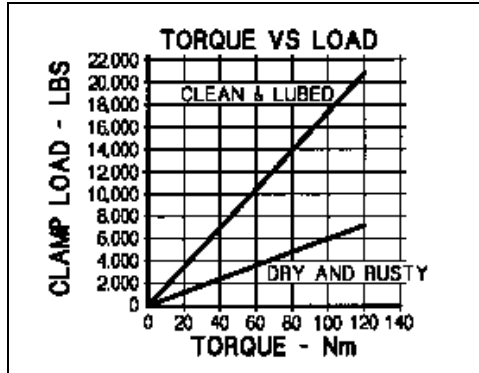


Torque-Angle Tutorial

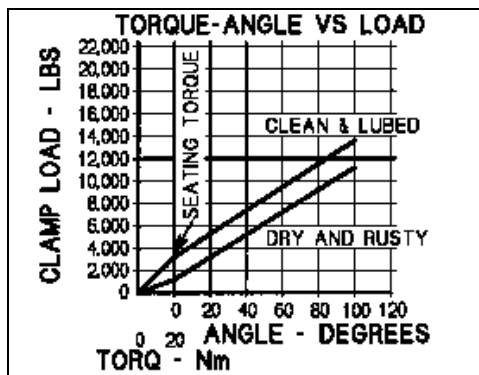
Torque vs Load



Today's torque wrenches are very accurate. Unfortunately, torque can be a poor parameter to measure when you're really interested in controlling load. As shown in the *Torque vs Load* graph at left, 120 Newton-meters of torque applied to a dry and corroded bolt only produces 7,000 pounds of clamping load in a sample joint. This same bolt, cleaned and lubricated, results in nearly 21,000 pounds of load for the same 120 Nm applied. That's 14,000 lbs of uncertainty.

The torque applied to a fastener (bolt or screw) is absorbed in three main areas. Over half of the total torque is lost to underhead friction. About a third of the torque is absorbed by the fastener threads. This leaves about 10 percent of the applied torque that actually develops into clamping load which holds a bolted assembly together. Unless the frictional forces have been carefully predetermined and controlled in some way, such as with special lubricants or expensive joint preparation, torque will never consistently relate to tightness.

Torque-Angle vs Load



When a fastener is installed, it stretches. This stretch (bolt tension) can be calculated very accurately by using the bolt length, slope of the threads (threads per inch) and fastener turns (degrees of rotation). As shown in the *Torque-Angle vs Load* graph at left, once seated, rotation is directly related to load regardless of bolt condition. In this case, a small torque is used to seat the fastener and 100 degrees of rotation produces the required 12,000 lbs of load with less than 2,000 lbs of uncertainty.

Front Panel Function Keys



Toggles between TORQUE and FORCE measurement modes.



Opens and terminates calibration mode.



Selects TRACK, PEAK HOLD, POWER TOOL, FIRST PEAK and ANGLE modes.



Edits DATE/TIME programming function.



Selects following units on LCD display:
Torque units in: Nm, dNm, cNm, mkg, cmkg, lb ft, in lb, in oz, or
Force units in: N, dN, kp, gf, lbf, oz.



Sets up high torque/force limit preset. Set up angle preset in torque-angle mode.



Manually resets ANGLE display on LCD.



Sets up low torque/force limit preset. Set up clamping torque preset in torque-angle mode.



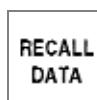
Manually resets ZERO TARE.



Stores present measurement to memory.



Selects LED or LCD digit to right (blinking) for setup and programming. Shift for printer and angle encoder programming.



Recalls memory data to display.



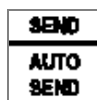
Selects LED or LCD digit to left (blinking) for setup and programming. Shift for printer and angle encoder programming.



Sends all memory data, statistical analysis and histogram to printer/port.



Terminates calibration and program modes. Returns to 4-in-1 transducer scan.



Sends data list with or without date-time stamp to computer printer. Sets up serial protocol function.



Increments selected digit during calibration and program modes. Scrolls statistical analysis display.



Sets up CLEAR, STORE, and SEND modes function.



Decrements selected digit during calibration and program modes. Scrolls statistical analysis display.



Manually clears display in PEAK, FIRST PEAK, POWER TOOL and ANGLE modes. Sets up memory clear options in RECALL mode.



TTC2000
Torque
Tester

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Using this Manual

This manual contains instructions for use and setup of the TTC2000 Torque Tester and Calibrator. A table of contents and a table of illustrations are provided to make this manual easy to use.

Some of the information shown in text or illustrations is obtained using optional equipment. A **Snap-on** Sales Representative can determine option availability.

Conventions

This section contains a list of conventions used in text.

Check Note

A check note provides additional information about the subject in the preceding paragraph.

Example:

- ✓ System capabilities include, data storage, retrieval, statistical analysis and automatic downloading to a printer or computer.

Chapter References

Additional information in text is referenced by chapter number and section name.

Example:

- ✓ For testing procedures refer to *Chapter 4—Using the TTC2000*.

Equipment Damage

The possibility of damage to vehicle or equipment is introduced by a signal word indicating this condition.

Example:

IMPORTANT

The connector on single transducer cables contains the EEPROM calibration memory chip. Never attempt to remove the connector from the transducer. It is installed with a permanent adhesive.

Safety Messages

Safety messages are provided to help prevent personal injury and equipment damage. All safety messages are introduced by a signal word indicating the hazard level. The types of safety messages are:



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury to the operator or to bystanders.



Indicates a potential hazard which, if not avoided, could result in death or serious injury to the operator or to bystanders.



Indicates a potential hazard which, if not avoided, may result in minor or moderate injury to the operator or to bystanders.

The three-part message panel, used with safety messages, uses three different type styles to further define the potential hazard:

- Normal type states the hazard,
- **Bold type** states how to avoid the hazard, and
- *Italic type* states the possible consequences of not avoiding the hazard.

Some safety messages contain visual symbols with signal words.

Example:

WARNING



Flying particles can discharge when applying torque.

- **Users and bystanders must wear safety goggles.**
 - **Always wear safety goggles when applying torque.**
- Flying particles can cause injury.*



Safety Information

IMPORTANT SAFETY INSTRUCTIONS

This manual contains important safety and operating instructions for **Snap-on** Torque Tester model TTC2000. Refer to the information in this manual often for safe operation.

Read All Instructions

Read, understand and follow all safety messages and instructions in this manual and on the test equipment. Safety messages in this section of the manual contain a signal word, a three-part message, and, in some instances, an icon.

The signal word indicates the level of hazard in a situation:

- **Danger** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury to the operator or bystanders.
- **Warning** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to the operator or bystanders.
- **Caution** indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury to the operator or bystanders.

The three-part message uses three different type styles to further define the potential hazard.

- Normal type states the hazard.
- **Bold type** states how to avoid the hazard.
- *Italic type* states the possible consequences of not avoiding the hazard.

An icon, when present, gives a graphical description of the potential hazard.

SAVE THESE INSTRUCTIONS

WARNING



Risk of electric shock and fire.

- **For indoor use only. Do not expose charger to rain or snow. Do not use in damp locations.**
- **Replace defective cord immediately. Return to qualified service center for replacement.**

Electric shock or fire can cause injury.

WARNING



Flying particles can discharge when applying torque.

- **Users and bystanders must wear safety goggles.**
- **Always wear safety goggles when applying torque.**
- **Do not use this equipment with the power off. Always turn on the indicator and loader so the torque and load values are indicated on the display. The safety relays only work when the power is on.**

Flying particles can cause injury.

WARNING



Risk of entanglement.

- **When starting power tools, check for obstacles near your hand and anticipate the reaction force by gripping the tool firmly.**
- **Do not wear loose clothing and jewelry while operating a power tool. Loose clothes and jewelry can be caught in moving parts.**
- **Keep body parts away from rotating parts.**
- **Wear a protective hair covering to contain long hair and prevent contact with moving parts.**
- **Do not overreach. Keep proper footing and balance at all times.**

Entanglement can cause injury.

WARNING



Improper use can cause breakage.

- **Read instructions before operating.**
- **Follow manufacturer's instructions, safety precautions, and specifications when operating tools.**

Broken equipment can cause injury.

WARNING

- Make sure all components, including, adaptors, extensions, drivers and sockets are rated to match or exceed the torque or load being applied.
- Be sure the capacity of the TTC2000 matches or exceeds each application before performing a procedure.
- Do not use the TTC2000 if it makes unusual noises, has loose parts, or shows any other sign of damage. Have repairs performed at an Authorized Service Center before use.
- Do not use chipped, cracked, or damaged sockets and accessories.
- Do not remove any labels. Replace any damaged label.
- Follow good, professional tool practices:
 - Pull on a wrench handle—do not push—and adjust stance to prevent a possible fall.
 - Do not use extensions, such as a pipe, on a wrench handle.
- When using ratchets, make sure the direction lever is fully engaged in the correct position.
- Never attempt to test an impact tool on this instrument.
- Always position the 40" arm over the front of the stand as shown. Never extend the test arm behind the stand. The stand will tip over when weights are applied.
- Always be alert to the potential for personal injury that may be caused by excessive torque applications, careless handling of heavy weights, and out-of-balance or unsafe weight distribution.

Introduction

The TTC610 Indicator is a laboratory grade instrument that provides TORQUE, FORCE and ANGLE of rotation measurements and set-able alert functions. Although designed as an integral component of the TTC2000 Torque Calibrator, it can also be used independently in many laboratory and industrial applications. The TTC610 features versatile data acquisition capabilities including measurement storage, retrieval, statistical analysis and automatic downloading to the built-in printer or external printer/computer. A remote computer COM port is available for PC interfacing.

Used with precision torque/force transducers, the TTC610 provides high speed monitoring of static or dynamic torque, force or angle inputs. Torque/force transducers, purchased separately, are available in ranges from 15-200 in oz, to 200-2000 ft lb, and provide system readings with an accuracy of 0.25%, or better. A special memory chip is built into each torque/force transducer that identifies its range and maintains its calibration between any other TTC610 Indicator with an accuracy of 0.5%. The indicator and its transducers may be calibrated by using accessory precision bars and certified weights.

The indicator features a bright red alpha-numeric LED display for readout of torque in ft lb, in lb, in oz, Nm, dNm, cNm, mkg and cmkg, or force in ounces, pounds, Newtons, decaNewtons, kiloponds (kilograms) or grams, depending upon the transducer in use.

Angle measurement, calibration, statistical analysis and set-up functions are reported on a 2-line by 16-character 5x8 dot matrix, backlighted LCD, display. A Torque-Angle mode can be set up for precision fastener installation monitoring. The TTC610 uses X4 quadrature logic that takes advantage of maximum resolution from industry standard bidirectional rotary encoders.

Set-up and calibration programming is entered on front panel membrane keys. HIGH and LOW torque limits are adjustable to give an audible alert. The user selects TRACK mode to display torque values as they are applied, PEAK HOLD or POWER TOOL modes to display the highest torque value applied, or FIRST PEAK mode which captures the torque output at the “click” of a set-able wrench or driver. CLEAR, STORE and PRINT functions can be set up for automatic or manual operation.

The indicator stores and recalls up to 3000 torque/force readings and does statistical analysis on them for downloading to printer or computer. The statistical report (print out) includes a simple histogram for process monitoring. True RS-232 serial printer and separate RS-232 computer COM ports are at the back of the unit.

The TTC610 Indicator operates from the AC power line and is switch selectable for either 120VAC or 220 VAC, 50–60 Hz. Its integral switching power supply is UL listed. A hard-wired lithium battery keeps the internal memory and date-time clock operating for up to 10 years.

The information in this manual is general. Operational features, procedures and specifications may change without notice.

Snap-on Tools makes no claims as to the suitability of this information for diverse user applications.

Functional Description and Specifications

2

The TTC2000 Torque Tester/Calibrator is comprised of the TTC610 Indicator, one of the TTC Torque/Force Transducers, a TTC600 Loader, and a KRL762PY roll cabinet. System accuracy is achieved when the Indicator and Transducer are calibrated together.

Functional Descriptions

TTC2000 Torque Tester/Calibrator

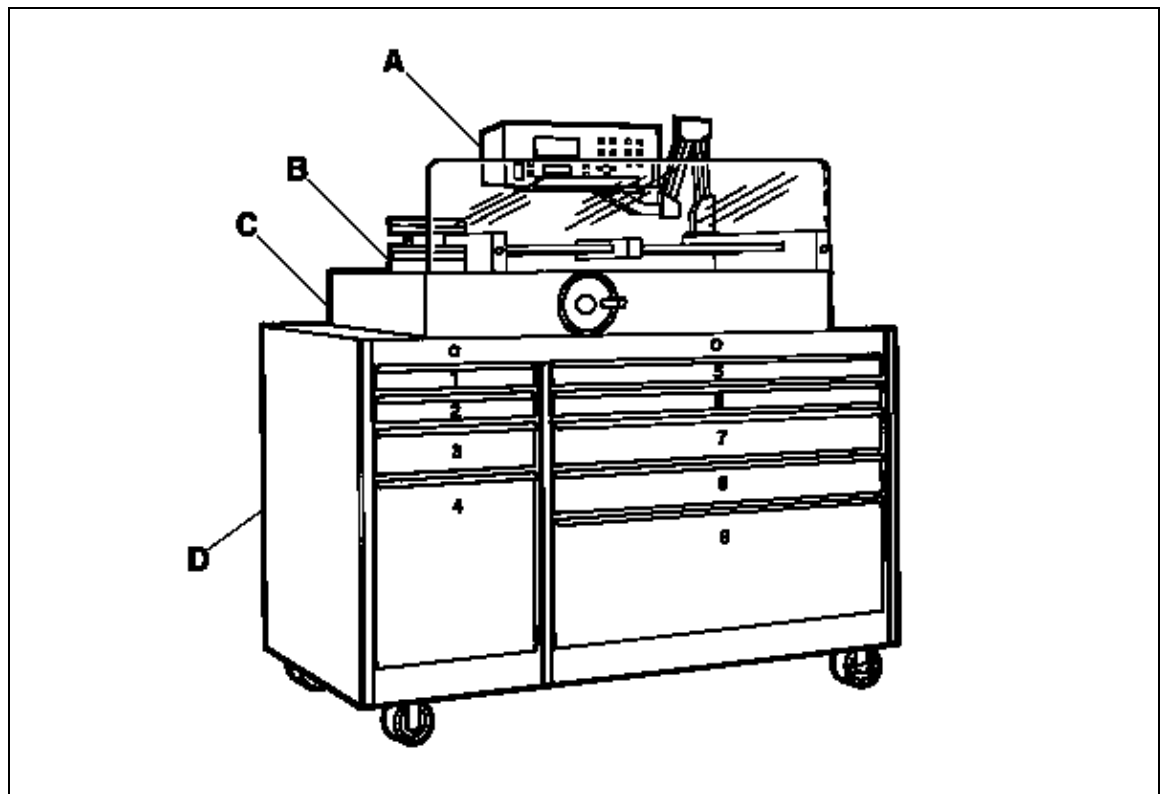


Figure 2-1: TTC2000 Torque Tester/Calibrator

A — Indicator

The TTC610 Indicator monitors and displays the torque applied.

B — Transducer (Accessory)

The loader accepts all TTC series single transducers directly. Use a TTC5000-1 adaptor kit to mount the optional TTC400 4-in-1 transducer. For additional information refer to *Appendix A—Accessories*.

C — Loader

Use the TTC600 Manual Loader for testing and calibrating all torque wrenches, drivers, torque multipliers, non-impact pneumatic and electric nut runners. It can also be mounted on a fixture for testing and calibrating cable tensiometers and compression or tension gauges. Loader components are:

- Indicator Stand
- Safety Shield
- Hand Crank
- Transducer Mounting

D — Roll Cabinet

The roll cabinet features nine heavy duty drawers with ball bearing slides, locking wheels and drawer locks. TTC2000 accessories are stored in the roll cabinet which is fitted with foam inserts for easy inventory control. The nine drawers are assigned and arranged as shown in *Figure 2-2*.

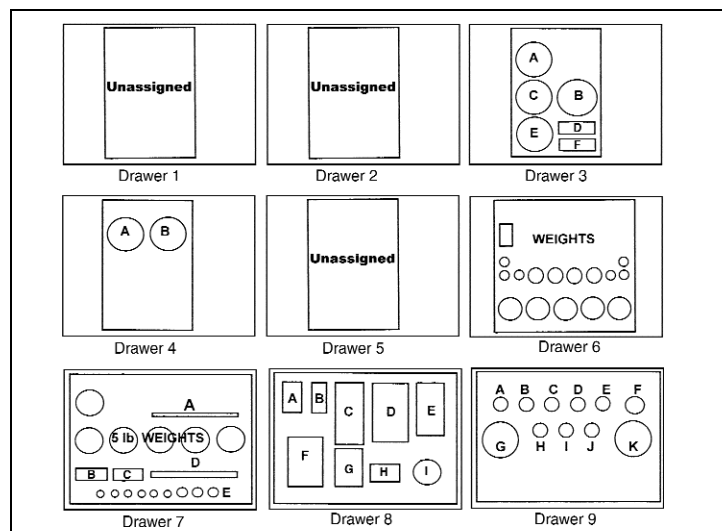


Figure 2-2: Roll Cabinet Drawer Layout

TTC610 Indicator

This section describes the major hardware components of the TTC610 Indicator, including:

- Front Panel
- Rear Panel (Input/Output)
- TTC Torque/Force Transducers

Front Panel

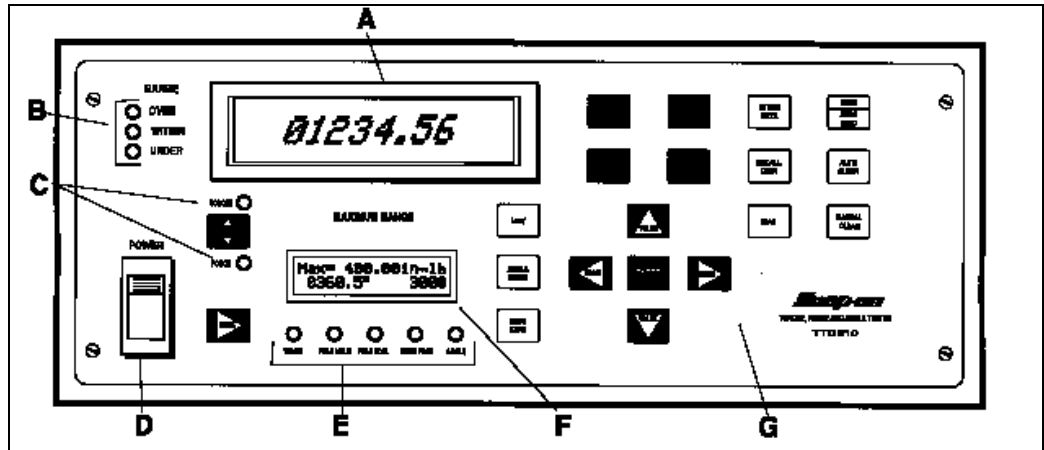


Figure 2-3: TTC610 Front Panel

A — TTC610 Torque/Force Display

TORQUE or FORCE displays on a bright red alphanumeric LED, with 0.55" high characters in selected engineering UNITS.

- (+) = Clockwise torque or force
- (-) = Counter clockwise torque or force

B — Range LED Torque or Force Limit Indicators

- Red—OVER (Input exceeds 110% of transducer range)
- Green—WITHIN (Input is within transducer range)
- Yellow—UNDER (Input is below transducer range)

C — Mode Select LEDs

- Red—TORQUE
- Green—FORCE

D — Power Switch

E — MODE Function LEDs

- Green—TRACK
- Red—PEAK HOLD
- Yellow—POWER TOOL
- Red—FIRST PEAK
- Green—ANGLE

F — Maximum Range Display

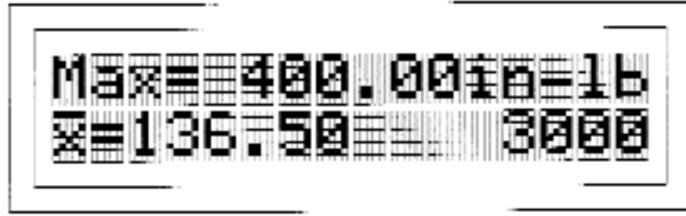


Figure 2-4: Maximum Range Display

Two line by 16 character 5x8 dot-matrix LCD display that shows:

- Maximum transducer range in the selected UNITS of measure on the upper line,
- Statistical mean of all measurements in memory on the lower line, left, and
- The number of the present data memory location on the lower line, right.

This display also is used to indicate:

- ANGLE, in degrees, CW=(+), CCW=(-) of rotation,
- Prompt CALibration mode,
- Programming of angle encoder,
- Printer protocol,
- RECALL display of data list and STATistical analysis, and
- Set up for:
 - DATE/TIME clock,
 - AUTO/MANUAL CLEAR, STORE and SEND, and
 - HIGH and LOW torque/force limits.

G — Front Panel Membrane Function Keys



Toggles between TORQUE and FORCE measurement modes.



Selects TRACK, PEAK HOLD, POWER TOOL, FIRST PEAK and ANGLE modes.



Selects following units on LCD display:
Torque units in: Nm, dNm, cNm, mkg, cmkg, lb ft, in lb, in oz,
or
Force units in: N, dN, kp, gf, lbf, oz



Manually resets ANGLE display on LCD at any time.



Manually resets ZERO TARE.



Selects LED or LCD digit to right (blinking) for setup and programming. Shift for printer and angle encoder programming.



Selects LED or LCD digit to left (blinking) for setup and programming. Shift for printer and angle encoder programming.



Terminates calibration and program modes. Returns to 4-in-1 transducer scan.



Increments selected digit during calibration and program modes. Scrolls statistical analysis display.



Decrements selected digit during calibration and program modes. Scrolls statistical analysis display.

Functional Description and Specifications

	Opens and terminates calibration mode.
	Edits DATE/TIME programming function.
	Sets up high torque/force limit preset. Set up angle preset in torque -angle mode.
	Sets up low torque/force limit preset. Set up clamping torque preset in torque-angle mode.
	Stores present measurement to memory.
	Recalls memory data to display.
	Sends all memory data, statistical analysis and histogram to printer/port.
	Sends data list with or without date-time stamp to computer printer. Sets up serial protocol function.
	Sets up CLEAR, STORE, and SEND modes function.
	Manually clears display in PEAK, FIRST PEAK, POWER TOOL and ANGLE modes. Sets up memory clear options in RECALL mode.

Rear Panel (Input/Output)

The TTC610 Indicator rear panel is shown in *Figure 2-5*.

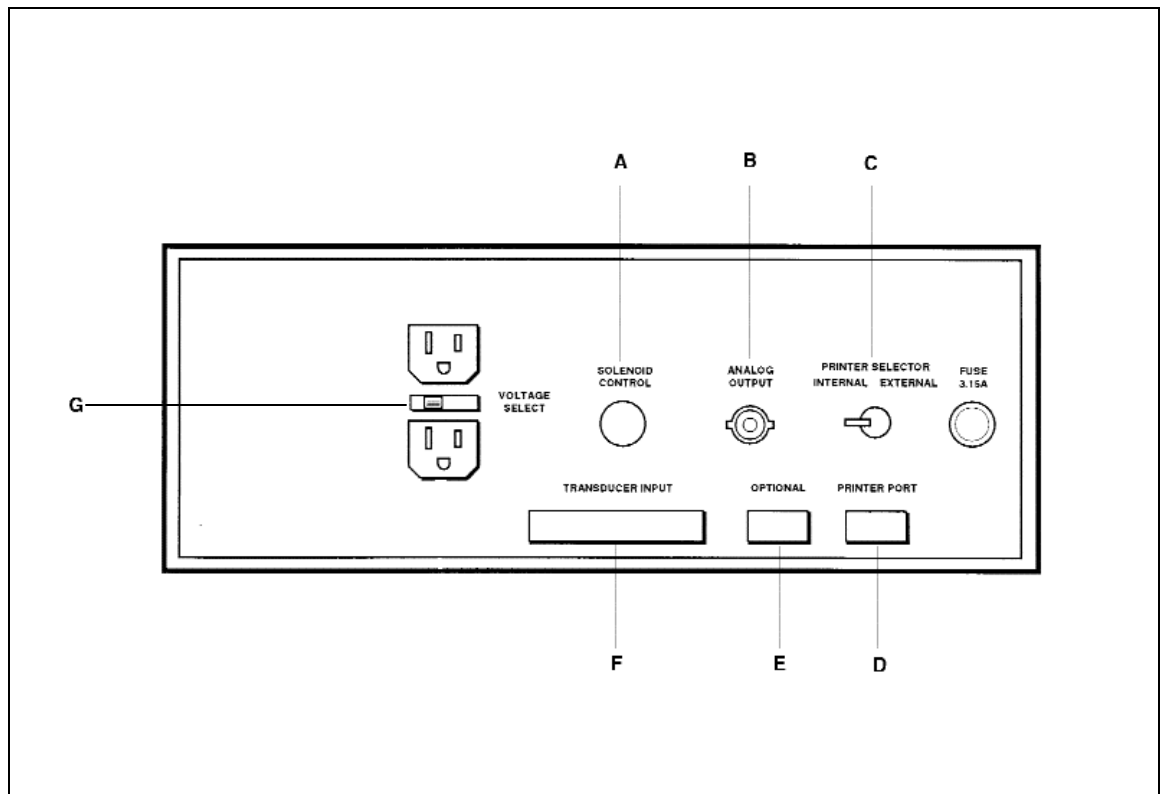
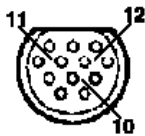


Figure 2-5: TTC610 Rear Panel



A — SOLENOID CONTROL (Hirose RM15TRD-12S)

PIN	FUNCTION
10	Loader Relay Common
11	Loader Relay CCW Limit
12	Loader Relay CW Limit

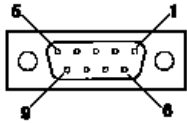
B — ANALOG OUTPUT (BNC)

Analog output provides a voltage level output that is directly proportional to transducer input, from -1.8V (full scale counter clockwise) to +1.8V (full scale clockwise). Zero offset +/-100 mV. Linearity +/-1% of reading. Maximum load = 5 Ma.

- ✓ When using the 4-in-1 transducer, zero output fluctuates until one of the transducers is scan selected by applying 5% of full scale torque.

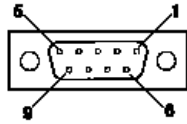
C — PRINTER SELECTOR

The INTERNAL/EXTERNAL switch disables the built-in printer.



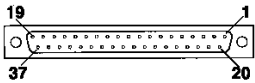
D — PRINTER PORT (DB-9P)

PIN	FUNCTION
2	Receive
3	Transmit
5	Ground



E — OPTIONAL (DB-9P)

PIN	FUNCTION
2	Receive
3	Transmit
5	Ground



F — TRANSDUCER INPUT (DB-37S)

PIN	FUNCTION
1	not used
2	ground
3	smart chip - bit 2
4	smart chip - bit 0
5	single xducer (-) signal
6	single xducer (+) signal
7	ground
8	4-in-1 xducer (-) signal 2
9	4-in-1 xducer (+) signal 2
10	ground
11	4-in-1 xducer (-) signal 4
12	4-in-1 xducer (+) signal 4
13	4-in-1 xducer LED 2
14	4-in-1 xducer LED 4
15	loader relay CW limit
16	rotary encoder signal A
17	rotary encoder signal B
18	ground
19	bridge excitation (+3V)
20	not used
21	smart chip - bit 3
22	smart chip - bit 1
23	ground
24	ground
25	4-in-1 xducer (-) signal 1
26	4-in-1 xducer (+) signal 1
27	ground
28	4-in-1 xducer (-) signal 3
29	4-in-1 xducer (+) signal 3
30	no transducer
31	4-in-1 xducer LED 1
32	4-in-1 xducer LED 3
33	loader relay CCW limit
34	loader relay common
35	Vcc (+5V@100 ma. max)
36	ground
37	bridge excitation (+3V)

G — VOLTAGE SELECT

Switch for selecting either 120VAC or 220VAC, 50-60 Hz.

TTC Torque/Force Transducers

TTC torque/force transducers provide industry standard internal square drives. They feature a full bridge strain-gauge @ 350 Ohms nominal. Full range output is 1500 μ E, 9mV, (3mV/V @ 3.0V excitation).

Torque/force transducers use a built-in EEPROM memory chip that stores range identification and calibration factors. Calibration of transducers is accomplished using precision torque bars and certified weights. For additional information, refer to *Chapter 5—Calibration*.

After a transducer is calibrated, it provides +/-0.5% system accuracy with any TTC610 Indicator. If the transducer and indicator are calibrated together, the system accuracy increases to +/-0.25%.

Transducer Dimensions/Transducer Indicator Torque Range and Force Range

Stock No.	Torque Range	Drive	Force Range	Height	Diameter	Weight
TTC5	15-200 in oz	1/4" Ext.		3.9 in	3.0 in	1.5 lb
TTC6	4-50 in lb	1/4" Ext.		3.9 in	3.0 in	1.5 lb
TTC65	15-150 in lb	1/4" Ext.		3.9 in	3.0 in	1.5 lb
TTC7	30-400 in lb	3/8" Ext.	33.3 lbf	4.1 in	3.0 in	3.0 lb
TTC8	80-1000 in lb	3/8" Ext.	83.3 lbf	4.1 in	3.0 in	3 lb
TTC10	10-125 ft lb	1/2" Ext.	125 lbf	4.25 in	4.0 in	5 lb
TTC11	20-250 ft lb	1/2" Ext.	250 lbf	4.25 in	4.0 in	5 lb
TTC12	60-600 ft lb	3/4" Ext.	600 lbf	4.25 in	4.0 in	5 lb
TTC13	100-1000 ft lb	1" Internal	1000 lbf	5.5 in	6.1 in	24 lb
TTC14	200-2000 ft lb	1" Internal	2000 lbf	5.5 in	6.1 in	24 lb
TTC400	4-50 in lb	1/4" Ext.	H2.6-W5.0-L10.0 in			6 lb
(4-in-1)	30-400 in lb	3/8" Ext.				
	80-1000 in lb	3/8" Ext.				
	20-250 ft lb	1/2" Ext.				

Calibration also results in a specified display resolution on the TTC610 Indicator. Display resolution is dependent on the type of transducer being used. The following table shows display resolutions for the specified transducer with the force arm.

Display Resolution for Transducers in Force Mode

	N	dN	lbf	ozf	kp	gf
TTC7	03	.3	.007	.1	.003	3
TTC8	.08	.8	.02	.3	.008	8
TTC10	.1	1	.02	.4	.01	10
TTC11	.2	2	.05	.8	.02	n/a
TTC12	.5	5	.12	2	.05	n/a
TTC13	.9	9	.2	3	.1	n/a
TTC14	1.8	18	.4	6	.2	n/a

Display Resolution for Transducers in Torque Mode

	mkg	cmkg	ft lb	in lb	in oz	Nm	dNm	cNm
TTC5	.00003	.003	.0002	.002	.04	.0003	.003	.03
TTC6	.0001	.01	.0008	.01	.2	.001	.03	.3
TTC65	.0003	.03	.002	.03	.5	.003	.03	.3
TTC7	.001	.1	.006	.08	1.2	.009	.09	.9
TTC8	.002	.2	.016	.2	3.2	.02	.2	2
TTC10	.004	.4	.03	.3	5	.03	.3	3
TTC11	.007	.7	.05	.6	10	.07	.7	7
TTC12	.016	1.6	.12	1.4	n/a	.16	1.6	16
TTC13	.03	3	.2	3	n/a	.3	2.7	n/a
TTC14	.05	5	.4	5	n/a	.5	5	n/a
TTC400	.0001	.01	.0008	.01	.2	.001	.03	.3
(4-in-1)	.001	.1	.006	.08	1.2	.009	.09	.9
	.002	.2	.016	.2	3.2	.02	.2	2
	.007	.7	.05	.6	10	.07	.7	7

TTC torque/force transducers can withstand an overload of 110% of full range. The TTC610 Indicator alarms, (audible beep and display "OVER" red LED) at 110% of rated capacity.

To protect the tool under test or serve as a fastener installation, torque preset alert, the TTC610 produces a constant audible tone when the input torque/force exceeds the SET LOW limit. It then produces a pulsating tone when the input torque/force exceeds the SET HIGH limit.

TTC610 ignores inputs less than 0.1% of full range in TRACK mode, 2% in PEAK HOLD mode, 7% in FIRST PEAK and POWER TOOL modes. With the 4-in-1 transducer, TTC2000 ignores inputs less than 2% of full range after scan select.

Specifications

TTC2000 System

System Accuracy

$\pm 0.25\%$ of reading @ 25°C
(Indicator and transducer calibrated together)

✓ TTC Transducers used with, but not calibrated to,
another TTC Indicator provide a system accuracy of
 $\pm 0.5\%$ of reading @ 25°C.

Temperature Drift

+0.03%/°C (+0.017%/°F)

Angle Precision

Bi-directional rotary encoder pulses/revolution X4

TTC610 Indicator

Display Accuracy

$\pm 0.05\%$ of reading @ 25°C

Temperature

Operating Temperature

10 to 32°C (50 to 90°F)

Storage

-20 to 50°C (-2 to 122°F)

Humidity

Up to 90%, Non-condensing

Temperature Drift

+0.011%/°C, (+0.006%/°F)

Dimensions

Width	16.5"
Height	6.25"
Depth*	14.5"

*Includes handle, feet, printer and connectors

Weight

13.5 lbs

Power Supply

UL approved, 120VAC/220VAC, 50-60 Hz
Amperage, 3.15 amps

Data Storage/Recall w/Date Time Stamp

3,000 measurements

Statistical Analysis

Max, Min, Range, Mean, Sigma N, Sigma, Cp, Cpk

%Error, -NoGo, +NoGo.

Histogram: Lower Set Limit, Upper Set Limit, 10 Divisions

Printer/Computer Serial Output Port

Serial Communications

RS-232 (true)

300—19.2K Baud

8 data bits

1 stop bit

no parity

Computer Serial COM Port

RS-232 (True)

300—19.2K Baud

OPTIONAL

Analog Output

+(CW)/-(CCW) 1.8V at transducer full range linearity

±1% of reading

Loader Control Relays

Two, normally open, Form A, rated 12VDC @ 1/2A close contact at 110% CW or CCW of torque/force transducer range.



For additional information refer to *Transducer* and *System* specifications.

Display Capacity

(16 bit A/D), 8 digits, ±32,000 counts

Units of Measurement

Torque

ft lb, in lb, in oz, Nm, dNm, cNm, mkg and cmkg

Force

lbf, ozf, N, dN, kp, and gf

Angle

degrees

Torque/Force Resolution

Refer to transducer-indicator range and display resolution tables in *Functional Description* of this chapter.

Angle Resolution

Bi-directional, X4 quadrature logic

Torque/Force Transducers

Accuracy

±0.2% of reading @ 25°C, within specified range, when used as prescribed with the TTC600 Loader.

Range and Resolution

Refer to transducer-indicator range and display resolution tables in *Functional Description* of this chapter.

Temperature

Operating Temperature

10 to 32°C (50 to 90°F)

Storage

-20 to 50°C (-2 to 122°F)

Humidity

Up to 90% non-condensing

Temperature Drift

+0.02%/°C (+.011%/°F)

TTC600 Manual Loader Specifications

Input Torque (Hand Crank)

8 ft lb maximum

Output Torque

2000 ft lb ±20 degrees rotation maximum

Power Requirements (safety solenoids)

115/230VAC ±10%, @ 50-60 Hz

Physical Dimensions

Width

45"

Height

50"

Depth

24"

Weight (including KRL762PY roll cab)

1500 lbs

Optional Calibration Fixturing (load bars and weights)

±0.05% accuracy

Setup and Programming

TTC2000 System Setup

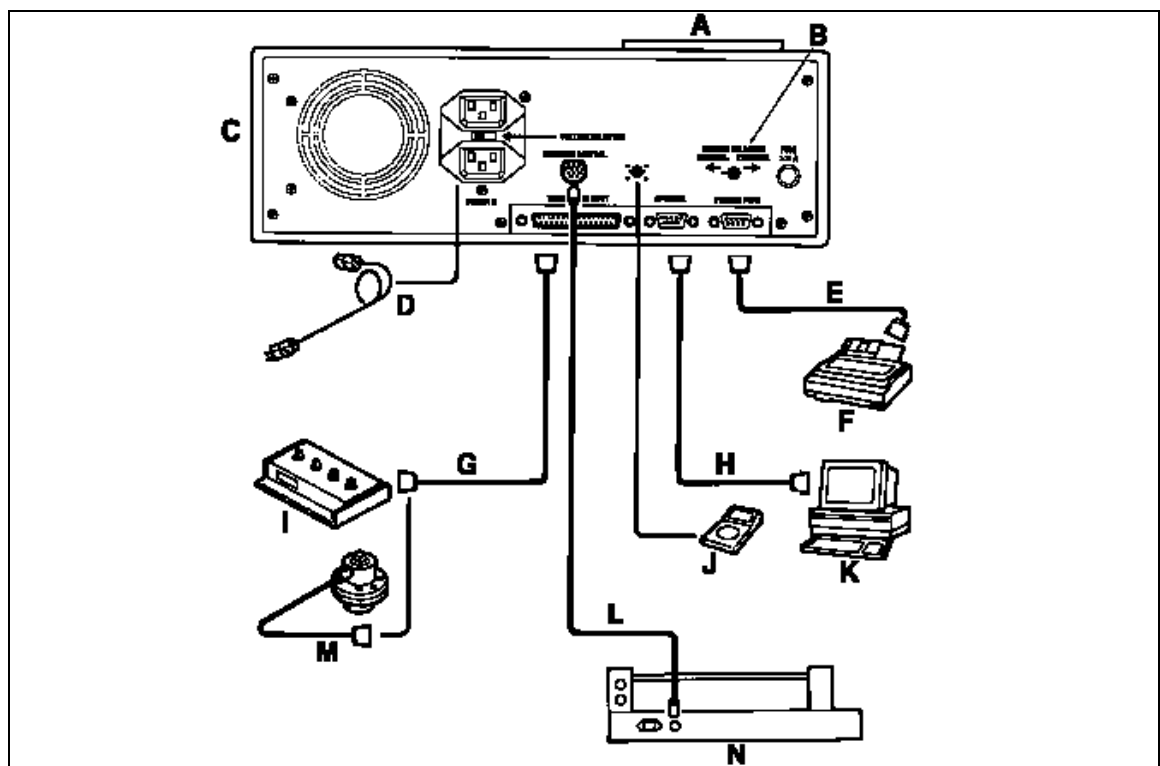


Figure 3-1: TTC2000 Torque Tester/Calibrator/Loader Setup

- A – Internal printer
- B – Internal/External printer selector switch
- C – TTC610 Indicator rear panel
- D – Power cables (110/220 VAC)
- E – Printer cable
- F – External printer
- G – Transducer cable
- H – Personal computer cable
- I – Smart 4-in-1 transducer
- J – Analog device
- K – Personal computer
- L – Solenoid control cable
- M – Smart single transducer
- N – TTC600 Manual Loader

Setting Up the TTC2000 System

1. Position the roll cabinet on a level floor and lock the wheels.
2. Mount the indicator stand, part number TTC1110, to the Loader.
3. Mount the TTC610 Indicator to the stand.
4. Connect the solenoid control cable between the Indicator and Loader.
5. Install the appropriate TTC transducer to the Loader drive.
6. Install two (2) quick release pins, part number TTC19512.
7. Connect the transducer cable, part number TTC116, between the Indicator and transducer.
8. Select the appropriate AC voltage input at the rear of the Indicator and Loader. Connect the AC power cables to the Indicator and the Loader. For additional information refer to *Chapter 6—Loader Rear Panel Controls*.
9. Install the safety shield to the front of the Loader.
10. Install the reaction pins into the reaction slide on the Loader.
11. Install two retention pins, part number TTC17311.

✓ For testing procedures refer to *Chapter 4—Using the Torque Tester*.

Various fixtures, cables and adaptors are available for testing the most common compression or tension gauges. Ask your **Snap-on** sales representative for design assistance.

Powering the Equipment

To power the equipment, press the power button on the front of the TTC610 Indicator.

- At POWER ON, the LED displays:

**SNAP-ON
TTC610
SELFTEST... MEM O.K.
EE O.K.**

- Then the following banners display:

**SOLENOID TEST
TEST CW
TEST CCW
SELFTEST O.K.**

and the LCD reads:

Firmware version *datacode*

- With no transducer installed, the LED display reads:

NO INPUT

and the LCD reads:

**No transducer
connected**

- When applying power with the transducer connected, or when connecting a transducer while the power is on, the LED displays:

**READ BOX
BOX O.K.
ZERO TARE
+zero**

The UNDER, TORQUE and TRACK indicators light. The LCD displays:

Max=transducer range and **units** - upper line
x=average and **memory location** - lower line

4-in-1 Transducer Select

If the 4-in-1 transducer is installed at power on, the LCD display reads:

Select Transducer

All four transducers are scanned as indicated by their associated red LED indicators. To select one of the transducers, apply at least 5% of its full range torque. To return to the scan mode, press ENTER.

Programming Setup

Setting up Date and Time

1. Press DATE/TIME. The LCD display reads
Date *dd/month/yy* - upper line
Time *hh:mm:ss* - lower line, with the seconds flashing

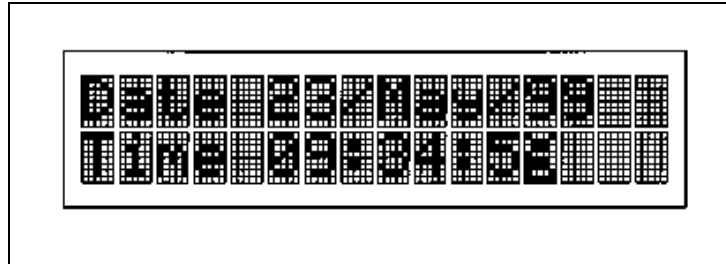


Figure 3-3: Date and Time Display

2. Push left or right DIGIT to select the date/time element being changed.
3. Increment or decrement the date/time element by repeatedly pushing up or down VALUE.
 - ✓ Push and hold up or down VALUE to change the display quickly. Incrementing/decrementing the day rolls over to the next or previous month; likewise month to year, seconds to minutes, and minutes to hours.
4. Press ENTER to update date and time and then return to measurements mode.

Setting Up High and Low Limits Alert

Torque/Force Mode

Use SET HIGH and SET LOW to protect the tool under test or serve as a fastener installation torque or force preset alert. The TTC610 produces a constant audible limits alert tone when the input torque/force exceeds the SET LOW limit. It then produces a pulsating limits alert tone when the input torque/force exceeds the SET HIGH limit.

- ✓ It is important to program these limits if statistical analysis is to draw a histogram which includes reporting out-of-limit parameters.
- ✓ Changing transducers does not automatically change SET HIGH and SET LOW limits.

Angle Mode

In the ANGLE mode, use SET LOW to program a clamping torque limit and use SET HIGH to program an angle measurement. For additional information refer to *Torque-Angle Measurement Modes* in this chapter.

Setting Low Torque/Force Limit

1. Press SET LOW.
 - The LED display reads:
last SET LOW value, with one digit flashing
 - The LCD display reads:
Edit low limit - upper line
[units] - lower line
- ✓ Change units of measure by pushing UNITS.
2. Select an LED digit to change (flashing) by pushing left or right DIGIT.
3. Increment or decrement the selected digit by pushing up or down VALUE. Push and hold up or down VALUE to change the display quickly.
 - ✓ A decimal point "." appears between "9" and "0" numerals. Maximum resolution is selected automatically, regardless of decimal point position, upon pushing ENTER. The program value is absolute, for both $\pm$ readings.
4. Select and change the next LED digit using left and right DIGIT and up and down VALUE. Continue until all digits are set.
5. Press ENTER to return to measurements mode.

Setting High Torque/Force Limit

1. Press SET HIGH.
 - The LED display reads:
last SET HIGH value, with one digit flashing
 - The LCD display reads:
Edit high limit - upper line
[units] - lower line

✓ Change units of measure by pushing UNITS.
2. Select an LED digit to change (flashing) by pushing left or right DIGIT.
3. Increment or decrement the selected digit by pushing up or down VALUE. Push and hold up or down VALUE to change the display quickly.

✓ A decimal point "." appears between "9" and "0" numerals. Maximum resolution is selected automatically regardless of decimal point position upon pushing ENTER. The program value is absolute, for both $\pm$ readings.
4. Select and change the next LED digit using left and right DIGIT and up and down VALUE. Continue until all digits are set.
5. Press ENTER to return to measurements mode.

Programming AUTO CLEAR

Use AUTO CLEAR to program the CLEAR, STORE and SEND functions for automatic or manual operation. Use these functions in PEAK HOLD, POWER TOOL and FIRST PEAK modes to STORE torque or force measurements to memory, CLEAR the display, and SEND the last measurement captured on the LED display to the printer or PC. Auto STORE and SEND are initiated at either AUTO or delayed CLEAR operations.

Use the manual modes to:

- Store the present reading by pushing STORE DATA,
- Clear a captured display by pushing MANUAL CLEAR, or
- Send a measurement to the printer/port by pushing SEND/AUTO SEND.

Use the automatic modes to:

- Store the last measurement, and/or
- Send the last measurement to the printer/port by initiating the auto or delayed CLEAR function.

AUTO CLEAR can be programmed with a 1 to 9 second delay. Use this feature to visually note the reading before the display clears. AUTO CLEAR with no delay stores, prints and/or clears with no delay at the initiation of the next torque or force input.

- ✓ STORE DATA must be pressed to save the last reading that displays on the LCD after a test.
- ✓ AUTO CLEAR must be selected to use AUTO STORE and AUTO SEND.

To use the AUTO CLEAR, STORE, or SEND:

1. Press AUTO CLEAR. LCD display reads:

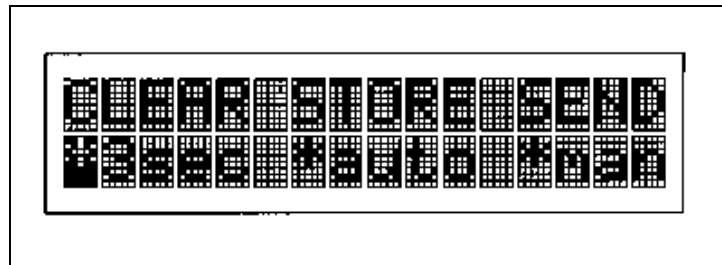


Figure 3-4: AUTO CLEAR, STORE, SEND Display

2. Use right and left DIGIT to position the flashing (*) character under the function being changed. To program:
 - CLEAR, press up or down VALUE to select "man" (manual clear), "auto" (automatic), or (delayed automatic) from "1Sec" to "9Sec" seconds.
 - STORE, press up or down VALUE to select "man" (manual) or "auto" (automatic).
 - SEND, press up or down VALUE to select "man" (manual) or "aut" (automatic).
3. Press ENTER to return to measurements mode.

DATA LIST Memory

When changing sensors, or when creating a new statistical data list, the data list memory must be cleared. The entire memory list or any single memory location may be selectively cleared. Clearing from the top of the list decrements the total number of memory locations. Clearing from inside the list shifts all subsequently taken readings down from that location and decrements the total number of memory locations.

Clear Last Memory Location

Use the procedure in this section to clear the last memory location.

1. Press RECALL DATA. The LCD displays as shown in *Figure 3-5*. The present memory location is at the upper left, the total number of memory locations to its right and the time the data was stored at the far right.
 - The LED display shows the measurement value of that memory location.
 - The LCD displays its engineering units at the lower right.

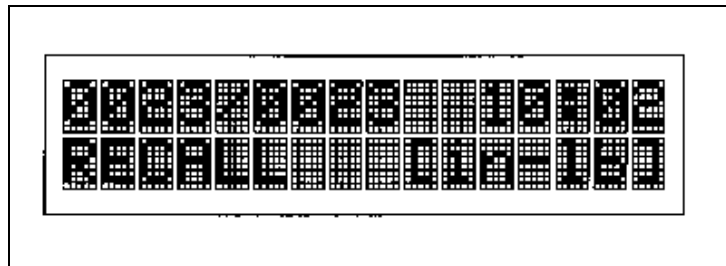


Figure 3-5: RECALL Data Display

2. Press MANUAL CLEAR. LCD display shows "CLEAR" and the present (left) and total (right) memory locations on the upper line, as shown in *Figure 3-6*.

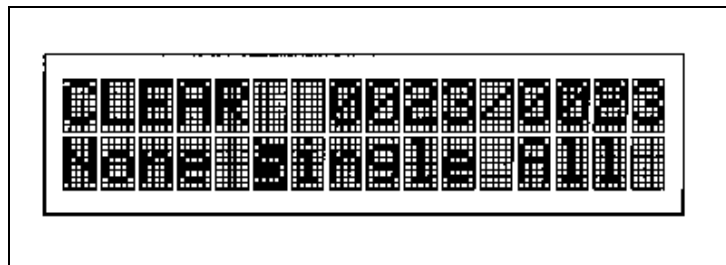


Figure 3-6: RECALL Data Display

3. Press right DIGIT to select "Single" on the lower LCD line.

4. Press ENTER to clear the last memory location. The number of total memory locations decrements by one.
✓ Pushing ENTER repeatedly continues to clear readings from the top of the list down.
5. Press left DIGIT to select "None."
6. Press ENTER to return to RECALL mode.
7. Press ENTER again to return to measurements mode.

Clear Single Memory Location

Use the procedure in this section to clear a single memory location.

1. Press RECALL DATA.
 - The LCD display reads as shown in *Figure 3-5*. The present memory location at the upper left, total number of memory locations to the right and time data was stored at far right.
 - The LED display shows the measurement value of that memory location while the LCD displays its engineering units at the lower right.
2. Press up or down VALUE to select the particular memory location to clear.
3. Press MANUAL CLEAR. The LCD display shows "CLEAR" and the present (left) and total (right) memory locations on the upper line, as shown in *Figure 3-6*.
4. Press right DIGIT to select "Single" on the lower LCD line.
5. Press ENTER to clear the present memory location. The number of total memory locations decrements by one and all subsequent measurements move down one location.
✓ Push ENTER repeatedly to continually clear readings until all subsequent and then prior locations clear.
6. Press left DIGIT to select "None."
7. Press ENTER to return to RECALL mode.
8. Press ENTER again to return to measurements mode.

Clear All Memory Locations

Use the procedure in this section to clear all memory locations.

1. Press RECALL DATA.
 - LCD displays as shown in *Figure 3-5*. The present memory location at the upper left, the total number of memory locations to the right and the time data was stored at far right.
 - LED display shows the measurement value of that memory location while the LCD displays its engineering units at the lower right.
2. Press MANUAL CLEAR.
 - LCD display shows "CLEAR" and the present (left) and total (right) memory locations on the upper line, as shown in *Figure 3-6*.
3. Press right DIGIT twice to select "All" on the lower LCD line.
4. Press ENTER to clear the entire data memory. LED display reads:

NO DATA

The audible alarm sounds momentarily. The TTC610 automatically returns to measurements mode.

Setting Up Printer/PC Ports

The TTC610 is equipped with two RS-232 serial communications ports for use with an external printer or personal computer. The transfer rate is programmable from 300 to 19.2K baud rate with 8 data bits, 1 stop bit and no parity.

- Select "PRINTER" to enable the printer port.
 - ✓ The built-in printer is connected to the PRINTER port. To disable the built-in printer, use the INTERNAL/EXTERNAL switch on the back of the TTC610 Indicator.
- Select "PC" to enable the OPTIONAL COM port.

Selecting Printer/PC Ports

1. Press CAL to enter calibration mode.
 - LED display reads the following with the least significant digit (LSD) flashing:
CODE0000
2. Use left and right DIGIT to select the appropriate digits and up and down VALUE to increment or decrement each digit between "0" and hexadecimal "F," program the number "2000" into the LED display.

3. Press ENTER.
 - The LED display reads:
PRINTER or PC
 - The LCD display reads:
Download: - upper line
Port - lower line
4. Press up VALUE to toggle between "PRINTER" port or optional "PC."
5. Press ENTER to return to measurements mode.

Setting Up Serial Communications

1. Press CAL to enter calibration mode.
 - LED display reads the following with the least significant digit (LSD) flashing:
CODE0000
2. Use left and right DIGIT to select the appropriate digits and up and down VALUE to increment or decrement each digit between "0" and hexadecimal "F," program the number "2000" into the LED display.
3. Press ENTER.
 - The LED display reads:
PRINTER or PC
 - The LCD display reads:
Download: - upper line
Port - lower line
4. Press right DIGIT.
 - LED display shows the previously programmed baud rate for the printer with the LSD flashing.
 - LCD display reads:
Baudrate Com1
5. Using up and down VALUE and left and right DIGIT, program the baud rate matching the printer being used.
 - ✓ The built-in printer operates at 09600 baud.
6. Press right DIGIT until LCD display reads:
Baudrate Com2
 - LED display shows the previously programmed baud rate for the optional PC port with the LSD flashing.
7. Using up and down VALUE and left and right program the desired baud rate that matches the PC being used.
 - ✓ The recommended default is 09600 baud.

8. Press right DIGIT.
 - LED display indicates:
YES or NO
 - LCD display reads:
Download: - upper line
Send Init yes/no - lower line
9. Press up or down VALUE to select "YES" to initialize the ports for reverse characters (on some external printers) or "NO" for standard characters.
10. Press ENTER to return to measurements mode.

Encoders

The TTC610 uses X4 quadrature logic for maximum resolution with any bi-directional incremental rotary encoder. Encoder output is mathematically converted and displays in degrees (°) of rotation, regardless of encoder count.

Example:

- A 90 count encoder measures $90 \times 4 = 360$ increments, (whole degrees).
- A 360 count encoder measures $360 \times 4 = 1440$ increments, (1/4 degrees), etc. Clockwise (CW) rotation is signified by (+) and counterclockwise (CCW) rotation is signified by (-).

Setting Up Angle Encoders

1. Press CAL.
 - LED display reads the following with the least significant digit (LSD) flashing:
CODE0000
2. Using up and down VALUE and left and right DIGIT, program the hexadecimal code "000E" into the display.
3. Press ENTER.
 - LED display reads:
SELECT
 - LCD display reads:
Encoder: Measure Resolut
- ✓ To determine the resolution of an unknown encoder:
 - A. Press ENTER.
 - The LED display reads:
COUNTING
 - The LCD display reads:
Count[0]= 000000 - upper line
Count[1]= 000000 - lower line

- B. Rotate the encoder shaft exactly one complete turn (360 degrees). The upper right LCD display reads the total number of counts for the encoder.
 - C. Push ENTER then CAL to return to the previous mode.
- ✓ To enter the resolution of a known encoder:
- A. Press up VALUE to select "Encoder: Enter Resolution" on the LCD display.
 - B. Press ENTER and, using up and down VALUE and left and right DIGIT, enter the counts resolution of the encoder.
 - C. Push ENTER then CAL to return the previous mode.
4. Check the encoder count to degrees of rotation conversion by pressing up VALUE to select "Encoder: Check Resolution" on the LCD display.
5. Press ENTER and rotate the encoder shaft exactly one complete turn.
- The LCD display reads:
Angle[0]= 0360.0

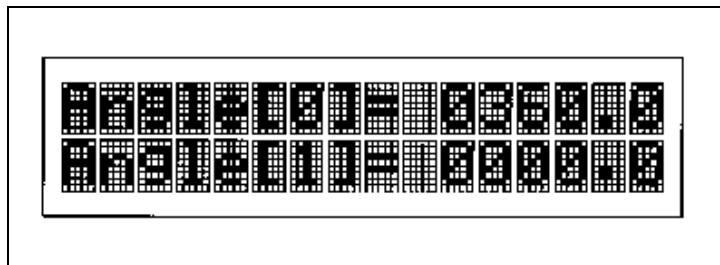


Figure 3-7: Encoder Count Display

6. Press ENTER.
7. Press CAL to return to measurements mode.
- ✓ "Count[1]" and "Angle[1]" in the LCD display are future options for use with a second encoder channel.

Setting Up Torque-Angle Measurement Modes

In using the torque-angle or "turn-of-the-nut" algorithm, a fastener is run down to a specified clamping torque and then rotated an additional number of angular degrees regardless of the torque necessary to turn it. A typical fastener specification might read: "15 ft lb & 50° rotation." For additional information, refer to the *Torque-Angle Tutorial* Quick Reference card that accompanies this manual.

When setting up torque-angle measurement modes:

- Angle measurements are not stored and cannot be printed.
- CLEAR, STORE and SEND must be set to MANUAL in the ANGLE mode. For additional information, refer to *Programming AUTO CLEAR* in this chapter.
- Torque SET HIGH must be set above the maximum torque expected. For additional information, refer to *Setting Up High and Low Limits Alert* in this chapter.

Setting Up the Torque/Angle Algorithm

When in the ANGLE mode, use SET LOW to preset the TTC610 to a clamping torque. At torque preset coincidence (when the input torque matches the SET LOW preset value), the TTC610 momentarily sounds an alert and automatically switches to measure angle from zero degrees. Preset the maximum angle using the SET HIGH function. A pulsating alert sounds at angle preset coincidence (when the measured angle matches the SET HIGH maximum angle preset value). SET HIGH torque preset also is active in the angle mode to protect the wrench from over-torque.

Set Up Torque-Angle Algorithm

Use the following procedure to set up the torque-angle algorithm.

1. Select ANGLE mode using MODE.
2. Press SET LOW.
 - The LED display shows the previously programmed clamping torque preset value.
 - The LCD display reads:

Clamping torque - upper line
[units] - lower line

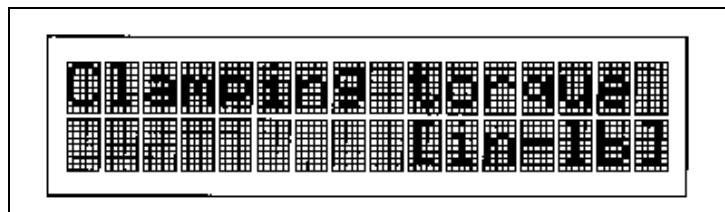


Figure 3-8: Clamping Torque Display

- ### Edit max. angle



- 3-16

5. Press SET HIGH.
 - The LED display shows the previously programmed degrees of rotation preset value.
 - The LCD display reads:
Edit max. angle
6. Using up and down VALUE and left and right DIGIT, enter the degrees of rotation from the fastener torque-angle specification onto the LED display.
7. Press ENTER to return to measurements mode.

Using the TTC2000

The TTC610 Indicator is designed to work specifically with the **Snap-on** TTC series of smart transducers for measuring torque. The **Snap-on** TTC series transducers contain a memory chip that identifies the transducer range and calibration parameters to the Indicator.

This chapter contains information on how to test, measure, and use the TTC2000 Torque Tester.

Testing Torque Wrenches and Drivers

To use the TTC2000 Torque Tester for torque wrench testing, a transducer of the appropriate range is fitted to the **Snap-on** TTC600 Manual Loader. The Loader provides a stop that holds the torque wrench handle fixed and rotates the transducer under the wrench drive. The system applies a precise, monitored torque to the wrench. For additional information refer to *Chapter 6—TTC600 Manual Loader*.

Selecting a Transducer

When selecting a transducer, choose a single transducer that covers the low to high end capacity of the torque wrench. Although possible, it is best not to change transducers between calibration check points. For example: to test or calibrate a 20 to 100 ft lb wrench, use the TTC10 transducer, which covers the range between 10 and 125 ft lb.

Installing a Transducer

Install the transducer by lining up the red mark with the "TORQUE" label on the loader. For additional information refer to TTC600 Loader.

- Before changing or replacing transducers, adjust SET HIGH and SET LOW limits to remain within the capacity of the tool under test. For additional information refer to *Chapter 3—Setting Up High and Low Limits Alert*.
- If you must retain the statistical analysis, do not change SET HIGH and SET LOW limits after changing the transducers and be careful not to exceed the wrench capacity.

The procedures provided are general. You may use or establish your own testing procedures, techniques or standards.

Dial and Bending Beam Torque Wrenches and Screwdrivers

Be sure the TTC transducer is capable of handling the intended torque to avoid damaging the transducer. Always operate the system with the TTC600 Loader power on.

WARNING



Do not use this equipment with the power off. Always turn on the indicator and loader so the torque and load values are indicated on the display. The safety relays only work when the power is on.

1. To program the TTC610 Indicator refer to *Chapter 3—Set Up and Programming*. Use SET HIGH and SET LOW limit alert, data STORE, display CLEAR, printer SEND and STATistical analysis features.
2. Press UNIT to select the desired engineering unit of measure as displayed on the LCD display. It is easiest to match that of the tool under test.
3. Press MODE to select TRACK mode.
 - The green TRACK lamp lights.
4. Install the tool onto the torque transducer-loader. Slowly apply clockwise (CW) torque using the Loader crank handle until the indicator displays the full scale torque for the tool. Release the torque and repeat twice again to exercise the tool and the transducer.
 - ✓ When applying torque by hand, make sure to hold the drive end of the tool perfectly in line with the transducer drive to minimize side loading errors.
5. Remove tool from the transducer-loader and press ZERO TARE. Set the dial indicator on the tool to zero, if possible.
6. Press MODE to select PEAK HOLD mode.
 - The red PEAK HOLD lamp lights.
7. Reinstall the tool and apply CW torque to the first check point or calibration point recommended by the manufacturer. If the point is not specified, use the desired working torque or about 70% of full scale.
8. Read the tool display. The percentage difference between the indicator and tool readings should not be greater than the sum of their respective accuracies.

Example:

When tool accuracy is 4% and TTC2000 accuracy is 0.25%, readings should be within $\pm 4.25\%$.

9. Release the torque, CLEAR the indicator display, and reapply torque for each of the remaining check points recommended by the tool manufacturer. If no recommendation is available, check at 20%, 40%, 60%, 80% and 100% of the tool full scale.
10. Repeat steps 4 through 9 in the counter clockwise (CCW) direction.

Adjustable or Preset “Click” Wrenches and Screwdrivers

Be sure the TTC transducer is capable of handling the intended torque to avoid damaging transducer. Always operate the system with the power on.

WARNING



Do not use this equipment with the power off. Always turn on the indicator and loader so the torque and load values are indicated on the display. The safety relays only work when the power is on.

1. To program the TTC610 Indicator refer to *Chapter 3–Set Up and Programming*. Use SET HIGH and SET LOW limit alert, data STORE, display CLEAR, printer SEND and STATistical analysis features.
 2. Press UNIT to select the desired engineering unit of measure as displayed on the LCD display. It is easiest to match that of the tool under test.
 3. Press MODE to select TRACK mode. The green TRACK lamp lights.
 4. Adjust the tool for maximum “click” setting. Install the tool on the torque transducer-loader. Slowly apply torque using the loader crank handle until the tool clicks or the Indicator displays 100% of the full scale capacity for the tool. Release the torque and repeat twice again to exercise the tool and the transducer.
- ✓ When applying torque by hand, make sure to hold the drive end of the tool perfectly in line with the transducer drive to minimize side loading errors.

5. Remove the tool from the transducer-loader and press ZERO TARE.
6. Press MODE to select FIRST PEAK mode. The red FIRST PEAK lamp lights.
 - ✓ When testing “click” screwdrivers, it may be easier to use the PEAK HOLD mode on the TTC610 Indicator to capture the maximum applied torque reading.
7. If featured, adjust the micrometer or preset knob on the tool to one of the following:
 - The first check point recommended by the manufacturer, or
 - The desired working torque, or
 - Approximately 70% of its full scale torque.
8. Reinstall tool and apply torque until the wrench “clicks.”
9. Release the torque and note the FIRST PEAK or PEAK HOLD reading. The percentage difference between the Indicator reading and tool setting should not be greater than the sum of their respective accuracies.

Example:

When the tool accuracy is 4%, and the TTC610 Indicator accuracy is 0.25%, then readings should be within $\pm 4.25\%$.)

10. CLEAR the Indicator display.
11. Repeat steps 4 through 10 in the opposite direction, if required.

Testing Power Tools

The dynamic torque characteristic of a power tool and the static torque applied when using a wrench usually result in different torque readings. Spinning electric and pneumatic motor armatures contain inertia that produces a higher torque reading than what is actually absorbed by a practical fastener. The difference is also due to individual fastener installation characteristics that exhibit anywhere from a gradually increasing run-down torque, (soft-joint) to a free speed, sudden dead stop, (hard-joint). The way in which a particular operator responds to the tool's reaction forces can also be reflected in the resulting torque measurements.

A joint rate simulator is required when testing a power tool to allow start-up rotation of the tool's armature. The simulator is experimentally adjusted to replicate the average joint hardness of the intended work. Joint rate simulators that may be used with transducers ranging from 50 in lb to 1000 in lb are:

- 50 in lb max, 1/4" internal square drive for use on TTC6 transducer, part number QC1JRS50,
- 400 in lb max, for use on TTC7 transducer, part number QC2JRS400, or
- 1000 in lb max, for use on TTC8 transducer, part number QC2JRS600.

✓ Be sure to operate any pneumatic or electrical power tool according to the manufacturer's recommendations.

Non-Impact Tools

Be sure the TTC transducer is capable of handling the intended torque to avoid damaging transducer. Always operate the system with the power on.

WARNING



Do not use this equipment with the power off. Always turn on the indicator and loader so the torque and load values are indicated on the display. The safety relays only work when the power is on.

1. To program the TTC610 Indicator, refer to *Chapter 3–Set Up and Programming* in this manual. Use SET HIGH and SET LOW limit alert, data STORE, display CLEAR, printer SEND and STATistical analysis features.
2. Press UNIT to select the desired engineering unit of measure as displayed on the LCD display. It is easiest to match that of the tool under test.

3. Press MODE to select TRACK mode. The green TRACK lamp lights.
4. Adjust the power tool to the desired torque output, if possible.
5. Adjust the appropriate joint rate simulator assembly for the desired soft-hard configuration.
6. Install the joint rate simulator onto the TTC transducer, as shown in *Figure 4-1*. Secure the transducer set screw, if provided. Loosen the simulator load screw using the appropriate hex or box wrench.

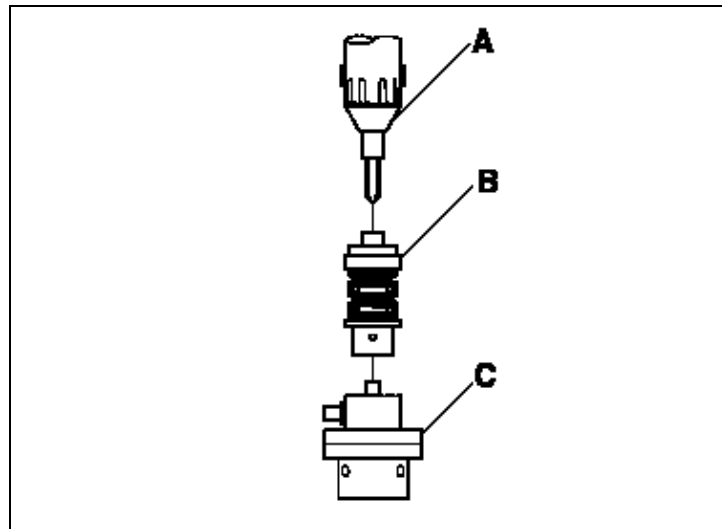


Figure 4-1: Power Tool Test Setup

*A – Power Tool
B – Joint Rate Simulator
C – Transducer*

7. Couple the power tool to the joint rate simulator using the appropriate accessory adaptor and bit.
8. While holding the power tool drive perfectly in-line with the transducer drive, energize the tool until its motor stalls or, if featured, the tool clutch slips.
9. Remove the power tool. Loosen the joint rate simulator load screw.
10. Repeat steps 7 through 9 twice again to exercise the tool-simulator assembly and the TTC transducer.
11. Remove the power tool from the loader-transducer and press ZERO TARE.
12. Press MODE to select POWER TOOL mode. The yellow POWER TOOL lamp lights.

13. While holding the power tool drive perfectly in-line with the transducer drive, reinstall the tool onto the simulator and energize the tool until its motor stalls or, if featured, the tool clutch slips. Be careful not to add torque by turning the tool by hand.
 14. Release the torque and note the Indicator POWER TOOL reading.
 15. CLEAR the display.
 16. Repeat steps 4 through 15 in the opposite direction, if required.
- ✓ Given the variables typical of power tools and fastener joint dynamics, a number of readings should be taken and averaged to best determine the accuracy and repeatability for each tool.

Measuring Force, Compression and Tension

The TTC2000 system can be configured to measure compression or tension force using TTC series torque transducers. A reaction arm is used on the transducer to mathematically cancel the length portion of the torque measurement leaving only the force portion for display.

Example:

The 250 ft lb transducer provides a display of up to 250 lbf (pounds force) if fixed with a one-foot long reaction arm.

Special reaction arm and mounting fixture kits are available for testing and calibrating the most common tension/compression gauges and cable tensiometers. Contact your **Snap-on** sales representative to discuss your specific test and calibration needs or call **Consolidated Devices, Inc.**, a **Snap-on** subsidiary, at 1-800-525-6319.

- To avoid damage to the TTC transducer, be sure it is capable of handling the force you intend to apply.
- Only single transducers of 400 in lb and higher range are recognized by the TTC610 Indicator for force measurement.
- Install the transducer by lining up the red mark with the "FORCE" label on the loader. Refer to the TTC600 Loader section of this manual.

- ✓ Never attempt to use the 4-in-1 transducer for force measurement.

Use the following procedure to make force measurements.

1. To program the TTC610 Indicator, refer to *Chapter 3—Set Up and Programming* in this manual. Use SET HIGH and SET LOW limit alert, data STORE, display CLEAR, printer SEND and STATistical analysis features.
2. Install the compression or tension fixture according to the manufacturer's instructions.
3. Press SELECT to select FORCE measurement.
4. Press MODE to select TRACK mode. The green TRACK lamp lights.
5. Press UNIT to select the desired engineering unit of measure as displayed on the LCD display. It is easiest to match that of the gauge being tested.
6. Apply load by turning the loader handle CW for tension or CCW for compression. This may be reversed depending on the fixture.
7. Release and reapply load twice again to exercise the transducer and gauge.
8. With the load released, press ZERO TARE.
9. Apply load according to one of the following:
 - The check points recommended by the gauge manufacturer, if specified, or
 - The desired working force, or
 - Approximately 70% of its full scale capacity.

Note or adjust the gauge reading to match that of the TTC610 LED display.

Displaying Statistical Analysis

The TTC610 accumulates torque/force measurements in a data list. The list is created with each AUTO or MANUAL data store entry. Statistical analysis is calculated on the list, and if SET HIGH and SET LOW limits are established, draws a simple histogram of the results. These features are very useful in statistical process control (SPC) management. Statistical analysis can be previewed on the LCD display or sent directly to a printer/computer port. For additional information on setting up printer or PC ports, refer to *Chapter 3—Set Up and Programming* in this manual.

Displaying Statistical Analysis on LCD

1. Press STAT.
 - The LED display reads:
TTSTATTT
 - The LCD displays reads:
HIT SEND = PRINT - upper line
- = LIST STAT - lower line

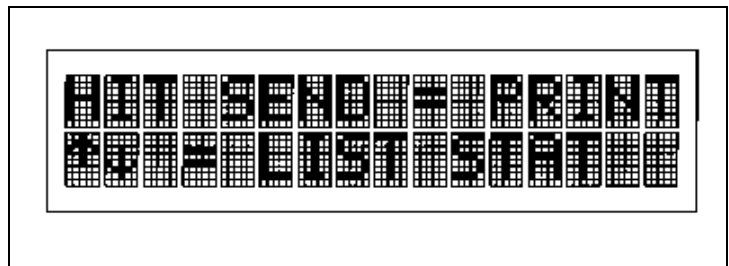


Figure 4-2: Statistical Analysis Display

2. Repeatedly press up or down VALUE to scroll through the LCD display as shown in Figure 4-3.

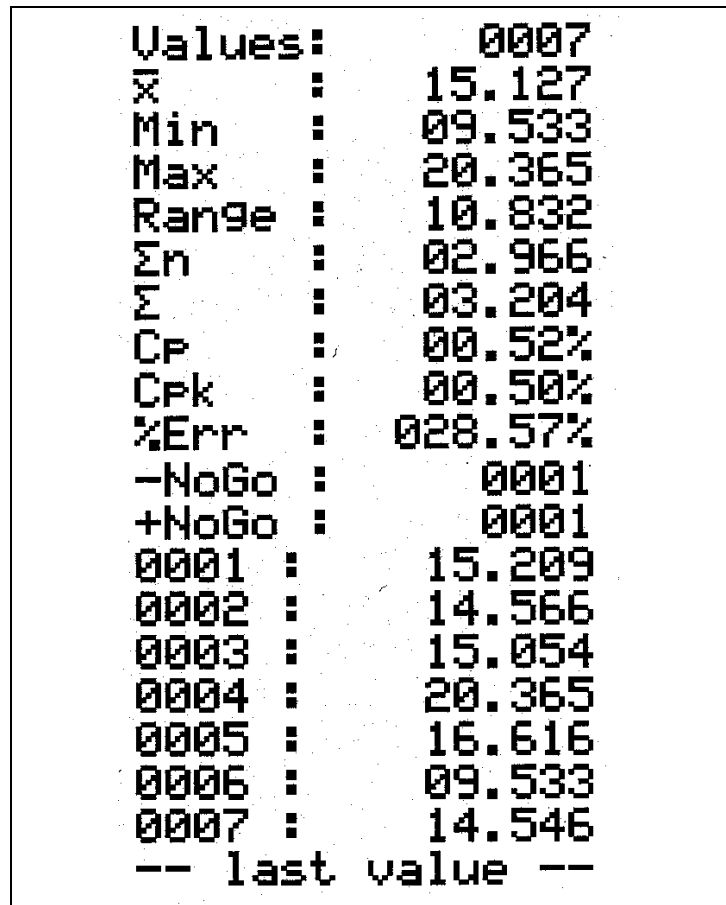


Figure 4-3: Value Display

3. Press ENTER to return to measurements mode.

Printing Statistical Analysis

- Press STAT.
— The LED display reads:
TTSTATTT
— The LCD display reads:
HIT SEND = PRINT - upper line
- = LIST STAT - lower line
- Press SEND to print out the entire statistical analysis.
LED display reads:

SENDING

✓ Refer to the sample printout in *Figure 4-4*. As indicated on the LCD display, use MANUAL CLEAR to cancel printing.

- Press ENTER to return to measurements mode.

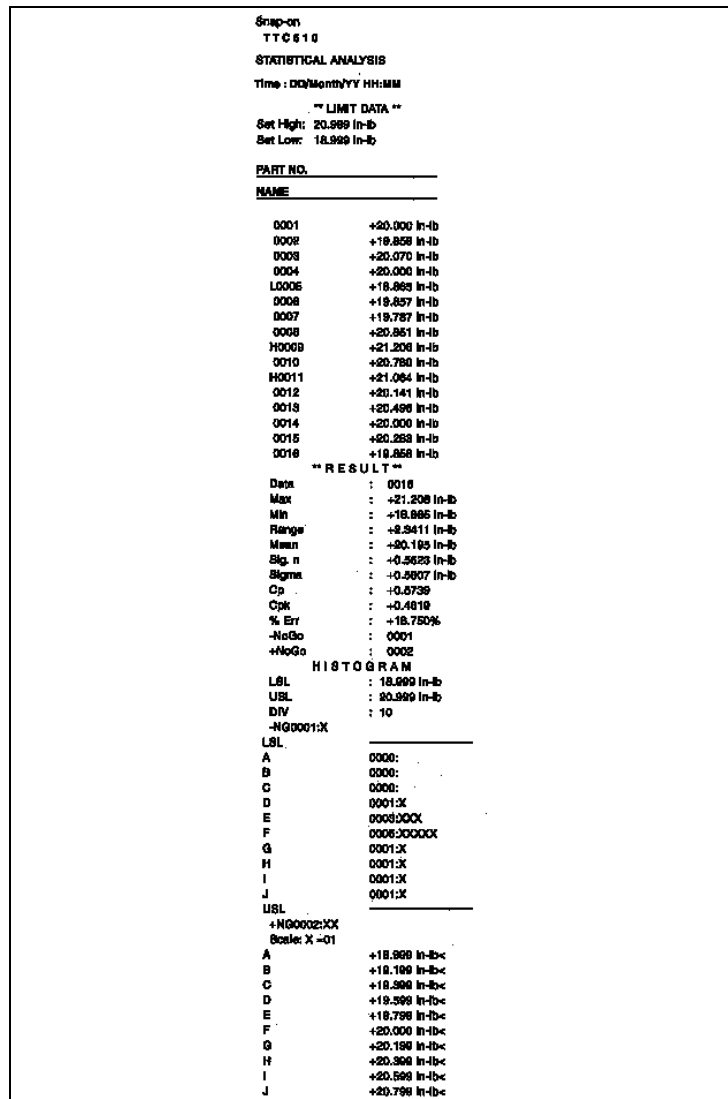


Figure 4-4: Sample Statistical Data Printout

Displaying or Downloading Data List

Torque measurements stored in the data list also include a date and time stamp. For additional information on setting up printer or PC ports, refer to *Chapter 3—Set Up and Programming* in this manual.

Displaying Data List on LCD

1. Press RECALL DATA.
 - The LCD display reads:
RECALL
 - ✓ The present memory location is at the upper left, the total number of memory locations to its right and the time the data was stored at the far right.
 - The LED display shows the measurement value of that memory location while the LCD displays its engineering units at the lower right.
2. Use up and down VALUE to view the data list.
3. Press ENTER to return to measurements mode.

Downloading Data List to Printer

1. Press RECALL DATA.
2. Press SEND/AUTO SEND.
 - The LCD display reads:
Download - upper line
+DateTime Raw - lower line, with the plus sign flashing

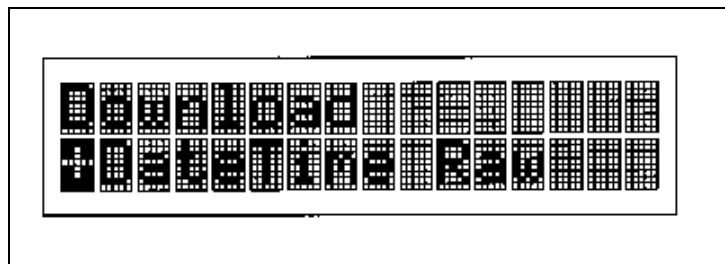


Figure 4-5: Data Download Display

3. To download the data list plus date-time stamp, press ENTER. The LED display reads:
SENDING
4. To download the raw data list, use right DIGIT to select "Raw" on the LCD display.

5. Press ENTER to download the raw data list. The LED display reads:

SENDING

6. Press ENTER again to return to measurements mode.

Downloading Data List to Personal Computer

1. Connect the accessory TTC501 cable between the TTC610 OPTIONAL port and the computer COM port. For additional information on setting up printer or PC ports, refer to *Chapter 3—Set Up and Programming*.
2. Set up your computer to receive serial communication.

Example:

If using an **IBM** compatible and **Windows 95**:

- Click on START—RUN to open the Terminal program.
- Type TERMINAL.
- Press <Enter>.

3. Press RECALL DATA.

4. Press SEND/AUTO SEND. As shown in *Figure 4-5*, the LCD display reads:

Download - upper line

+Date Time Raw - lower line, with the plus sign flashing

- To download the data list plus date-time stamp, press ENTER. The LED display reads:

SENDING

- To download the raw data list, use right DIGIT to select "Raw" on the LCD display. Then press ENTER to download. The LED display reads:

SENDING

5. Press ENTER again to return to measurements mode.
6. Copy the data list to your chosen software.

Example:

If using an **IBM** compatible and **Windows 95**:

- Select EDIT—SELECT ALL, and then EDIT—COPY.
- Open the spreadsheet or data program being used.
- Select EDIT—PASTE in the program being used.

How to Use Analog Output (Rear Panel BNC Connector)

Analog Output on the TTC610 provides a real time voltage level that is directly proportional to the torque/force measurement applied to the transducer. It is useful for direct driving equipment such as analog plotters and chart recorders, or interfacing to a computer/controller with analog to digital (A/D) data acquisition capability. Maximum output loading must be less than 5 mA.

The output varies between approximately +1.8 volts, full clockwise (CW) torque/force applied and approximately -1.8 volts, full counter clockwise (CCW) torque/force applied. Zero offset is within ± 100 mv. Linearity is better than $\pm 1\%$ of reading.

- ✓ When used with the 4-in-1 transducer, zero output varies with the scan of the four transducers. Select one of the four by applying at least 5% of its full range torque to it. Press ENTER to return to scanning.
- 1. To program the TTC610 Indicator, refer to *Chapter 3—Set Up and Programming*. Use SET HIGH and SET LOW limit alert, data STORE, display CLEAR, printer SEND and STATistical analysis features.
- 2. Press MODE to select the TRACK mode.
- 3. Connect the recording or monitoring equipment to the ANALOG OUTPUT port using a BNC coaxial connector.
- 4. With no torque applied, measure the ANALOG OUTPUT voltage and adjust or program your equipment for zero.
- 5. Apply full range torque to the transducer in the CW direction as shown on the TTC610 Indicator LED display.
- 6. Measure the ANALOG OUTPUT voltage and adjust or program your equipment to display the full range torque value.
- 7. Apply full range torque to the transducer in the CCW direction as shown on the TTC610 Indicator LED display.
- 8. Measure the ANALOG OUTPUT voltage and adjust or program your equipment to display the full range torque value.

Measuring Torque and Angle

Although measuring torque and angle is not a torque testing feature, transducers and the TTC610 Indicator may be used to monitor torque during fastener installation. The Indicator can also be set up to monitor "turn-of-the-nut" or angle of rotation using common bi-directional incremental rotary encoders for critical fastener installations. Typically, a torque-angle algorithm is used where the joint is clamped using a preload torque. The fastener is then rotated a specific number of degrees regardless of the torque necessary to turn it.

Torque Only

When using the instructions in this section refer to the *Torque-Angle Tutorial* Quick Reference Card that accompanies this manual.

1. For additional information on setting SET HIGH and LOW limits alert, Data STORE, display CLEAR, printer SEND and STATistical analysis features, refer to *Chapter 3—Set Up and Programming*.
2. Press UNIT to select the desired engineering unit of measure as displayed on the LCD display.
3. Press MODE to select TRACK or PEAK HOLD mode.
4. Install the transducer between the fastener and the wrench or tool.
5. Apply increasing torque until the audible tone indicates that measured torque matches or exceeds the SET LOW torque limit. If you match or exceed the SET HIGH torque limit, the alert sounds a pulsating tone.

Angle Only

The TTC610 accepts input from common bi-directional incremental rotary encoders. The Indicator interfaces to any encoder resolution (counts per revolution) and can be programmed to display angle in degrees of rotation. Contact your **Snap-on** sales representative for information on angle encoders and torque-angle transducers.

For additional information on setting up angle encoders and measurement modes, refer to *Chapter 3—Set Up and Programming* in this manual.

1. Press MODE to select ANGLE.
 - LED displays torque.
 - LCD displays degrees of rotation at the lower left.

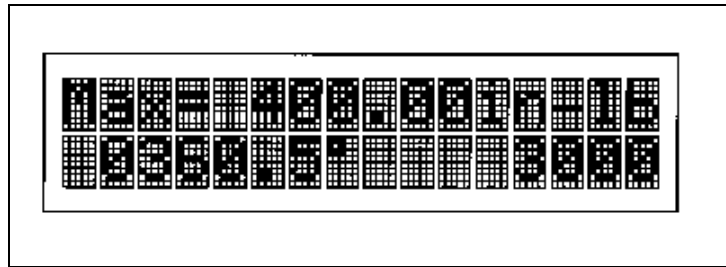


Figure 4-6: Angle Mode Display

2. Install the angle encoder between the fastener and an appropriate wrench or breaker bar. Fix the encoder reference arm, strap, clamp or magnet to the work.
3. Press ANGLE RESET to zero the angle display.
4. Rotate the fastener while monitoring the angle on the LCD display. The SET HIGH limit momentarily sounds an audible tone at angle preset coincidence (when the measured angle matches the SET LOW angle).
5. Press ANGLE RESET to clear the angle display.

Torque-Angle Algorithm

In addition to TTC series torque transducers, the TTC610 Indicator accepts input from common bi-directional incremental rotary encoders. The Indicator features a special Torque-Angle measurement mode where a clamping torque is first applied and measured, then at torque preset coincidence, (when the input torque matches the SET LOW limit), the Indicator automatically switches to measuring angle in degrees of rotation.

The operator continues to rotate the fastener until angle preset coincidence (angle matches the SET HIGH limit). With this, the specified torque and angle parameters are accomplished in one wrenching operation.

For additional information on setting up angle encoders, programming a particular angle and measurement modes, refer to *Chapter 3—Set Up and Programming* in this manual.

1. Press MODE to select ANGLE.
 - The LED display reads:
0
 - The LCD angle display is blank at the lower left, as shown in *Figure 4-6*.
2. Install the angle encoder and torque transducer between the fastener and an appropriate wrench or breaker bar.
3. With the encoder reference arm, strap, clamp or magnet fixed to the work, rotate fastener while monitoring torque on the LED display. At torque preset coincidence, (when the torque measurement matches the SET LOW torque limit) the Indicator sounds a momentary tone and initiates display of degrees of rotation on the LCD.
4. Continue rotating the fastener until angle preset coincidence (when the angle measurement matches the SET HIGH angle limit). The Indicator sounds a pulsating tone. The LED display holds the peak torque applied and reads:
A+torque (angle plus torque)
5. Press MANUAL CLEAR to zero the torque and angle displays.

Calibration

The TTC2000 Torque Tester/Calibrator is factory calibrated using precision torque test arms, certified weights and laboratory grade equipment. TTC series transducers must be positioned horizontally, with torque applied within ± 15 degrees of horizontal.

This chapter contains calibration instructions and information for the TTC2000 Torque Tester/Calibrator.

- ✓ Annual calibration is recommended. Calibration by the user is recorded in memory and voids factory certification. Contact your authorized **Snap-on** sales representative for calibration and repair services.
- ✓ If extreme calibration precision is required, refer to *Correction Factors on Test Weights* in this chapter.

Calibration Equipment

Equipment Required

- Precision test arms and certified calibration weights,
- Test stand,
- Laboratory grade 4-1/2 digit digital volt/millivolt meter, and
- Calibration fixture as shown in *Figure 5-1*.

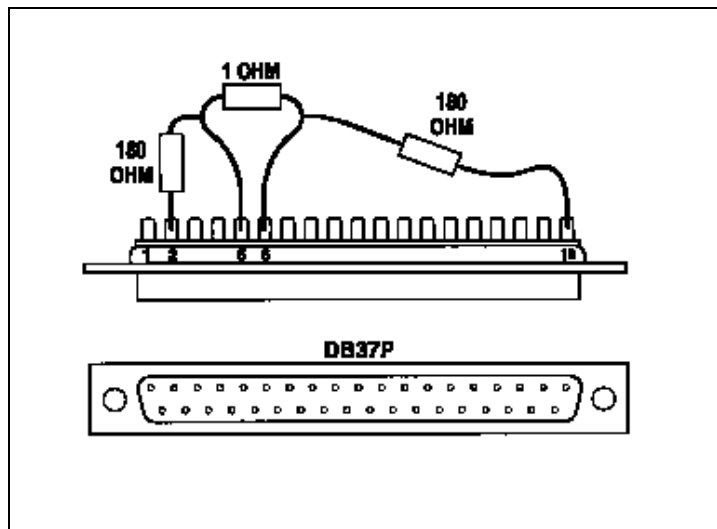


Figure 5-1: TTC610 Indicator Calibration Fixture

Mounting Details

Single Transducer Mounting Detail for Calibration

Single transducer calibration requires the use of a reaction stand and transducer calibration block.

As shown in *Figure 5-2*, the transducer is secured to the calibration block with two quick release pins.

- Both pins must be installed for safety and stability of the mount.
- The white mark on the transducer is aligned in the up position.

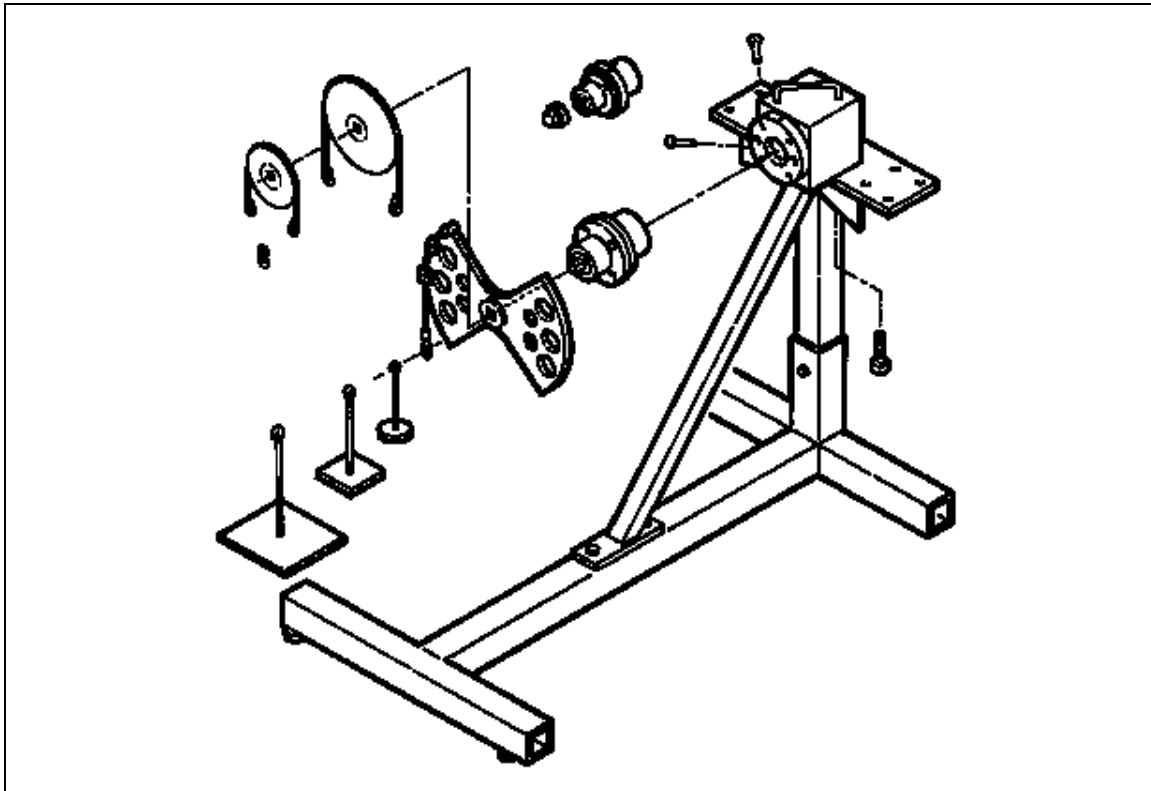


Figure 5-2: Single Low Torque Transducer Mounting Detail

Torque Under 250 ft lb

Mount the calibration block at the center of the stand with two 1/2-13 socket head cap screws with test bars that are 10" or shorter. Install these screws using the supplied torque wrench and 3/8-3/8 socket driver adapter. Use this configuration for up to 250 ft lb of applied torque.

- ✓ A 1/2" to 3/8" reducer is required when mounting the 10" arm to transducers having 3/8" drives.

Torque Over 250 ft lb

For torque calibration above 250 ft lb, the calibration block is moved to the left for CCW loading and to the right for CW loading. The torque arm is always extended over the front of the reaction bracket for both CW and CCW torque applications.

In this configuration, useful up to 2000 ft lb, the calibration block is secured to the stand using four 1/2-13 socket head cap screws, each torqued to 75 ft lb. For additional information refer to *Figure 5-3*.

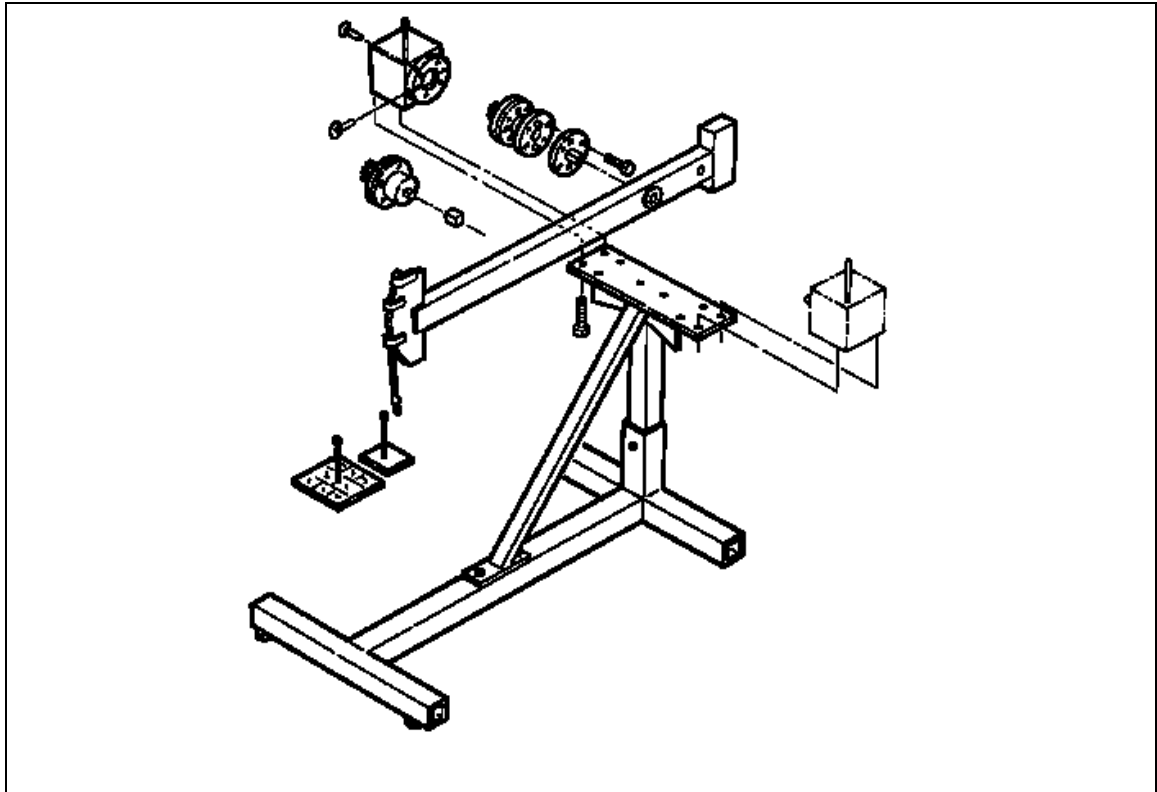


Figure 5-3: Single High Torque Transducer Mounting Detail

The TTC12, 600 ft lb transducer, requires the 1-1/4" to 3/4" drive reducer, supplied, to couple to the 40" test bar.

WARNING

Always position the 40" arm over the front of the stand as shown. Never extend the test arm behind the stand. The stand will tip over when weights are applied.

The 40" test arm is coupled to the TTC13, 1000 ft lb, and TTC14, 2000 ft lb transducers using a 1-1/4" drive adaptor plate.

1. Remove the internal drive adaptor plate and bottom plate from the transducer using the torque wrench, ratchet head and 3/8-3/8 hex bit or 3/4" open end adaptor supplied.

2. Remove separated adaptor from calibration block.
3. Attach transducer to the calibration block so that red mark on transducer lines up with white dot in left bottom corner on calibration block. Tighten six 1/2"-13 hex head bolts to 75 ft lb torque.
4. Attach the 1-1/4" drive adaptor plate using six 1/2"x13 hex head bolts, each torqued to 75 ft lb using the torque wrench, and 3/4" open end adaptor, supplied.
5. After calibration, re-install the internal drive plate and bottom plate using appropriate 1/2"x13 screws, torquing them to 75 ft lb. Also re-install the separated adaptor to the calibration block.

Appropriate hangers and weights are listed in the calibration check point table in this chapter. Notice that the weight of the hanger is included in all measurements. The hanger must be removed to set ZERO TARE on the Indicator.

4-in-1 Transducer Mounting Detail for Calibration

The 4-in-1 transducer mounts upright with integral transducers in the horizontal position. This transducer may be mounted to a:

- Wall using four 1/4" bolts torqued to 10 ft lb, or
- Sturdy table using a right angle bracket. Refer to *Figure 5-4*.

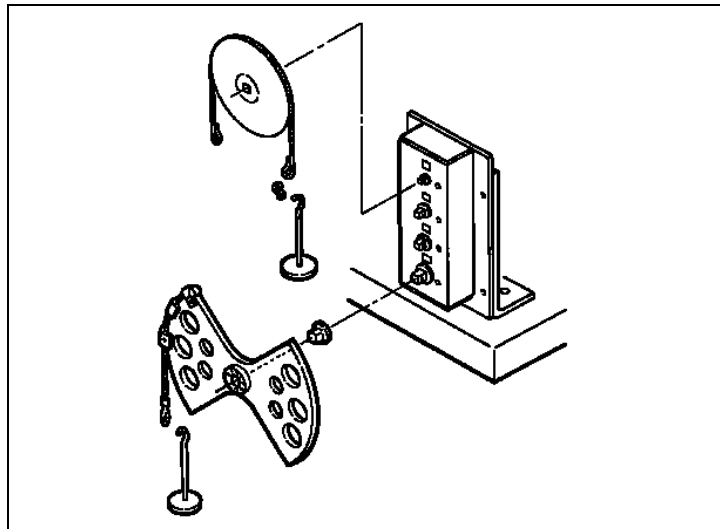


Figure 5-4: 4-in-1 Transducer Mounting Detail

The 4-in-1 transducer may also be mounted to the calibration stand, shown in *Figure 5-2*, using the standoff fixture and bracket assembly. For this mounting configuration the two slide knobs must be loosened and four 5/16-18 bolts attached to secure the 4-in-1 transducer to the bracket assembly.

Quick Check

WARNING

Always be alert to the potential for personal injury that may be caused by excessive torque applications, careless handling of heavy weights, and out-of-balance or unsafe weight distribution.

1. With the TTC610 Indicator ON, select TORQUE measurement, TRACK mode, and select the UNITS of measure appropriate to the transducer as specified in the calibration check point table in this chapter.
 2. Install the transducer to be checked and allow a 5 minute warm up period to stabilize the electronic circuits and transducer elements.
 3. Transducers are mounted horizontally for calibration as instructed in *Mounting Details* in this chapter. Mount the 4-in-1 transducer to a sturdy bench using the bracket provided. Mount single transducers horizontally using the accessory stand and block. Attach the specified torque test bar, wheel or butterfly, secured with its drive retention screw, and install the specified hanger for clockwise (CW) torque application.
 4. Apply and remove the full range torque for the transducer three times.
 5. Remove the weights and hanger, but leave the arm attached, and press ZERO TARE.
 6. At each of the check points specified for the transducer in the calibration check point table (in this chapter), apply torque in the CW direction and verify the display readings are within 0.25% of applied torque. If any reading is out of specification, proceed to *Calibrating TTC Torque/Force Transducers* in this chapter.
 7. Repeat Steps 3 through 6 in the counter clockwise (CCW) direction.
- ✓ When using the 2-1/2" or 5" test wheel, a small "S" hook is supplied to provide a positive zero bias in the direction (CW or CCW) that the calibration is performed. Do not remove the "S" hook when setting zero tare.

**Suggested Transducer Calibration Check Points, Bars, Hangers and Weights
(Sheet 1 of 2)**

Part No.	Range	Bar Length	Hanger Weight	Calibration Points	Check Points	Weights to Add (n) = more than 1	Total Weight
TTC5	15-200 in oz	2.5"	none		15.0 in oz	2 oz, 4 oz	6 oz
		2.5"	1/2 lb	1 20.0 in oz	20.0 in oz	none	1/2 lb
		2.5"	1/2 lb	2 40.0 in oz	40.0 in oz	1/2 lb	1 lb
		2.5"	1/2 lb	3 80.0 in oz	80.0 in oz	1/2 lb, 1 lb	2 lb
		2.5"	1/2 lb	4 120.0 in oz	120.0 in oz	1/2 lb, (2) 1 lb	3 lb
		2.5"	1/2 lb	5 200.0 in oz	200.0 in oz	1/2 lb, (2) 2 lb	5 lb
TTC6	4-50 in lb	5.0"	1/2 lb		4.0 in lb	0.3 oz, 0.5 oz, 4 oz	0.8 lb
		5.0"	1/2 lb	1 5.0 in lb	5.0 in lb	1/2 lb	1 lb
		5.0"	1/2 lb	2 10.0 in lb	10.0 in lb	1/2 lb, 1 lb	2 lb
		5.0"	1/2 lb	3 20.0 in lb	20.0 in lb	1/2 lb, 1 lb, 2 lb	4 lb
		5.0"	1/2 lb	4 30.0 in lb	30.0 in lb	1/2 lb, 1 lb, (2) 2 lb	6 lb
		5.0"	1/2 lb	5 50.0 in lb	50.0 in lb	1/2 lb, 1 lb, (4) 2 lb	10 lb
TTC65	15-150 in lb	5.0"	1/2 lb	1 15.0 in lb	15.0 in lb	1/2 lb, 2 lb	3 lb
		5.0"	1/2 lb	2 30.0 in lb	30.0 in lb	1/2 lb, 1 lb, (2) 2 lb	6 lb
		5.0"	1/2 lb	3 60.0 in lb	60.0 in lb	1/2 lb, 1 lb, (2) 5 lb	12 lb
		5.0"	1/2 lb	4 90.0 in lb	90.0 in lb	1/2 lb, 2 lb, (3) 5 lb	18 lb
		5.0"	1/2 lb	5 150.0 in lb	150.0 in lb	1/2 lb, (2) 2 lb, (5) 5 lb	30 lb
TTC7	30-400 in lb	10.0"	1/2 lb		30.0 in lb	1/2 lb, 2lb	3 lb
		10.0"	1/2 lb	1 40.0 in lb	40.0 in lb	1/2 lb, 1 lb, 2 lb	4 lb
		10.0"	1/2 lb	2 80.0 in lb	80.0 in lb	1/2 lb, 2 lb, 5 lb	8 lb
		10.0"	1/2 lb	3 160.0 in lb	160.0 in lb	1/2 lb, (3) 5 lb	16 lb
		10.0"	1/2 lb	4 240.0 in lb	240.0 in lb	1/2 lb, 1 lb, 2 lb, (4) 5 lb	24 lb
		10.0"	1/2 lb	5 400.0 in lb	400.0 in lb	1/2 lb, 1 lb, (4) 2 lb, (6) 5 lb	40 lb
TTC8	80-1000 in lb	10.0"	7-1/2 lb		80.0 in lb	1/2 lb	8 lb
		10.0"	7-1/2 lb	1 100.0 in lb	100.0 in lb	1/2 lb, 2 lb	10 lb
		10.0"	7-1/2 lb	2 200.0 in lb	200.0 in lb	1/2 lb, 2 lb, (2) 5 lb	20 lb
		10.0"	7-1/2 lb	3 400.0 in lb	400.0 in lb	1/2 lb, 2 lb, (2) 5 lb, (2) 10 lb	40 lb
		10.0"	7-1/2 lb	4 600.0 in lb	600.0 in lb	1/2 lb, 2 lb, (2) 5 lb, (4) 10 lb	60 lb
		10.0"	7-1/2 lb	5 1000 in lb	1000 in lb	1/2 lb, 2 lb, (2) 5 lb, (4) 10 lb, (2) 20 lb	100 lb
TTC10	10-125 ft lb	10.0"	7-1/2 lb		10 ft lb	1/2 lb, (2) 2 lb	12 lb
		10.0"	15 lb	1 12.5 ft lb	12.5 ft lb	none	15 lb
		10.0"	15 lb	2 25.0 ft lb	25.0 ft lb	(3) 5 lb	30 lb
		10.0"	15 lb	3 50.0 ft lb	50.0 ft lb	5 lb, (2) 10 lb, 20 lb	60 lb
		10.0"	15 lb	4 75.0 ft lb	75.0 ft lb	(3) 5 lb, (2) 10 lb, (2) 20 lb	90 lb
		10.0"	15 lb	5 125.0 ft lb	125.0 ft lb	5 lb, 10 lb, 20 lb, (2) 50 lb	150 lb
TTC11	20-250 ft lb	10.0"	15 lb		20.0 ft lb	(2) 2 lb, 5 lb	24 lb
		10.0"	15 lb	1 25.0 ft lb	25.0 ft lb	5 lb, 10 lb	30 lb
		10.0"	15 lb	2 50.0 ft. lb	50.0 ft. lb	5 lb, (2) 20 lb	60 lb
		10.0"	15 lb	3 100.0 ft. lb	100.0 ft. lb	5 lb, (2) 50 lb	120 lb
		10.0"	15 lb	4 150.0 ft. lb	150.0 ft. lb	5 lb, (3) 20 lb, (2) 50 lb	180 lb
		10.0"	15 lb	5 250.0 ft. lb	250.0 ft. lb	5 lb, (4) 20 lb, (4) 50 lb	300 lb

Suggested Transducer Calibration Check Points, Bars, Hangers and Weights
(Sheet 2 of 2)

Part No.	Range	Bar Length	Hanger Weight	Calibration Points	Check Points	Weights to Add (n) = more than 1	Total Weight
TTC12 60-600 ft lb	40"	15 lb	1	60.0 ft lb	60.0 ft lb	1 lb, 2 lb	18 lb
	40"	15 lb	2	120.0 ft lb	120.0 ft lb	1 lb, (2) 10 lb	36 lb
	40"	15 lb	3	240.0 ft lb	240.0 ft lb	2 lb, 5 lb, 10 lb, (2) 20 lb	72 lb
	40"	15 lb	4	360.0 ft lb	360.0 ft lb	1 lb, 2 lb, 10 lb, (4) 20 lb	108 lb
	40"	15 lb	5	600.0 ft lb	600.0 ft lb	5 lb, (3) 20 lb, (2) 50 lb	180 lb
TTC13 100-1000 ft lb	40"	15 lb	1	100.0 ft lb	100.0 ft lb	5 lb, 10 lb	30 lb
	40"	15 lb	2	200.0 ft lb	200.0 ft lb	5 lb, (2) 20 lb	60 lb
	40"	15 lb	3	400.0 ft lb	400.0 ft lb	5 lb, (5) 20 lb	120 lb
	40"	15 lb	4	600.0 ft lb	600.0 ft lb	5 lb, (2) 10 lb, (2) 20, (2) 50 lb	180 lb
	40"	15 lb	5	1000.0 ft lb	1000.0 ft lb	5 lb, (4) 20 lb, (4) 50 lb	300 lb
TTC14 200-2000 ft lb	40"	50 lb	1	200.0 ft lb	200.0 ft lb	(2) 5 lb	60 lb
	40"	50 lb	2	400.0 ft lb	400.0 ft lb	20 lb, 50 lb	120 lb
	40"	50 lb	3	800.0 ft lb	800.0 ft lb	(2) 5 lb, (4) 20 lb, (2) 50 lb	240 lb
	40"	50 lb	4	1200.0 ft lb	1200.0 ft lb	(2) 5 lb, (5) 20 lb (4) 50 lb	360 lb
	40"	50 lb	5	2000.0 ft lb	2000.0 ft lb	(2) 5 lb, (4) 10 lb, (5) 20 lb (8) 50 lb	600 lb
TTC400 4-50 in lb (4-in-1)	5"	1/2 lb			4.0 in lb	0.3 oz, 0.5 oz, 4 oz	0.8 lb
	5"	1/2 lb	1	5.0 in lb	5.0 in lb	1/2 lb	1 lb
	5"	1/2 lb	2	10.0 in lb	10.0 in lb	1/2 lb, 1 lb	2 lb
	5"	1/2 lb	3	20.0 in lb	20.0 in lb	1/2 lb, 1 lb, 2 lb	4 lb
	5"	1/2 lb	4	30.0 in lb	30.0 in lb	1/2 lb, 1 lb, (2) 2 lb	6 lb
	5"	1/2 lb	5	50.0 in lb	50.0 in lb	1/2 lb, 1 lb, (4) 2 lb	10 lb
30-400 in lb	10"	1/2 lb			30.0 in lb	1/2 lb, 2 lb	3 lb
	10"	1/2 lb	1	40.0 in lb	40.0 in lb	1/2 lb, 1 lb, 2 lb	4 lb
	10"	1/2 lb	2	80.0 in lb	80.0 in lb	1/2 lb, 1 lb, (3) 2 lb	8 lb
	10"	1/2 lb	3	160.0 in lb	160.0 in lb	1/2 lb, (3) 5 lb	16 lb
	10"	1/2 lb	4	240.0 in lb	240.0 in lb	1/2 lb, 1 lb, 2 lb, (4) 5 lb	24 lb
	10"	1/2 lb	5	400.0 in lb	400.0 in lb	1/2 lb, 1 lb (4) 2 lb, (6) 5 lb	40 lb
80-1000 in lb	10"	7-1/2 lb			80.0 in lb	1/2 lb	8 lb
	10"	7-1/2 lb	1	100.0 in lb	100.0 in lb	1/2 lb, 2 lb	10 lb
	10"	7-1/2 lb	2	200.0 in lb	200.0 in lb	1/2 lb, 2 lb, (2) 5 lb	20 lb
	10"	7-1/2 lb	3	400.0 in lb	400.0 in lb	1/2 lb, 2 lb, (2) 5 lb, (2) 10 lb	40 lb
	10"	7-1/2 lb	4	600.0 in lb	600.0 in lb	1/2 lb, 2 lb, (2) 5 lb, (4) 10 lb	60 lb
	10"	7-1/2 lb	5	1000 in lb	1000 in lb	1/2 lb, 2 lb, (2) 5 lb, (4) 10 lb, (2) 20	100 lb
20-250 ft lb	10"	15 lb			20.0 ft lb	(2) 2 lb, 5 lb	24 lb
	10"	15 lb	1	25.0 ft lb	25.0 ft lb	5 lb, 10 lb	30 lb
	10"	15 lb	2	50.0 ft. lb	50.0 ft. lb	5 lb, (2) 20 lb	60 lb
	10"	15 lb	3	100.0 ft. lb	100.0 ft. lb	5 lb, (2) 50 lb	120 lb
	10"	15 lb	4	150.0 ft. lb	150.0 ft. lb	5 lb, (3) 20 lb, (2) 50 lb	180 lb
	10"	15 lb	5	250.0 ft. lb	250.0 ft. lb	5 lb, (4) 20 lb, (4) 50 lb	300 lb

Torque/Force Calibrations

TTC Torque/Force Transducer Calibration

IMPORTANT

Improper calibration can result in torque measurement errors. Follow these procedures precisely. If an error is made in the procedure, turn the indicator off and begin again. Users are responsible for the results of their transducer calibration.

TTC series torque/force transducers can only be calibrated using the TTC610 Indicator. Calibration data is calculated and then stored in the EEPROM memory chip of the transducer by the microcontroller in the Indicator.



WARNING

Always be alert to the potential for personal injury and equipment damage that may be caused by excessive torque applications, careless handling of heavy weights, and out-of-balance or unsafe weight distribution.

Equipment

- Precision test arms and certified calibration weights.
- Test stand.

Procedure

1. With the TTC610 Indicator ON, select TORQUE measurement, TRACK mode, and select the UNITS of measure appropriate to the transducer. Refer to the calibration check point table in this chapter for the transducer calibration check points, and specified arms, hangers and weights.
2. Install the transducer being calibrated and allow a 5 minute warm up period to stabilize the electronic circuits and transducer elements.
3. Mount the 4-in-1 transducer upright, drives horizontal, as shown in *Figure 5-4*, or mount single transducers horizontally using the accessory stand and block as detailed in *Figure 5-3*. Attach the specified torque arm, secured with the drive retention screw, and install the specified hanger for clockwise (CW) torque application. Use the "S" hook on the 2-1/2" or 5" bars.
4. Press CAL. LED display reads the following message with least significant digit (LSD) flashing:
CODE0000

5. Enter the following code into the display using the DIGIT right and left keys and the up and down VALUE keys:

CODE5222

6. Press ENTER.

— The LED display reads:

SELECT

— The LCD display reads:

Calibrate CW

7. Press ENTER.

— The LED display reads a flashing number in the LSD.

— The LCD display reads:

Enter no. of transducers

8. Using the up and down VALUE keys, enter "1" for a single transducer or "4" for the 4-in-1 transducer.

— If you enter "1" skip to step 11.

9. Press ENTER. The LED display reads a flashing number in the LSD and the LCD display reads:

Select transducer

10. Using the up and down VALUE keys, enter the number of the 4-in-1 transducer to calibrate. Possible values are:

1 = 50 in oz

2 = 400 in lb

3 = 1000 in lb

4 = 250 ft lb

11. Press ENTER.

— The LED display banners:

ENTER FS

followed by the last full scale calibration point for the particular transducer installed or selected with its MSD flashing.

— The LCD display reads:

**ENTER FS transducer
[units]**

12. Using the up and down VALUE keys and the left and right DIGIT keys, enter the full scale torque capacity of the transducer in the engineering units selected.

13. Press ENTER.

— The LED display banners:

ZERO TARE

Four zeros follow shifting alternately across the display.

— The LCD display reads:

**CALIBRATION
<ZEROTARE> CONT.**

14. Apply and release full scale torque to the transducer three times in the CW direction, then remove the weights and hanger. Leave the torque arm installed and wait for 30 seconds.
15. Press ENTER.
 - For single transducers, the LED display momentarily reads:
ZEROTARE and then **LOAD + + 1**
with the two plus signs alternating
 - For 4-in-1 transducers, the LED display reads:
ZERO T1 through 4 as each transducer is scanned
 - The LCD display reads:
CALIBRATION - upper line
Load transducer - lower line
16. Apply torque using the precision arm, hanger or certified weights listed as calibration point 1 in the calibration check point table in this chapter.
17. When the reading is stable, push and hold the up and down VALUE keys to enter the exact torque value into the LED display.
18. Press ENTER. LED display momentarily reads
O-K and then **LOAD ++ 2**

Apply the next calibration point torque from the chart and press ENTER. Repeat for all five calibration points.
—LED display banners:
O-K,
MAX NUMBER OF CAL POINTS REACHED
SAVING
CAL SAVED
SELECT

— LCD display reads
Calibrate CW
19. Remove weight and remove the arm.
20. Select "Calibrate CCW" on the LCD display by pushing the VALUE up key.
21. Repeat steps 7 through 18, applying all torque in the counter clockwise (CCW) direction.

✓ All readings show minus signs (-).
22. Press CAL to return to measurements mode.

TTC610 Indicator Torque/Force Calibration

IMPORTANT

Improper calibration can result in torque measurement errors. Follow these procedures precisely. If an error is made in the procedure, turn the indicator off and begin again. Users are responsible for the results of their calibration.

Equipment

- Laboratory grade millivolt meter for calibration measurements capable of resolving 1/100 millivolts.
- Calibration fixture as shown in *Figure 5-1*.

Procedure

1. With the power off, plug the calibration fixture into the TRANSDUCER INPUT connector at the back of the TTC610 indicator.
2. Turn the power on. After initialization:
 - LED display reads:
NO INPUT
 - LCD display reads:
No Transducer Connected
3. Press CAL. LED display reads with least significant digit (LSD) flashing:
CODE0000
4. Using the DIGIT right and left keys and the up and down VALUE keys enter the following code into the display:
CODE5111
5. Press ENTER.
 - The LED display banners the message shown below followed by the last excitation voltage programmed:
CALIBRATING VOLTAGE (mV)
3023.79 (example voltage)
 - The LCD display reads
Calibrate tester - upper line
STEP 1 Supply mv - lower line
6. Using a laboratory millivolt meter, measure the voltage across pins 2 (ground) and 19 (gage excitation) of the calibration fixture.

Example:

3023.79 millivolts

7. Program the measured voltage (example provided in step 5 on the previous page) into the TTC610 Indicator using the up and down VALUE keys and the left and right DIGIT keys.
8. Press ENTER.
 - The LED display reads:
APPLY 0V
 - The LCD display reads:
Calibrate tester - upper line
STEP 2 0V tare - lower line
9. Short pins 5 and 6 together on the calibration fixture.
10. Press ENTER.
 - The LED display reads in millivolts input:
G+XX.XXX
 - The LCD display reads
Calibrate Tester - upper line
STEP 3 Adjust mV - lower line
11. Remove the short between pins 5 and 6 of the calibration fixture.
12. Using a laboratory millivolt meter, measure the voltage across pins 5 and 6.

Example:

08.262 mV

13. Program the measured voltage into the TTC610 Indicator as demonstrated in the example, "+08.262" by pushing and holding the up and down VALUE keys.
14. Press ENTER. The LED display momentarily reads:
SAVING...
15. Turn the power to OFF. Remove the calibration fixture.

Gravitational Effects

Correction Factors on Test Weights

Weights used in torque calibration are affected by their acceleration due to:

- Altitude above or below sea level, and
- Latitude on earth between the equator and the poles.

Test bars are not affected by these conditions. The accuracy of torque wrenches and testers does not change due to changes in geographic location. Only when using weights must correction factors be considered. After an analysis is made for a given location, it is often found that the correction factor is insignificant.

Two methods of correction are provided. They are:

- Correction factor for check point readings adjusts the calibration readings without changing the applied weight.
- Correction factor for weights adjusts the weight applied without changing check point readings. For additional information refer to *Gravitational Charts* in this chapter.

Gravitational Charts

The charts in this section are taken from *CRC Handbook of Chemistry and Physics, 58th Edition*. CRC Press, Inc., 18901 Cranswood Parkway. Cleveland, Ohio 44128.

Acceleration Due to Gravity for Sea Level at Various Latitudes

<u>Latitude Degrees</u>	<u>Acceleration cm/sec²</u>	<u>Latitude Degrees</u>	<u>Acceleration cm/sec²</u>
0	978.039	46	980.711
5	978.078	48	980.892
10	978.195	50	981.071
15	978.384	52	981.247
20	978.641	54	981.422
25	978.960	56	981.592
30	979.329	58	981.757
32	979.487	60	981.918
34	979.652	65	982.288
36	979.822	70	982.608
38	979.995	75	982.868
40	980.171	80	983.059
42	980.350	85	983.178
44	980.531	90	983.217

Free Air Correction for Altitude

Altitude <u>Meters</u>	Correction <u>cm/sec²</u>
200	-.0617
300	-.0926
400	-.1234
500	-.1543
600	-.1852
700	-.2160
800	-.2469
900	-.2777

Correction Factor for Check Point Readings

1. Determine latitude and altitude. Obtain information from local geological survey office or library.
2. Find the acceleration due to gravity for sea level from its chart.
3. Subtract the free air correction for altitude from its chart.
4. Divide the result calculated in step 3 by the standard gravitational factor 980.665 cm/sec/sec.
5. Multiply the check point in the calibration charts by the factor calculated in step 4 to obtain the corrected check point readings while using the original weight.

Correction Factor for Weights

1. Determine latitude and altitude. Obtain information from local geological survey office or library.
2. Find the acceleration due to gravity for sea level from its chart.
3. Subtract the free air correction for altitude from its chart.
4. Divide the result, calculated in step 3, by the standard gravitational factor 980.665 cm/sec/sec.
5. Calculate the inverse of the calculation in step 4 by dividing it into 1.
6. Multiply the weight given for each check point in the calibration charts by the inverse factor, calculated in step 5, and use this corrected weight with the original check point readings.

TTC600 Manual Loader

The TTC600 Manual Loader is designed as an integral component of the **Snap-on** TTC2000 Torque Tester/Calibrator, providing a precision output torque of up to 2000 ft lb while requiring only 8 ft lb input.

Application

The loader is a laboratory grade instrument used for testing and calibrating all torque wrenches, drivers, torque multipliers, non-impact pneumatic and electric nut runners. This equipment also can be mounted on a fixture for testing and calibrating cable tensiometers and compression or tension gauges.

Power

To activate the limit solenoids that protect the transducers from overload, the loader requires AC power, 115/230VAC, 50 to 60 Hz, 3.15 amps.



WARNING



Do not use this equipment with the power off. Always turn on the indicator and loader so the torque and load values are indicated on the display. The safety relays only work when the power is on.

Transducer Rotation

The manual hand crank provides up to 20° of transducer rotation in both clockwise (CW) and counter clockwise (CCW) directions.

TTC2000 System

Components included in the TTC2000 System are:

- TTC610 Indicator,
- TTC600 Loader, and
- KRL762PY Roll Cabinet.

When the TTC600 Manual Loader interfaces with the TTC610 Torque/Force Indicator and the TTC series of torque transducers, the TTC2000 system provides precision loading, monitoring and data acquisition of torque, force and angle parameters within 0.25% accuracy.

System capabilities include, data storage, retrieval, statistical analysis and automatic downloading to a printer or computer.

Torque/force transducers, purchased separately, are available in ranges from 15-200 in oz, to 200-2000 ft lb. The TTC2000 system features accessory calibration equipment including precision torque bars, certified weights, calibration mounts and stands. Reaction arms, cables, mounting plates and fixtures are also available for testing tensiometers, compression and tension gauges, and torque multipliers.

The TTC2000 includes a **Snap-on** roll cabinet, part number KRL762PY, with heavy duty casters and nine drawers with ball bearing slides for transducer and calibration equipment storage. An extendable swivel monitor stand accepts mounting of the TTC610 Indicator for operator convenience.

Functional Description

This section describes major hardware components of the torque tester, including the:

- Torque tester/calibrator,
- TTC600 Manual Loader,
- Loader rear panel controls,
- Ball handle adaptor,
- 4-in-1 transducer (accessory), and
- Extension arm (accessory).

Torque Tester/Calibrator

The TTC600 Manual Loader mounts on a **Snap-on** roll cabinet, part number KRL762PY. An indicator stand mounts onto the loader.

TTC600 Manual Loader

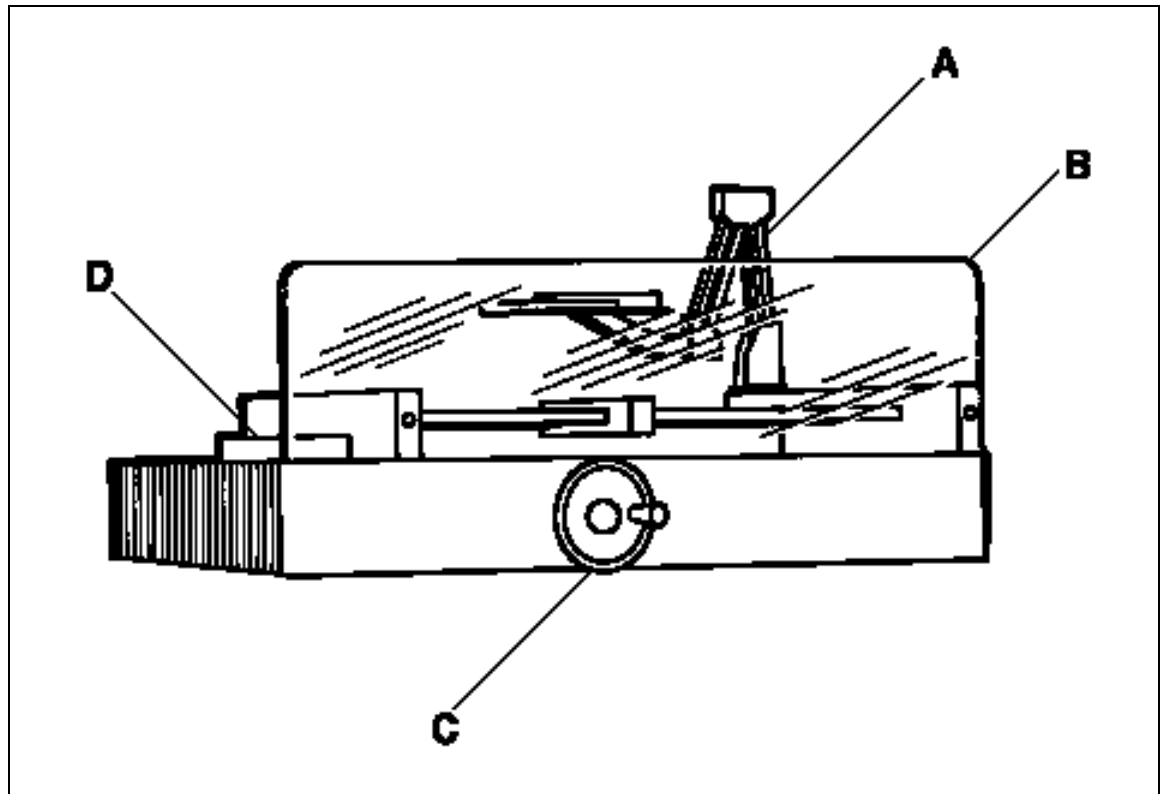


Figure 6-1: TTC600 Manual Loader

- A – Indicator Stand*
- B – Safety Shield*
- C – Hand Crank*
- D – Transducer Mounting*

Use the TTC600 Manual Loader to test torque wrenches. Refer to *Figure 6-2* for an exploded view of the Loader and components.

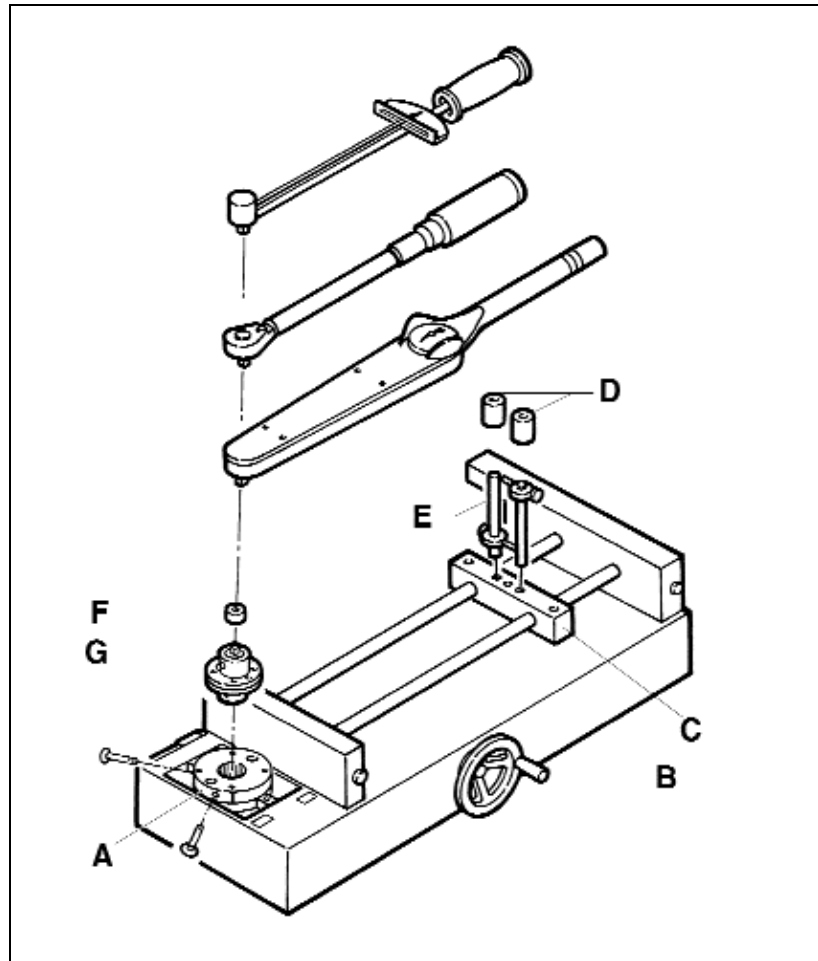


Figure 6-2: TTC600 Manual Loader, Exploded View

A — Transducer Mounting

A transducer facilitates the low-to-high ranges of the wrench under test. The transducer must be installed into the loader by lining up the red mark with the "TORQUE" label on the loader and securing it using two quick release pins.

IMPORTANT

The connector on single transducer cables contains the EEPROM calibration memory chip. Never attempt to remove the connector from the transducer.

B — Hand Crank

Turn hand crank on the loader to apply torque. 2000 ft lbs of torque are generated with only 8 ft lbs of manual torque applied.

C — Reaction Block

The reaction block is positioned so that the reaction pins straddle the wrench handle at the hand hold position specified on the wrench.

D — Linear Bearings

May be slipped over the reaction pins to reduce friction when testing very small or high resolution electronic wrenches.

E — Reaction Pins

Hold the reaction block in place.

IMPORTANT

Adjustable stops on the reaction pins may be raised or lowered to level the wrench prior to loading. Do not place a second stop above the wrench handle. It is normal for the wrench handle to rise as it levels itself under load.

F — Drive Adaptor

A drive adaptor couples the wrench to the transducer. Low torque TTC series transducers use an internal-internal drive adaptor and high torque TTC transducers may use an adaptor/reducer.

G — Transducer (Accessory)

The loader accepts all TTC series single transducers directly. An optional TTC400 4-in-1 transducer can be mounted using a TTC5000-1 adaptor kit. For more information, refer to *Appendix A—Accessories*.

Loader Rear Panel Controls

The TTC600 Manual Loader rear panel is shown in *Figure 6-3*.

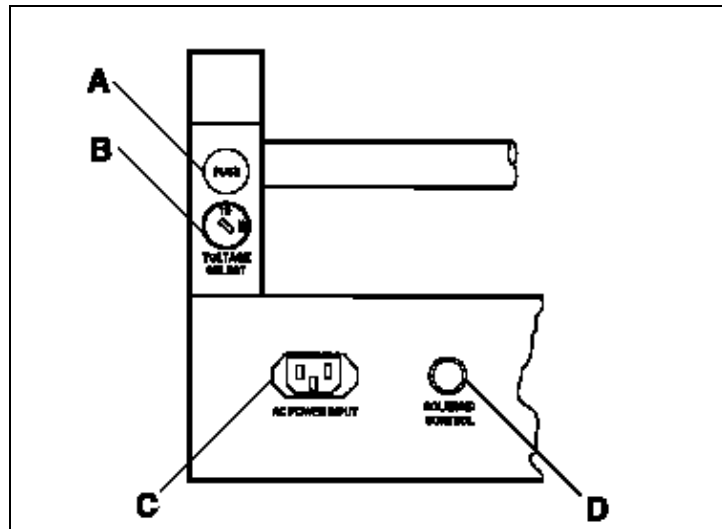


Figure 6-3: TTC600 Manual Loader Rear Panel Controls

A — Fuse

The loader power supply is protected with a 1 amp slo-blow fuse.

B — Voltage Select

A selector switch allows the loader to use both 110VAC or 220VAC.

C — AC Power Input

The loader uses either 110VAC or 220VAC power. The loader connects to the TTC610 Indicator by the TTC117 cable.

D — Solenoid Control

AC power is applied to the loader to operate a pair of safety solenoids used to protect the transducers from overloading. Should the applied torque exceed 110% of the transducer capacity, in either CW or CCW directions, the indicator energizes the solenoids to lock the hand crank.

Ball Handle Adaptor

Wrenches featuring a ball handle are fixtured using the ball handle reaction adaptor shown in *Figure 6-4*. Install the adaptor onto the reaction slide using both reaction pins. Fix the adaptor height with the threaded knob.

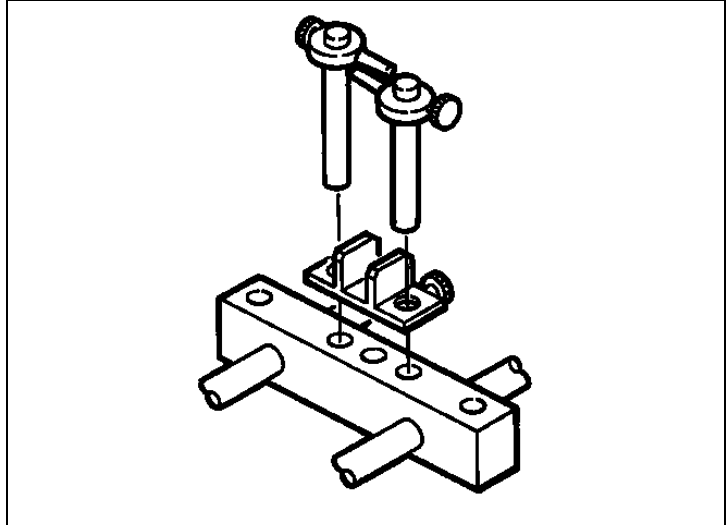


Figure 6-4: Ball Handle Adaptor

4-in-1 Transducer (Accessory)

The 4-in-1 transducer is mounted to the loader using the standoff fixture and bracket assembly as shown in *Figure 6-5*.

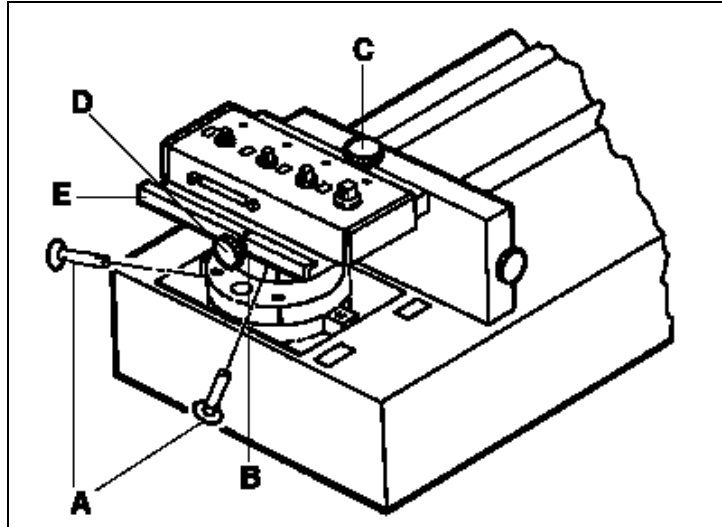


Figure 6-5: 4-in-1 Transducer on TTC600 Manual Loader

A — Quick Release Pins

Four quick release pins must be installed. The first two secure the standoff fixture to the loader and the second two lock the adaptor to the transducer bracket.

B — Loader Standoff (under bracket)

The standoff and bracket must be installed into the loader by lining up the holes of the standoff to the holes of the loader.

C & D — Bracket Knobs

Two knobs on the bracket are used to align the selected transducer over the loader drive. Tighten the left knob (D) first, then the top knob (C). The wrench or driver to be tested is then coupled to the selected transducer using an internal-internal adaptor.

E — 4-in-1 Adapter Bracket

Holds the 4-in-1 transducer horizontal to the loader.

Extension Arm (Accessory)

The TTC600 Manual Loader accepts torque wrenches up to 80" in length. The extension arm is attached as shown in *Figure 6-6*. A quick release pin is used at the end of the arm to capture the reaction pin slide assembly.

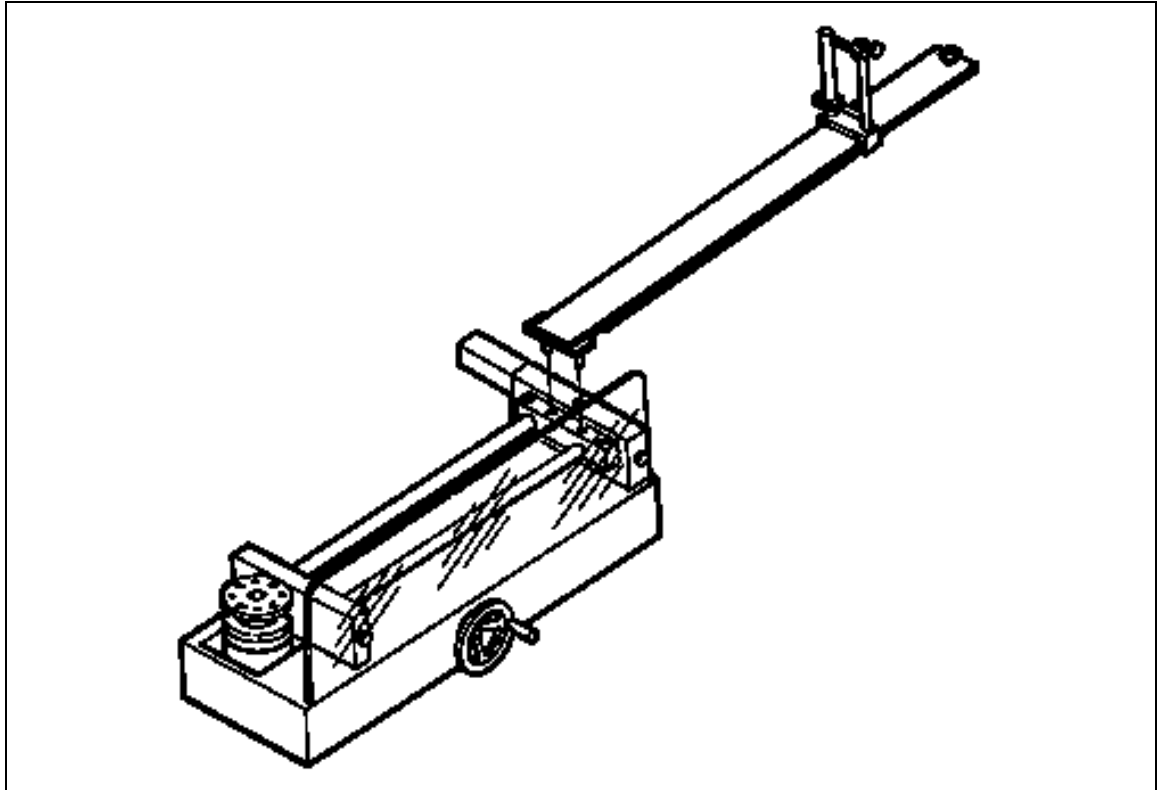


Figure 6-6: TTC600 Manual Loader Extension Arm

Types of Loader Testing

Torque Driver Testing

An accessory torque screwdriver testing kit, TTC75002, is available for use in testing or calibrating most torque screwdrivers and "T" handled drivers. In addition to providing perfect driver-transducer alignment, it allows the use of the TTC600 loader crank for precision torque application.

Certain torque screwdrivers, "T" handled drivers, electric or pneumatic nut runners, and non-impact power tools must be tested by hand. Double check to be sure that the transducer you choose is capable of handling the maximum torque that you will apply. Hold the tool exactly in line with the transducer drive while testing. Off-axis side loading may compromise the test or calibration of the tool.

Torque Multiplier Testing

The TTC600 Manual Loader and TTC series transducers can be configured to test certain torque multipliers. The TTC610 Indicator also provides measurement, display, storage and statistical analysis of multiplier output torque to 2,000 ft lbs.

In practice, the multiplier is attached to the loader using custom fixturing. The operator provides input torque with an appropriate wrench, breaker bar or the multiplier's integral hand crank.

Various mounting fixtures, adaptors, reaction stops and pins are available for testing the most common torque multipliers. Ask your **Snap-on** sales representative for design assistance.

Force Testing

The TTC600 Manual Loader and TTC series transducers can be configured to deliver compression and tension loads. The TTC610 Indicator also provides measurement, display, storage and statistical analysis of FORCE inputs.

A 12" load arm attaches to the transducer drive which mathematically cancels the length factor from the torque measurement. For example, a 250 ft lb transducer translates into 250 lbf (pounds force). The transducer is installed by lining up its red locator line with the FORCE marker on the loader. Only single transducers ranging above 400 in lb can be used to measure force.

A cable attaches to the load arm. The cable pulls against a tension gauge or closes a compression block mounted at the right side of the loader.

Cable tensiometers are attached directly onto the cable itself. The arm pulls against a block fixed at the right side of the loader.

Appendix Accessories

*This appendix contains information on replacement parts and accessories that are available from **Consolidated Devices, Inc.**, a **Snap-on** subsidiary, 1-800-525-6319. All TTC part numbers are available through your **Snap-on** sales representative.

Refer to *Figure A-1*, below, for drawer and cutout arrangement information.

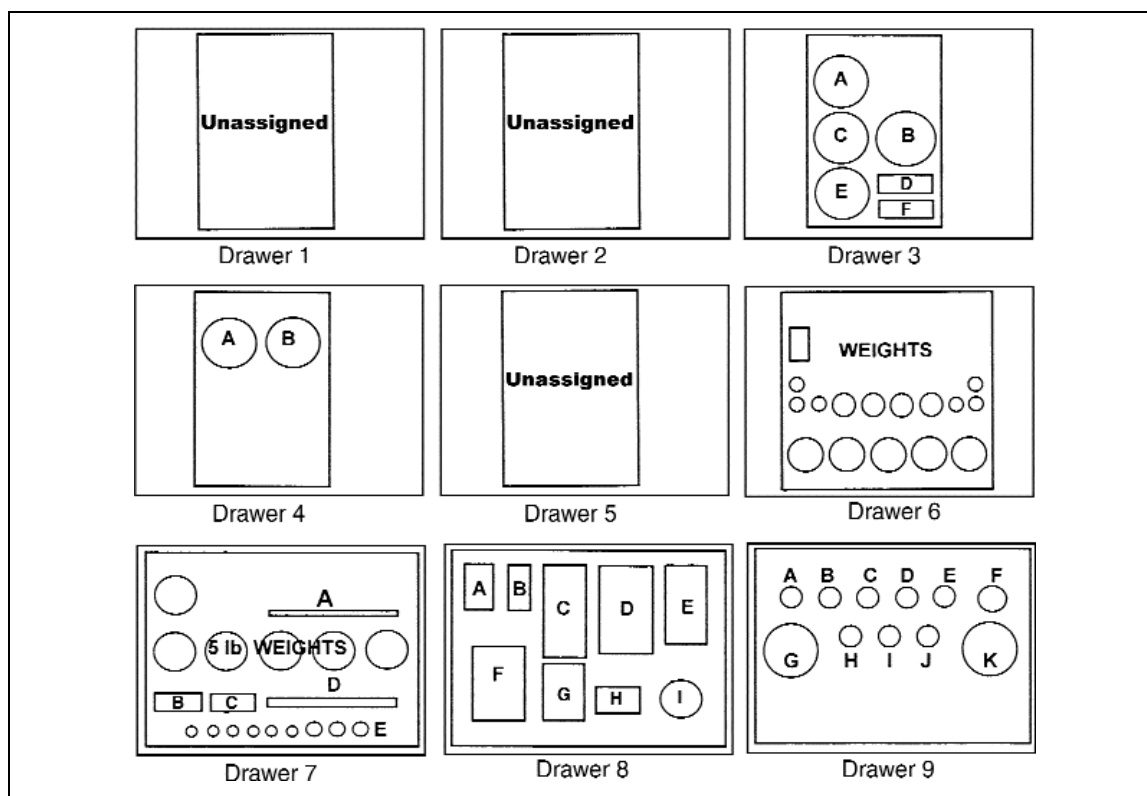


Figure A-1: Roll Cabinet Drawer Arrangement

TTC2000 System Components and Inventory Control

Component	Description	Drawer-Cutout
KRL762PY[†]	Roll cabinet	
TTC1002	Foam insert	6
TTC1003	Foam insert	7
TTC1004	Foam insert	8
TTC1005	Foam insert	9
TTC1007	Foam insert	3
TTC1008	Foam insert	4
TTC600	Manual torque loader	
TTC60010	Loader	
TTC560	Plexiglass safety shield	
TTC1110	Indicator stand	
TTC1731	Reaction pin assembly	8-C
TTC1732	Reaction pin assembly	8-C
TTC343502	Standoff fixture	9-A
TTC17311	(2) Linear ball bearing	
TTC1736	Reaction ball handle adaptor	8-B
QC2I75 ⁻	Torque wrench	7-D
QJ022 ⁻	11/16" Open end adaptor	7-B
QIJR50 ⁻	3/8" Interchangeable ratchet head	7-C
FA12E ⁻	3/8" x 3/8" Hex driver bit	7-C
TTC114	110VAC Power cord	3-D
TTC118	220VAC Power cord - Europe	
TTC119	220VAC Power cord - Australia	
TTC120	220VAC Power cord - Great Britain	
TTC19512	Quick Release (2)	8-I
TTC610	Digital torque/force/angle indicator kit	
TTC11001	Indicator with printer	
TTC114	110VAC Power cord	3-F
TTC118	220VAC Power cord - Europe	3-F
TTC119	220VAC Power cord - Australia	3-F
TTC120	220VAC Power cord - Great Britain	3-F
TTC116	Cable, Indicator to transducers	3-B
TTC117	Cable, Indicator to loader	3-E

[†] The KRL762PY roll cabinet is fitted with 1" thick foam inserts for storage and effective tool control. Storage space is also available for calibration hangers, torque arms and small weights.

⁻ Used for calibration plate and internal drive plate installation on the TTC13 and TTC14 transducers. Item is *not* available from **Consolidated Devices, Inc.**

Optional Transducers and Accessories

Component	Description	Drawer-Cutout
TTC5 1/4" ext. drive TTC34240	15-200 in oz transducer 1/4" internal adaptor	9-B 7-E
TTC6 1/4" ext. drive TTC34240	4-50 in lb transducer 1/4" internal adaptor	9-C 7-E
TTC65 1/4" ext. drive TTC34240	15-150 in lb transducer 1/4" internal adaptor	9-D 7-E
TTC7 3/8" ext. drive TTC342412	30-400 in lb transducer 3/8" internal adaptor	9-E 7-E
TTC8 3/8" ext. drive TTC342412	80-1000 in lb transducer 3/8" internal adaptor	9-F 7-E
TTC10 1/2" ext. drive TTC65263	10-125 ft lb transducer 1/2" internal adaptor	9-H 7-E
TTC11 1/2" ext. drive TTC65263	20-250 ft lb transducer 1/2" internal adaptor	9-I 7-E
TTC12 3/4" ext. drive TTC65782	60-600 ft lb transducer 3/4" internal adaptor	9-J 7-E
TTC13 1" int. drive TTC2262	100-1000 ft lb transducer 1"-3/4" reducer	9-G or 4-A 7-E
TTC14 1" int. drive TTC2262	200-2000 ft lb transducer 1"-3/4" reducer	9-K or 4-B 7-E
TTC400 TTC343410	4-in-1 transducer kit Multiple transducer 1/4" ext. drive, 4-50 in lb 3/8" ext. drive, 30-400 in lb 3/8" ext. drive, 80-1000 in lb 1/2" ext. drive, 20-250 ft lb	8-E
TTC34240	1/4" internal adaptor	7-E
TTC34241	1/4"-3/8" internal adaptor	7-E
TTC342412	3/8" internal adaptor	7-E
TTC65263	1/2" internal adaptor	7-E
TTC34325	Right angle mounting bracket	8-E
TTC5000-1 TTC19513 TTC3435000	4-in-1 transducer adaptor kit Quick release pin (2) Bracket assembly	8-I 8-D

Accessories

Component	Description	Drawer-Cutout
TTC5500-1	Extension arm kit , for up to 80" wrenches	
TTC550108	Arm	
TTC550115	Reaction pin slide block assembly	8-F
TTC8A1951	Retention pin	8-I
TTC501	Cable, Indicator to PC	3-C
TTC502	Cable, Indicator to serial printer	3-A
TTC900121	Cable, smart cable replacement	
TTC75002	Torque screwdriver testing kit	
TTC2600	Tensiometer testing kit	
TTC2610	Force (tension) gauge kit	
TTC2620	Force (compression) gauge kit	
TTC2630	Force arm kit	
QC1JRS50	Joint rate simulator; 50 in lb max, 1/4" internal square drive for use on TTC6 transducer	
QC2JRS400	Joint rate simulator; 400 in lb max, for use on TTC7 transducer	
QC2JRS600	Joint rate simulator; 1000 in lb max, for use on TTC8 transducer	

Calibration Accessories

Calibration of the TTC610 Indicator and TTC series transducers is recommended at least every 1 year.

Component	Description	Drawer-Cutout
TTC25002	Calibration stand kit	
TTC2500	Stand	
TTC15001	Transducer mounting block	
TTC1523	3/8" Square drive adaptor	7E
TTC2210	1-1/4" Square drive adaptor	7E
TTC1548	1-1/4" - 3/4" Drive reducer	7E

200 in oz - 2000 ft lb arm and weight set

TTC3200 200 in oz - 2000 ft lb weight set

Weights

TTC3101	0.2 oz Hook (1)	6
TTC53101	0.3 oz Hook (1)	6
TTC53102	0.5 oz Hook (1)	6
TTC3102	2 oz Bob (1)	6
TTC3103	4 oz Bob (1)	6
TTC3002	1/2 lb Disk (1)	6
TTC3003	1 lb Disk (2)	6
TTC3004	2 lb Disk (4)	6
TTC3005	5 lb Disk (6)	7
TTC3006	10 lb Block (4)	
TTC3007	20 lb Block (4)	
TTC3008	50 lb Block (4)	

*Hangers

TTC3010	1/2 lb Weight hanger	7-A
TTC3040	7.5 lb Weight tray	
TTC3020	15 lb Weight tray	
TTC3030	50 lb Weight tray	

*Torque Arms

TTC500	2.5" Radius wheel
TTC1510	5" Radius wheel
TTC1520	10" Radius butterfly
TTC1540	40" Calibration arm

200 in oz - 250 ft lb arm and weight set**TTC3210****200 in oz - 250 ft lb weight set****Weights**

TTC53101	0.3 oz Hook (1)	6
TTC53102	0.5 oz Hook (1)	6
TTC3102	2 oz Bob (1)	6
TTC3103	4 oz Bob (1)	6
TTC3002	1/2 lb Disk (1)	6
TTC3003	1 lb Disk (2)	6
TTC3004	2 lb Disk (4)	6
TTC3005	5 lb Disk (6)	7
TTC3006	10 lb Block (4)	
TTC3007	20 lb Block (4)	
TTC3008	50 lb Block (4)	

***Hangers**

TTC3010	1/2 lb Weight hanger
TTC3040	7.5 lb Weight tray
TTC3020	15 lb Weight tray

***Torque Arms**

TTC5500	2.5" Radius wheel
TTC1510	5" Radius wheel
TTC1520	10" Radius butterfly

600 ft-lb - 2000 ft lb arm and weight set**TTC322-0****600 ft-lb - 2000 ft lb weight set****Weights**

TTC3003	1 lb Disk (1)	6
TTC3004	2 lb Disk (1)	6
TTC3005	5 lb Disk (2)	7
TTC3006	10 lb Block (4)	
TTC3007	20 lb Block (5)	
TTC3008	50 lb Block (8)	

***Hangers**

TTC3020	15 lb Weight tray
TTC3030	50 lb Weight tray

***Torque Arms**

TTC1540	40" Calibration arm
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