Model 933A
Life Cycle Test System

Software / Hardware Manual

NOTICE

Microsoft Windows, Windows 95, Windows 98, Windows ME, Windows 2000 and Windows NT are registered trademarks of Microsoft Corporation.

The Model 933A application software operates in a graphical environment named Microsoft Windows, created by Microsoft Corporation. Microsoft Windows gives a standard look and feel to TRICOR's application as well as all other Windows applications.

In order to run the Model 933A application under Microsoft Windows, the user needs to license and install a Microsoft Windows version listed in Section 2, Getting Started.

Contents

Section 1
Introduction

Tester Description

The Model 933A Life Cycle Test System (LCTS) is a complete and ready to use piece of test equipment for the endurance testing of materials and electrical switches. The LCTS can be configured to continuously depress a test sample using a pneumatically controlled cylinder. The Model 933A is designed to measure one electrical contact with each up/down stroke according to ASTM Designation F1578 - 96. The LCTS can also be used to mechanically stress a device without a contact measurement. In this case, testing is performed at a fixed speed and there are no pass / fail results. The air pressure to the cylinder can be adjusted to control the maximum force applied to the sample and with the optional flow restrictors the rate at which this force is applied can also be adjusted. The electrical contact can be tested for resistance and also bounce. Bounce is measured using techniques described in the ASTM Designation F1661 - 96. These measurements have tolerances assigned so that the LCTS can determine the pass / fail status of each test cycle. A count is kept of all cycles, failures and sequential test failures. These counts are compared against programmed limits to stop testing at user defined events. For example, the testing can be stopped after 1,000,000 test cycles or after 100 test failures.

The basic LCTS consists of:

Controller Unit - containing the pneumatic air valves, pressure regulator, pressure gauge, air couplings, electronics module and computer data connector.

Power Module - a wall mount power source.

Test Head - consisting of the air cylinder, flexible air hose and quick disconnect air coupling (with an adjustable slide post) and mounting hardware.

Test Stand - an 8-inch base plate to which the Test Head slide post can be mounted.

Data Cable - a 20 foot cable with modular connectors on each end and a 9-pin adaptor to attach to the user's PC.

Application Software - a single software application to communicate, control and store data from the Controller Unit. This is provided on a CD.

The application software can configure all the programmable features of the LCTS including test times, resistance and bounce tolerances and maximum event counts. It has a "learn" mode for switches to automatically set test tolerances and a mode for manual operation and contact measurement. The software can be set up to store the test results to an open file. The file format is comma delimited text which is easily imported to other programs such as Microsoft Excel and Access. The text file format is directly readable by both of these programs. The configuration setup of the LCTS can also be stored and recalled from files. All test data is viewable on the main application screen. The software application will run on any of Microsoft's 32-bit Windows Operating Systems. It will not function on Windows 3.11 or earlier versions.

Section 2
Getting Started

General

This section is for new users and describes the installation and hookup of the Life Cycle Test System. The user supplied resources are discussed and verification of proper setup is provided.

User Supplied Resources

The LCTS uses shop air to drive the pneumatic air cylinder. There is a coupling on the back of the Controller Unit which will accept a standard 1/4 inch NPT quick disconnect hose coupling. The user must supply the air using a sleeve lock socket. The maximum air pressure must be limited to 150 psi. Standard pressures of 85 to 125 psi are best. The air must be clean and free of water and oil. The air exhausted from the air cylinder is expelled into the Controller Unit. Excessive liquids will build up in the Controller Unit and may cause failure. An air dryer is recommended. Only compressed air should be used. No other gasses are approved.

Controller Unit power is powered by a wall mount power source. The basic unit comes complete with an American style, 115 vac, 60 Hz module. Other variations are available from TRICOR Systems by special request. A suitable power receptacle must be located near the LCTS so that the Power Module can be connected.

User Supplied Computer

A personal computer running any 32-bit version of Microsoft Windows is required to configure the LCTS and to download test data. Any version of Windows 95, Windows 98, Windows Me, Windows 2000 or Windows NT version 4.0 can be used. The computer does not need to be located at the same sight where testing will occur, but it is much more convenient if it is. The LCTS can operate stand-alone, and can be configured at a different location. It then can be moved to the sight of the testing. The LCTS is connected to a serial port on the PC. The LCTS comes with a 20 foot cable with modular connectors on each end. One end plugs into the back of the Controller Unit. The other end of the cable plugs into the modular connector of a 9-pin D connector adaptor which is also supplied. The adapter plugs into the serial communication port of the user's PC. A special order, 25-pin version of the adaptor can be obtained from TRICOR Systems. The PC must have one active serial port available. The application software will automatically search all available ports in an attempt to locate the LCTS. The application software is delivered on CD-ROM. The PC must have a CD-ROM drive to install this software. By special request when ordering the LCTS, TRICOR Systems can provide the application on floppy disks.

Software Installation

Begin the setup process by installing the application software. This software is on the CD provided with the basic unit. Since you are viewing the manual provided on this disk it is assumed that the installation should be complete. If not, follow the instructions below.

- Close all other windows applications before starting the installation.

- Insert the 933A Software installation CD in the CD disk drive of your computer. On most systems, the installation program will begin running as soon as the computer sees the disk inserted. If not, navigate to CD file folder using Windows Explorer or My Computer. Double click the setup.exe file.

- The installer will ask you to shut down any other applications that may be running. Press the OK button if you have already closed other programs.

- A dialog box will appear which will allow you to change the location on your hard-drive where the 933 application will be stored. You may change this location if necessary, but TRICOR recommends the default setting. Press the large button (top left) on this dialog to begin the installation.

- A second dialog appears that allows the name of the program group on the start button menu to be changed. Again, TRICOR recommends that the default setting be used.

- The software installs quickly and a dialog indicating successful completion should appear. Click OK. The Life Cycle application software is now ready to use.

Test Contacts
Terminal Connection

Air Cylinder Coupling

Air Inlet Coupling

Expansion Connector

Serial Data Connector

Power Connector
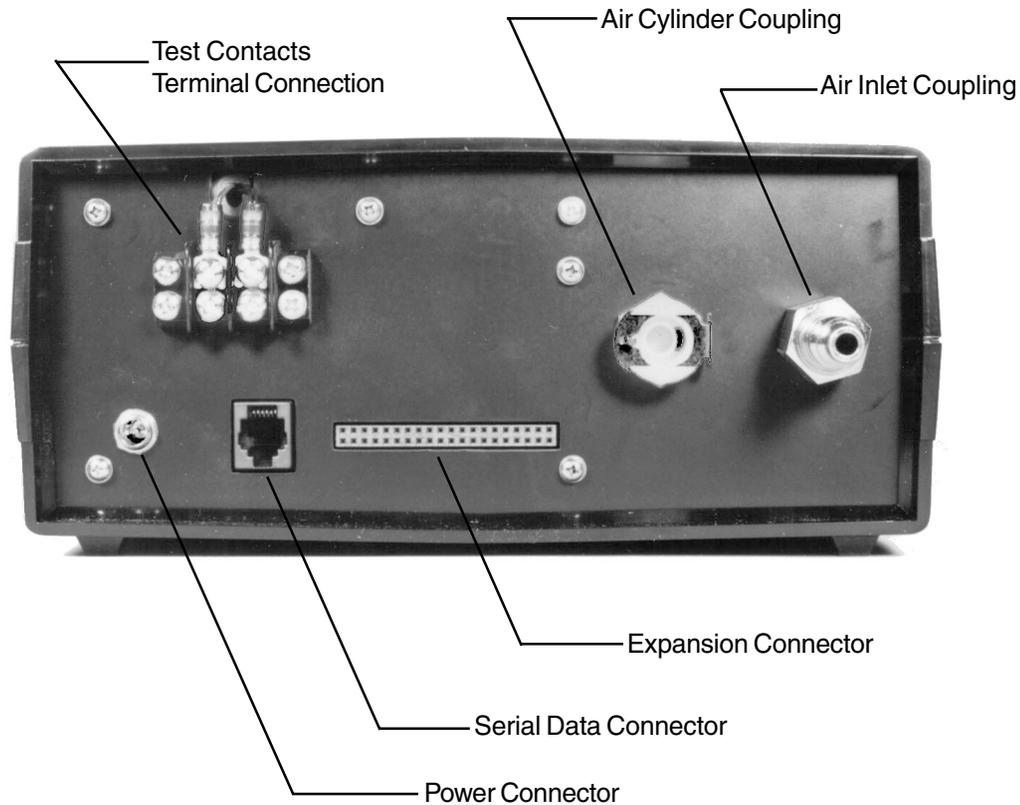
Figure 1.
Back of Control Unit

Equipment Setup

Connect a supply of air to the air inlet coupling on the back of the Control Unit (Figure 1). This fitting accepts a 1/4 NPT quick disconnect sleeve lock socket.

The Test Head is delivered mounted on the slide post. Attach the slide post to the base plate using the 1/4 x 20 screws and washers found in the mounting hardware plastic bag. See Figure 2 for details.

Connect the Test Head air hose connector to the air cylinder coupling on the back of the Control Unit (Figure 1). This connector can be released by depressing the metal thumb slide on the air cylinder coupling. This coupling/connector should be coupled together whenever power is applied to the Control Unit to prevent air from escaping. Adjust the pressure regulator on the front panel of the Control Unit for at least 40 psi on the gauge.

Connect the Power Module cable to the power connector on the back of the Control Unit (Figure 1). Plug the Power Module into a suitable power source receptacle. The Control Unit should now be powered with the power status indicator on the front of the Control Unit illuminated. See figure 3. The air cylinder should be pulled to the retracted position. The LCTS does not need a computer connected to operate. The Control Unit is shipped
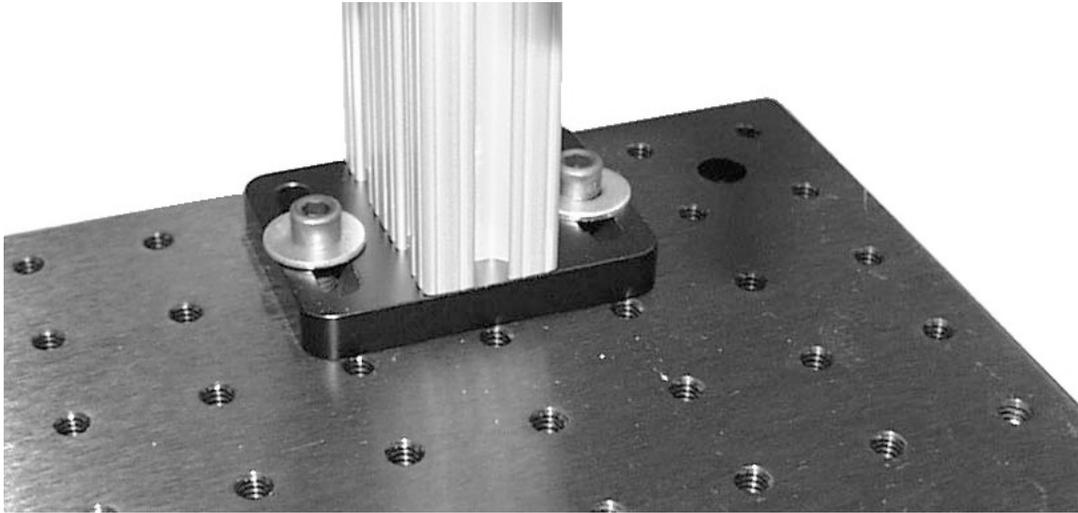
Figure 2.
Slide Post Mounted to Base Plate
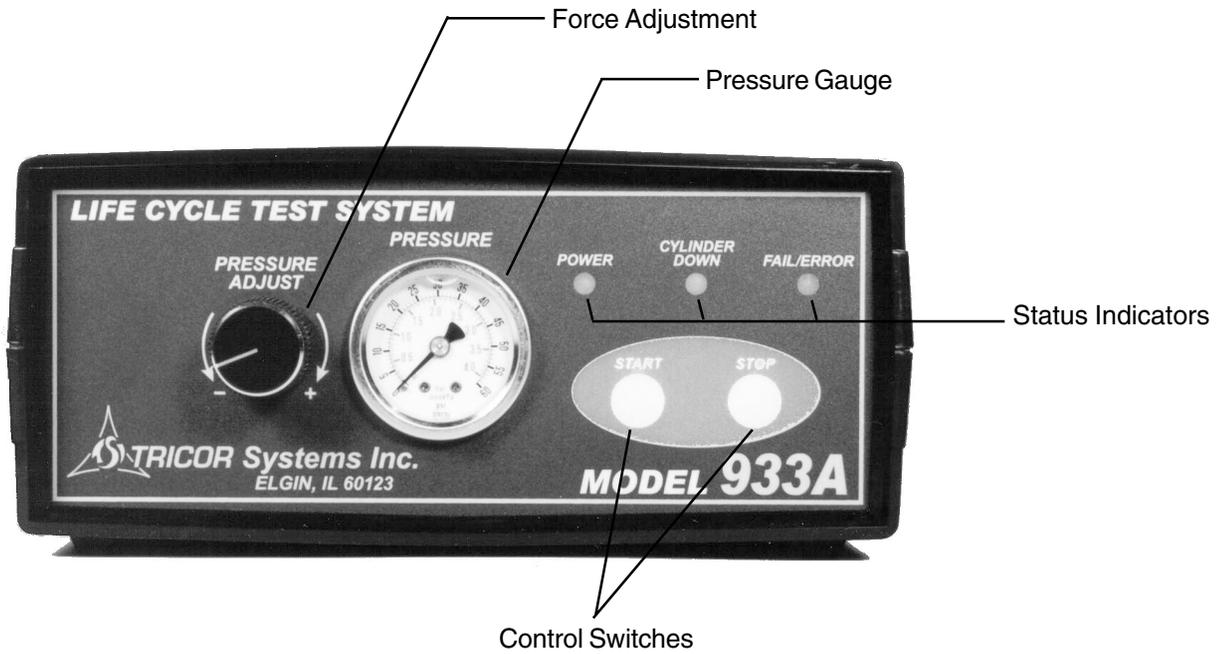
Figure 3.
Control Unit Front Panel

with a test configuration that will cycle the air cylinder 10 times per second. Press the Start button on the Control Unit to cycle the cylinder. Press Stop when satisfied that the setup is functional.

To configure the LCTS to test your specific device, it must be connected to the personal computer (PC) running the software application provided. Attach the 9-pin adaptor to either end of the 20 foot serial cable with modular connectors (both provided). Attach the other modular connector of the serial data cable to the serial data connector (figure 1) on the back of the Control Unit. Plug the 9-pin adapter into any active RS232 serial communications ports on your PC.

When the software application starts, it automatically starts searching for the LCTS on all available serial channels between COM1 and COM8. There is a status bar of information at the bottom of the main window for the application. While searching, the information will indicate what channel it is testing. When the LCTS is found, there is a brief message stating that the tester was found on a specific communication channel. The status bar will then display the serial number, resistance test range and mode, as well as the software version of the LCTS.

If the software cannot detect the LCTS, verify the serial data connection. Be certain that the LCTS is powered (power indicator illuminated). If the LCTS still cannot be detected, the serial communications ports on your PC may be suspect. Load the software on another PC and test the setup.

This completes setup of the LCTS. Review Section 3 for an understanding of how the LCTS tests switches. Read Section 4 to learn how to configure and use the LCTS using the application software.
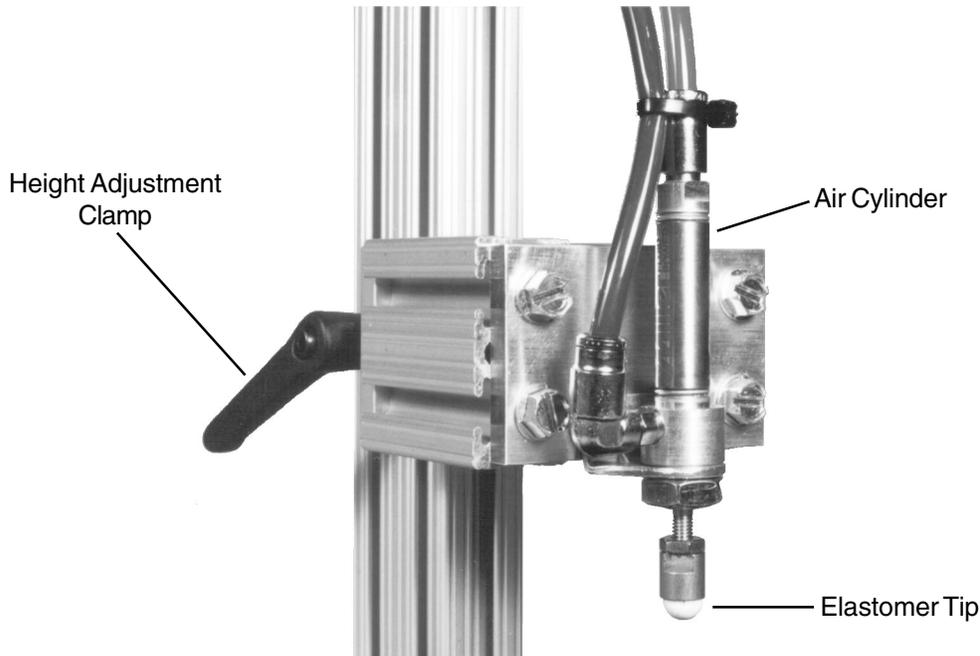
Figure 4.
Test Head

Section 3
Testing

Test Methods

The LCTS uses a single chip microprocessor for control and test measurement. Integrated into the design is nonvolatile data storage. This allows the unit to be stopped and powered down without losing the configuration information or accumulated test data. The LCTS does not retain test results for each test cycle. Instead, it keeps a running value for the minimum and maximum contact value measured.

If enabled, the LCTS measures the contact resistance and checks it against the minimum and maximum tolerances. It also keeps the maximum bounce time measured. Bounce can be optionally enabled. Typically, bounce is desired to be as small as possible. Thus, the minimum bounce time is assumed to be 0.0 usec.
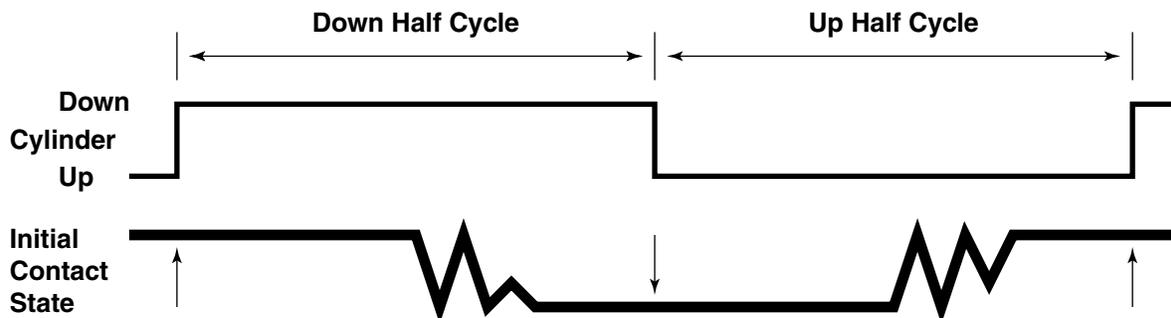
Figure 5.
Initial Contact State Testing

When any single contact measurement is made, the value is checked against the minimum and maximum contact resistance tolerances. If the value falls outside this range, the contact measurement is considered to have failed. Similarly, the bounce is checked to be sure it is less than or equal to the maximum bounce time tolerance. Exceeding this tolerance value is also a failure. There are a total of 4 possible failures for each test half cycle. The 3 specified above and the initial state of the contact (Figure 5). The initial contact state is a go / no-go test to be sure the switch contacts are in the proper state before the air cylinder even begins to actuate. For example, with a normally-open switch (NO), the contact is expected to be "open" before the air cylinder presses down on the switch. This test is performed with the same thresholds that the bounce test uses (to be described shortly). There are up to 4 failures possible on the down stroke of the air cylinder, and another 4 on the up stroke. All operations of the LCTS are symmetrical between the up and down stroke half cycles.

The LCTS does report the last up and down contact measurements and bounce times when queried. These values are displayed on the application screen and are stored in the test result file. It is possible to set the LCTS to stop after each test cycle. This allows each test cycle to have its data recorded. However, the operation will not be smooth due

to the constant transfer interruption. Also, the amount of data gathered will quickly become unmanageable. The LCTS is a life cycle tester and is <u>not</u> intended for continuous data collection.

Test Circuitry

A simplified diagram of the contact measurement circuitry is shown in figure 6. The contact is measured using a precision 1.00 KOhm pullup resistor to a 5 volt power source. The switch contact is arranged between this resistor and ground. A 10-bit analog to digital converter is used to measure the voltage across the switch contacts. This type of measurement yields a nonlinear voltage verses resistance characteristic. This approach has advantages and disadvantages. Advanced calculations must be performed to generate the equivalent resistance from the measured voltage, but this is easily accomplished by the PC running the application software. The Model 933A never needs to make this calculation. The real advantage of this test technique is the resolution enhancement that it provides on the low end of the resistance range. The scale is compressed downward. This provides a greater resolution to the "closed" circuit condition while also yielding an extended dynamic range. The resolution at the top end of the scale becomes very coarse, but at least very large resistance values can still be measured.
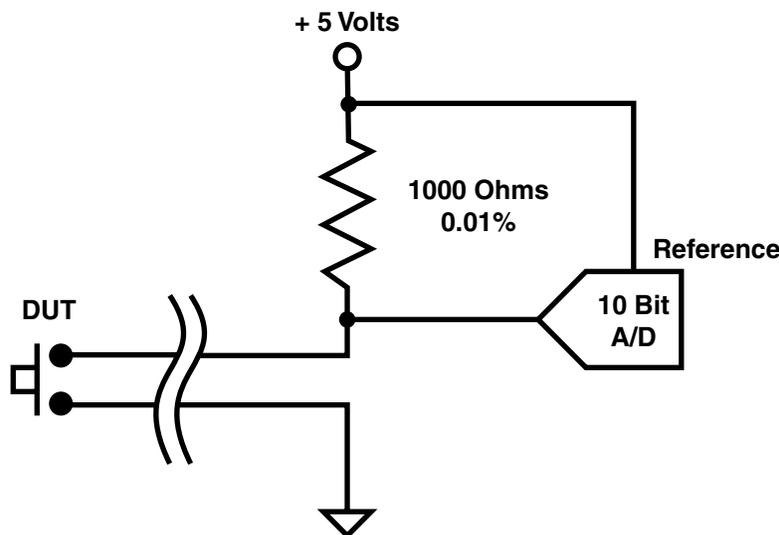
Figure 6.
Simplified Contact Measurement Circuitry

Bounce Measurement

The Model 933A measures the electrical contact bounce according to the methods described in the ASTM Designation F1661 - 96. This testing is optional, and can be disabled in the failure analysis if not required. It should be noted that the LCTS does not monitor nor directly control the actuation speed of the device under test. This speed can

directly affect the results of bounce testing. The maximum air pressure used to actuate the air cylinder and the adjustment of the air flow restrictors (optional and not part of the basic LCTS) will affect bounce measurements as well as overall test speed. Consider these variables when making bounce measurements. Slower test speed results in longer bounce values.

Figure 7 illustrates the voltage measured across a typical normally open contact as it is actuated. The open circuit voltage is 5.0 volts for the LCTS since the contact has a 1.0 KOhm pullup load to a 5 volt source. When actuated, the voltage will typically drop to near 0.0 volts. The ASTM designation calls out 2 threshold voltages, the *specified upper transition voltage* (SUTV) and the *specified lower transition voltage* (SLTV). The bounce time is measured from the initial point where the measured voltage (V_m) falls below SLTV until the last time V_m transitions below SLTV after exceeding SUTV. The LCTS allows the adjustment of SLTV and SUTV to meet the requirements of the device being tested. The allowable range is 0 to 5 volts. SUTV can not be set below SLTV. The LCTS application software displays these thresholds as voltage, resistance and a percentage of the open circuit voltage.
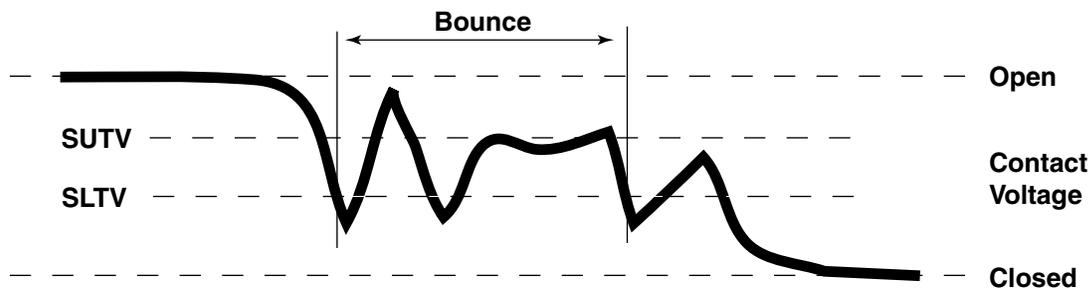
Figure 7.
Bounce Timing

The LCTS is a software controlled system. It uses a tight timing loop to monitor the contact during the testing. This loop time is slightly less than 25 usec. Thus the sampling resolution is this same time, even though the counters used to record the time event have approximately a 1 usec resolution. Bounce events that are less than 25 usec in duration are likely to be missed. If extremely short duration bounce events must be measured, TRICOR Systems offers a hardware bounce module with 1.6 usec resolution.

The maximum bounce time measurable is 0.104856 seconds. The application software limits maximum bounce tolerances to 0.1 seconds.

The bounce time measurements are symmetrical for both the opening and closing contact states. The transition directions are, of coarse, reversed. The threshold tolerances are the same for both the opening and closing conditions. It is not possible to separate tolerance for the two conditions.

The bounce threshold tolerances are also used to determine the initial state of the switch contact prior to each half cycle of the test. If the contact condition should be "open", the

value measured must be above the SUTV. For the closed condition, the measured value must be below the SLTV threshold. It is important to set these threshold values even if bounce testing is not performed. If improperly set, the switch may fail the initial state condition test. This test is performed whenever contact resistance testing is performed.

Bounce testing can only be performed if contact resistance testing is performed. It makes no sense to test bounce if final contact resistance is not proper. To measure bounce implies that contact resistance will be measured. To measure contact resistance implies that the initial state condition of the contact is tested and appropriate.

Test Times

The LCTS controls the time of each cycle of the switch. There is independent control of both the up and down stroke of the air cylinder. To simplify discussion, only the down stroke of a normally open switch will be discussed. All operations and setup applies equally to the up stroke, and testing the closed condition of the contact inverts the tolerance and threshold directions. Figure 8 illustrates a typical down half cycle.
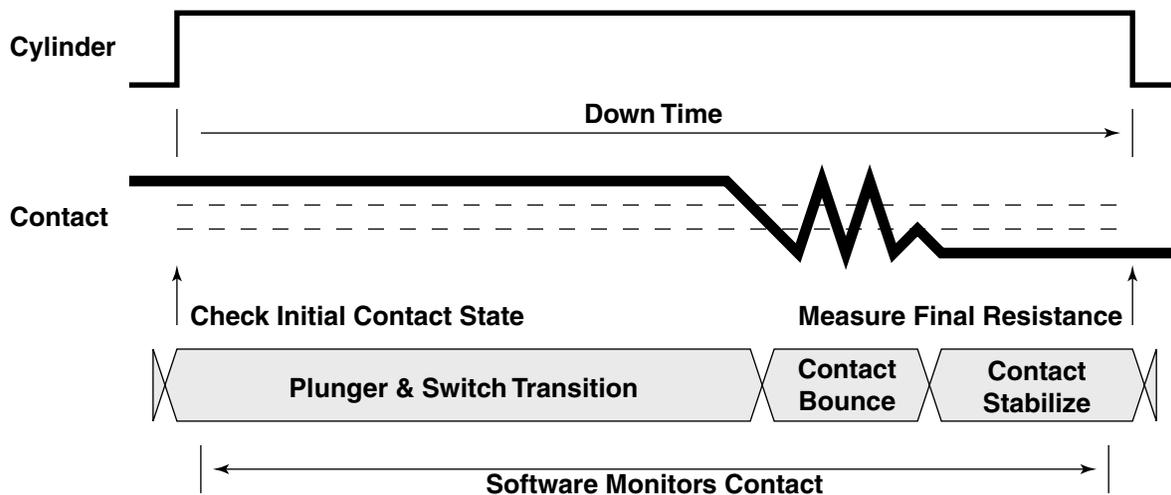
Figure 8.
Typical Down Stroke of NO Switch Type

This half cycle begins with a measurement of the initial state of the contact. It should be open to pass the test. The measured value must be greater than the SUTV of the bounce thresholds to pass. If not, an *Initial Contact Failure* occurs. If the contact is not being measured for this half cycle, then no contact measurements are made and the down time is fixed to the *Maximum Down Time* value programmed into the configuration.

Once the test of the initial condition is complete, the pneumatic control valve is actuated to apply pressure and drive the air cylinder down. Immediately software begins monitoring the switch contact for state transitions above and below the set thresholds. The pressure builds behind the air cylinder and the plunger begins to move. This

continues until the elastomer tip on the cylinder reaches the switch. The tip and the switch now begin to deform until the electrical contact first closes. When the measured contact resistance falls below the SLTV for the first time, a free running counter is read to record this initial event. Each time, including the first time that the measured contact value transitions through SUTV and then SLTV, the counter is latched. At the end of the testing, the initial latched count is subtracted from the recurring latched count to calculate the time interval. If there is only a single transition, both latched counts are identical and the difference is zero, a no bounce condition.

At some point in time, the contact should stabilize. The LCTS continues to monitor the contact resistance until the end of the half test cycle. This end point will be a timed event that will be discussed shortly. When the cycle end occurs, the LCTS will make a final measurement of the contact. This is the measured value used for the contact resistance testing. This value is temporarily stored by overwriting the previous down contact resistance. If the test data is transferred to the PC, this last down contact value will be available for inspection, otherwise it is lost when the next cycle occurs.

The down contact value is compared against the *Minimum Down Contact Resistance* and the *Maximum Down Contact Resistance*. If the value is less than the minimum tolerance, a *Min Contact Failure* occurs. If the value is greater than the maximum tolerance, a *Max Contact Failure* occurs. The down contact value is also compared against a *Maximum Contact* value. If the down contact value is greater than the current *Maximum Contact* value, the *Maximum Contact* value is replaced with the down contact value. This is the new maximum. Similarly, the *Minimum Contact* value is replaced with down contact value if this new reading is less than the *Minimum Contact* value. This becomes the new minimum. These values can be reset so that the worst readings are returned. The *Maximum Contact* value is reset to 0, and the *Minimum Contact* value is initialized to "open". These values are never tested, but are returned to the PC running the application software so that they can be inspected.

The down bounce value is compared against the *Maximum Down Bounce* time. If the new value exceeds the *Maximum Down Bounce* time, down *Bounce Failure* occurs. Similar to the contact resistance, the bounce measurement has a *Maximum Bounce* value. When the new bounce value is greater then the *Maximum Bounce* value, the *Maximum Bounce* value is replaced with the new value. This value is never tested, but is reported back to the application software. The reset value of the *Maximum Bounce* value is 0. The last down bounce value is also available for download from the tester and is display by the application software.

The LCTS checks the failures at the end of the up half cycle. If any failures have occurred in either the down or up stroke of this cycle, the cycle has failed. The internal failure counter is then incremented. For each failed cycle, the *Failure Counter* this counter has one added to it. The count limit is 65,535,000. The *Sequential Failure* counter is also incremented. It also has a maximum limit of 65,535,000 counts. However, when the test cycle passes all test conditions, the *Sequential Failure* counter is reset to 0. For all test cycles, whether they pass or not, the *Cycle Count* is incremented. This keeps track of the total cycle applied to the device under test. All

three of these counters can be individually reset under user control from the software application.

The red failure LED on the front panel of the Controller Unit will illuminate if the individual cycle fails. It will be extinguished if all the tests of that cycle pass. The LED will be pulsing if the switch is randomly failing.

The 4 failure conditions of each half cycle may not all be active. The following table shows the possible variations. The up and down strokes are independently set.

Test State	Failures -	**Init**	**Max**	**Min**	**Bounce**
No Testing		-	-	-	-
Contact Resistance		x	x	x	-
Bounce Testing		x	x	x	x

The *Maximum Contact Resistance*, *Minimum Contact Resistance* and *Maximum Bounce Time* are only valid if the test state is active.

Test Duration

The test duration is programmed by the user when the configuration data is created. The half cycle time is specified in one millisecond resolution in a range from 0.025 to 5.000 seconds. The duration of the up or down stroke is dependent on the test state selected for that half cycle. If **No Testing** is chosen, then the algorithms use the *Maximum Test Time* configuration value for that half of the cycle. The *Minimum Test Time* value can be set to any valid time, it will have no affect. The maximum cycle rate is set by this limitation. Assuming that the minimum time is used for both half cycles, 0.025 seconds, the total test time is 0.050 seconds, or 20 cycles per second. Higher rates can be ordered as an option by contacting TRICOR Systems.

When the contact resistance is measured, it is possible to measure switches faster since there is information about the air cylinder plunger obtained by monitoring the contact of the device under test. The maximum rate is still limited to 20 cycles per second. However, some speedup is possible over the worst case settings that may be necessary for configuring a switch to prevent random failures. This is where the *Minimum Test Time* value becomes useful. The speedup is diagrammed in figure 9.
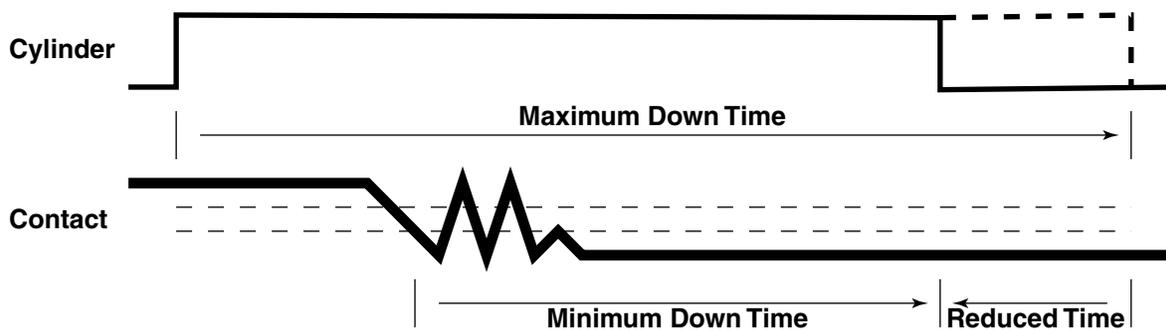
Figure 9.
Testing Speed-Up

Without knowledge of the contact closure, the user is forced to configure the LCTS so that the *Maximum Test Time* has enough padding to allow for variations in the plunger travel time to get to the switch, the switch travel time, the bounce and stabilize times of the switch as well as the variations that may result from temperature and pressure uncertainties. The *Maximum Test Time* value is set to encompass all these times plus any worst case padding. The *Maximum Test Time* is a limit case to prevent the system from locking up should the device being tested fail to actuate. Typical settings for this configuration parameter might be 0.5 seconds. This value keeps the LCTS running, but is long enough to encompass most system failures such as lost air pressure or a failed switch. The test half cycle is always guaranteed to complete in no more than the *Maximum Test Time* value.

The *Minimum Test Time* is set according to the characteristics of the device under test. This time should be set to provide a minimum delay from the point where the switch is first detected crossing the SLTV threshold. Typically the value assigned to this configuration parameter should be adjusted to guarantee that the contact has stabilized so that the final contact resistance can be read. As a switch wears, the amount of bounce and stabilization time increase. This *Minimum Test Time* should included padding to allow for device approved wear.

By setting the Minimum Test Time to an appropriate value, the LCTS can make the final contact resistance measurement based on the time from the contact transition, not the air cylinder command. This allows an improvement in test time because the travel times of the cylinder and switch can be ignored. This results in a reduced test time. The travel times are, of coarse, still important, but by positioning the switch appropriately, these times can be minimized without concern for their actual values. See Section 8 on Force and Speed for suggestions on increasing the test rate.

It is important to set the *Minimum Test Time* greater than the *Maximum Bounce Time* Tolerance. If not, the testing will end and the last bounce transition will become the bounce measurement. This value may be incorrectly small. The application software does not validate the relationship between *Maximum Bounce Time* and *Minimum Test Time*. Be sure to set both of these test limits according to the properties of the device under test.

Section 4
Configuration

LCTS Configuration

The main window of the LCTS software application is shown in Figure 10. The recessed areas and check boxes show test results gathered from the LCTS. The data in non-recessed areas indicated test parameters and configuration settings used in verification of the tested item. This window shows all the test result data downloaded from the LCTS. It shows most, but not all, of the configuration parameters. Parameters not shown here are available in the configuration data dialog window. These parameters include the test time limits, the contact type (normally Open/Closed) and the SUTV/SLTV transition threshold (see Section 3). The status bar at the bottom of the main window displays characteristics of the LCTS.

None of the text or check boxes on the main window screen can be modified. They are for display of test results and configuration data. The only active resources on this window is the menu bar and the Sample button. The Sample button interrupts the LCTS, whether it is testing or not, and downloads a complete copy of all the information in the tester. The sample time and date are displayed beneath the button. All the other fields of the screen are also updated.
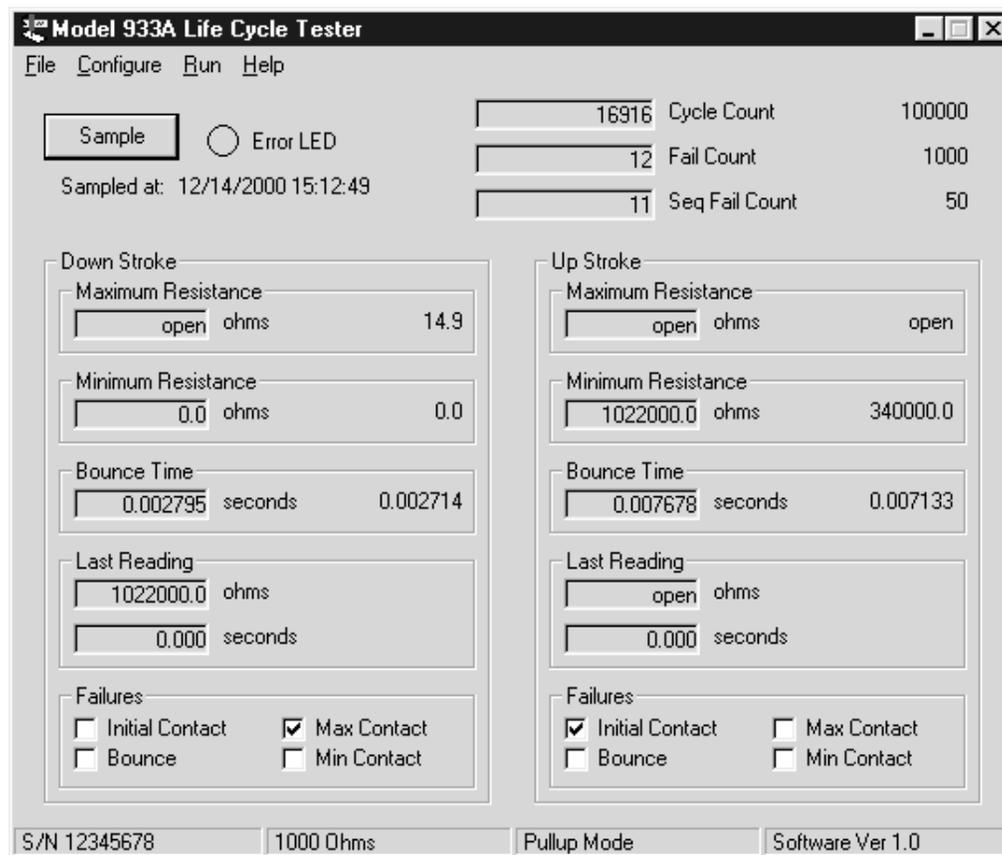
Figure 10.
Model 933A Application Software Main Window

How to Configure the LCTS

The LCTS was designed to test keypads and switches. These devices have an electrical contact. The resistance of this contact is part of the test measurement, and pass/fail criteria is assigned to the results obtained. To learn how to configure the LCTS for an electrical switch see the section below on Configuring For Devices With Contacts.

The LCTS can also be used to test devices that don't have an electrical contact. In this case, there is no test data collected on the item. The LCTS merely exercises the test item for a programmed number of cycles. For a discussion of setup of a non-contact device see the section below on Configuring For Devices Without Contacts.

The configuration data programmed into the LCTS as well as test result, are stored in non-volatile memory which is retained even when the LCTS is disconnected and powered off. Because of this feature, the LCTS can be programmed is a separate location and then moved to where the testing will be performed. When testing is complete, the LCTS can be returned to the PC location to download the test results.

The configuration data stored in the LCTS and that displayed by the software application are the same. They will remain in synchronization as long as both remain connected and are properly communicating.

Configuration Files

The configuration parameters loaded into the LCTS can also be saved to files for later retrieval. Under the Configure menu are Open/Save menu items. The Open item will show a standard windows dialog of files in folders. Select the file to open. The file format is checked, and if proper will be transferred to the LCTS. At the bottom of the Configure menu is a list of the 4 most-recently opened/saved configuration files. Clicking on any of these files is the same as opening the file. The Save menu item prompts for a file name. If no extension is specified, the default extension ".cfg" is added. The current configuration parameters are then stored in the user's file.

Editing The Configuration.

To edit or review the configuration parameter, select the Edit menu item under the Configure menu. Note that no changes or review of the configuration parameters is possible while the LCTS is running tests. The LCTS must be stopped. A three tab configuration dialog box appears. Figure 11 shows the first tab of this dialog. Configuration parameters are not saved or transferred to the LCTS if the cancel button on this dialog is pressed. To make changes and have them transferred to the LCTS, press the OK button. If new configuration parameter are created or existing parameters modified, the user will be asked whether or not to save the data before the application is closed or a existing configuration file is opened.
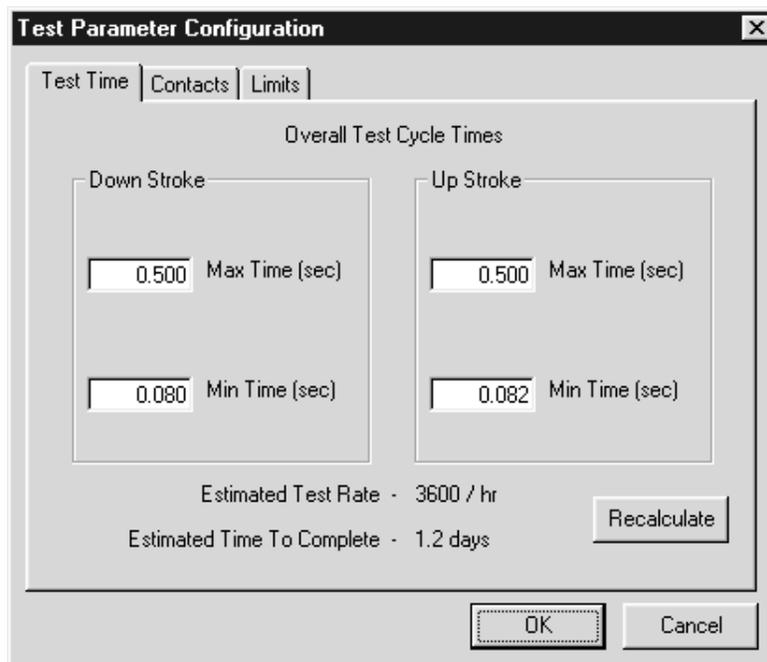
Figure 11.
Model 933A Application Software Configuration Dialog, Test Time Tab

Configuring For Devices Without Contacts

Edit the current configuration parameters by opening the configuration dialog. See Editing The Configuration, above, for details. Select the Contacts tab at the top of the dialog. Be sure the Contact Type is set to "None" (Figure 12). This will disable all contact testing.

Choose the Test Time tab. Set the maximum up and down times based on the test criteria. The cylinder air pressure, flow rate and stroke length all affect the test time. Also required is extra time for the LCTS to dwell at the motion extremes. The user must determine the up and down stroke times based on the item to be tested. The Maximum stroke times must be limited to a range of 0.025 to 5.000 seconds each. Thus the fastest test time is 0.050 seconds or 20 cycles/sec. The slowest is 0.1 cycles/sec.

The minimum stroke times must be limited to the same range as the maximum. Though these parameters are not applicable to non-contact testing, they are still verified (as are all configuration parameters). By definition, the minimum time must be less than the maximum time. Thus, for a non-contact device, it is easiest to set both minimum stroke times to 0.025 seconds.

Choose the Limits tab on the configuration dialog box. Enter the number of Test Cycles to perform on the tested device. The minimum limits are 1 and maximum are 10,000,000. Since a non-contact device can't fail, the Maximum Test Failures and Maximum Sequential Failures settings are irrelevant, but must be in the same range for limits. Click the OK button to transfer the parameters.

Test Parameter Configuration   ✕

Test Time | Contacts | Limits |

Contact Type: ┌ Transition Thresholds ─────────────
                                              Ohms   Volts   Percent
| Normally Open ▼ |
  ☑ Test Down Stroke   ▲▼ Upper 1017.8   2.53   50.6 %
    ☑ Down Bounce
  ☑ Test Up Stroke   ▲▼ Lower   956.0   2.45   49.0 %
    ☑ Up Bounce

┌ Down Stroke Tolerances ──────┐   ┌ Up Stroke Tolerances ──────────┐
│   │   │   │
│ [14.9] Max   │   │ [open] Max   │
│   Resistance │   │   Resistance   │
│ [0.0] Min   │   │ [340000.0] Min   │
│   Resistance │   │   Resistance   │
│ [0.002714] Max Bounce │   │ [0.007133] Max Bounce   │
│   Time   │   │   Time   │
└──────────────────────────────┘   └────────────────────────────────┘

                                              [OK   ]   [Cancel]

Figure 12.
Model 933A Application Software Configuration Dialog, Contacts Tab

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Test Parameter Configuration   ✕

Test Time | Contacts | Limits |

            [100000]   Maximum Test Cycles

            [1000]   Maximum Test Failures

            [50]   Maximum Sequential Failures

                                              [OK   ]   [Cancel]
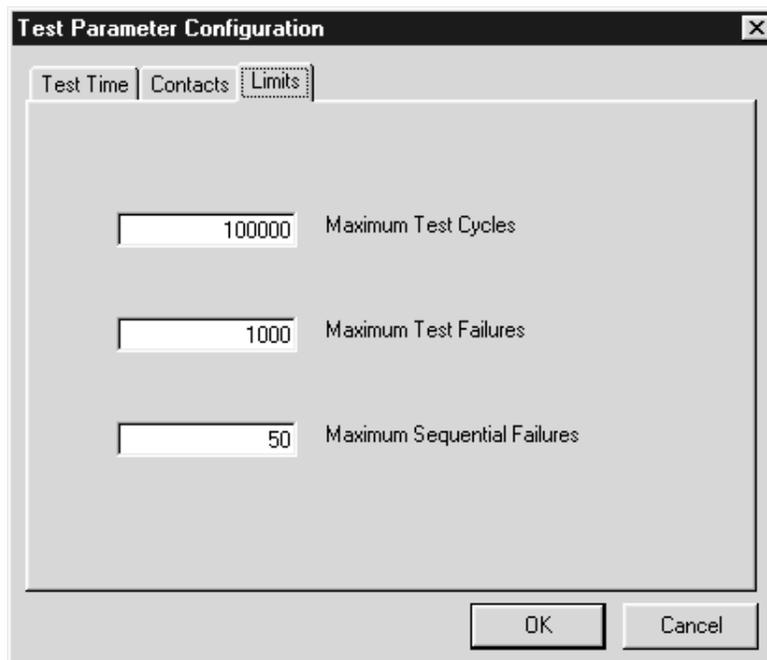
Figure 13.
Model 933A Application Software Configuration Dialog, Limits Tab

Configuring For Devices With Contacts

Edit the current configuration parameters by opening the configuration dialog. See Editing The Configuration, above, for details. Select the Contacts tab at the top of the dialog. Set the Contact Type to the type of switch to be tested, Normally Open (NO) or Normally Closed (NC) (Figure 11). This will establish the state of the contact when the air cylinder is in the up (retracted) position.

Check or uncheck the Test Down Stroke and Test Up Stroke check boxes according to the requirements of the switch. At least one of these check boxes must be checked. If neither are checked, no contact testing is performed and there cannot be any test failures.   This is the same as setting up a no contact configuration. If bounce testing is to be performed, check the appropriate up/down check boxes. Note that bounce can only be tested if the resistance is tested in the same direction.

Set the Transition Thresholds by clicking or pressing and holding the adjacent spin buttons. If bounce is not being tested, the upper and lower thresholds should both be set to approximately 50%. If bounce is tested, set the thresholds according to the requirements of your switch and the ASTM Designation F1661-96 specification. The lower threshold must be less than or equal to the upper threshold.

Set the Minimum and Maximum Resistance for both the up and down strokes. The minimum values can be 0. The maximum values can be very large. The word "open" can also be used to set a tolerance limit for an open circuit. Note that for each stroke direction the Min Resistance value must be less than or equal to the Max Resistance value. Because of the granular resolution of the resistance measurement method, some numeric values entered must be re-adjusted when the OK button gets pressed. When a value is modified, the user is warned and a dialog box pops up asking if the user wants to review the changes. By pressing yes, the user is again presented with the configuration data dialog showing the altered values.

Set the up and down stroke bounce limits. The minimum value is 0, the maximum is 0.1 seconds. If bounce isn't being tested, just enter a valid value.

Choose the Test Time tab. Set the maximum up and down stroke time based on the test criteria. The cylinder air pressure, flow rates and stroke length all affect the test time. Also required is extra time for the LCTS to dwell at the motion extremes. The user must determine the up and down stroke times based on the item tested. The Maximum stroke times must be limit to a range of 0.025 to 5.000 seconds each. The Minimum stroke times are limited to the same range and, by definition, must be less than or equal to the same direction Maximum stroke time.

The Minimum stroke times are measured from the first transition of the electrical contact. The Maximum Stroke times are measured from the command to the air value that drives the air cylinder. The Minimum stroke times should be based on the characteristics of the switch contact as it stabilizes. Note that the bounce test measurement will never exceed the Minimum stroke time. Be certain that the Maximum Bounce Tolerance is less than the Minimum stroke test time. See Section 3 for further discussion.

Choose the Limits tab on the configuration dialog. These limits are events which will stop the testing. Exceeding any of these limits will halt the LCTS. The range for all limits is between 1 and 10,000,000 events. Set the Test Cycles limit to the number of tests to perform on the switch item. Since this device has a contact which is being tested, there is a pass/fail status for each test cycle. The total number of failures and the number of sequential failures is counted. When these failure counts reaches the set limits, testing will be halted. Set the failure limits according to your test criteria. Click the OK button to transfer the parameters.

Resetting the Test Data

The LCTS keeps a set of cumulative results for all the testing it performs. This includes the cycle count, fail count, sequential fail count and min/max resistance and bounce values measured. The user is given complete control over when these values get reset. Loading new configuration will not change any of the stored numbers. The user must perform the reset manually. To reset the data select the Reset Limits menu item on the Configuration menu. The dialog box shown in Figure 14 will allow selection of the items to be reset. The LCTS must be stopped before this operation can be performed.
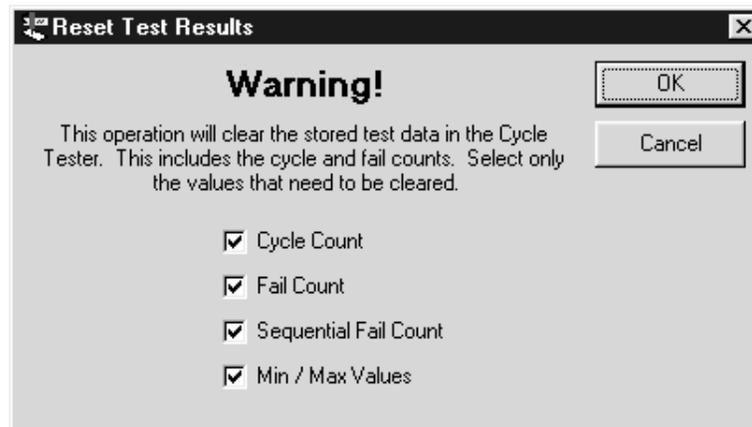
Figure 14.
Model 933A Application Software Reset Dialog

Automatic Learn Mode

The software application has an automatic learn mode. This is only available when the LCTS is stopped. Using the learn mode will erase any previous test data or configuration parameters. The learn mode can be used only to configure the LCTS for devices with contacts.

The learn mode is used to simplify the configuration setup of the LCTS. It may not find suitable values for all parameters. It cannot know the event limits to which the device must be tested. The learn mode also requires a know, good switch which is accepted as the "golden master". If the switch fails, bad results can be expected.

Choose the Learn menu item under the Configuration menu. The dialog shown in Figure 15 is displayed. The user must tell the system the type of switch contact (NO/NC) and whether bounce will be tested. With the switch attached and in its fixture, press the OK button. A relatively slow test of the switch is repeated 10 times until a cumulative average is obtained. These test results are downloaded and used to calculate the configuration parameters. The configuration data dialog box is then displayed. Inspect and modify and parameters as necessary. Click OK to send these values to the LCTS.
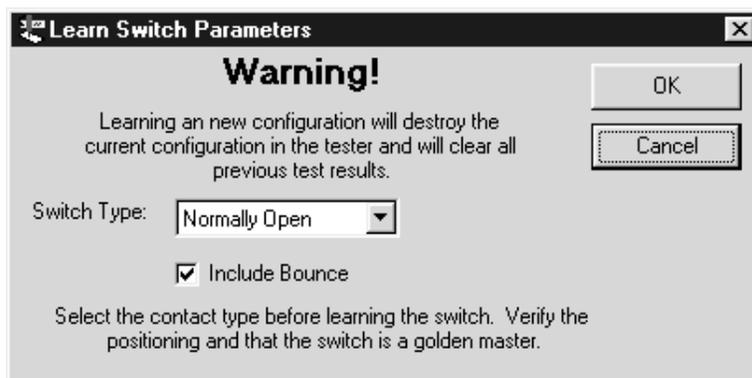
Figure 15.
Model 933A Application Software Learn Switch Dialog

Section 5
Test Results

Test Data

The application software gathers the cumulative test data from the LCTS every time it first connects to the LCTS, every time the LCTS is stopped (by whatever means) and when the Sample button is pressed.   All data downloaded is displayed in the main window screen.

The current test data can be printed by selecting the Print menu item under the File menu. The contents of the printed page depends on what items of the device are tested.

Test data can also be automatically stored into a file. If a file has been opened, then each new data sample is written as a line of text. Each file, if newly created contains a header at the beginning of the file to identify the "columns" of data. These files have a default extension of .txt (Text Format). The data is comma-delimited and can be directly imported into Microsoft Excel and Access. Most other data base and spread sheet programs can also import this type of file. When the file is closed, the new data samples are no longer saved.   The file which is opened has its name added to the title bar of the software application.

Generating Test Data

To generate test data, the LCTS must be run. This can be done using the push buttons on the LCTS front panel. The LCTS can also be commanded to run by the software application. There are more options available using the software.

The options for starting and stopping the LCTS are under the Run menu. Most of these options also have short-cut accelerator keys. For example, Ctrl + S will stop the LCTS. Ctrl + R will make it run. The LCTS must be stopped for the Run menu items to be accessible. The following run modes are available:

- Run To Limits (Ctrl - R) - Runs at least one test and continues until one of the stop events is reached.

- Run No Limit - Runs without stopping.   The even limits are ignored. In this mode, the fail LED on the LCTS flashes.

- Break Update (Ctrl - B) - Runs for the specified number of cycles that the user must enter into a dialog box which pops up. The LCTS stops after the specified number of cycles and the test data is downloaded. The LCTS is then started again with the same count limit. This continues until the user manually stops the testing or the event limits are reached.

- Run Once (Ctrl - O) - Runs a single test and stops.

- Manual - Allows the user to manually drive the air cylinder up and down as well as make a contact resistance reading. Test data is not collected.

When the break update run mode is selected, the user is caution to enter a relatively large value. The LCTS is a life cycle tester. It is not intended to take data readings with every test cycle. Windows has unpredictable timing. Setting the update count less than 20 usually get the LCTS and software application into a race condition which eventually locks out the communications. Close and restart the application to restore communications. Use an update count greater than 100.

Force Adjustment

Maximum test force is set by limiting the air pressure applied to the air cylinder. The pressure regulator and gauge for reading the pressure are on the front panel of the LCTS (Figure 3). The force is determined by a simple equation.

$$Force = Pressure \bullet Piston\ Surface\ Area$$

The piston of the standard LCTS has a diameter of 7/16 inch which results in a surface area of 0.150 inches^2. The force is then

$$Force\ (lbs) = 0.150 \bullet Gauge\ Reading\ (lbs/in^2).$$

Setting the pressure to 40 psi will give a force maximum of 6.0 lbs. The maximum pressure should not be set above 45 psi. The internal air values will begin to leak above this pressure.

Speed Adjustment (Option)

Some LCTS are equipped with air flow rate restrictors. These permit the velocity of the cylinder stroke to be reduced. The tested device is impacted with less acceleration force. The flow rates for the up and down strokes can each be independently set. The adjustments are accessible through covered openings on the right side of the LCTS. A long, flat blade screwdriver is required. Remember that restricting flow rate will lengthen the test cycle time.

Section 6
Force and Speed

Life Cycle Testing

The LCTS was designed for life cycle testing. It will exercise the test sample through to final wear out. It normally takes millions of test cycles to reach the wear out point. For this reason, it is important to reduce the time of each test cycle. The total test program will then be completed in a minimum amount of time.

Reduce Mechanical Stroke Time

The first, and most effective, method of increasing the cycle rate is to decrease the mechanical stroke times. Limit the air cylinder stroke distance by moving the probe tip as close as possible to the tested item. Use the highest air pressure which your device can withstand. Higher pressure force the air cylinder to move faster. If your LCTS is equipped with the option air flow restrictors, set these for the minimum restriction that can be tolerated. If appropriate replace the elastomer tip with a more ridged replacement.

Reduce Contact Test Time

Minimize the time spent testing the contact. If the contact doesn't need to be tested on the return stork, turn off this testing in the configuration set up. Set the Minimum and Maximum stroke times as small as practical for the device to be tested. If the device has a tested contact, use Minimum stroke times to effectively reduce to cycle time as discussed in section 3. Avoid bounce testing if not required.