the specification limits. The data sheet and control chart can provide evidence of quality for use by the Quality Assurance organization if the information is properly recorded and traceable to the products manufactured.

6. Start Production

Take samples of five units (preferably consecutive units produced) at the designated frequency, and record each measurement (X) on the data sheet. For each sample of five calculate the average ($\bar{X}$) and range (R), and plot the results on the chart (see graph 4-3).



$\bar{X}$ - Add the five measurements and divide the sum by five. For a sample of five, it is often easier to multiply the sum by two and move the decimal one place to the left.

R - Substract the smallest measurement from the largest. (Note that the range can never be negative.)

Fig. 4-3: Entries for Range and Average

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7. Calculate Process Center Lines

After data for 20 samples of five have been plotted, calculate the center lines for both the average and range plottings.

The center line for the average chart is known as the grand average ($\bar{\bar{x}}$) and is the average of all of the sample averages. This is the value that best represents the size of all measurements:

$$\bar{\bar{X}} = \frac{\Sigma \bar{X}}{n}$$

where Σ is used to indicate the sum of the sample averages, ($\bar{x}$), *(be careful to observe the + and - signs)*, and n the number of samples, in this case 20.

Similarly, the center line for the range chart ($\bar{R}$) is the average of the ranges for all samples.

$$\bar{R} = \frac{\Sigma R}{n}$$

Draw solid lines on the control chart for values representing $\bar{\bar{x}}$ and $\bar{R}$ (see graph 4-4).

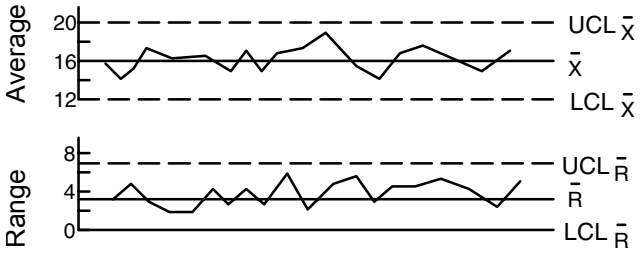


Fig. 4-4: Drawing The Center Lines And Control Limits

8. Calculate Control Limits

Calculate the upper and lower control limits (UCL and LCL) using the following formulas and the values previously calculated for the grand average ($\bar{\bar{x}}$) and the average range ($\bar{R}$). *(Factors are for samples of five units only.)*

Average

$$UCL_{\bar{x}} = \bar{\bar{X}} + 0.577(\bar{R})$$

$$LCL_{\bar{x}} = \bar{\bar{X}} - 0.577(\bar{R})$$

Range

$$UCL_{R} = \bar{\bar{X}} + 2.114(\bar{R})$$

$$LCL_{R} = 0$$

Note: For a sample size of six or less, the lower control limit for the range is zero.

Plot the limits on the control chart as broken lines.

9. Evaluate for Statistical Control

Analyze the control chart to see if the process is in a state of statistical control. Variation should be random about the center lines for both averages and ranges, with all points within the control limits. If these conditions are not satisfied, special cause variation may be present.

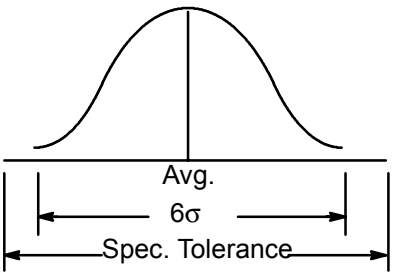
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Sometimes a process takes time to stabilize after start-up. If the indication of special cause variation occurs only in the first few samples, continue to take several more samples and recalculate the limits by omitting the special cause values. However, if the indications of special cause variation occur other than at start-up, action should be taken to identify and correct the cause, and the process re-started.

10. Evaluate for Process Capability

When the process is in a state of statistical control, estimate the standard deviation (σ) using the value for the average range ($\bar{R}$) previously calculated. *(The factor is for samples of five units only.)*

$$\text{Estimate of } \sigma = \frac{\bar{R}}{2.326}$$



If the 6σ spread is equal to or less than the total specification tolerance, the process is capable. It will produce at least 99.7% of all items to specification.

Fig. 4-5: Capable Process

If the 6σ spread is greater than the specification tolerance, three options are available:

- Improve the system - reduce variability
- Increase the specification tolerance
- Continue production and sort by 100% inspection

11. Center the Process

After the 6σ capability requirement is satisfied, it may be desirable to center the process so that the process average is close to the middle of the specification tolerance. This can usually be accomplished by a simple machine or tooling adjustment. If the magnitude of the adjustment is known, the center line and the control limit lines for the average plotting may be moved a distance equal to the adjustment, and re-verified after 20 additional samples are plotted. Centering the process does not affect the center line or control limits for the range, so no adjustment should be made to them.

12. Realign the Inspection Activity

When properly controlled, production can usually continue without the need for 100% inspection. More attention can be placed on process surveillance and audits of operator performance. However, certain safety critical requirements will justify an independent verification.

13. Maintain Control

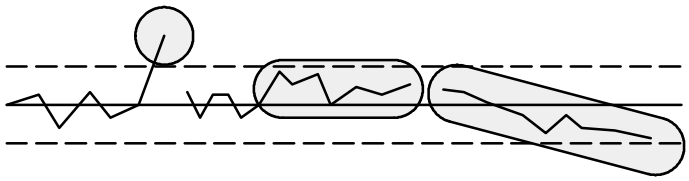
The operator shall continue to take sample measurements and plot the results on the control chart. As long as the pattern of variation remains random and within the control limits, no action is taken. However, if an indication of special cause variation is detected, the trouble should be identified and corrected *(see graph 4-6)*. An indication of special cause variation can result from conditions such as tool wear, tool breakage, defective material, measurement error, a mistake in

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calculating the average or range for a sample, and plotting a point on the control chart incorrectly.

Special cause variation may be indicated by one of the following situations:

- A point outside a control limit.
- A shift, with several consecutive points inside a control limit but on the same side of the center line.
- A trend of consecutive points that moves steadily toward a control limit.



Outside of Limit Shift Trend

Fig. 4-6: Indications of Special Cause Variation

Since we are controlling by evaluating only small sample sizes from the process, the criteria for continuing production must be the control limits. For this reason, we do not place the specification limits (which are recorded on the data sheet) on the control chart.

4.1.4 System Improvement

There are always two risks associated with statistical control. The first is the risk of accepting bad product, and the second is the risk of rejecting good product. Both are undesirable, but our primary concern is usually the first since it has a direct impact on customer satisfaction.

The six sigma spread of the process described in this procedure is in general use throughout American industry. When properly applied, it assures us that at least 99.7% of all units produced will meet specification. This relates to a risk of delivering three substandard units for each thousand produced. While this provides much better quality than can be obtained with an uncontrolled process and 100% inspection, it may not be good enough in the future as competition becomes stronger in the world market.

So it's important that we continue to improve the manufacturing system - to reduce the influence of conditions that affect variations in the performance of people, machines, and materials (see graph 4-7). There will be practical and economic limitations to this effort, but to the extent that we can further reduce process variation we will increase the probability that all delivered product meets the specification.

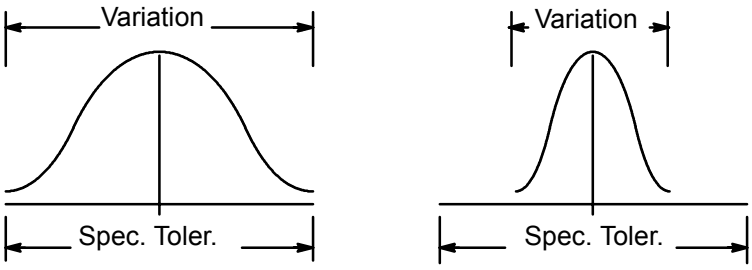


Fig. 4-7: Improving The System By Reducing Variation

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4.2 Statistic Symbols

- σ = standard deviation (or sigma)
- $\bar{x}$ = mean (or average)
- R = range
- Cp = Capability of Process
- Cpk = Capability index
- n = number of runs
- Sub Sz= Subgroup size
- Y = Torque summary run data
- A = Angle summary run data

(Note: See glossary for definitions)

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5 Glossary

accepted data	data that fall within the acceptable limits in a fastening strategy
accepted rundown	a run cycle within limits
angle capability indexes	a measure of acceptable variation of final angle values in a fastening process
angle control	a fastening strategy by which you are controlling a tool by predetermined angle limits
angle encoder	a device that measures the angle of rotation
angle high	active if final angle > angle high limit
angle high limit (AHL)	the maximum acceptable angle for a run cycle
angle limits	the range between the maximum and minimum acceptable angle for one cycle
angle low	active if final angle < angle low limit
angle low limit (ALL)	the minimum acceptable angle for a run cycle
angle monitor	a fastening strategy by which you are monitoring a tool by predetermined angle limits
angle reject	a cycle rejected when the acceptable angle is not achieved
application	a programmed setting of the unit for a given application; TME 100 has eight application settings. Often referred to as product group
application select 0-2	application selects 0-2 are used to select applications 1-8 using a binary count of 0-7 where app. sel. 0 is the least significant bit
baud rate	the frequency at which the unit communicates
capability of process (Cp)	The ratio of the process tolerance to 6 standard deviations. Ranges from 0.0 to infinity with larger values indicating a more capable process. (Often referred to as Process Potential Index or Inherent Capability Index.)
capability index (Cpk)	An index combining the process potential and the measure of the difference between process and the specification mean. CPK will equal Cp if the process mean is centered on the target (nominal) specification value; if CPK is negative, the process mean (X-Bar) is outside the specification limits; if CPK is between 0 and 1, then some of the 6 sigma spread will fall outside of the specifications; if CPK is larger than 1 then the 6 sigma spread is completely within the specification tolerance.

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control parameters	the parameters that define the fastening strategy sequence for a given tool
cycle complete	active whenever tool is not running
cycle NOK	active if torque/angle/yield are outside limits or some other error has occurred
cycle OK	active if torque/angle/yield are within programmed limits
cycle start switch	the switch on a tool that initiates a run cycle
default parameters	parameters automatically selected by the unit
desired final torque	the final torque desired in a fastening process (referred to as torque setpoint)
end delay time [ms]	time delay from the tool turnoff until the torque measurement ends
engineering units	units of torque measurement
external transducer	a transducer physically located on the outside of a tool
fastener rotation	direction in which a fastener rotates
fastening strategy	a strategy used to control or monitor a fastening process
final angle	the final angle desired in a fastening process
histogram	a printout generated from statistical data output
if NOK go to stage	gives the control system direction if the stage is NOK
internal transducer	a transducer physically located inside the tool
LCD screen	the screen on the unit that provides directions to programming the unit
LED flashing in reverse	if yes, the tool LED's will blink when the tool is in reverse
LED screen	the screen on the unit that provides the readout data from a run cycle
load	refers to the amount of torque applied to a device or tool
main menu	the first menu that appears on LCD screen
marking output	output from paint marker solenoid after each cycle
master transducer	a transducer used as a benchmark to calibrate another transducer
max. fastening time [mS]	max time for the tool to run during the stage
mean (Xbar)	the average of all readings taken in a sample
NOK after reverse	if yes, the controller will report an NOK if the tool is run in reverse
peak torque	the maximum torque achieved in a run cycle

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port	the socket used for connecting a cable or peripheral equipment
power supply	a unit used to supply power to an electrical device
pulses per degree	number of encoder pulses generated by the tool when rotating the head exactly 1 degree or 1/360 of a revolution
range (R)	a statistical measurement of the difference between the lowest and highest reading taken in a sample
redundant transducer	secondary transducer used to read torque
redundant transducer calibration	the calibration process of the secondary transducer
reject interlock	the stopping of further operation of the system after a predetermined number of rejected cycles has occurred
rejected data	the data generated by unacceptable rundowns
rejected rundown	a rundown that has not met the criteria of a fastening strategy
remote parameter select	a remote device that bypasses the parameter select button on your unit
rundown printout	gives the control system direction for when to print
run number	number of accepted and rejected rundowns
second transducer	frequently referred to as the redundant transducer
sequence 11	high speed rundown
sequence 30	torque control/angle monitor
sequence 50	angle control/torque monitor
sequence 41	angle controlled backoff
speed	max speed of the nutrunner during the tightening stage
standard deviation (σ)	the measurement of the scatter of the population around a mean
start delay time [ms]	time delay before the stage will start
start spike time [ms]	time delay for the control system to start measuring torque after the stage starts
statistical data	data used to measure the performance and accuracy of the unit and tool
status light	lights located either on the unit or tool that represent accepted and rejected cycles
sub group size (Sub Sz)	the sub group size of data used for statistical analysis; the smallest sub group size = 5

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synchronization input	when active allows the tool to start from stage to stage in conjunction with tool start
synchronization output	active at the end of each stage to signal a stage is complete
threshold torque [Nm]	torque to begin counting angle
tool enable	when active allows the tool to start in conjunction with tool start
tool rpm capability	maximum allowable speed of the tool
tool reverse	when active prior to tool start, the tool will run counter-clockwise using the backoff strategy
tool start (LCD and Outputs also clear)	starts the tool
tool stop	stops the tool
torque capability indexes	a measure of acceptable variation of final torque values in a fastening process
torque control	a fastening strategy by which you are controlling a tool by predetermined torque limits
torque filter factor	used for torque averaging
torque high	active of peak torque > torque high limit
torque high limit (THL)	the maximum acceptable torque value for one cycle
torque low	active if peak torque < torque low limit
torque low limit (TLL)	the minimum acceptable torque value for one cycle
torque monitoring	a fastening strategy by which a tool is monitored based on predetermined torque limits
torque reject	a cycle rejected when the acceptable torque is not achieved
torque threshold (TTH)	the point at which the angle counting starts
transducer	a device used to read torque
transducer span (torque cal.)	full load reading of transducer
trigger torque [Nm]	torque to start collecting oscilloscope data
turn off angle	the angle at which a tool is shutoff
turn off torque	the torque at which a tool is shutoff

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