

# MODEL 960

TRANSIENT RECORDER INSTRUCTION MANUAL

Software Version 0.5-u+

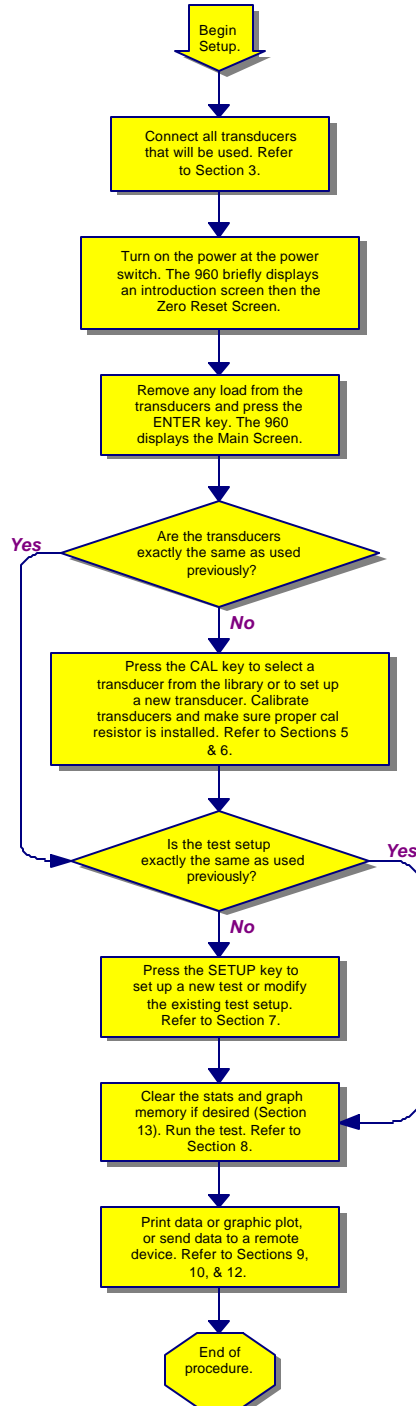


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TABLE OF CONTENTS

<b>1.0 EQUIPMENT.....</b>	<b>5</b>	<b>12.0 USING FASTPLOT FOR WINDOWS.13</b>	
<b>2.0 OVERVIEW.....</b>	<b>5</b>	12.1 START FASTPLOT FOR WINDOWS.....13	
<b>3.0 CONNECTIONS.....</b>	<b>5</b>	12.2 UPLOAD PLOT DATA FILES.....14	
<b>4.0 POWER UP.....</b>	<b>6</b>	12.3 NUMERIC DATA.....14	
<b>5.0 TRANSDUCER SELECTION/SETUP...7</b>		12.4 PLOT DATA.....14	
5.1 STANDARD ROTARY TORQUE OR TORQUE- ANGLE SENSOR.....7		12.5 M-ALPHA PLOTS.....15	
5.2 CUSTOM TRANSDUCER.....7		12.6 STATISTICAL PLOTS.....16	
<b>6.0 TRANSDUCER CALIBRATION..... 8</b>		12.7 EXIT FASTPLOT.....17	
6.1 AUTOMATIC CALIBRATION..... 8		<b>13.0 DELETING DATA.....17</b>	
6.2 MANUAL CALIBRATION..... 8		<b>14.0 M-ALPHA ANALYSIS..... 18</b>	
6.3 CALIBRATION MENU SUMMARY ..... 8		14.1 M-ALPHA OVERVIEW.....18	
<b>7.0 TEST SETUP..... 9</b>		14.2 M-ALPHA ANALYSIS PROCEDURE.....18	
<b>8.0 RUN THE TEST &amp; RECORD DATA.....11</b>		<b>15.0 USING 960 DATA WITH LABMASTER DEMO PROGRAM..... 19</b>	
<b>9.0 STORING DATA.....11</b>		<b>16.0 INSTALLATIONS OF SOFTWARE UPGRADE..... 19</b>	
<b>10.0 PRINTING/UPLOADING DATA.....12</b>		16.1 HYPERTERMINAL METHOD.....19	
<b>11.0 NOTE ON FILE TYPES.....13</b>		16.2 PORTUP METHOD ..... 20	
		<b>17.0 ADDITIONAL UTILITIES.....21</b>	
		<b>18.0 BATTERY USE &amp; RECHARGING ..... 21</b>	
		<b>19.0 HANDLING.....21</b>	
		<b>20.0 SPECIFICATIONS ..... 22</b>	

## Model 960 Quick Setup Guide





# MODEL 960 RECORDER

*Congratulations on your purchase of a Model 960 Transient Recorder. Please review and follow these Quick Setup Instructions as you put your instrument to use. Since these instructions are brief by design, it is recommended that you read the full instruction manual prior to operating the equipment for the first time. In the event that you have problems or questions, please contact our customer technical support department by phone (+248-888-8260), fax (+248-888-8266), or email (info@rstechltd.com).*

## 1.0 EQUIPMENT

Please review the packing list to ensure that you have received all of the equipment that was shipped from the factory. Depending on your order, it may include any or all of the following (\* indicates option at extra cost):

- ▲ Model 960 Recorder
- ▲ Serial Cable (9-position)
- ▲ Model 960 Software
- ▲ Battery Charger Module
- ▲ Carrying Case w/Strap
- ▲ Calibration certificates for instrument and transducer(s)
- ▲ Torque-Angle Sensor(s)\*
- ▲ Fastener Force Washer(s)\*
- ▲ Clamp Force Load Cell(s)\*
- ▲ Transducer Cable\*
- ▲ Load Cell Cable\*
- ▲ Transducer Junction Box\*
- ▲ FastPlot for Windows Software\*

In the event that some equipment is missing or damaged, please contact the freight carrier, your customs broker, and the RS Technologies factory.

## 2.0 OVERVIEW

There are 5 basic steps to using the Model 960 as follows:

1. Connect transducers and power up the instrument (refer to Sections 3 and 4).
2. Select or define transducers and calibrate them (refer to Sections 5 and 6).
3. Review or modify test parameters (refer to Section 7).
4. Record data (refer to Section 8).
5. Store, print or upload data (refer to Sections 9 & 10).

## 3.0 CONNECTIONS

Torque sensors are usually connected to Channel 1; force transducers are usually connected to Channel 2. Some applications make have a second torque sensor connected to Channel 2 or a force transducer connected to Channel 1.

In addition, some applications may require the use of a transducer junction box to connect and calibrate a transducer. The junction box is connected to the appropriate channel of the instrument, and the transducer is then connected to the junction box along with the associated calibration resistor.

A local printer (HP DeskJet-compatible) can be connected to the 25-position parallel port. The 9-position serial port is used to connect the Model 960 to a remote computer to upload recorded data or download a program update.

## 4.0 POWER UP

Use the following procedure to power up the Model 960.

1. Turn on the Model 960 using the “rocker-style” power switch located on the lower front end of the instrument. The instrument briefly displays an introductory screen and software program version number. **NOTE:** Record this program version number for use when contacting RS Tech for technical support.
2. The instrument then displays the currently selected set of transducers (these may have already been set up for you at the factory). With no load on the transducers, press the ENTER key to proceed. Note the arrangement of the Main Screen when it is displayed. Refer to Figure 1.
  - ▲ At the top are the torque, force, and angle data fields, an indicator for rotation direction, and peak or track mode, and the engineering units.
  - ▲ At the center left is the real-time plot area that shows threshold, test target, and scaling for the X and Y axes.
  - ▲ At the center right are the test statistics, including low, median, high, sigma, Cpk, and number of recorded cycles stored in stats or “results” memory.
  - ▲ At the lower left is the test status indicator. “Ready” indicates the 960 is ready for the next test; “In Cycle” indicates a test is underway; “Done” indicates the test is complete.
3. Designate the engineering units of measure that will be used for the testing for both channels. To do so, press the SETUP key to access the Setup Menu. Once this menu is displayed, press the 2 key to toggle through the available selections. Once you have made your selection, press the ESC key to return to the Main Screen.
4. As you toggle through the available selections, note that your choice here will also designate the corresponding units for Channel 2 as relating to either torque or force. Refer to the table that follows.

Selection	CH1 Units	CH2 Units
Lbft CH2-Force	Lbft	Lbs
Lbin CH2-Force	Lbin	Lbs
ozin CH2-Force	Ozin	Lbs
Nm CH2-Force	Nm	N
KNmm CH2-Force	kNm	N
Kgcm CH2-Force	Kgcm	kg
Kgm CH2-Force	Kgm	kg
Lbft CH2-Torque	Lbft	Lbft
Lbin CH2-Torque	Lbin	Lbin
Ozin CH@-Torque	Ozin	Ozin
Nm CH2-Torque	Nm	Nm
kNm CH2-Torque	kNm	kNm
Kgcm CH2-Torque	Kgcm	Kgcm
Kgm CH2-Torque	Kgm	Kgm

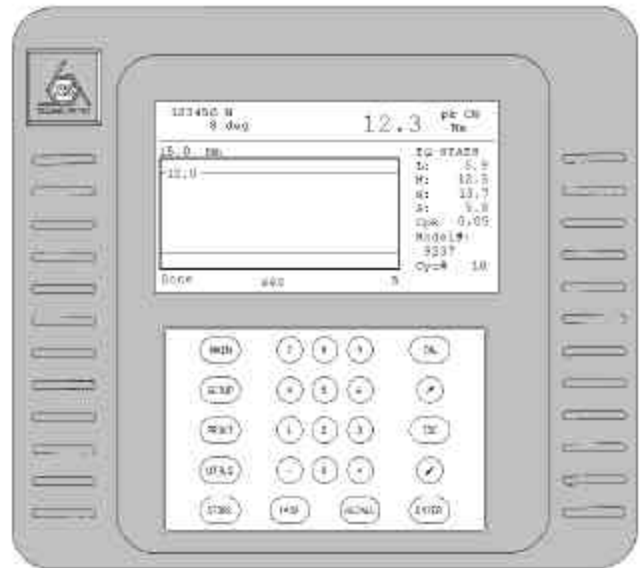


Figure 1. Model 960 Front Panel

## 5.0 TRANSDUCER SELECTION/SETUP

If you are using a standard RS Technologies torque or torque-angle sensor, you can select it from the on-board library of transducers and then calibrate it. Refer to Sections 5.1 and 6.0.

If your transducer is not in the library, you will enter the transducer information as one of the five additional “custom” transducers that you can add to the library. Refer to Section 5.2.

### 5.1 STANDARD ROTARY TORQUE OR TORQUE-ANGLE SENSOR

If you are using a standard rotary torque or torque-angle transducer or a transducer that has already been setup in the 960, use the following procedure.

1. Press the CAL key to access the Calibration Menu and press the 4 key.
2. Cycle through the available selections using the arrow keys until the sensor you will be using is highlighted.
3. Press the ENTER key and the Model 960 displays the Set Channel Precision screen that lets you enter the calibration value of the transducer and the number of places after the decimal.
4. Use the up and down arrow keys to move between these parameters, enter the correct calibration value for the transducer and set the display precision as desired.
5. When the settings are correct press the ENTER key to save your settings, then press the ESC key to return to the Calibration Menu.
6. Perform a calibration as described in Section 6.

## 5.2 CUSTOM TRANSDUCER

Use the following procedure to set up a non-standard or “custom” transducer for use with the Model 960.

1. From the Main Screen, press the CAL key.
2. To set up a “custom” transducer for use on Channel 1 press the 5 key; to set up a “custom” transducer for use on Channel 2, press the 8 key.
3. On the Define Tool Menu use the up and down arrow keys to move between the following parameters:
  - ▲ Trans No (1-5). Enter the number (1-5) of the custom transducer that you want to define and the Model 960 displays the current data for that selection.
  - ▲ Model No. Enter up to 5 digits to identify the transducer.
  - ▲ F.S. Tq (*units*). Enter the full scale capacity of the transducer.
  - ▲ CAL Tq (*units*). Enter the calibration value of the transducer.
  - ▲ Pulses Per Rev (Channel 1 only). Enter the number of pulses per revolution for the transducer. Enter 0 if the transducer does not have angle.
4. Press the ENTER key to save your changes.
5. Press the ESC key to return to the Calibration Menu and perform a calibration as described in Section 6.

### NOTE

Be sure to perform a calibration before starting any tests.

## 6.0 TRANSDUCER CALIBRATION

The factory recommendation is to perform a calibration each time the instrument is powered-up. Allow 2 minutes warm-up time for the transducers before performing the calibration. If the transducer uses the internal calibration resistor, use the automatic calibration method; if an external load will be used for the calibration (such as a deadweight torque calibrator), or an external calibration resistor is used with a junction box, use the manual calibration method.

### 6.1 AUTOMATIC CALIBRATION

Use the following procedure to calibrate the transducer you selected or setup as described in Section 5.

1. Press the CAL key to display the Calibration Menu.
2. Press the 2 key to perform an automatic calibration.
3. If two transducers are enabled for use, you are prompted to select which transducer you want to calibrate by pressing the 1 key to select the Channel 1 transducer or the 2 key for the Channel 2 transducer.
4. When prompted remove any load from the transducer and press the ENTER key. The instrument takes the zero reading, performs its scaling factor adjustment using the internal calibration resistor, and, when successful, returns you to the Calibration Menu.
5. If needed, calibrate your second transducer or press the ESC key to return to the Main Screen.

### 6.2 MANUAL CALIBRATION

Use the following procedure to perform a manual calibration of the Model 960.

1. From the Main Screen, press the CAL key to display the Calibration Menu.
2. Press the 3 key to perform a manual calibration.
3. If two transducers are enabled for use, you are prompted to select which transducer you want to calibrate by pressing the 1 key to select the Channel 1 transducer or the 2 key for the Channel 2 transducer.

4. When prompted, remove any load from the transducer and press the ENTER key. The instrument takes the zero reading and prompts you to apply the calibration load.
5. Either apply the load to the transducer or, if using a junction box, press and hold the CAL button on the junction box while you press the ENTER key on the Model 960. Either way, the instrument performs its scaling factor adjustment and returns you to the Calibration Menu.
6. If needed, calibrate your second transducer or press the ESC key to return to the Main Screen.

### 6.3 CALIBRATION MENU SUMMARY

The following is a summary of the Calibration Menu selections.

- ▲ Press the 1 key to zero out the input channels. It is recommended that you do this occasionally when you are running a lengthy series of tests.
- ▲ Press the 2 key to perform an automatic calibration (see the procedure in Transducer Calibration below).
- ▲ Press the 3 key to perform a manual calibration (see the procedure in Transducer Calibration below).
- ▲ Press the 4 key to select a transducer from the library for use with Channel 1. Refer to Section 5.1.
- ▲ Press the 5 key to set up a custom transducer (one not in the library) for use on Channel 1. Refer to Section 5.2
- ▲ Press the 6 key to enable or disable Channel 2.
- ▲ Press the 7 key to select a transducer from the library for use with Channel 2. Refer to Section 5.1.
- ▲ Press the 8 key to set up a custom transducer (one not in the library) for use with Channel 2. Refer to Section 5.2.
- ▲ Press the 9 key to enter the serial numbers of the transducers that will be connected to the Model 960.

## 7.0 TEST SETUP

Use the following procedure to set up a test on the Model 960.

1. Press the SETUP key to select the Setup Menu. Then press the 1 key to set the torque limits. Refer to the following descriptions when setting the torque limits.

- ▲ **Cycle Start** is the threshold value the instrument uses to start recording data and is typically set to a value about 10-20 percent of the expected peak. Refer to Figure 2.
- ▲ **Cycle End** is used to stop recording once the torque value falls below the value entered here and is set to a value below Cycle Start. Refer to Figure 2.

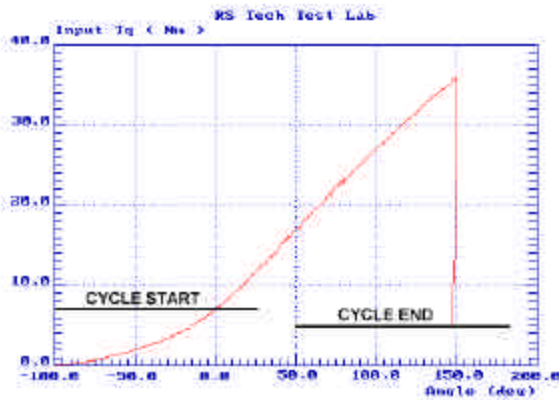


Figure 2. Cycle Start

- ▲ **Cycle End Time** is the amount of time that the torque level must remain below Cycle End for data recording to stop (this is used for tool verification when multi-stage tightening strategies are used. Refer to Figure 3.
  - ▲ **Low Torque, Target Torque, High Torque** are used to help scale the graph area of the Main Screen and to calculate the torque data statistics.
2. Before exiting the limits screen, be sure to press the ENTER key to save any changes, and then press the ESC key to return to the Setup Menu.
  3. Press the 2 key to toggle through the engineering units selections as described previously in Section 4, Step 3.
  4. Press the 3 key to switch between CW and CCW direction.

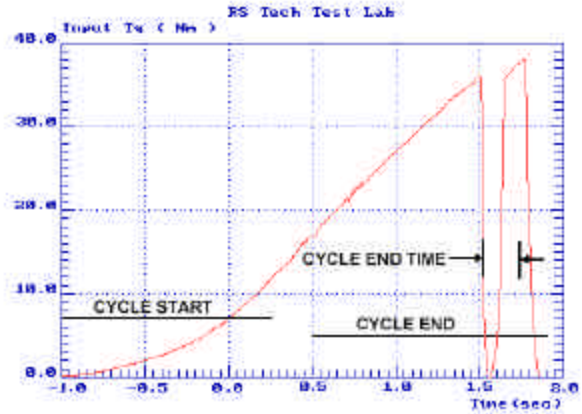


Figure 3. Cycle End Time

5. Press the 4 key to select between TWOWAY and ONEWAY for angle measurement. Most applications require the TWOWAY selection. The ONEWAY selection is used only for special testing that requires the angle measurement to move in the positive direction no matter which way the transducer turns (CW or CCW).
6. If recording versus a time basis (not vs. angle), press the 5 key to review the time recording parameters as follows:
  - ▲ **Full Scale** sets the duration of the test in seconds.
  - ▲ **Advance Time** sets aside a portion of the full scale time to record data prior to the Cycle Start torque being reached.
  - ▲ **Auto Reset**, when enabled (Auto Reset is set to 1), automatically resets the instrument for the next test after an amount of time that you designate. When disabled (Auto Reset is set to 0), you have to press the MAIN key to make the instrument ready to take data.
7. Press the ENTER key to save any changes, and then press the ESC key to return to the Setup Menu.
8. If recording versus angle (not vs. time), press the 6 key to review the following angle recording parameters and change as needed.
  - ▲ **Full Scale** sets the duration of the test in degrees of rotation.
  - ▲ **Advance Angle** sets aside a portion of the test data to record data prior to the Cycle Start torque being reached.

- ▲ **Auto Reset**, when enabled (Auto Reset is set to 1), automatically resets the instrument for the next test after an amount of time that you designate. When disabled (Auto Reset is set to 0), you have to press the MAIN key to make the instrument ready to take data.
9. Press the ENTER key to save any changes, and then press the ESC key to return to the Setup Menu.
  10. Press the 7 key to access the special analysis parameters as follows.

▲ **Lower Tangent Torque** is used for M-Alpha joint analysis process (see Section 14). This parameter sets a value as a percentage of the peak torque recorded during the test for use in determining the tightening angle, which is related to the relative clamping force in the joint. Refer to Figure 4. The tightening angle is included on the numeric data printout. Typical values are in the range of 60 to 80 percent. Enter 0 if you want to disable this feature.

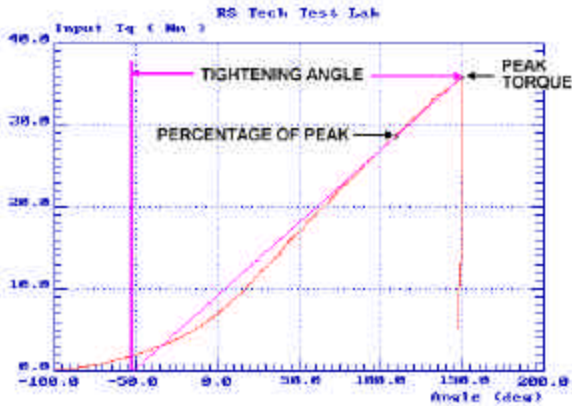


Figure 4. Tightening Angle for M-Alpha Analysis

- ▲ **Pulse Window Type** is used only when conducting the test using an impulse-type tool. This parameter sets a window at the beginning of data recording in which the data is ignored. This will avoid having any torque spikes related to impulse tool startup recorded as the peak torque. The window can be set as a factor of time or angle of rotation (depending upon your recording base). Enter 0 if you want to disable this feature.
11. Press the ESC key to return to the Setup Menu.
  12. Press the 8 key to define a set of Channel 2 values (typically tension) at which the 960 will return Channel 1 values (typically torque). Entering 0 will disable a data point and all of the data points that follow it.
  13. Press the ESC key to return to the Setup Menu.
  14. Press the 9 key to enable or disable the Model 960's ability to read the ID chip of RS Technologies transducers that are so equipped. If set to ON, the Model 960 will look for the ID chip whenever a calibration routine is selected. If the ID chip is found the pertinent information will be read from the chip and entered into appropriate data registers on the Model 960. If set to OFF, the Model 960 will not look for the ID chip and all calibration information will have to be entered into the instrument manually.
  15. Press the ESC key to return to the Main Screen.

## 8.0 RUN THE TEST & RECORD DATA

Use the following procedure to run the test and record data.

1. Select either the Peak or Track display mode by pressing the TASK key. When the instrument is in the Peak display mode, a “pk” indicator is displayed on the upper line of the Main Screen. The Peak mode displays the peak or maximum values recorded for torque, angle, and clamp load during the previous test. The Track mode displays the current readings for torque, angle, and clamp load.

### NOTE

The message displayed in the lower left-hand portion of the Main Screen indicates the status of the Model 960: when it reads “Done” the instrument has finished the last cycle and is waiting to be reset for the next test; when it reads “Ready” it has been reset for the next test and is ready to record data (once the torque input rises above the Cycle Start level); when it reads “Incyt” the instrument is recording data.

2. Press the MAIN key to reset the instrument from the “Done” state to the “Ready” state. If the **Auto Reset** feature has been enabled (see Section 7, Step 6 or 8), the instrument will automatically switch to the Ready state.
3. Observe the graphing area of the Main Screen. The Cycle Start and the Target Torque levels are indicated. As torque is applied to the fastener (or load is applied to the Channel 1 transducer), the increasing input level is displayed. When recording data using electric tools, this will be a fairly straight line; when recording data obtained using “pulse-type” tools, the line may be less distinct.
4. After three cycles are recorded and saved to results memory, the statistics on the right hand of the screen are updated following each recorded cycle. The statistics include the low torque, the median torque, the high torque, the standard deviation, and the Cpk value. Below the stats is a display of the model number associated with the transducer on Channel 1 and the number of cycles stored in memory.

## 9.0 STORING DATA

Press the STORE key to reach the Store Menu. In this menu you can do the following:

- ▲ Store the numeric peak data for the current rundown by pressing the 1 key (Store Limit Results).
- ▲ Store the graphic data for the current rundown by pressing the 2 key.
- ▲ Enable or disable the **AutoStore** feature by pressing the 3 key (for numeric data) or the 4 key (for graphic data). Selecting this feature will let you avoid having to perform the manual store routines described above. AutoStore is recommended when you are certain that you want to save the test data without having to manually make the instrument ready to take data. Some users may choose to enable auto-storing the numeric data but disable auto-storage of the plot data to conserve memory. In those cases, when you get a graph that you want to store, then you can store the plot manually.

Current storage capability of the Model 960 is approximately 500 numeric rundowns and 20 graphic rundowns. The AutoStore feature stores the data away automatically after each rundown is complete.

## 10.0 PRINTING/UPLOADING DATA

Use the following procedure to print the numeric and graphic data from the Model 960.

1. Press the PRINT key to print or upload the data stored in the Model 960. You have the following options:

- ▲ Press the 1 key to print all of the numeric peak data stored in memory to a local printer attached to the parallel port. The printer can be a HP DeskJet-compatible printer. The data can also be uploaded and saved on a computer via the optional FastPlot software (refer to Section 12). The data can then be printed out on a local or network printer that is accessible by the computer.
- ▲ Press the 2 key to print the current graphic plot data to the local printer attached to the parallel port. Recommended is a HP DeskJet compatible printer. The printing selections may include the following:
  - ◆ 1) Channel 1 versus time
  - ◆ 2) Channel 1 versus angle
  - ◆ 3) RPM versus time
  - ◆ 4) RPM versus angle
  - ◆ 5) Channel 1 and angle versus time
  - ◆ 6) Channel 1 and Channel 2 versus time
  - ◆ 7) Channel 2 and Channel 2 versus angle
  - ◆ 8) Channel 2 versus Channel 1

- ▲ Press the 3 key to upload the numeric data results to a remote computer via the serial port.
- ▲ Press the 4 key to upload the numeric data results to a remote computer via the serial port in a quote (") delimited file format.
- ▲ Press the 5 key to upload the graphic data of the current rundown to a remote computer via the serial port (also refer to FastPlot for Windows instructions).
- ▲ Press the 6 key to upload the graphic data for all stored rundowns to a remote computer via the serial port (also see FastPlot for Windows below).

### Note

When printing graphic data, the instrument displays an intermediate screen showing the available selections. After pressing the key corresponding to the desired selection, the instrument then displays the plot on its screen.

2. Press the PRINT key to send the plot to the printer or press the ESC key to return to the Select XY Plot menu.
3. Press the ESC key to return to the Main Screen.

## 11.0 NOTE ON FILE TYPES

There are two file types that the Model 960 uses to store and upload its data. This is particularly important when uploading data to a remote computing device and when opening the uploaded file. The file types are as follows:

- ▲ The \*.RPT file, or numerical data reports file
- ▲ The \*.RST file, or graphic plot data file

A file with the \*.RPT extension is used to store the numeric results of the tests you run and the statistical summary data for the test. This file contains some information about the test, the peak recorded values, statistics, and related data. The file is created when you upload the data to a remote laptop or desktop computer using FastPlot for Windows (refer to Section 12) and is given a filename during the upload process. Numeric data can be uploaded in a fixed width format or in a delimited format. The data may then be opened for printing or further analysis by another applications, such as a word processor or spreadsheet.

XY plot data can be stored in the Model 960 and uploaded to a remote laptop or desktop computer using the FastPlot for Windows utility (available from RS Technologies, Ltd.). It is stored in the computer in a file with the \*.RST extension and contains all of the data points taken during a test. It can be used with FastPlot for Windows to generate and print graphs. Unlike the \*.RPT file, which only holds a few select points, such as the peak torque, peak angle, etc., the \*.RST file hold every sample obtained during the course of the rundown.

## 12.0 USING FASTPLOT FOR WINDOWS

Use the following procedure to start and use FastPlot for Windows. This procedure assumes you have installed the software on the computer by running the *setup.exe* file located on the installation diskettes.

### 12.1 START FASTPLOT FOR WINDOWS

Click on the FastPlot icon on your desktop or select FastPlot from the Program Group in which you have installed the program. The initial FastPlot screen looks like that shown in Figure 5 below.

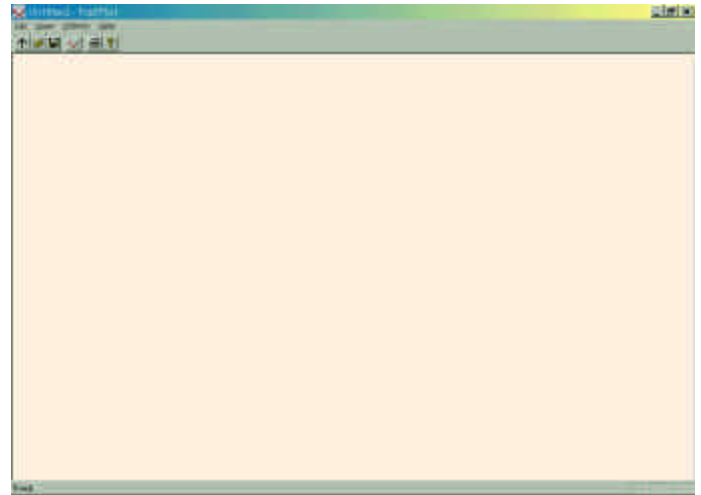


Figure 5. FastPlot for Windows Screen

Note the following parts of the screen:

- ▲ The **Title Bar** at the top of the screen that identifies the application on the left and provides the *Minimize*, *Full Screen/Window*, and *Exit* buttons on the right.
- ▲ The **Menu Bar** below the **Title Bar** that gives you access to the *File*, *View*, *Utilities*, and *Help* menus.
- ▲ The **Button Bar** below the **Menu Bar** that provides the *Upload*, *Open*, *Save*, *Draw*, *Print*, and *Help* functions. These functions are used as follows.
  - ◆ The Upload button (Up Arrow) lets you upload data from the Model 960.
  - ◆ The Open a saved file for FastPlotting button (Open Folder) lets you open an existing plot file.
  - ◆ The Save As button (Diskette) lets you save the current open file under a new name.
  - ◆ The Setup and Draw Graph button (Line Graph) lets you display the currently opened plot file.
  - ◆ The Print button (Printer) lets you print the plot that is currently displayed.

## 12.2 UPLOAD PLOT DATA FILES

When using a Model 960 recorder, it is often desirable to upload the numeric data or XY plot data files. Use the following procedure.

1. Connect the serial port of the computer to the serial port of the Model 960 using a 9-socket to 9-socket serial cable.
2. Make sure the correct com port is selected on the computer by clicking on the *Utilities* button and selecting the proper port.
3. To upload a file from the Model 960, click on the Upload button in FastPlot. Then press the Print key on the Model 960 and press either the 3, 4, 5, or 6 key to upload the desired results or graph file. The Model 960 will send the desired data to the computer which then displays a *Save As* dialog box. Use standard Windows methods to select a directory in which to store the file and assign a filename. You also have the option of clicking on the Cancel button to skip saving the file.
4. Depending upon the type of file that was uploaded, FastPlot displays either a WordPad window showing the stats report (if stats report was uploaded; refer to Section 4.0) or a Graph Details dialog box (if graph data was uploaded; refer to Section 5.0).

## 12.3 NUMERIC DATA

Once you have uploaded a numeric data file, the program displays the data file in a window using the NotePad text editor application. You can then edit the data if desired. To print the data, simply click on the Print button to send the displayed graph to the printer.

## 12.4 PLOT DATA

Once you have uploaded a XY plot file, the program displays a dialog box that you can use to name the file and save it, as well as to view and print the data.

1. In the Graph Details dialog box (refer to Figure 6), you have the following options:
  - ▲ Select the Y-Axis set of data (unavailable selections are grayed out).
  - ▲ Select a second Y-Axis set of data.
  - ▲ Select the X-Axis set of data.
  - ▲ Enter an appropriate Title.

- ▲ If more than one plot is stored in the file, select either a multiple plot or a single plot. For multiple plots, you may specify which plots to display (i.e., 1-5 or 1,2,4,5 etc. as shown in Figure 7). If desired, you can specify an amount of offset for multiple plots in units of the X-axis data.

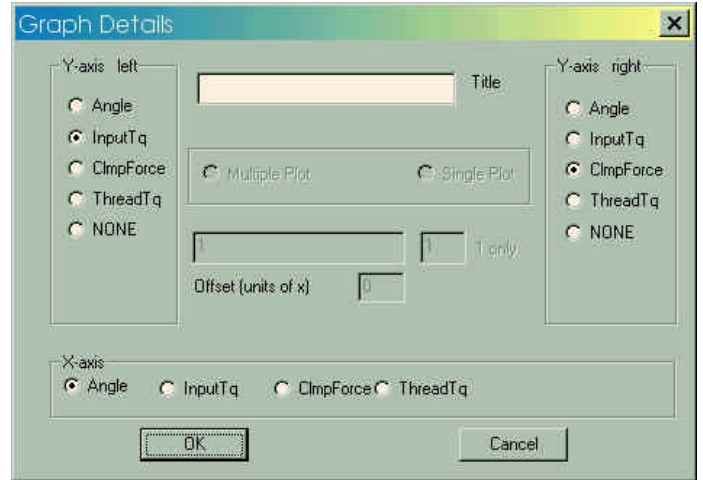


Figure 6. Graph Data Dialog Box, Single Plot

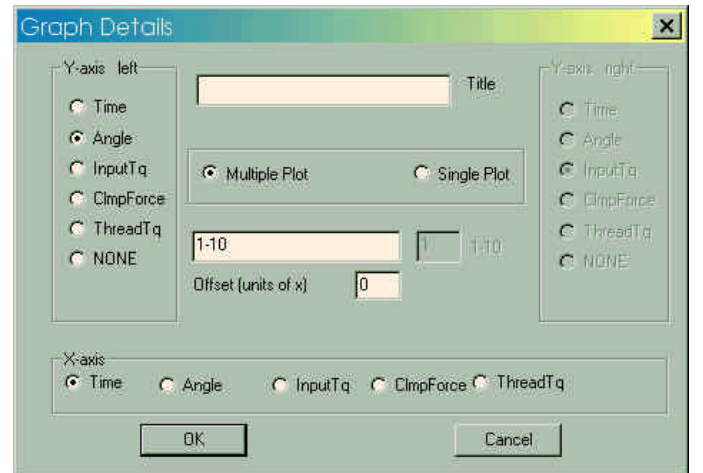


Figure 7. Graph Data Dialog Box, Multiple Plots

2. When the proper selections have been made, click on the *OK* button and FastPlot displays the data.
3. To select a different set of data for display, click on the Setup and Draw button and rearrange your selections.
4. To “zoom in” on a portion of data, click and drag a box around the desired section of the plot using the mouse. When you release the mouse button, FastPlot rescales the plot accordingly. To zoom back to the

original configuration, click on the Setup and Draw button and click on the *OK* button.

5. Click on the Print button to send the displayed graph to the printer.
6. To view a file that was previously stored, click on the *Open* button or select *Open* from the *File* menu.
7. Use the *Graph Details* dialog box as discussed previously to select how you want to view the data.
8. When you have selected the type of graph you want to plot, click on *OK* and FastPlot draws the graph as shown in Figure 8 below.

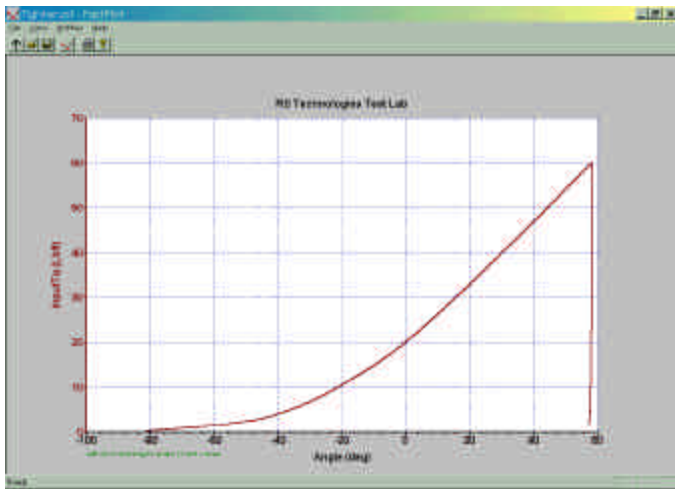


Figure 8. Plotted Data

9. If you want to zoom in on a section of the graph, click and draw a box around the desired portion of data, as shown in Figure 9, and the program zooms in to the desired selection, as shown in Figure 10. You may then draw another box to zoom in further, or click on the *Draw* button to go back to the original view or reconfigure your view of the data.

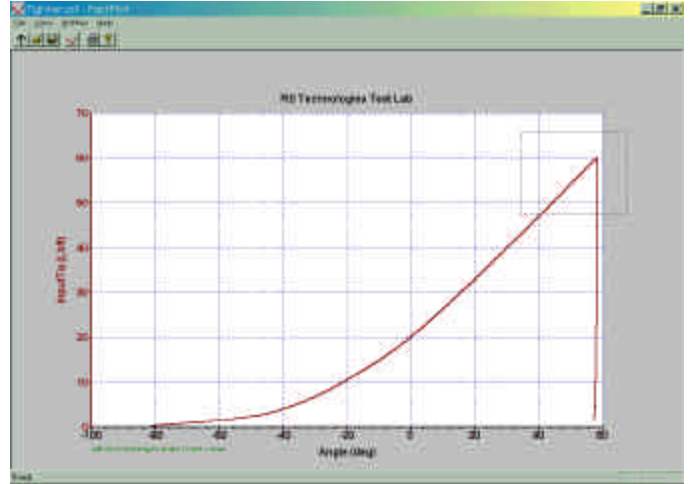


Figure 9. Zoom In Data

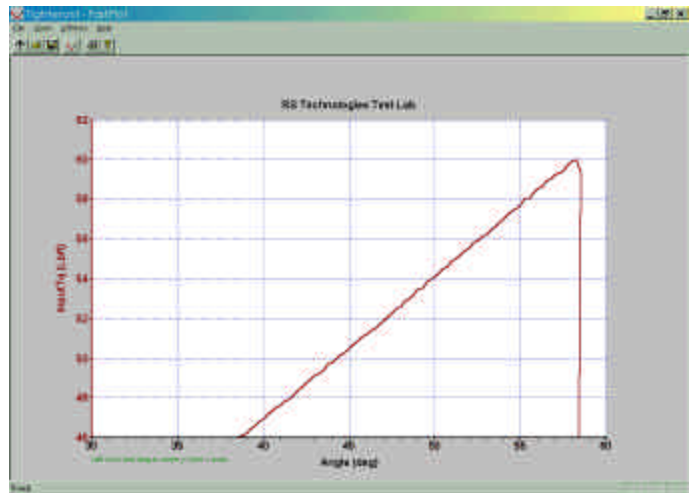


Figure 10. Zoomed In Graph

10. You can print the graph by clicking on the *Print* button.
11. You can select another file to plot using the *Open* button or by selecting *Open* from the *File* menu.

## 12.5 M-ALPHA PLOTS

To assist in determining the tightening angle for M-Alpha audits, FastPlot will display a M-Alpha plot. To do so, select Input Torque for the Y-axis and Angle for the X-axis on the Graph Details window. Then click on the Alpha Plot selection box as shown in Figure 11. This selection will enable you to select a pair of points along the linear tightening zone of the torque-angle curve through which FastPlot will draw a straight line back to the 0 torque level. You can use this plot to calculate the tightening angle for the joint.

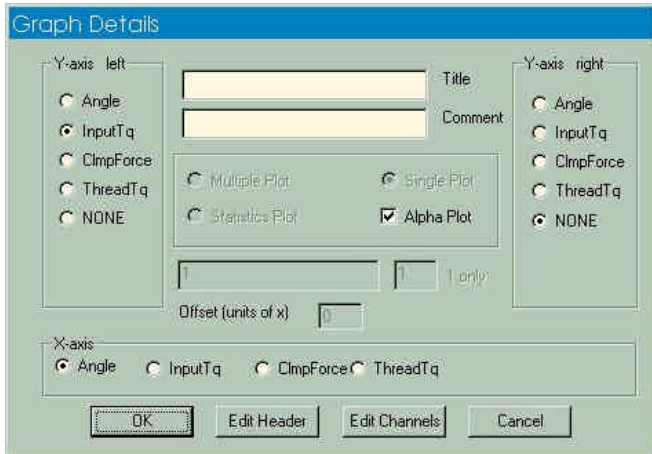


Figure 11. Alpha Plot Selection

After you make the Alpha Plot selection, FastPlot displays the Alpha Plot Parameters window as shown in Figure 12.

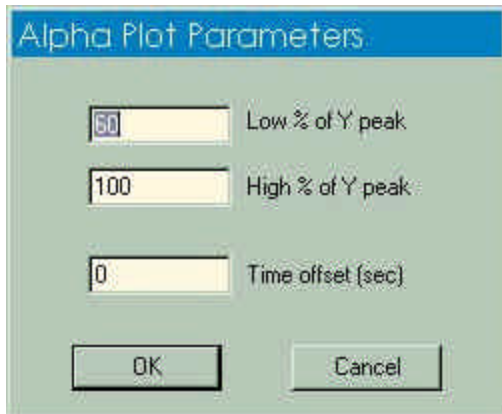


Figure 12. Alpha Plot Parameters

There are two important entries that can be made in the Alpha Plot Parameters window: the Low % of Y peak and the High % of Y peak. These points will be used to construct the M-Alpha plot. Depending on the slope of your torque-angle curve the low point should usually be selected as between 60-90% of peak torque. The high point is usually at or near to the 100% point. Once you have entered these values click *OK* and the Graph Details window is redisplayed. When you click *OK*, FastPlot will draw your M-Alpha plot as shown in Figure 13.

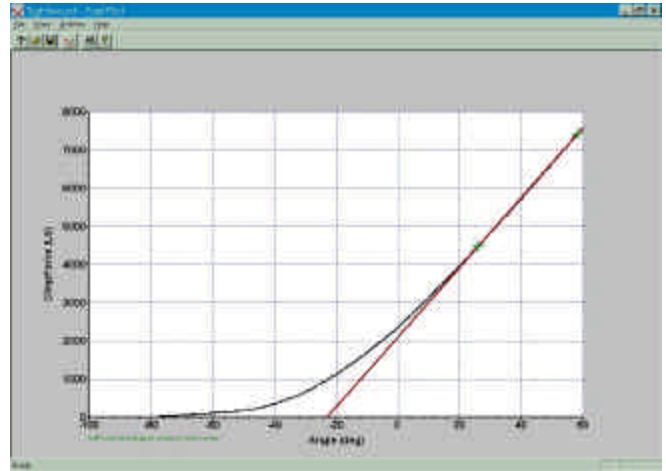


Figure 13. M-Alpha Plot

Using this plot you can determine the Tightening Angle for your rundown. The tightening angle represents the amount of fastener rotation that goes into actually clamping the assembly together. Add up the amount of angle from where the straight line intersects the zero torque level to where tightening stops. In the example shown in Figure 9, the tightening angle would be 80 degrees (-22 plus 58 = 80). If you know the angle-tension coefficient for this joint, you would then be able to accurately estimate the tension in the joint. In this case, the angle-tension coefficient has been determined as 94 lbs. of clamp force per degree of tightening angle. Thus, 80 degrees of tightening angle X 94 lbs/degree = 7520 lbs. of estimated clamp load.

## 12.6 STATISTICAL PLOTS

In the case where you have multiple plots of the same joint and desire to see a statistical representation of the set of rundowns, you can make the Statistics Plot selection in the Graph Details screen. When you click *OK*, FastPlot will plot the  $\pm 3$  Sigma for the data along with the mean as shown in Figure 14.

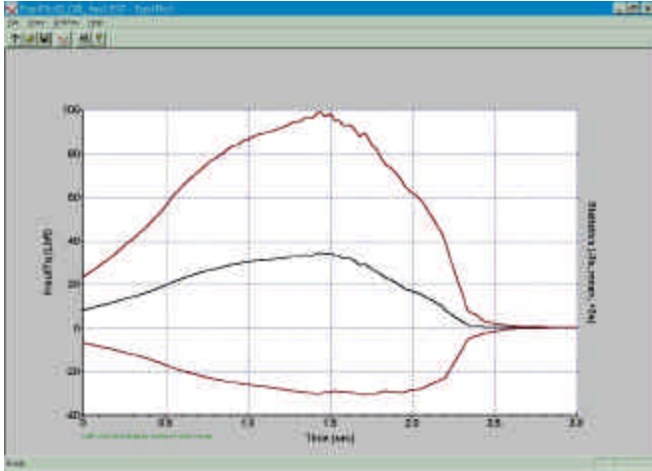


Figure 14. Statistics Plot

### 12.7 EXIT FASTPLOT

To exit you can click on the *Exit* button in the upper right corner or select *Exit* from the *File* menu.

### 13.0 DELETING DATA

Use the following procedure to clear memory.

1. Press the UTILS key to display the Utility Menu.
2. Press the 2 key to clear the memory.
3. Press the 1 key to clear the numeric results data or press the 2 key to clear the graphic plot data.
4. Press the ESC key twice to return to the Main Screen.

## 14.0 M-ALPHA ANALYSIS

The Model 960 is ideal for threaded fastener joint analysis. One of the best tools is our patented M-Alpha analysis that lets you estimate fastener tension simply by recording and analyzing torque-angle signatures.

### 14.1 M-ALPHA OVERVIEW

There are three basic steps to conducting an M-Alpha analysis on a problematic bolted joint. The first step is to qualify the joint components by performing some preliminary tests to determine the relationship between torque, angle, and tension. Once a consistent relationship between angle and tension is established, you can calculate the angle-tension coefficient in terms of tension per degrees of turn. Finally you can audit the assemblies and estimate the tension on the fastener by analyzing the torque-angle curve.

### 14.2 M-ALPHA ANALYSIS PROCEDURE

Use the following steps to conduct an M-Alpha Analysis using the Model 960.

1. Using your Model 960, rotary torque sensor, and clamp force sensor run a series of torque-angle-tension tests. Make sure that you have set the Lower Tangent Torque properly as described in Section 7.0, p. 10. After the tests are done, print out the numeric and graphic data.
2. Examine the torque-angle graphs to determine if you are recording data in the elastic clamping zone. This means that the slope of the torque-angle curve is a straight line leading up to the final torque being reached. A bend or curve in the line means that embedment or thread strip or some other factor is adversely affecting the joint.
3. Examine the numeric data and locate the data listed in the column labeled *Elas Pk*. This is the tightening angle or the amount of turn of the fastener that went directly into clamping the parts together.
4. To determine the angle-tension coefficient, divide the average tension by the average tightening angle (*Elas Pk*). The result will be in terms of force vs. degrees. For example, if your average tension is 7500 N and your average tightening angle is 40 degrees, your angle-tension coefficient is 187.5, meaning for every degree of turn, 187.5 N of clamping force is generated.

5. Subsequently, when you conduct torque-angle audits of the bolted joint using your Model 960 and a rotary torque-angle sensor, estimate your clamp load by multiplying the resulting tightening angle (*Elas Pk*) by the angle-tension coefficient.

#### NOTE

The effectiveness of the M-Alpha analysis method is affected by yield in the fastener and by the state of friction in the joint. The presence of yield or differences in friction can produce errors in the estimation of clamp load. Slight differences in the plating finish or protective coating on the fastener may produce error as well.

## 15.0 USING 960 DATA WITH LABMASTER DEMO PROGRAM

Use the following procedure to transfer data recorded by a Model 960 recorder for graphing with the Model 9504 LabMaster Demonstration program. The LabMaster demo software can be used to graph a number of different plots, many of which can be plotted using the FastPlot for Windows software. The series of plots that LabMaster demo provides that FastPlot does not is the M-Alpha series.

1. Transfer the plot data to the remote computer by using one of the procedures described in Section 13. Make sure that you have sent the data in a \*.RST file format.
2. Start the 9504 Demo program on the remote device.
3. After the demo program is started and the Main Screen is displayed, press F6 to select the **Save/Recall Recorded Data** command.
4. Press the 2 key to select the **Recall Rundown File** command.
5. If the data was stored in the current directory, press the 1 key to select **Read Data**; if the data was stored in another directory, press the 2 key to select **Change Directory**, enter the complete path of the new directory, then press the 1 key to select **Read Data**.
6. The program displays a "Normalizing Data" message.
7. Press F7 to select the **View/Print/Plot Recorded Data** command.
8. Press the 1 key to select the **Current Rundown**.
9. Select the type of graph you want to plot. The key plot here is the M-Alpha (Torque-Angle signature with Elastic Origin), or the F-Alpha (Clamp Force-Angle with Elastic Origin).

## 16.0 INSTALLATIONS OF SOFTWARE UPGRADE

Software upgrades are installed by uploading the new software from a remote laptop or desktop computer via the serial port. Generally, Model 960 units manufactured after May, 1999 can use the HyperTerminal method; units manufactured prior to this date use the Portup Method. If the HyperTerminal method does not work, try using the Portup method.

### 16.1 HYPERTERMINAL METHOD

HyperTerminal is a utility provided with Windows 95/98/NT. Use the following procedure to install an upgrade of the Model 960 software. You will need the following equipment:

- ▲ Model 960 instrument, fully charged or powered by the battery charger.
  - ▲ Laptop or desktop computer with COM1 or COM2 available.
  - ▲ 9-position serial port cable.
  - ▲ Model 960 software upgrade diskette. It is recommended that you copy the file from the floppy diskette onto the hard disk of the computer.
1. Connect the Model 960 to the computer using the 9-position serial cable. One end connects to the serial port of the Model 960, the other to the available serial port of the computer. It is helpful to know which serial port (COM1 or COM2) that is being used.
  2. Start the HyperTerminal application on the computer. The executable file is *hypertrm.exe*.
  3. The first time you use HyperTerminal with the Model 960, you will need to set up the connection. If you have already done so, simply click on the connection icon and go to Step 7. If you haven't yet setup a connection follow Steps 4-6.
  4. HyperTerminal displays the *Connection Description* dialog box into which you enter a name for the connection and choose the icon that will be associated with the connection and placed in the HyperTerminal program group. Enter an appropriate name into the field, such as "Direct to COMX" (where X is the number of the com port), choose an icon, and then click on OK.

5. In the *Connect To* dialog box, select the communications port that you will be using in the *Connect Using* field. Make sure the port you choose is functional on your computer. Then click on OK.
6. In the *Com x Properties* dialog box that is displayed confirm the communications protocol (x = com port number). Make sure the baud rate of the com port is set to 38400, with 8 data bits, no parity, 1 stop bit, and no flow control. Click on OK.
7. With the "Caps Lock" turned on, press the "L" key on the computer repeatedly while turning on the power to the Model 960. When the computer displays the message "Ready to receive file:" you are ready to send the program upgrade as described in Step 8. However, if the computer displays several rows of "junk" characters followed by a test report, the HyperTerminal method cannot be used and you must use the Portup method instead.
8. From the Transfer menu of HyperTerminal, select *Send Text File*.
9. Using the displayed dialog box, select the Model 960 upgrade program file from the drive and/or directory in which it is stored. You will need to select "All files (\*.\*)" in the *Files of type* field of the dialog box in order to view the program filename, which typically has a file name such as *960-5g.s19*.
10. Click on the OK button. The computer begins to draw rows of dots as it uploads the program. This process will take several minutes.
11. When completed, the computer displays a message indicating it has completed a series of tests followed by the word "Done". At this time you can exit HyperTerminal.
12. Observe the message displayed on the Model 960. Follow the prompts to complete the reinitialization process.

## 16.2 PORTUP METHOD

Use the following procedure to install an upgrade of the Model 960 software. You will need the following equipment:

- ▲ Model 960 instrument, fully charged or powered by the battery charger.
  - ▲ Laptop or desktop computer with COM1 or COM2 available.
  - ▲ Serial port cable (LapLink compatible).
  - ▲ Model 960 software upgrade diskette.
1. Install the new software on the computer by placing the upgrade diskette in the A: drive, making the A: drive the current drive, and typing **INSTALL**.
  2. For example, place the diskette into the A: drive, type A: and press ENTER. Then type **INSTALL** and press ENTER.
  3. Connect the serial port cable between the 9-pin connector on the Model 960 and the desired serial port on the computer.
  4. Run the program loader utility on the computer by typing the following command:
 

```
PORTUP x filename L
```

Where:  
 X=0 for COM1 or 1 for COM2  
 Filename the name of the new software upgrade  
 L= The "L" switch must be capitalized.

For example, to load a new release with the filename *960-5g.s19* to the Model 960 using the COM1 port on the computer, enter the following:

```
Portup 0 960-5g.s19 L
```
  5. When the program load utility displays the message "waiting for portable meter," turn the Model 960 power on, or if the 960 was already turned on, cycle the power off and on. The utility will transfer the new software to the 960.
  6. When the transfer process is complete, return to the main screen by pressing the ENTER key on the 960.

### NOTE

Any transducers to be used with the 960 must be recalibrated and the test must be re-set using the SETUP menu.

## 17.0 ADDITIONAL UTILITIES

After you press the UTILS key from the Main Screen, you have the following options.

- ▲ Press 1 to reset the current data and time.
- ▲ Press 2 to clear the memory (as described above).
- ▲ Press 3 to set or change a password.
- ▲ Press 4 to select the Diagnostics Menu. From this menu you can install the default settings, change the screen contrast, and view the raw transducer inputs.
- ▲ Press 5 to enter the serial number of the Model 960 so that it is included in printouts and data uploads.
- ▲ Press the 6 key to select the Standard or GMPT mode.

### IMPORTANT NOTE

**MOST** users should use the STANDARD mode. The GMPT mode is an application used for specialized testing only. Selecting GMPT mode will prohibit certain important setup parameters used for standard testing from being displayed.

## 18.0 BATTERY USE & RECHARGING

The Model 960 is a portable instrument. It can operate for up to 8 hours on the fully charged internal battery. If it will be operated for longer periods of time, it can be operated on AC power by plugging in the charger to a suitable outlet and connecting the power cord to the 960.

### Note

If you will be conducting tests in an industrial environment where the power supply may contain electrical noise and interference, it is recommended that you operate the instrument on battery power alone. This will minimize the interference of electrical noise in acquiring data.

## 19.0 HANDLING

Please observe the precautions contained in the following paragraphs.

In general, since the Model 960 is computer equipment, take the same precautions with it as you would a portable or laptop personal computer.

Allow adequate air circulation to prevent internal heat buildup.

Do not set up or operate in close proximity to heat sources such as radiators or air ducts.

The cast aluminum housing of the Model 960 makes the instrument a durable design, but avoid situations that will induce vibration, and, of course, avoid dropping the instrument.

Since The Model 960 instrument is computer equipment, use the same cleaning routine as you would for a personal computer. The Model 960 is not watertight so do **NOT** let the unit get wet. Keep solvent type cleaners away from the front panel display. Care for the keypad as you would for a personal computer.

## 20.0 SPECIFICATIONS

### Torque and Force Input Channels

Input Range:.....  $\pm 2.5$  mV/V,  $\pm 4.5$  mV/V,  
 $\pm 5$  VDC or user selectable  
 Excitation: ..... 4.5 VDC or 9 VDC (standard),  
 120 ma max.  
 Resolution: ..... 16-bit  
 Non-linearity:..... 0.15% full scale  
 Frequency Response: ..... 25 kHz  
 Positive Voltage Peak Trap Circuit: ..... 7  $\mu$ s reset time  
 Peak Threshold: ..... Software Programmable  
 Peak Reset: ..... Manual or software programmable,  
 automatic reset

### Angle Input Channels

Type: ..... Quadrature A/B Track  
 Excitation: ..... 5 VDC  
 Input Frequency: ..... 1 MHz max.

### Display

Viewing Area: ..... 4.85 x 2.68 inches  
 Resolution: ..... 240 x 128, CFL Backlight

### Battery

Indication: ..... Two-stage Battery Low indication  
 Battery Life: ..... 8 Hours maximum, continuous use  
 Charge Time: ..... 3 1/2 hours, max.

### General

Temperature Range:..... 0 -70° C  
 Operation Modes: ..... Torque, Angle, or Clamp Force  
 in Track (Real Time) or Peak  
 Dimensions (inches): ..... 9.75 inches W x 8.75 inches D  
 x 2.75 inches H  
 Weight (lbs.): ..... 7.0 lbs.  
 Mating Connectors: ..... Channel 1, DB, 15 pins  
 Channel 2, DB, 15 pins  
 Parallel Port, DB, 25 pins  
 Serial Port, DB, 9 sockets

The Model 960 uses the following pinouts for connecting transducers to the DB-15 Channel 1 or Channel 2 input receptacles.

Pin	Function	Pin	Function
1	-Signal	9	+ Excitation
2	+Signal	10	- Excitation
3	GS1 (see below)	11	GS3
4	GS2 (see below)	12	GS4 (see below)
5	Analog Ground	13	Shunt
6	Transducer Type	14	Encoder A
7	Encoder 5V	15	Encoder B
8	Digital Ground		

A jumper **must** be added when wiring a connector for the Model 960 in order to scale the output of the transducer or input device properly unless the device output is  $\pm 5$  vdc.

Jumper Position	Signal Level
3 & 12	Up to 2.5 mV/V
4 & 12	Up to 4.5 mV/V
None	Up to $\pm 5$ vdc



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