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Form P7352
Edition 1

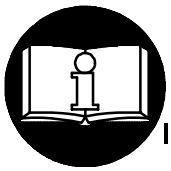
OPERATORS MANUAL FOR MODEL ST9100 TORQUE TESTER

NOTICE

This ST9100 Torque Tester is used for calibration of torque tools, power and hand operated, using internal and/or external transducer(s). This Tester can also be used for joint development and as a failure analysis instrument (using internal or external transducers).

Ingersoll–Rand is not responsible for customer modification of units for applications on which Ingersoll–Rand was not consulted.

⚠ WARNING



IMPORTANT SAFETY INFORMATION ENCLOSED.
READ ALL THESE INSTRUCTIONS BEFORE PLACING UNIT IN SERVICE OR OPERATING THIS UNIT AND SAVE THESE INSTRUCTIONS.
IT IS THE RESPONSIBILITY OF THE EMPLOYER TO PLACE THE INFORMATION IN THIS MANUAL INTO THE HANDS OF THE OPERATOR.
FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.
WHEN USING ELECTRIC TOOLS, BASIC SAFETY PRECAUTIONS SHOULD ALWAYS BE FOLLOWED TO REDUCE THE RISK OF FIRE, ELECTRIC SHOCK AND PERSONAL INJURY, INCLUDING THE FOLLOWING.

PLACING TORQUE TESTER UNIT IN SERVICE

- **Always operate, inspect and maintain this unit in accordance with all regulations (local, state, federal and country), that may apply.**
- **Inspect extension cords periodically and replace if damaged.**
- **Do not remove any labels. Replace any damaged label.**

USING THE TORQUE TESTER UNIT

- **Always wear eye protection when operating or performing maintenance on this unit.**
- **Power tools can vibrate in use. Vibration, repetitive motions, or uncomfortable positions may be harmful to your hands and arms. Stop using any tool if discomfort, tingling feeling or pain occurs. Seek medical advice before resuming use.**
- **Guard Against Electric Shock.** Prevent body contact with earthed or grounded surfaces. For example; pipes, radiators, ranges, refrigerator enclosures.
- **Keep work area clean.** Cluttered areas and benches invite injuries.
- **Consider work area environment.** Don't expose unit and chargers to water. Keep work area well lighted. Do not use unit in explosive or flammable atmospheres.
- **Keep bystanders and children away.** Do not permit unauthorized personnel to operate this unit.
- **Store idle units.** When not in use, units should be stored in a dry, high or locked up place, out of reach of children.
- **Dress properly.** Do not wear loose clothing or jewelry. They can be caught in moving parts. Rubber gloves and non–skid footwear are recommended when working outdoors. Wear protective hair covering to contain long hair.

NOTICE

The use of other than genuine Ingersoll–Rand replacement parts may result in personal injury, decreased performance and increased maintenance, and may invalidate all warranties.

Have your unit repaired by a qualified person. This electric unit is in accordance with the relevant safety requirements. Repairs should only be carried out by qualified persons using original spare parts, otherwise this may result in considerable danger to the user.

Repairs should be made only by authorized, trained personnel. Consult your nearest Ingersoll–Rand Authorized Servicenter.

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INGERSOLL-RAND®
PROFESSIONAL TOOLS

⚠ WARNING

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

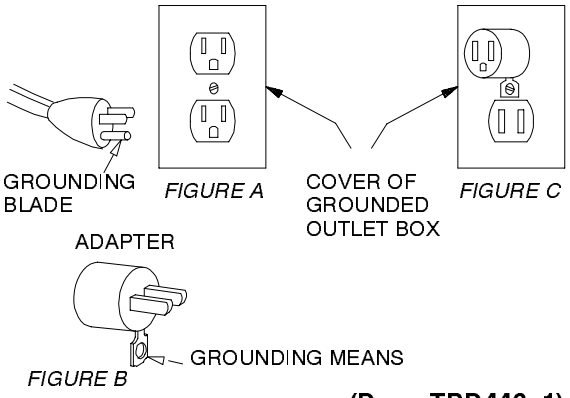
USING THE TORQUE TESTER UNIT *(Continued)*

- **Secure work.** Use clamps or a vise to hold work. Operators often need both hands to perform job functions.
- **Don't overreach.** Keep proper footing, balance, and a firm grip on the tool at all times.
- **Maintain unit with care.** Keep unit clean for better and safer performance. Follow instructions for lubricating and changing accessories. Inspect unit cords periodically and if damaged, have them repaired by an authorized service facility. Inspect extension cords periodically and replace if damaged. Keep handles dry, clean, and free from oil and grease.
- **Do not drop or abuse the unit.**
- **Whenever a unit is not being used, position the Power Switch to the "OFF" position and unplug the power cord.**
- **Stay alert.** Watch what you are doing. Use common sense.
- **Check damaged parts.** Before further use of the unit, a guard or other part that is damaged should be carefully checked to determine that it will operate properly and perform its intended function. Check for alignment of moving parts, binding of moving parts, breakage of parts, mounting, and any other conditions that may affect its operation. A guard or other part that is damaged should be properly repaired or replaced by an authorized service center unless otherwise indicated elsewhere in this operation manual.
- **Have defective switches replaced by an authorized service center.**
- **Do not use the unit if the switch does not turn it on and off.**
- **Do not allow chemicals such as acetone, benzene, thinner, ketone, trichloroethylene or other similar chemicals to come in contact with the housing, as damage will result.**
- **The use of any accessory or attachment other than recommended in this manual can present a risk of personal injury.**

GROUNDING INSTRUCTIONS

The Controller should be grounded while in use to protect the operator from electric shock. The Controller is equipped with a three–conductor cord and three–prong grounding–type plug to fit the proper grounding–type receptacle.

The green (or green and yellow) conductor in the cord is the grounding wire. Never connect the green (or green and yellow) wire to a live terminal. If your unit is for use on less than 150V, it has a plug that looks like that shown in Figure A. An adapter (see Figure B) is available for connecting Figure A–type plugs to 2–prong receptacles. The green colored rigid grounding strap extending from the adapter must be connected to a permanent ground such as to a properly grounded outlet box.



(Dwg. TPD446–1)

⚠ WARNING

For safe use of adapters, the outlet box must be grounded. If there is any doubt, have a qualified electrician check connections.

Extension Cords

⚠ WARNING

Use only 3–wire extension cords that have 3–prong grounding–type plugs and 3 pole receptacles that accept the controller's plug. Replace or repair damaged cords.

Make sure your extension cord is in good condition. When using an extension cord, be sure to use one heavy enough to carry the current your product will draw. An undersized cord will cause a drop in line voltage resulting in loss of power and overheating.

Table shows the correct size to use depending on cord length and nameplate ampere rating. If in doubt, use the next heavier gage. The smaller the gage number, the heavier the cord.

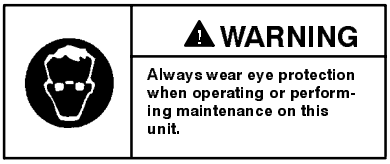
Total Length of Cord in Feet				
0 – 25	26 – 50		51 – 100	101 – 150
18	16	AWO	16	14

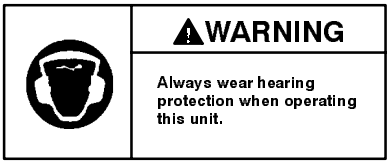
CAUTION

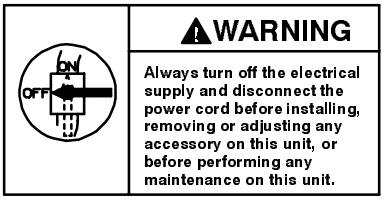
FAILURE TO OBSERVE THE FOLLOWING CAUTIONS COULD RESULT IN INJURY.

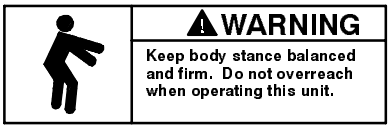
- **The unit should be checked periodically to ensure that the zero point is adjusted properly and that the torque readings are accurate. The zero point may drift due to changes in the temperature.**
- **DO NOT store the Torque Tester in relative humidity above 85%.**
- **DO NOT operate the Torque Tester without an adapter between the tool and the Tester.**
- **Have the unit calibrated at least once a year.**
- **Keep the exterior of the Tester clean and dry.**

WARNING LABEL IDENTIFICATION







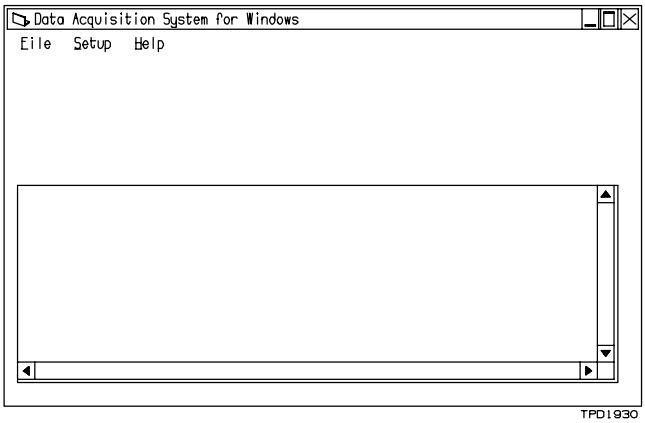


SOFTWARE INSTALLATION

Insert disk 1 in drive a: and go to Start then Run and type a:setup. Insert disk 2 when prompted to do so. If any previous version has been installed delete all the files and directories before installing this version.

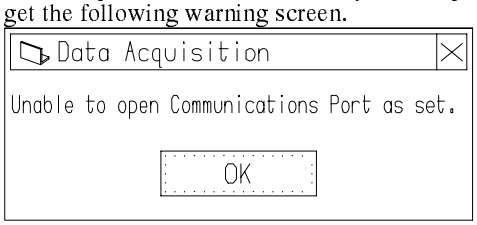
RUNNING THE PROGRAM

Go to Start, then choose Programs and select Win_Data_Aq from the program list. The following startup screen should appear. Note that the default Communication Port setup for this program is COM2. If this is not the communication port that the analyzer is connected to, select Setup to change it.



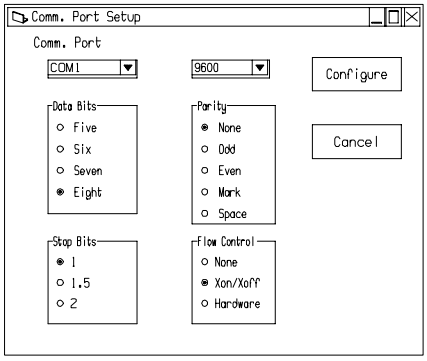
TPD1930

If COM port 2 is not available on your computer then you will get the following warning screen.



TPD1932

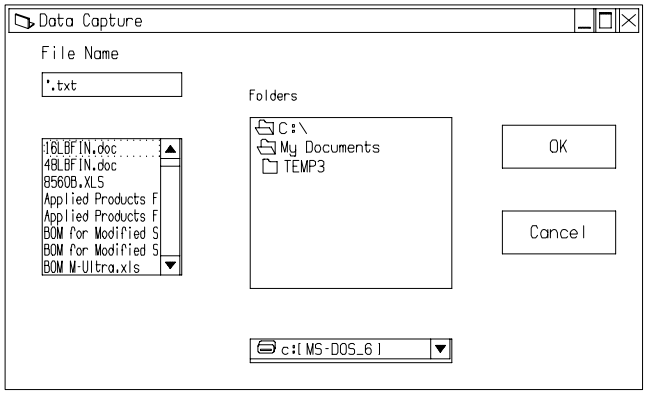
Just click OK and then go to the menu bar in the main screen and click on setup and select Comm Port. You should now see the following screen. Here you can select the Comm Port that is available on your computer and click the configure button. The other settings should be left as they are as these are the only speed and character format available for the analyzer. If the communication port chosen is not available then you will get a warning screen saying the communications port can not be opened as set. Click OK and try again.



TPD1933

After the communications port is successfully configured, the main screen will appear again. Now any data that is sent from the analyzer will be displayed in the text box on the main screen. If you send data from the analyzer and it does not appear on the screen, you may not be using the port the analyzer is connected to, even though it may be a valid communication port. Try changing it to another communication port.

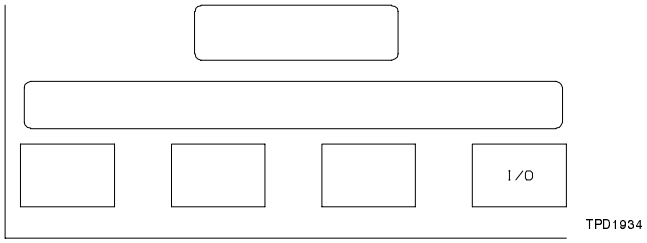
If you want to capture data to a file go to the menu bar and click on "File". Then select "Capture Data" and "To New File" and you will be presented with a new screen that will allow you to choose the drive, directory and file name to which you can capture the data. See the screen below.



TPD1931

After you have entered a file name in the "File Name" text box you click OK to return to the main screen. Now any data that comes into the RS232 port will be displayed to the screen as well as added to the file name you entered. As new data comes in it will continue to be appended to the file until you select File again and then select Close Capture. If at a later time you run the program again and wish to add the data to an existing file go to the menu bar and click on "File"' and select "Capture Data" and "Append To File". Then choose the existing file from the menu selection and click OK to begin adding any new data to the existing file.

OPERATING A TORQUE ANALYZER

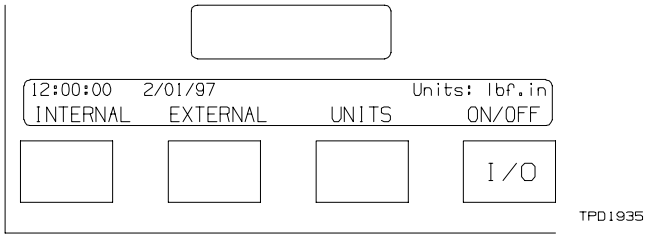


TPD1934

This is a portrayal of your new Ingersoll–Rand Analyzer. Throughout this Operations Manual, there will be pictures like the one above to guide you through any operations that may be needed. The first step in learning how to operate the analyzer is to become acquainted with its features.

The four bottom keys are a guide to the menus. In order to turn the unit on, press the I/O button as shown above.

MAIN MENU



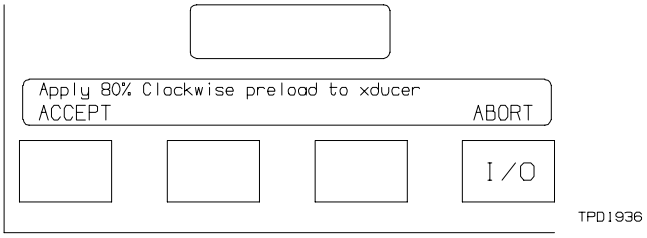
TPD1935

This is the main menu for the torque tester. It is the starting point for most operations from this menu, there is a choice of INTERNAL, EXTERNAL, UNITS, and ON/OFF.

To check or calibrate a hand or power tool, choose your required units. This field will automatically default to the units in which the analyzer is calibrated. These master default units are printed on your Calibration certificate. In this case, it is lbf.in., denoted in the top right–hand corner of the menu box. To change the unit of measurement, press the button underneath the word UNITS. This will change the units to alternate measurement scales.

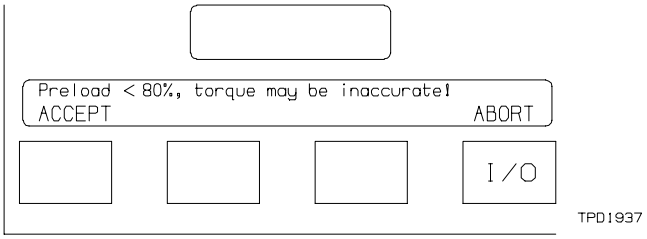
If you change your units back and forth during operation, the stored memory or stored readings (when MEMORY is activated) will be deleted so use this feature carefully. Also, if the analyzer is turned off, the units will default to the last unit of measurement used once the unit is turned on again.

Next, determine if you want to use the internal or an external transducer. If using an external transducer, the modular plug on the external cable assembly (ECA) (9) must be inserted into the jack on the left hand side of the unit (See section on External Cable Assemblies). Based on what is best for your application, press INTERNAL or EXTERNAL now.

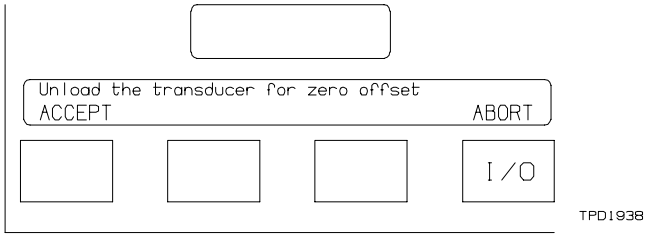


After selection of INTERNAL or EXTERNAL from the main menu, the above prompt will be displayed indicating to apply an 80% CLOCKWISE preload to the transducer. This is necessary to re–establish the current transducer raw zero offset. It is important for lower range transducers (below 500lbf.in) to meet or exceed the 80% of full scale threshold since these transducer mechanisms may exhibit hysteresis effects near the zero point.

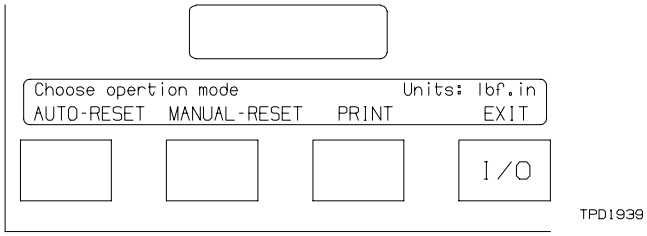
This is also recommended for any transducer that has been dead weight calibrated with the system. Large ranged external transducers (> 500 lbf.in) can be exempt from this procedure, especially if the "QUICK" method of external calibration is used (LINEAR, 1ST order approximation, see CALIBRATION SECTION.)
Note that the numerical display will show the approximate values of torque of the transducer if the unit has been previously calibrated using the LINEAR or CURVE FIT method. If an overtorque situation arises, verify the transducer's calibration before proceeding (see INT/EXT CALIBRATION).



If the 80% clockwise preload is NOT met, the above prompt will warn the user and allow a change to ABORT the preload. If the 80% preload is established, then the zero prompt will be presented (see below). Press ACCEPT to acknowledge and to continue. Ignore the prompt if exceeding the 80% threshold is impractical and press ACCEPT.



If the 80% clockwise preload is established or if a lower threshold is ACCEPTED from the previous menu, then the above prompt will ask the user to unload the transducer to determine the raw zero offset. This means to remove any preload device from the transducer input drive and remove any source of force on the internal/external transducer. Press ACCEPT after unloading to establish the new zero point or press ABORT to exit to the main menu without accepting the preload.

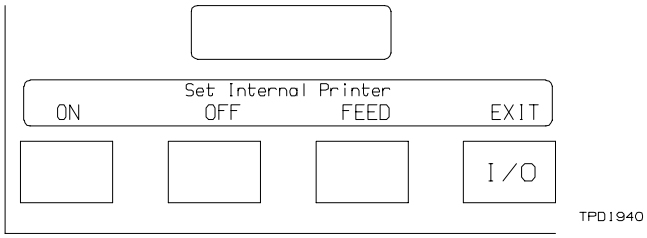


The menus for internal and external look the same. The menu choices are AUTO–RESET, MANUAL–RESET, PRINT and EXIT.

At any time during the operation of the torque tester, the EXIT button can be pressed to go back to the previous menu.

Press the PRINT button at this point if continuous "on line" printing is desired.

PRINT MENU

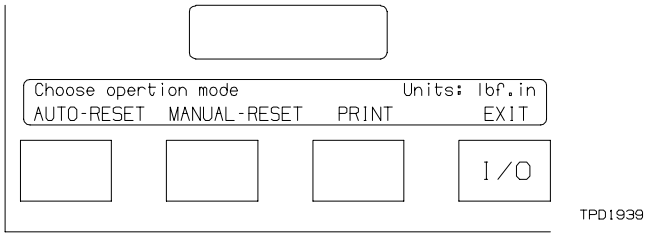


If you wish to turn the internal printer on for a line by line print during testing, press the ON button.

To feed blank paper through the internal printer press FEED.

To turn the printer off, press the OFF button. The default status of the printer is in the OFF state.

INTERNAL/EXTERNAL MENU



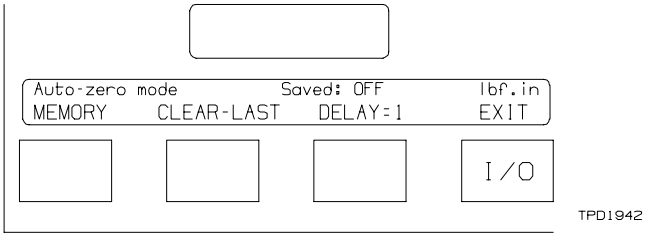
Now that the print status has been determined, choose the auto–reset or manual–reset mode of operation.

Auto–reset will reset the torque reading to zero between 1–9 seconds after the torque has been applied. Press AUTO–RESET if you want to use this feature.

Manual–reset allows you to manually reset the analyzer by pressing a button. It will display the tool's peak torque indefinitely until you actively reset the machine. Press MANUAL–RESET if you want to activate this feature.

Once you select either AUTO–RESET or MANUAL–RESET, any torque applied will be displayed on the large LCD.

AUTO–RESET MENU

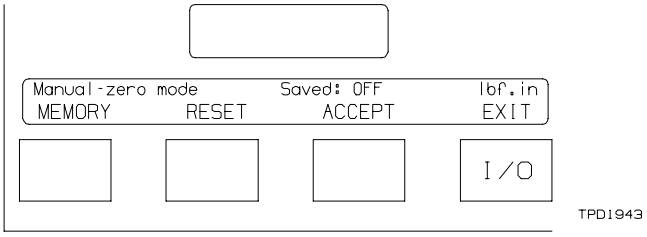


At this point, the tool that you are checking can be inserted into the input drive at the lower right–hand side of the unit or into the external transducer.

After Auto–reset is chosen and torque is applied, the transducer will capture the peak torque and hold the value for the number of seconds preset in the DELAY mode. To change this number, press DELAY until the number of seconds you want the reading to stay on screen appears. The limits are from 1 to 9 seconds. To activate the save function, press MEMORY now. Once MEMORY is activated, the unit will display the number of saved readings next to the word SAVED (See MEMORY menu for more detail on save functions.)

To clear the last saved reading, press CLEAR–LAST.

MANUAL–RESET MENU



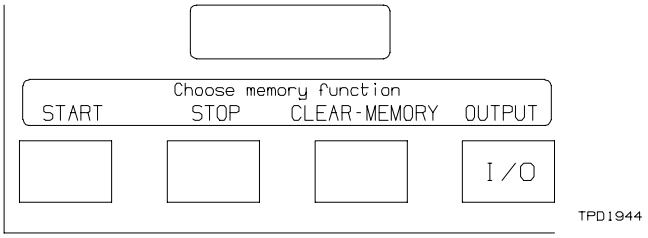
At this point, insert the tool that you are checking into the input drive at the lower right–hand side of the unit.

After you choose Manual–reset and apply torque, the transducer will capture the peak torque and hold a value until you press RESET or ACCEPT.

If the MEMORY function is on and you press ACCEPT, the reading will be saved into memory. If the save function is not on, the ACCEPT button has the same feature as RESET.

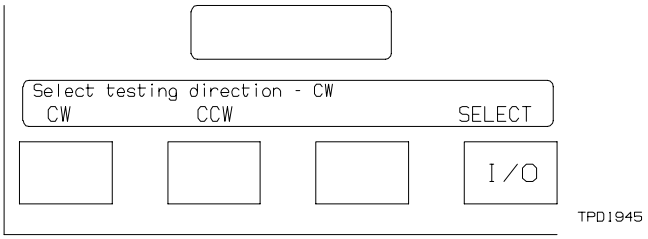
To start your MEMORY function, press MEMORY.

MEMORY MENU



The MEMORY menu operates the same for both Auto–Reset and Manual–Reset. Once activated, MEMORY has a maximum capacity of 10,000 readings (factory configured). To start the MEMORY function, press START; to stop your memory function, press STOP; to clear your memory, press CLEAR–MEMORY; and to dump to an external device or internal printer, press OUTPUT.

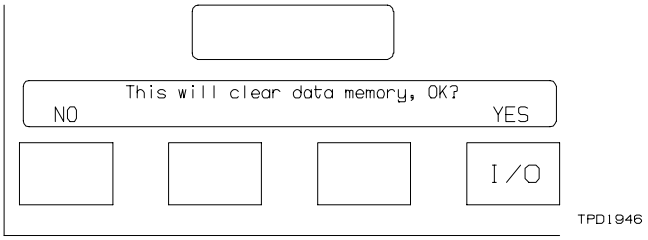
START/MEMORY MENU



From this menu, choose your test direction. If it is clockwise, press CW. If your test direction is counter–clockwise, press CCW.

Once the direction has been determined, press the SELECT button. The new direction will be noted in the upper right–hand corner of the display.

CLEAR–MEMORY MENU



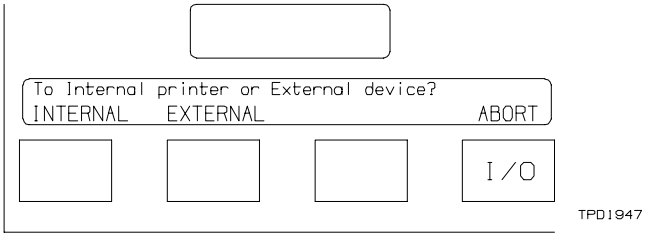
If you want to clear the memory, press YES.

If you want to keep your memory, press NO.

It is advised that every time you test a new tool, the memory should be cleared.

If line number of tests are tracked for each tool then the memory may be maintained.

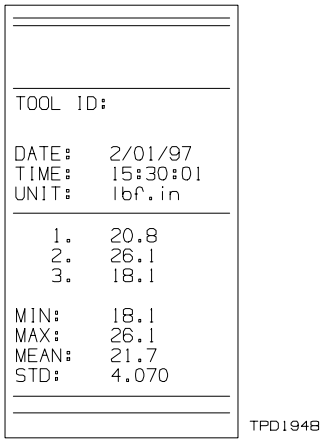
OUTPUT/MEMORY MENU



This menu will output saved readings to the internal (on board) printer or to the external serial port. In order to use the external serial port, plug the provided cable into the port marked RS232. Make the necessary connections to your output device.

See Addendum A, section 2b for further explanation regarding RS232 communication. Adapters are supplied with each unit to interface with common device serial ports. Press EXTERNAL once all connections have been made. If you would like to output your stored information to the internal printer, press INTERNAL now.

If you want a summary of all saved readings and basic statistical analysis, use the OUTPUT menu. The print–out will look like this:



TOOL ID:	This is where the operator records the tool identification.
DATE:	The date that the readings were printed. This will be filled in by the unit's internal computer.
TIME:	The time that the printout was made. The time is in standard military time.
UNIT:	The unit of measurement in which the tool was tested.
1., 2., 3.	The test numbers. This tool was tested three times, so there are three numbers listed.
MIN:	The minimum torque value tested.
MAX:	The maximum torque value tested.
MEAN:	The mean of all torque readings taken.
STD:	The standard deviation of all torque values taken.

Additional Notes on the Torque Tester

OVERTORQUING:

If the torque tester unit is overtorqued during operation, the unit will sound an alarm and the overtorque value will remain flashing on the display until EXIT is pressed to acknowledge.

NOTICE: Avoid overtorquing as this could damage the unit. If the unit is "stuck" in this condition, holding down the EXIT button will allow the user to escape from the menu(s).

Disconnecting an external transducer prematurely may also be sensed as an overtorque condition.

Back out to the main menu before disconnecting the transducer.

EXIT/ABORT/STOP:
If you arrive at a menu that you do not understand or a menu that you do not wish to be in, press the EXIT, ABORT, or STOP button. This will put you back to the previous menu.

MEMORY:
If you do not save data, information will not be available for printing in the OUTPUT mode.

It is advised that you clear your memory for each new tool that you test.

EXITING FROM AUTO TO MANUAL:
If you exit from the AUTO–RESET to MANUAL–RESET and the line printer function is active the printer will print a new heading.

NUMERICAL DISPLAY LIMITATIONS:
The limitations on the numerical display are 14999 counts. However, the internal circuitry will only allow a maximum of 8000 counts of resolution of + or – 1 count.
Beyond 8000 counts the resolution of the display will display in increments of 2 or 4 counts depending on the entered full scale value.

CHANGING PRINTER RIBBON, PAPER

Push down on the upper left hand side of the printer cover. The top should pop up. Pull up and out to remove the cover.

RIBBON:
On the right hand side of the ribbon, it should say EJECT. Press down on that spot. The ribbon will pop up. Take out and replace in the same manner that you ejected it. Push down on the word EJECT. The ribbon should be in place. Reinsert door.

PAPER:
Unscrew the paper spool (3).
This is a large screw on the right hand side of the analyzer unit. Once unscrewed, pull out then proceed to pull up on the empty paper spool.
Insert new spool, lead side facing in and up.
The new paper roll will be self–aligning.
Screw in the paper spool.
Put the paper lead into the printer slot, turn unit on and press INTERNAL, PRINT, and FEED.
The paper should be near the height of the door. Reinsert door.

REPLACEMENT:

For replacement paper or ribbon, please order from

Item	Item#
Paper	ST9100–816
Ribbon	ST9100–821

BATTERY RECHARGING CONSIDERATIONS

The analyzer utilizes rechargeable Nicad batteries and should operate for approximately 20 hours on fully charged batteries. The menu on the analyzer will indicate Low Battery State thereby prompting the user to recharge batteries. Upon the recharging of the Nicad batteries, the LED situated next to the charger socket on the analyzer will be illuminated. This will indicate that the batteries are fully charged and the charger should be removed from the analyzer.

Although the analyzer has a safeguard against overcharging, it is recommended that upon proper recharge of the Nicad batteries, the charger is disengaged from the analyzer. The battery low

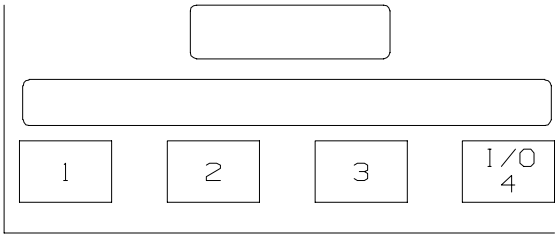
condition is indicated on the alphanumeric display. There are two levels of the battery low condition. The first level will still allow usage of the analyzer after prompt is acknowledged. "Batteries are low, plug in battery charger" will be displayed.

If the unit is not recharged after this prompt, then the second low battery condition may be reached. **Batteries are very low, plug in battery charger now!** will be displayed and the unit will be reset (power on sequence).

CALIBRATION INSTRUCTIONS

Calibration of the Torque Analyzer:

1) The Torque Analyzers are calibrated by dead weight testing. A certificate traceable to NIST is included with each unit.
2) In order to calibrate your analyzer, it must be mounted vertically using the supplied U-Mounting bracket. Use the supplied screws to mount the unit to the U-bracket. (12)
3) Be sure you have the appropriate equipment for calibration: one 4" dia. with 3/8" drive calwheel; 1/4 lb, 1 lb and 5 lb hanger and four 5 lb weights.
4) If you have any questions about calibrating your unit, please call Ingersoll-Rand technical assistance at (615)672-7555. (Whitehouse, TN)

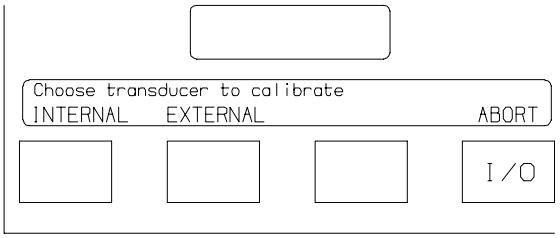


TPD1949

The above picture is a representation of the analyzer unit. In order to turn the unit on, press the I/O Key. The unit will then beep once when the I/O button is first pressed and twice before the main menu is shown. Between the initial "on beep" and the main menu, there is time to push a coded sequence of buttons to allow the unit to enter an alternate "special" menu(s). For clarification, we name each button as shown above. Turn the unit on and press the keys 1234 in that order. The Calibration menu should appear.

If the Main menu appears instead of the Calibration menu, turn the unit off and start over. It indicates that the correct code was not entered.

CALIBRATION MAIN MENU



TPD1950

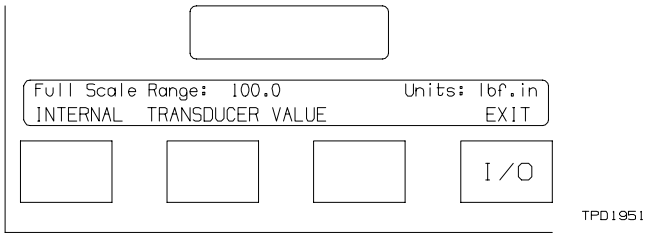
This is the main Calibration menu for the analyzer. You have a choice of using the internal transducer, the external transducer, or aborting.

If you decide to use the internal transducer, the unit must be secured as mentioned above. Press the INTERNAL key.

To use an external transducer, press the EXTERNAL key.

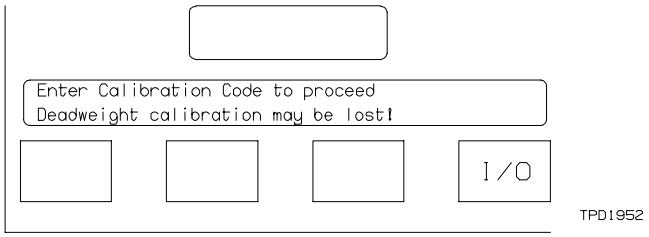
To leave the calibration menu, press ABORT.

INTERNAL CALIBRATION MENU



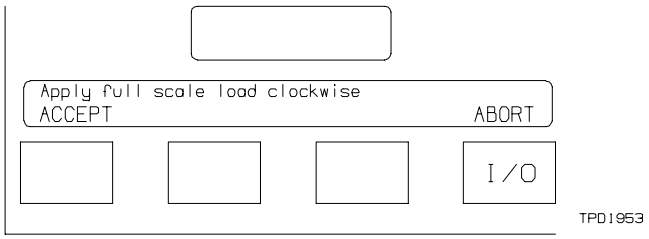
TPD1951

The Full Scale Range will depict the full scale value of the analyzer. This is preset at the factory. Please consult Ingersoll-Rand if values are incorrect. At this menu, press ENTER, accepting the full scale value and default unit system.



TPD1952

The above prompt will be displayed asking the user for the calibration entry code. This is a safeguard to prevent the casual user from destroying the calibration coefficients that may exist. A five second delay time is given for entering the calibration entry code. **The code is 21234314**.



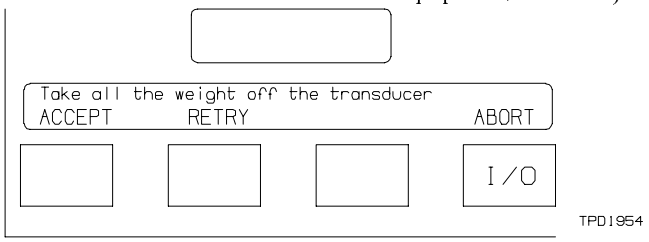
TPD1953

Once the proper calibration code has been entered, you will see this menu. On the top numerical display, raw A/D voltage will be shown. These values DO NOT apply to torque.

If you do not want to calibrate, press ABORT.

If you are calibrating, apply full scale load using appropriate calibration equipment. For the ST9100, this would be 100 lbf. in., 1600 ozf. in., 115.2 kgf. cm. or 1130 cNm.

Once your full scale load is applied and the reading has stabilized, press ACCEPT. (Contact Ingersoll-Rand Technical Service for recommended Calibration equipment, if needed).



TPD1954

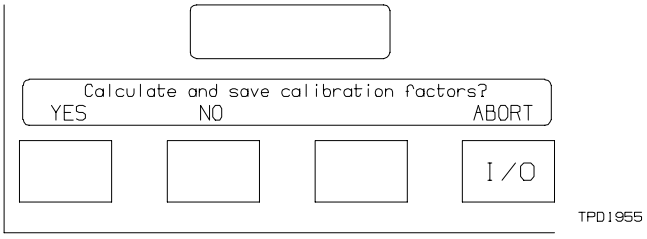
From this menu on, the analyzer will give you explicit instructions on what to do for calibration. The analyzer will ask you to apply weight clockwise and counter-clockwise. Follow all of these instructions until the end of calibration, which will be shown in the next two menus.

Calibration test points are based on 6 percentage values: 5%, 20%, 40%, 60%, 80%, and 100% of full scale in both clockwise and counterclockwise directions. Press RETRY at any point in the calibration procedure to re–enter a data point. This function will allow you to re–do a "bad" reading due to noise or unplanned vibrations.

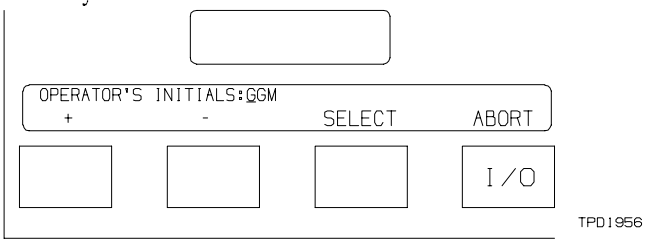
NOTE: analog system noise of + or – 3 counts is normal. Best calibration results are obtained by accepting mid–point values of this variation.

If there is excess noise (10 counts or more of "flutter"), then the unit must be serviced.

END OF INTERNAL CALIBRATION



If you pick YES here, you will save and calculate your calibration factors. If you pick NO, you will exit and your calibration will not be saved.If you pick ABORT, you will need to start your calibration all over!



If you selected YES on the last menu, this is the next menu you will see.

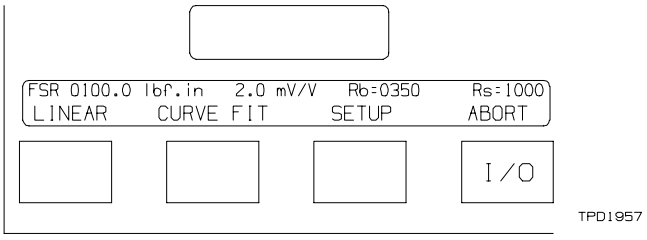
The operator's initials must be entered.

+ raises the letter, – lowers the letter, SELECT goes to the next letter.

After all letters are correct, press SELECT and it will start calculating coefficients.

The numerical display will count down from 8 to 1 to let you know that it is calculating. The process takes approximately 5 minutes. The analyzer will return to the main menu when the calculation is complete.

EXTERNAL CALIBRATION MENU



External Calibration allows more options than Internal Calibration since many different transducers can be used with the unit. The current setup of the external transducer is displayed upon entering this menu when the cable is physically connected to the external port. If the cable is not connected or is defective, the prompt **No external transducer detected** will be displayed with the only the ABORT option available. Verify connection with the external port and try again.

FSR denotes the transducer Full Scale Range. This numerical value is limited to 14999 counts. The default unit of measurement is next. The unit system shown should be the preferred or desired units of the transducer to be used.

All alternative systems chosen will be conversions from the default system. The transducer sensitivity relationship is next; the mV/V scale.

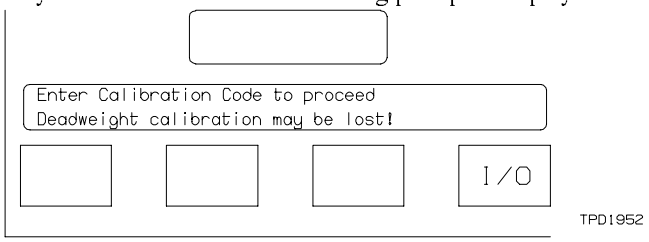
This value is usually visible on the external transducer nameplate. Typical values are 2.0 mV/V; 1.0 mV/V; 0.5 mV/V. Bridge resistance Rb and scaling resistance Rs are then shown. These values are in ohms and Rb is also visible on the external transducer.

Rs is a scaling resistor value that resides in the Ingersoll–Rand external transducer cable. Typical value of this resistor is 1000 ohms (for 2.0 mV/V transducer.)

If the transducer is less sensitive (< 2.0 mV/V), the Rs value can be decreased by Ingersoll–Rand. For additional information regarding this feature, please contact the Ingersoll–Rand Technical Sales Representative.

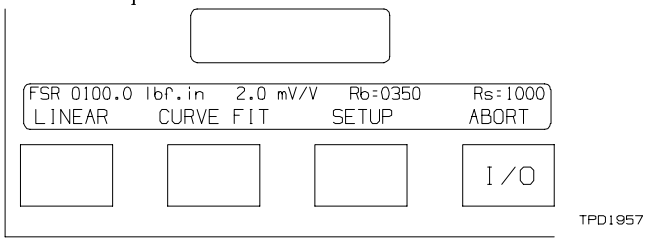
If the external transducer has been previously deadweight calibrated, the mV/V, Rb and Rs will be replaced with the following – DEADWEIGHT CALIBRATED, to signal the user a CURVE FIT calibration has already been completed. Proceeding to perform the LINEAR or SETUP functions in this situation will require a second level calibration code to be entered into the unit. This code is the same code for performing an internal or external CURVE FIT calibration.

Key in **21234314** when the following prompt is displayed.



If the setup shown on the display is correct for the external transducer and the unit is not deadweight calibrated and a LINEAR, "Quick Calibration" is desired, press LINEAR. The unit will calculate the 1ST order linear coefficients given the previous information and will return to the main menu.

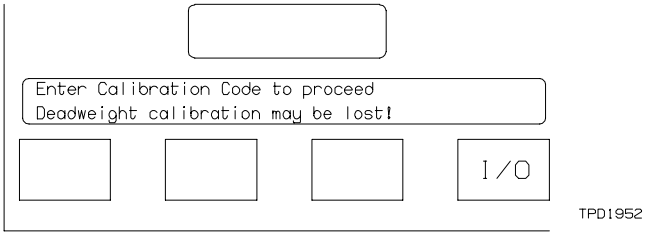
The coefficients will then be sent to the cable EEPROM to be stored for future use. If this function is not desired, press ABORT to quit.



If the setup is correct and a second order CURVE FIT is desired, press the CURVE FIT button. The unit will ask you to perform a full dead weight calibration on the external transducer.

The analyzer will ask you to apply torque clockwise and counterclockwise. Follow all of these instructions until the end of calibration.

Calibration test points are based on six percentage values: 5%, 20%, 40%, 60%, 80% and 100% of full scale in both clockwise and counterclockwise directions.

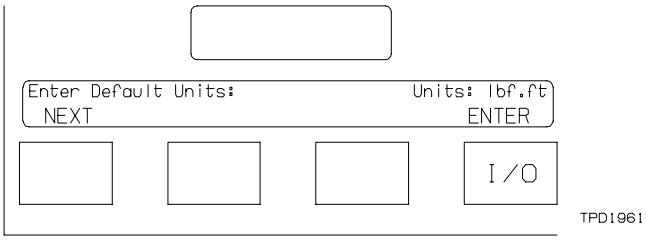


The above prompt will be displayed asking the user for the calibration entry code. This is a safeguard to prevent the casual user from destroying the calibration coefficients that may exist. A five second delay time is given for entering the calibration entry code. The code is 21234314. After proper entry of this sequence, the unit will enter the normal deadweight calibration routine as previously explained in the INTERNAL CALIBRATION MENU.

Refer to this section before continuing. Press SETUP if the displayed information is not correct. See SETUP/EXTERNAL CALIBRATION for details.

Pressing ABORT takes you to the main menu.

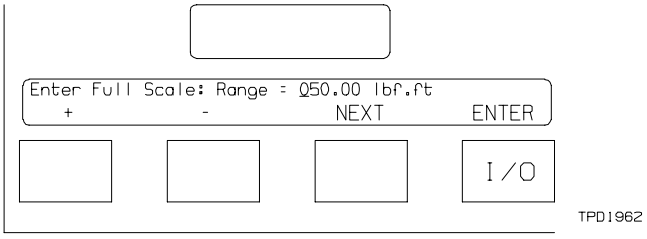
SETUP/EXTERNAL CALIBRATION MENUS



If the NEXT button is pressed, the Units on the upper right–hand side will change. The choices for default units are:

kgf.cm, kgf.m, ozf.in, lbf.in, lbf.ft, gf.cm, N–m, cN–m, mN–m.

Once the default units have been determined, press ENTER. The unit system selected should be the desired or preferred system. Note: You will need to inspect your external transducer to determine default measurement scale.



The + or – buttons will raise or lower the range.

The NEXT button advances to the next number.

If the cursor is placed on a decimal, it can be moved up or down for decimal position selection.

When you are satisfied with the Full Scale Range, press ENTER.

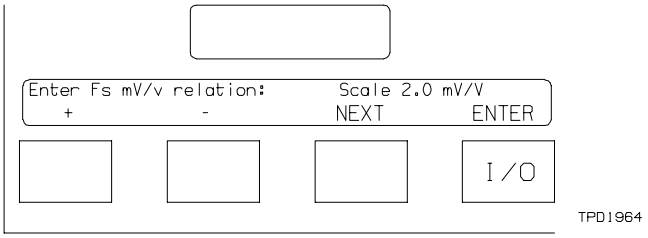
These two menus will continue with slight modifications for the rest of the cycle. The next units menu will ask for American Alternate units, then Metric Alternate units, and finally SI Alternate units.

The full scale range menus will be the same as the one shown above. Conversion calculations may be needed to enter the correct alternate unit system scales. See conversion table below.

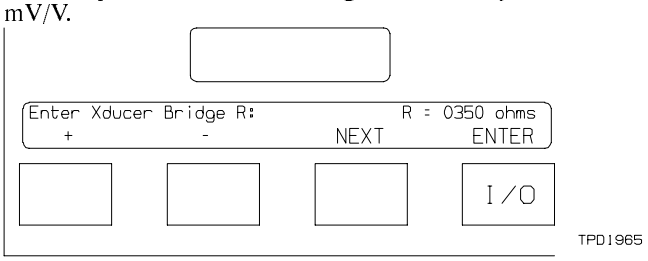
TORQUE CONVERSION CHART

Units to Convert	American			S.I.			Metric		
	ozf.in	lbf.in	lbf.ft	mN.m	cN.m	N.m	gf.cm	kgf.cm	kgf.m
mN.m	0.142	0.009	0.0007	1	0.1	0.001	10.2	0.01	0.0001
cN.m	1.416	0.088	0.007	10	1	0.01	102	0.102	0.001
N.m	141.6	8.851	0.738	1000	100	1	10,197	10.20	0.102
ozf.in	1	.0625	0.005	7.062	0.706	0.007	72	0.072	0.0007
lbf.in	16	1	0.083	113	11.3	0.113	1152.1	1.152	0.0115
lbf.ft	192	12	1	1356	135.6	1.356	13,826	13.83	0.138
gf.cm	0.014	0.0009	1.11117	0.098	0.01	0.0001	1	0.001	0.00001
kgf.cm	13.89	0.868	0.072	98.07	9.807	0.098	1000	1	0.01
kgf.m	1389	86.8	7.233	9807	980.7	9.807	100,000	100	1

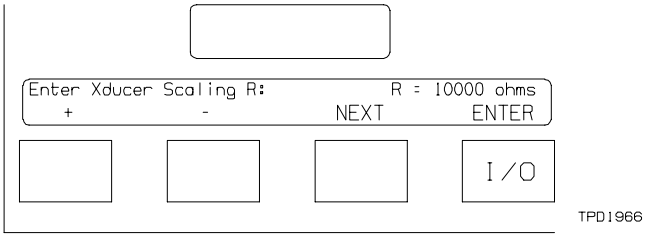
TPD1963



This menu sets up the mV/V relationship. Press + or – to raise or lower the scale. The NEXT button advances the cursor to the next digit. When you are satisfied with the Full Scale mV/V relation, press ENTER. The range of sensitivity is 0.1 to 9.9 mV/V.



This menu sets the transducer bridge resistance in ohms. Press + or – to raise or lower the resistance. The NEXT button advances the cursor to the next digit. When you are satisfied with the bridge resistance, press ENTER. The allowable range is 120–2000 ohms.



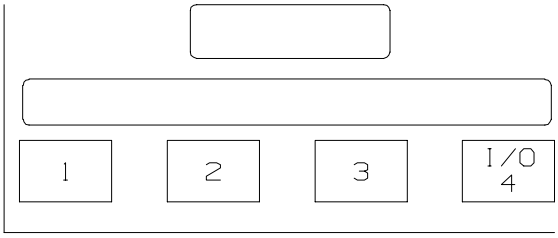
This menu sets the external cable scaling resistance Rs. This value allows the flexibility of a wide range of transducer sensitivities.

However, if this value is altered in software, the correct resistor value must be placed within the external cable box Consult the Ingersoll–Rand Company, Technical Sales Representative for additional information.

After completion of this menu, the setup information will be shown again with the main external calibration options shown. The 1ST order LINEAR approximation can be performed or the 2ND order CURVE FIT method can be used to calibrate the external transducer.

Use ABORT to exit the external calibration menu.

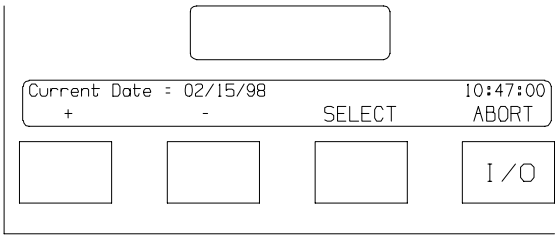
TIME AND DATE OPERATIONS



In order to access the Time/Date menu, first press to I/O key.

You will hear one beep. Immediately following the beep, press 432134 in that order before the two beep prompt is heard.

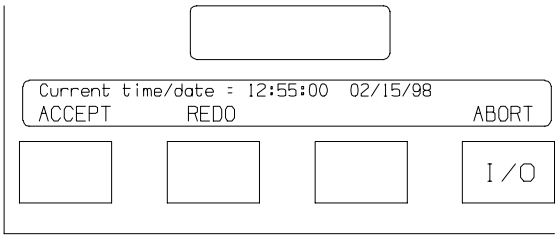
The Time and Date menu will appear. If it doesn't, turn the unit off and start over.



To raise or lower the date or time, press + or –.

Pressing SELECT allows the cursor to move to the next number for selection. Pressing ABORT abandons the operation.

Once the date and time are changed, press SELECT to advance to the next parameter.



Pressing ACCEPT will accept the above Time/Date and return to the main menu.

Pressing REDO will start the time process over again. Pressing ABORT will cancel all changes and return to the main menu.

ADDENDUM A

SUPPLEMENTAL INFORMATION TO TORQUE TESTER OPERATION MANUAL

1. Proper usage of external transducers with the torque analyzers.

a. Make all connections to cables and transducers prior to powering up the system.

b. Perform the necessary preload (if applicable to transducer range used; recommended for units with full scale ranges of less than 500 lbf–in).

c. At "Unload transducer for zero offset," prompt, allow transducer to stabilize or "warm–up" for a period of 5 to 10 minutes. The exact time period can be noted by observing the "real time" offset reading shown on the big LCD display. Once this reading has stabilized to + or – 1 display count, then the unit is ready for use.

d. Select ACCEPT to establish the new zero offset value and continue to lower menus to operate the unit as desired.

2. Proper configuration of RS–232 communications with the torque analyzers.

a. Use supplied modular cable and/or connectors to establish the hardware link to the external serial device or computer. Be sure to make all necessary connections to the analyzer port prior to powering up the unit.

b. Configure the external serial device or computer to receive information in the following format:

DATA TRANSFER RATE: 9600 Baud
NO. DATA BITS: . . . . . 8 Bits
PARITY: . . . . . NO Parity
NO. STOP BITS: . . . . . 1 Bit
ABBREVIATION: 9600 8–N–1
DATA CODE: . . . . . ASCII Format

c. This configuration is usually accomplished in hardware by configuring a "bank" of DIP switches within the device or by selection of jumper settings (i.e. serial printers). Personal Computers are usually configured to match this format by using a software setup for the particular program that is being used to gather the incoming data (i.e. Windows or spreadsheet programs)

d. Once configuration is complete and all software setups have been initialized then the torque analyzer can download its data in memory to the external device. Note that only data stored in the torque unit can be downloaded through the RS–232 port of the analyzer. No "online" downloading is possible with the units.

e. Using the MEMORY function of the analyzer, the user can redirect the OUTPUT to an EXTERNAL device instead of the INTERNAL mini impact printer (See page 5 supplied with each unit). The analyzer will assume the external device is ready for data transfer and the data will be "dumped" to the RS–232 port regardless of a physical connection. There is no "handshaking" protocol or bi–directional transfer of information during this process. If the external device is ready and waiting when the EXTERNAL prompt is displayed and selected on the analyzer's menu, then the information will be properly transferred.

EXPLANATION OF SECOND ORDER CALIBRATION ALGORITHM (CURVE FIT)

The use of a second order equation for a curve instead of relying on a strict linear representation improves the accuracy of the analyzer by fitting the response of the transducer used more closely than by conventional means.

This method also enhances the serviceable life of any transducer since, after calibration, any nonlinearities from wear, stress, creep, etc. will be compensated in software not in hardware. Out of specification conditions can be corrected much easier through calibration instead of transducer repair. The idea of allowing a user to calibrate an otherwise nonlinear transducer can be envisioned.

Most equipment using mV/V relationship transducers rely on very linear devices and in most cases very tight linear specifications are costly to design and manufacture. Now with the ability of the analyzer to compensate for imperfections in transducer design and production, the restrictions and limitations of transducer types may be loosened.

For a simplified explanation of how the algorithm works, we must get involved in some basic mathematical equations. For mV/V relationship transducers (strain gage types) there are two parameters that we are primarily concerned with: output voltage (V) and torque (T).

These parameters are what the analyzer uses to represent a value to a user. To represent the linear relationship of these two parameters we can present a graph showing each parameter on an axis (as shown).

The first order representation of a line in these two dimensions is:

T= mV + b, where "m" is the slope of the line and "b" is a constant (the y intercept vertical crossover).

m, the slope can be thought of as

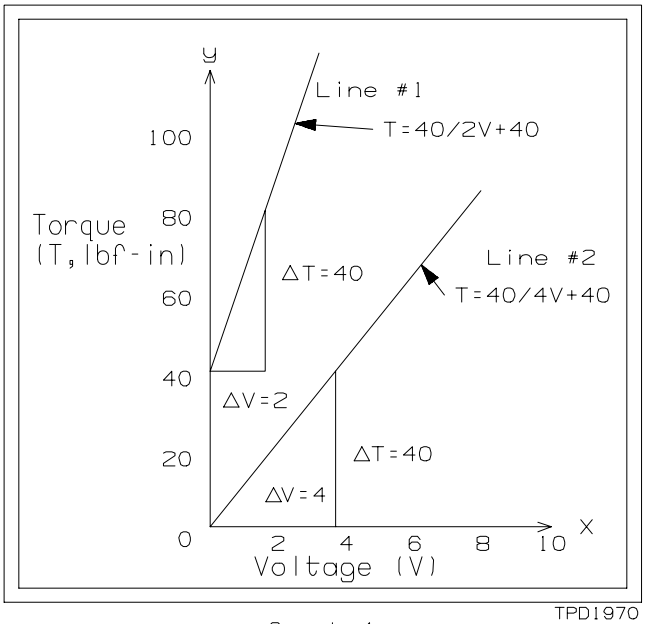
$$\frac{\text{the change in T}}{\text{the change in V}} = \frac{\text{"rise"}}{\text{"run"}}$$

The second order representation of a line in these dimensions is:

T a V + mV + b, where "m" and "b" are as before but "a" is an added coefficient.

This added coefficient "a" (second order term), is a nonlinear term that is responsible for the "curve–fitting" of nonlinear inputs into the system. If the relationship is ideally linear, this term will be zero and the equation will be reduced to the 1ST order shown above.

A graph illustrating the concepts of a line is shown below.



Graph 1

Line #1 shown with a slope, m=40/2 or m=20, with a y-intercept of 40.

Line #2 is shown with a slope, m=40/4 or m=10, with a y-intercept of 0.

Thus, in the real world where there are inconsistencies of part manufacturing, age, etc., there will be the case where this "2nd order" term "a" is not zero and relying on a strict linear relationship will not be within the allowable tolerance limits.

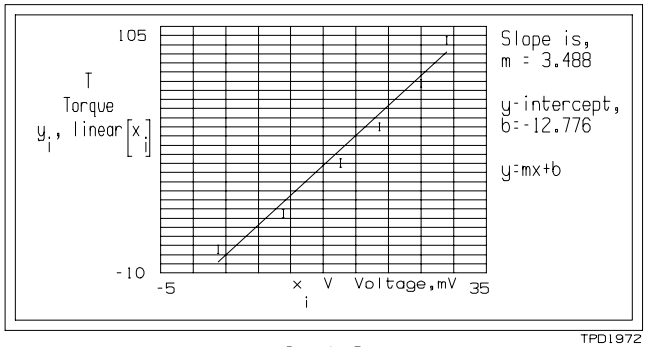
	TORQUE (lbf-in)	VOLTAGE (mV)
1	0	2
2	20	10
3	40	17
4	60	22
5	80	27
6	100	30

TPD1971

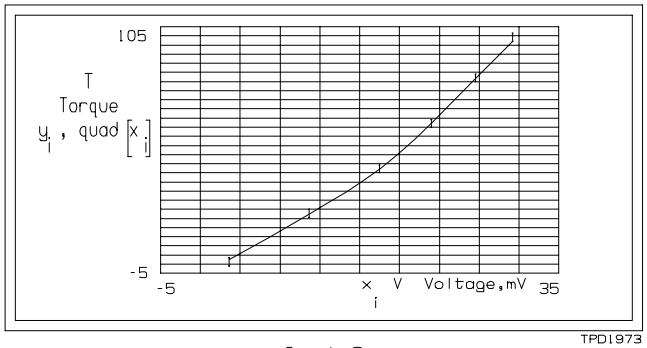
Chart 1

The following graphs will illustrate the differences in curve representation of typical real world transducer responses. The data points used are fictional, but the characteristics are real. Six data points are used just as within the analyzer.

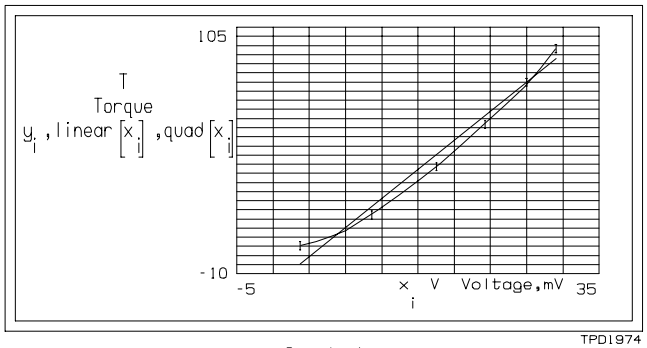
Chart 1 presents the Torque and Voltage coordinates. Graph 2 shows the data points and a linear approximation (least square method) for the given data. The data represents a common occurrence in transducer responses: a "bowing" effect in readings can be seen from the lower and higher points. The linear representation tries to fit as best as possible to all the data, but is obviously inaccurate at the end-points and toward the middle ranges.



Graph 2



Graph 3



Graph 4

Graph 4 superimposes the two representations together for comparison.

The linear representation outlined previously illustrates mathematically how lines are defined. The examples shown are strictly for clarification of the differences between a linear or 1st order approximation and a curve-fitted 2nd order approximation. This linear representation shown NOT to be confused with the analyzer's method of linear fitting transducers. This will be briefly explained here to clear up any confusion concerning this function of the analyzer.

When utilizing the EXTERNAL transducer port, the analyzer will be expecting calibration information concerning the type of transducer that is physically connected to the unit. This information resides within the Special External Transducer box, known as the "S.E.T. Box", which is part of the cable assembly.

The "S.E.T. Box" contains a rewriteable form of memory (EEPROM) that stores, 1) the calibration information, 2) maximum range, 3) the working unit system(s), 4) over torque information of the transducer, and 5) the serial number of the cable assembly (transducer).

When an external transducer is used with the torque analyzer, the information obtained from reading this memory chip will determine which calibration method is used. If the transducer has been "dead weight" tested and calibrated, then the unit will

utilize the 2nd order curve–fitted calibration coefficients for determining displayed torque information.

If the "LINEAR" or "Quick Calibration" method of calibration is used for the external device then only 1ST order, linear calibration coefficients will be used. Under normal function of the analyzer the actual method used will appear to be transparent to the user. The user will be able to determine the method of calibration only in the CALIBRATION MODE of the analyzer.

This "LINEAR" method of external calibration strictly bases the calibration of the transducer on the supplied information given to the torque analyzer in the CALIBRATION MODE of the analyzer. Within this CALIBRATION MODE of the analyzer is a SETUP function that requires the following information: 1) Full Scale Range of the transducer, 2) Unit systems(s), 3) mV/V relationship of the unit, 4) bridge resistance in ohms.

From this information the unit will calculate the 1ST offer coefficients of a line mathematically. One added piece of information needed to calculate these coefficients is the transducer's raw voltage offset when no load is applied to the unit (this is the y–intercept explained previously). The unit will prompt the user to "unload the transducer" to determine this offset. Once this is done the 1ST order coefficients can be calculated (essentially all that is calculated is the slope of the line). All this information is stored in the EEPROM of the "S.E.T. Box" for later use in the normal operating mode of the analyzer.

If the transducer is "dead–weight" calibrated, and the "LINEAR" method is used to recalibrate the external transducer, then the 2ND order, curve–fitted information will be overwritten and lost until a re calibration is done (or vice–versa is also true).

The linear approximation will also be symmetrical about the y–axis.

This means the transducer will be assumed to exhibit identical characteristics in the clockwise and counterclockwise direc–tions. In most cases this assumption will not be true due to offsets of mechanical hysteresis and transducer manufacturing and errors will be evident.

Further information will be supplied defining the maximum deviations allowed for the 2ND order, curve–fitted approximation to "linearize" the external transducers.

SUPPLEMENTAL INFORMATION

FIRST–PEAK/MEMORY PARTITIONING

PEAK / FIRST–PEAK DATA CAPTURE OPTION

After an internal or external transducer is selected and at the "Choose operation mode" prompt (selecting the type of reset function), a menu will appear when AUTO–RESET or MANUAL–RESET is selected. This menu is shown below.

Select peak capture mode: Peak
_____
Peak 1ST Peak SELECT

This menu is to enable the analyzer to capture the peak torque of a tool or joint in two different ways. The current mode is shown on the first line of the prompting display. When the SELECT button is pressed, the shown mode will be activated for either the AUTO– or MANUAL–RESET data taking modes.

When "Peak" mode is selected, the torque displayed by the analyzer is the highest peak torque captured by the transducer (internal or external) during the test operation. The unit will hold the highest reading until a higher value is input or until the unit is automatically or manually reset.

When "1ST Peak" mode is selected, the torque displayed by the analyzer is the first peak that is encountered during the test operation. The first peak is defined as a peak that has traversed a X% decrease from the maximum point captured. All other subsequent higher values above the first peak will be effectively "filtered" and not shown on the display once the first peak is established. However, the analyzer will still monitor the transducer for overtorque situations to warn the user of possible mechanical damage.

The first peak mode is useful for cam–over or click style torque tools that utilize a slipping mode of final torque indication. The first highest peak is captured instead of possible subsequent false torques.

Configuring the X% for the 1ST peak function is done using the Calibration Menu function of the unit. Reviewing this function, access to this menu is obtained by entering the key sequence of "1234" during the power on sequence. The menu will appear as shown.

Choose transducer to calibrate
_____
INTERNAL EXTERNAL CONFIG EXIT

The CONFIG selection will access the X% setup.

Set 1st peak threshold percentage 10%
_____
+ – SELECT

Pressing "+" will increase the percentage value and "–" will decrease this value. A finite range of 1% to 10% is fixed. When the desired percentage is shown, pressing SELECT will record this value for usage in the operating mode of the analyzer. Pressing EXIT will return the unit to the normal operating mode.

MEMORY PARTITIONING FUNCTION OUTLINE

When in AUTO– or MANUAL–RESET operation modes. the prompt screen will indicate the memory condition the unit is currently in.

"SET#=OFF" and "SAVED=OFF", indicates that the analyzer memory function is currently not in use.

"SET#=XXX" and "SAVED=XXX" indicates that the memory function is activated where XXX is an integer.

The "SET#" is the data set or partition number and the "SAVED" number is the number of saved data values within the data set #. SET# can range from 1 to 256 and SAVED can range from 0 to 999.

There are some limitations to these ranges. however. The memory is mapped into 30,000 bytes of space maximum. 18 bytes is used for each partition's header information. 2 bytes are used for each stored reading. Thus if all 256 partitions are used, then 49 readings can be saved in each partition maximum. Other calculations can be done to find the desired combination of partitions and maximum readings allowed given the above information.

To activate the memory function while in the AUTO– or MANUAL–RESET data taking modes, press the MEMORY button. The following menu will appear.

Choose memory function
_____
START STOP CLEAR–MEMORY OUTPUT

For memory partitioning functions, the START and OUTPUT functions have been updated to support the new functions. The other functions of the memory prompt remain the same.

To begin saving readings to a memory partition, press START. The testing direction prompt will be shown. Select CW for the Clockwise or CCW for the Counterclockwise testing direction. If the last partition was closed (STOP used) or if this is the first partition being opened, then the Tool ID entry menu will be shown.

Enter tool ID: SET#:001
_____
+ – NEXT ENTER

This menu is used to enter the tool ID of the memory partition or data set number shown in the upper right corner, SET#:001. This ID is just the name attached to the data set number 001. The ID can be a code of up to 10 digits, alphas, numerals, punctuation, special symbols. 0 to 10 spaces may be used to define the tool name. + will increment through all characters. – will decrement though all characters. NEXT will rotate to the next digit. ENTER will accept the current ID shown.

When ENTER is pressed then the next available partition will be opened for entry of new data values.

The AUTO– or MANUAL–RESET mode menu will display the current memory condition. "SET#=001" and "SAVED=000" indicates data set number 1 (one) is open and ready for readings with 000 values currently stored. By automatically or manually accepting readings the 'SAVED' value will increase.

When the last desired reading is stored in memory and if the partition needs to be closed then select MEMORY and STOP to end all data entry info the partition. It is not possible to re–enter data values into a closed partition. Once the record is stopped, it cannot be reopened to append to the partition. If it is desired to re–enter data to the partition, then do not STOP the memory mode. Use EXIT instead to escape out of the data taking mode. This will keep the partition open, so upon re–activation of the memory function, appending is possible.

The OUTPUT function of the memory mode also has some improvements. One menu has been added to this function. When in AUTO– or MANUAL data modes and MEMORY is selected and OUTPUT is selected and either INTERNAL or EXTERNAL is selected the following menu will appear.

Select data set number/range 001–XXX
_____
+ – NEXT ENTER

This menu will determine the individual or range of data set numbers or partitions to print. The cursor will default on the first data set number.

XXX will denote the last partition or data set number saved to memory.
+ will increase the set numbers.
– will decrease the set numbers.
NEXT will toggle between the beginning and end set numbers, ENTER will output the shown range to the internal printer or external serial port.

BATTERY CHARGING UPDATE PROCEDURE

NEW FEATURES

• The battery charging function has been changed to improve the reliability of the NiCad battery pack.

• The following operational procedure will be used to charge the analyzer:

1. The unit can be TURNED ON or OFF in order for charging to occur.

2. The function of the LED on the side of the unit has changed. With this modification, it may or may not light up when the charger is plugged in. This is normal. The LED's new function is to indicate when the unit is charging, NOT THAT CHARGING IS COMPLETE.

3. Manual removal of the charger plug from the unit is NO LONGER NECESSARY when charging is complete. The LED will indicate this point and be OFF.

4. A Manual RESET BUTTON has been added to the unit on the left side next to the charger jack. This button may be used to initiate the charging process and will reset both the system and the charging circuit.

OPERATIONAL PROCEDURE

• The following prompt will be displayed when the battery pack needs to be charged.

Batteries are very low,
_____
Plug in battery charger NOW! EXIT

If the charger is not plugged in when this prompt is shown and EXIT is pressed, the analyzer will turn OFF to conserve the power that is left. There is a 30 second "time–out" from the time this menu is displayed to automatically power down if no keys are pressed.

• If the charger is plugged in, the analyzer will sense that the charger is present and will begin the charging process automatically. Continued analyzer use can occur during the charging process.

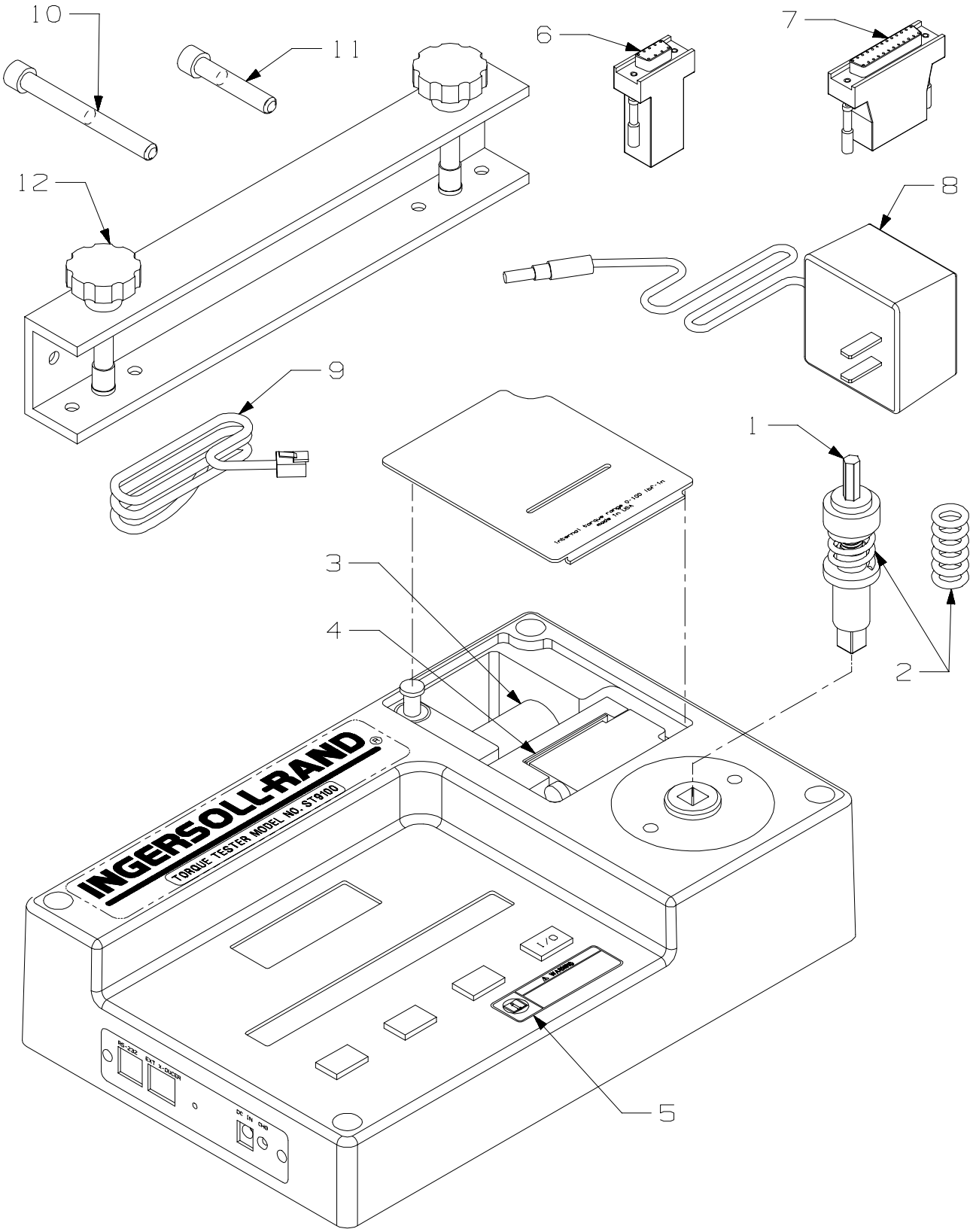
• It is OK to leave the battery charger plugged in to the analyzer. This will allow an automatic charging process to occur. The unit will determine that the batteries are low and automatically charge the battery with no user interruption while the unit is ON or OFF.

• If the battery has discharged well below the beginning charge threshold, it may be necessary to force a charger on condition by first plugging in the charger then pressing the RESET BUTTON on the left side of the unit. The charger LED will illuminate and charging can occur. Let the unit charge for a few minutes, then try to turn the unit on again to see if the battery has reached a safe operating level.

• If the battery is very low (less than 5.0 VDC, for the 6 cell pack), then the unit may continually BEEP in the startup mode or power down by itself. The battery pack will need to be replaced if a normal operating mode cannot be obtained with the charger plugged in.

• It is now possible to operate the unit without a battery at all. If this is desired, remove the battery (note warranty may be void if unauthorized entry into the unit is performed), plug in the charger and press the RESET BUTTON on the left of the unit. The unit should be able to power up and function normally.

Electronic Torque Tester
Model ST9100



(Dwg. TPA1639)

PART NUMBER FOR ORDERING

1	Rundown Adapter Spring Assembly (includes Hard and Soft Draw Simulator Springs)	ST9100–800
2	Simulator Spring	
	Hard Draw	ST9100–801
	Soft Draw	ST9100–802
3	Paper Roll	ST9100–816
4	Printer Head	ST9100–817
5	Warning Label	WARNING–10–99
6	9–pin Connector	ST9100–814
7	24–pin Connector	ST900–813
8	120 Volt Charger	ST9100–803
9	Computer Attachment Cable	ST9100–815
10	Socket Head Cap Screw (3) (5/16" x 3.00")	ST9100–818
11	Socket Head Cap Screw (5/16" x 1.75")	ST9100–819
12	Mounting Bracket Assembly	ST9100–812
*	Carrying Case	ST9100–804
*	3–1/2" Disk (2)	ST9100–810
*	Battery Pack	ST9100–820
*	Printer Ribbon	ST9100–821

* Not illustrated.

NOTES