Operation Manual

for the

Computer Aided Tap Tester
(C A T T)

Version 2.01

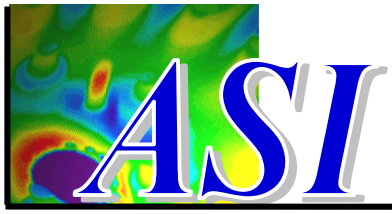

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TABLE OF CONTENTS

Introduction

About This Manual

This manual provides general operation instructions for use of the Computer Aided Tap Tester (CATT) system. The basic steps in producing a scan are to 1) start and configure the software, 2) attach a grid template to the area to be inspected, 3) tap the area using the manual tap probe or the semi-automated inspection cart, and 4) analyze the data. These steps will be covered in more detail in the following sections. Prior to operation of the system, the operator should read and understand the information contained herein.

Overview of the CATT System

The CATT system improves the time-proven NDT practice of tap test by collecting quantitative data and displaying the information in a graphical format for easy review and archiving. Specifically, the CATT measures the surface stiffness of thin walled components and presents this data in the form of a two-dimensional false-color plot. Often, use of the CATT can appreciably improve the detection and characterization of certain damage, defects, and internal structure in the inspected components.

Applications

Tap testing is a commonly used method of inspecting thin-skinned composite and bonded metallic components for signs of damage. When operating within certain material restrictions, the CATT system can be used to detect and characterize:

- disbonds between face sheet and honeycomb core.
- crushed core due to impact or overload.
- voids, inclusions and delaminations in composite repairs.
- core splice and thickness change, potting, ply drop-off.
- doublers, ribs, spars location.
- composite repairs on fan cowling, flaps.

System Advantages

Use of the CATT instrument offers several significant advantages over the currently employed tap testing technique. First, the sensitivity of the inspection is improved over uninstrumented tap methods since the system provides quantitative data, and is not affected by the hearing of the inspector or the ambient noise level in the inspection area. Second, the CATT produces an image that provides visual information about the size and shape of the damage, as well as normal substructure. The image serves as documentation of the inspection and can be archived. Third, the speed of inspection is improved with the use of the inspection cart, which facilitates the efficient inspection of large areas.

Handling and Storage

As with any piece of electronic equipment, care must be taken when transporting and handling the CATT system. In general, the unit should be handled in a manner that would be suitable for a laptop computer. Care should be taken not to drop or otherwise subject the unit to impact loading. The unit should always be protected from moisture. When storing the system for an extended period, the batteries should be removed to avoid possible damage as batteries can corrode and leak with age.

Equipment Setup

Before the CATT system can be used to collect data, the following equipment set-up actions must be completed.

Load the CATT Software

The CATT software must first be loaded onto a computer that meets the minimum requirements specified below. The CATT program makes use of Microsoft Excel to store and plot the collected data. Therefore, Microsoft Excel 95 or a more recent release (not provided) must be loaded on the computer.

Minimum Computer Requirements

- IBM Compatible, Pentium 200
- 128 MB of memory
- 200 MB of free disk space
- An open serial port
- CD-Rom or 3 ½ disk drive
- Windows 95®, Windows 98® or Windows 2000®
- Microsoft Excel 95® or a more recent release

1. Place the CATT software CD or diskette into the proper drive and locate the **install.bat** file or the **install** shortcut. The install program will create a directory called "TapTest" on the C drive and load the following files into this directory:

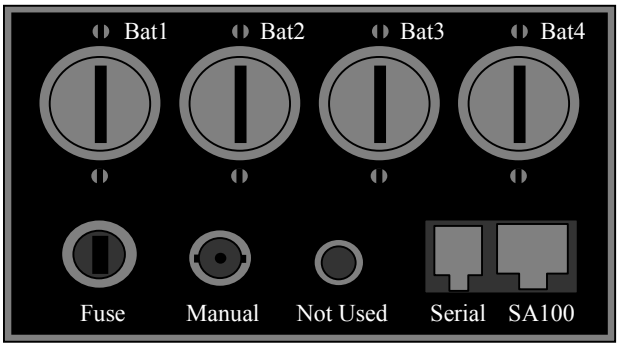
   AnalyzeTap.xls
   AsiCATT_v2.01.xls
   Calibration.exe
   CATT V2.0 software instructions-II.doc
   MsComm32.ocx
   Outloop.exe
   Outloop2.exe
   Parameters.xls
   PCTone.ocx

   The program will also register the location of several of the above files with your computer system.

2. Close the install program when it indicates that it is finished loading the required files.

Connecting the Hardware

1. Connect the computer interface box to the computer by inserting the 6 pin RJ-12 network cable into the Serial port on the computer interface box and the other end to the computer's serial port. A schematic representation of the back of the computer interface box is shown below.

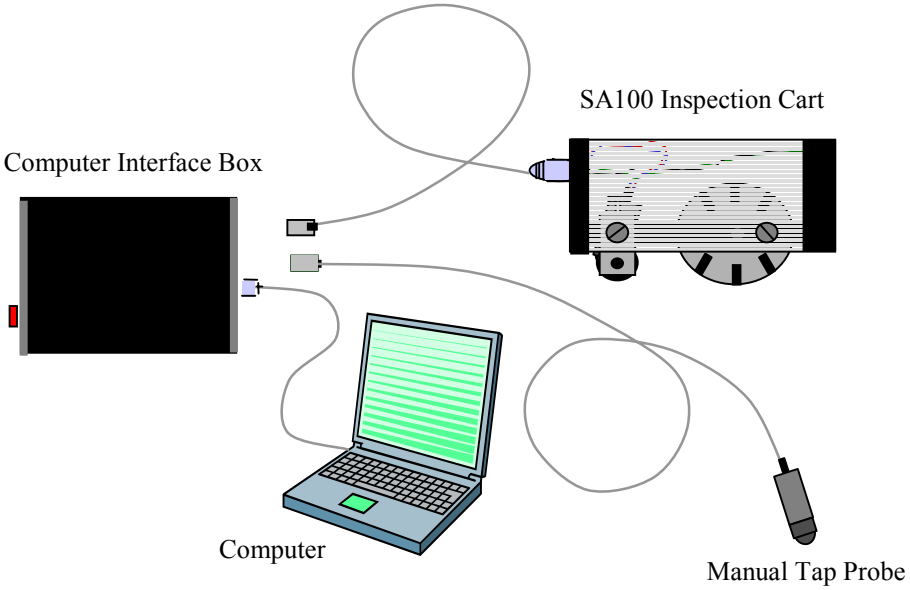


2. Connect either the manual tap probe or the semi-automated inspection cart to the computer interface box.

   a. Connect the manual tap probe by attaching the BNC-to-Microdot cable to the "Manual" port on the back of the interface box and the other end to the probe.

   or

   b. Connect the SA100 cart by plugging one end of the 8 pin RJ-45 network cable into the SA100 port on the interface box. Plug the other end into the matching connector on the SA100 Cart.



3. Load batteries by opening the battery access caps on the back of the computer interface box. Insert 8 AA batteries with the positive end facing outward and replace the battery access caps. Replace the batteries as necessary.

Using the Computer Aided Tap Tester

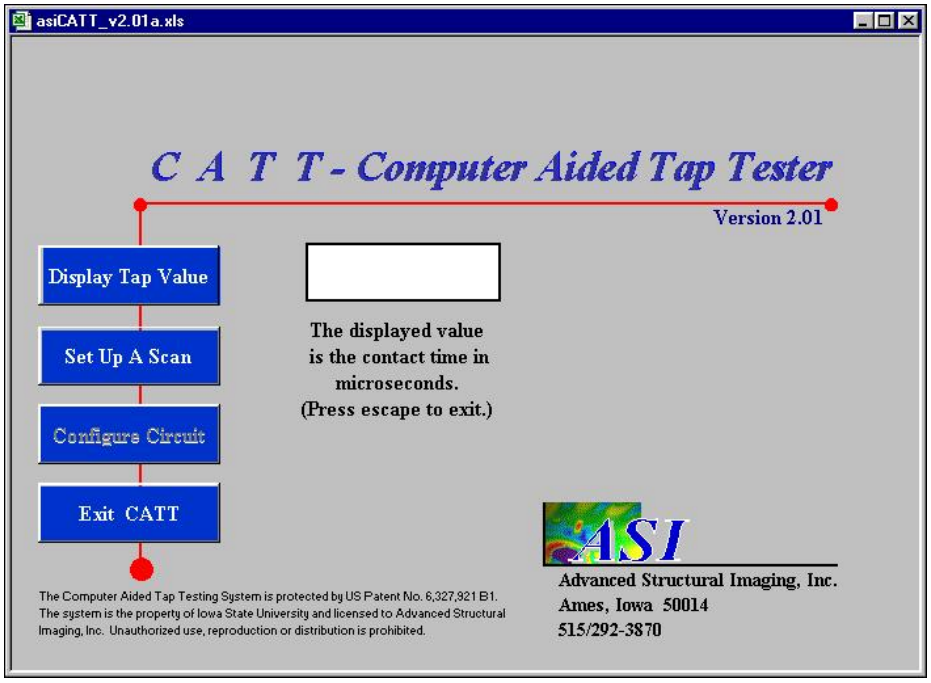
Getting Started

1. Turn on the computer interface box by engaging the red button on front of the box.

2. Locate and open CATT computer interface program at the following path - C:\TapTest\asiCATT_v2.01.xls.

3. The Excel box shown below may appear to indicate that the program contains macros. "**Enable Macros"** must be selected for the program to run properly. (This box will not appear if Excel is set to allow macro to run without warning.)

The CATT startup screen shown below will then appear.



4. Click any of the buttons along the left side of the screen to proceed. The functions of these buttons are outlined in the following section.

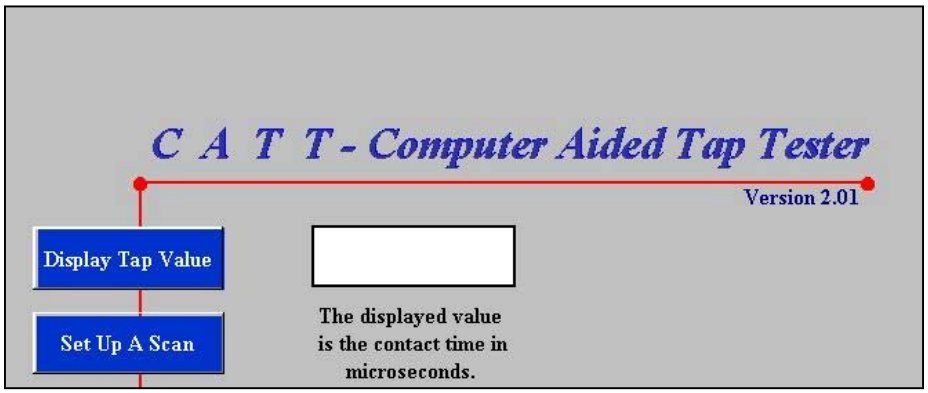
Button Functions

Display Tap Value

The "Display Tap Value" button should be selected when the impact duration of each individual tap is of interest. Each time the probe is tapped on a surface, the impact duration, in microseconds, is displayed. This mode of operation can be used to check the performance of the CATT system and to make manual inspections when a plot of the results is not needed.

1. Click on the **Display Tap Value** button. A message box will open and provide a status of the batteries. In some cases, a double click of the button will be required. Replace the batteries if they are found to be weak.

2. Close the battery status box and the tap duration display box will be active.



3. Begin tapping and the contact duration time will be shown in the display box for each tap.

4. Verify that the system is performing properly by tapping a number of times on the check specimen provided with the system. The values obtained should be in the range indicated on the check specimen. If the proper values are not obtained, replace the batteries and repeat. Contact ASI if new batteries fail to correct the situation.

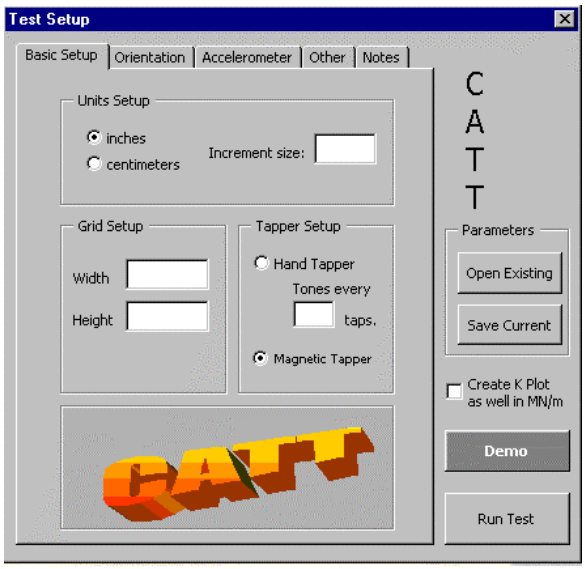
Troubleshooting:
If values do not appear in the Tap Value Box:
- Check all of the cable connections.
- Make sure the computer interface box is turned on. You may need to exit Microsoft Excel, turn the computer interface box on, and then re-open the program.

5. To exit the **Display Tap Value** mode, press **Escape**.

Set Up A Scan

The "Set Up A Scan" button leads to the core function of this program. This button will open a dialog box that will be used to set up and perform a 2-dimensional tap scan of a surface.

1. Click **Set Up A Scan.** A dialog box for specifying test parameters will open.



2. Specify the necessary parameters. Some of the test parameters must be specified initially to collect and process the data. Other parameter input boxes are provided solely for documentation purposes and their use is left to the discretion of the operator. The parameter on each of the pages is outlined in the Tap Test Parameters section and the required fields are indicated.

> **Tip:** Click the "Demo" button on the lower right to run a quick sample test.

Tap Test Parameters

Basic Setup Page

The Basic Setup Page is used to enter information about the tap grid and to indicate whether hand (manual) tapping will be done or whether the semi-automated cart will be used.

Units Setup

Units of measurement ***must be specified*** in either inches or centimeters.

Increment Size

The increment size is the distance between adjacent taps (typically ¼, ½, ¾ or 1 inch) and ***must be specified***.

Grid Setup

In the width and height boxes, the number of taps in each of these dimensions of the grid ***must be specified*** with positive integers.

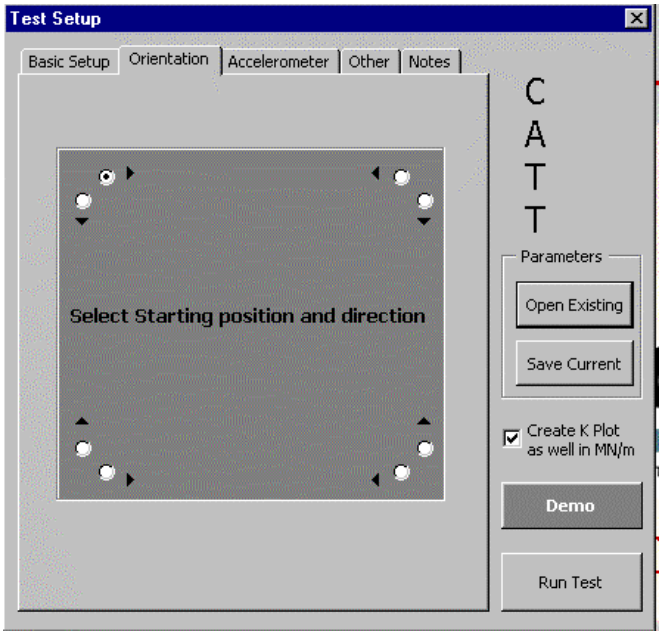
Tapper Setup

Either the "Hand Tapper" or the "Magnetic Tapper" option ***must be specified***. "Magnetic Tapper" refers to the semi-automated cart.

When using the manual tap option, the user may choose to have audio cues after a specific number of taps have been made to help keep track of progress. Entering a positive integer in the "tones every __ taps" box will cause the computer to beep every time the specified number of taps has been completed. It is usually most helpful to set the value to correspond to the end of a row or some other positions (e.g. every 5 or 10 grid points) marked on the template. (Headphones may be required in high ambient noise environments.)

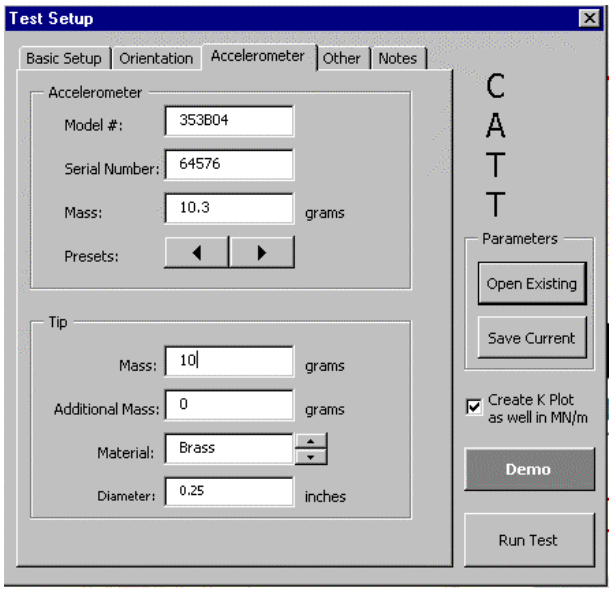
Orientation Page

The Orientation Page is used to orient the image produced by the scan. The operator can specify the corner of the grid where tapping will start, and the direction in which the tapping will proceed. The default setting has the scan starting in the upper left hand corner with taps proceeding to the right.



Accelerometer Page

The Accelerometer Page is used to record information about the tap probe. The tap probe is comprised of an accelerometer and a hard impact tip that is attached to the accelerometer. The mass of the tap probe (accelerometer and impact tip) is critical for making the proper stiffness calculation and ***must be entered***. All other information is optional and can be input for future reference.



Model #

The model number of the accelerometer is marked on its side and can be recorded in the input box for future reference.

Serial Number

The serial number of the accelerometer is marked on its side and can be recorded in the input box for future reference.

Mass

The mass of the accelerometer and the mass of the tip plus the threaded stud ***must be specified*** in order for the test to proceed. These values will be provided by ASI and should be entered to the nearest gram.

Additional Mass

In some circumstances, such as when relatively thick composites are being inspected, it may be desirable to add additional mass to the tap probe. (However, using a heavier accelerometer is more desirable.) Any additional mass that has been added ***must be specified*** in order for the test program to make the proper calculations. If no additional mass is being used, this dialog box can be left empty or a zero can be entered.

Material
The tip material can be specified for future reference. Tips supplied by ASI are made from 300 series stainless steel, which should last for a considerable period. The tip should be replaced if it becomes nicked or deformed.

Diameter
The tip diameter can be specified at the discretion of the user.

Other and Notes Pages
The Other and Notes Pages are provided for the user to record additional information about the test. All of the information is for reference only and usage of the field is left to the discretion of the operator.

3. The program will automatically create a plot of the impact duration. It can also calculate stiffness using the impact time and the tap probe mass. If a plot of the stiffness information is desired, check the box next to the words, "Create K plot as well in MN/m." The unit of the stiffness, K, is megaNewtons per meter.

4. The entered parameters can be saved into a new parameter file or saved to replace an existing parameter file. When the "Save Current" button is selected, a "save as" dialog will open to allow the user to select a file name. When the "Open Existing" button is selected, a dialog box will open that displays a list of all the previously saved parameter files. Once a file is selected, all parameters stored in the file will be loaded into the CATT program.

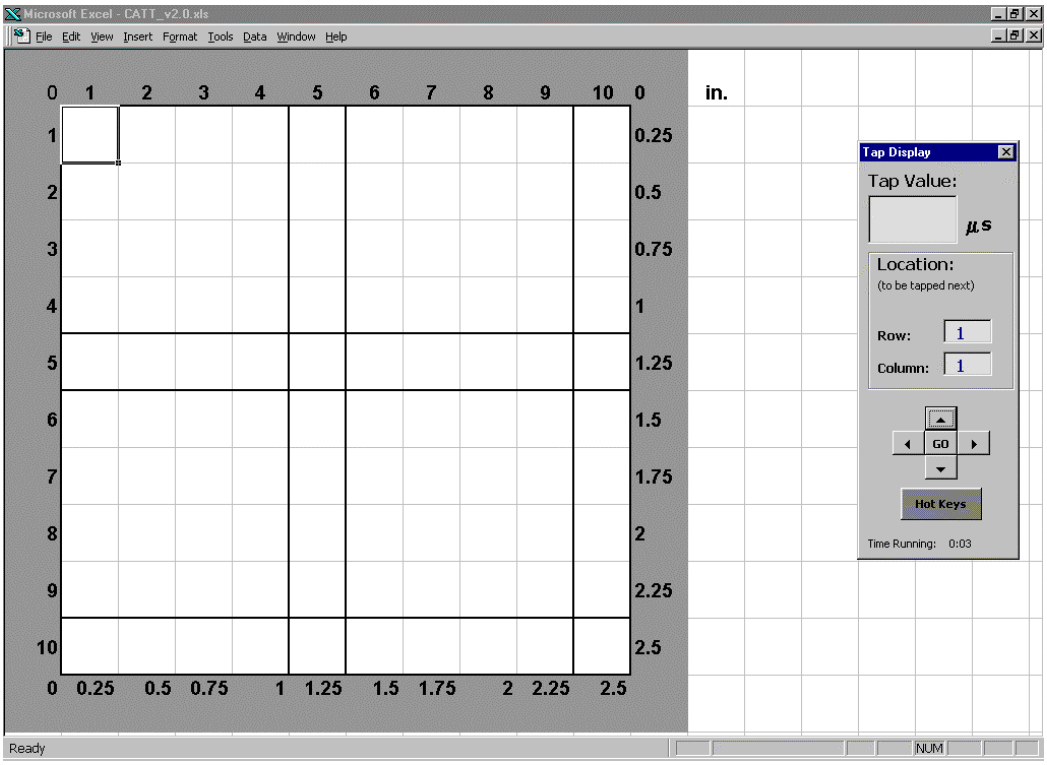
5. Once all of the appropriate test parameters have been specified, click the **Run Test** button. A grid with the dimensions specified by the user will be generated in the test window. If any of the test parameters that are required were left blank or are of inappropriate value, an error message will appear and the user will be brought back to the **Test Setup** dialog box. If no error messages appear, see the section titled "Running a Test."

Configure Circuit

The Configure Circuit button is inactivated within the software. This function is used at the factory to set the circuit gain and threshold values so that the computer can accurately interpret the tap values.

Running A Test

This section summarizes how to run a tap test scan. Once a scan is set up in the **Set Up A Scan** section, the test window is generated according to the scan dimensions specified in setup. An example window is shown below for a 10 by 10 point scan at ¼ inch spacing.



1. Attach a grid template that matches the grid specified in the "Set Up A Scan" page, to the surface to be inspected or mark a grid on the surface. Templates work very well as long as the template material is not too compressible. Thin Mylar sheets work well for templates but regular paper does not. Test the material by tapping on and off the template and comparing the results. Any difference in the values should be slight. The template can be attached to the surface with masking tape.

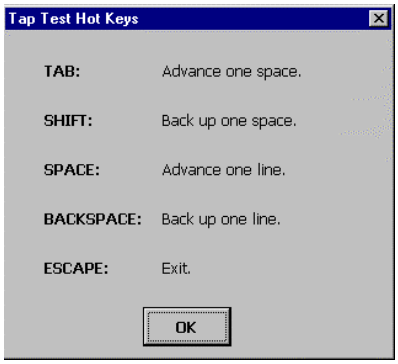
2. Data can now be collected by tapping at each point on the template. When the manual system is used, the operator must tap at each point on the grid. When the semi-automated cart is used, the operator pushes it along each line on the grid and the cart does the tapping at regular intervals. Retain the proper orientation of the scan by beginning the tapping and progressing in the direction established in the "Set Up A Scan" page.

   Note: The circuit is equipped with a sleep mode. If you stop during a test for several minutes, you will hear the circuit chime. This means that it is in sleep mode. To wake it up, simply begin tapping. The circuit will chime again, when it awakes. No data will be sent to the computer for several seconds after the circuit has awakened to

allow the user to reposition the cart at the location where scanning left off.

The Tap Display dialog box, which appears in the test window, displays the tap value and the grid location. The dialog box can also be used to navigate the grid so that points can be retapped if necessary. The arrow buttons can be used to move around the grid. Inputting the grid row and column numbers and clicking on the go button will move the cursor to the desired grid box. **Note:** The dialog box floats so that it can be moved around by the operator. The box should not be closed, however, as it cannot be reopened without restarting the program.

A number of keyboard "hot keys" have also been provided to facilitate movement around the grid in the test window. Click the **Hot Keys** button on the Tap Display dialog box to get a description of the keyboard shortcuts. These descriptions are also provided below.



3. Once the grid area is completely covered a dialog box will appear asking the user if they want to "re-tap" any points or lines. Points with a contact time less than 100 microseconds will be flagged as misregistered or "bad" by the system. Some bad points are to be expected. The operator can retap any of these points if desired. However, it is not always necessary to retap bad points as they occur with fairly random frequency and usually do not interfere with the imaging of the features of interest. The program can also correct bad points in the final plot by setting their values equal to the average of the values in adjacent cells.

4. If no points or lines are to be re-tapped the test ends and the user is asked if they wish to save the test data. Choose "**Yes**" to save the data and a dialog box will open so the file name and path can be specified. Choosing "**No"** will result in the data being discarded and the user will be returned to the main window. **BE SURE TO CLICK YES IF YOU WANT TO SAVE THE DATA OR THE DATA WILL BE LOST!)**

5. Once the data is saved, a plot will be generated displaying the contact time and data collection is concluded.

6. Upon completion of a test, the operator may choose to run further analysis on the sample or perform another test. For more information on the data analysis features, see the Data Analysis section.

Using the Semi-Automated Inspection Cart to Collect Data

1. When conducting a tap test using the semi-automated cart, the cart should be held like a computer mouse with the operator's fingers near the microswitches located near the forward edge of the cart. The switch on the left is for advancing one line on the test window grid, and the switch on the right is for backing up one line.

2. Place the cart at the starting point and push the cart along the first grid line on the test surface. The cart should be moved in the direction such that its cord trails behind it.

3. When the end of the first line is reached, pick up the cart and position it at the beginning of the second line. To make sure that the whole line is tapped, the cart may be run past the end of the grid. The software will only record the number of taps specified in the setup section.

4. Press the left switch to move the cursor in the test window to the beginning of the second line of the test grid.

5. Proceed to tap on the second line and repeat the process until all lines have been tapped. If it becomes necessary to retap a line, the right switch on the cart can be used to move the cursor back a line on the test window grid.

   Note: Hot keys on the computer may also be used to move the cursor around on the grid. The space bar can be used to advance the cursor ahead one line and the backspace key will move the cursor back one line.

   Note: While the cart significantly speeds the tapping process, it has a limit as to how fast it can tap. Tapping too fast will result in data loss. For instance, a line that should produce 40 taps may only produce 37. This is because the circuit cannot read the incoming data fast enough to record every point. The operator should experiment with the cart to find a speed that is appropriate for the test conditions.

   Note: The cart is designed such that the tap probe is loosely held by the yoke. The tap probe should be allowed to slide within the rubber grommet and no action should be taken to fix the probe more securely.

Cart Impact Force Adjustment

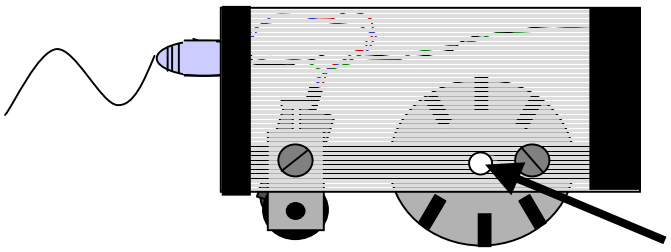
The impact of the tap probe on the test surface can be adjusted via the two adjustment screws. Threading the screws in will decrease the impact force, and alternatively, threading the screws out will increase the impact force. Care should be taken to ensure that the impact force does not cause damage to delicate test pieces such as thin aluminum skins. The contact time values are relatively insensitive to the impact force.

Changing the Cart Drive Wheel

1. The SA100 Inspection Cart uses magnetic forces from permanent magnets mounted in the drive wheel to control the movement of the tap probe. To change the pitch of tapping, the drive wheel must be changed out. This is done by following this simple procedure.

2. Using a pencil or other long narrow object, gently push the drive wheel axle (indicated by arrow in the image below) out of one side of the cart frame. There is a slight interference fit between the axle and the frame but the axle should push out fairly easily.

SA100 Inspection Cart



3. Continue to push the axle until it is clear of the drive wheel and remove the drive wheel. It is best to leave the axle engaged in one side of the tap probe yoke and the frame, so as not to put unnecessary stress on the wires connected to the tap probe.

4. Line-up the new wheel with the axle. The orientation of the wheel is not important.

5. Push the axle back through the wheel and the opposite arm of the yoke and seat it back into the frame. The axle should be firmly seated into both sides of the cart frame.

6. Check to make sure the yoke moves freely and is not being squeezed by the frame. The frame has some flexibility and if it is found to be binding on the yoke, gently spread it a small amount until the binding no longer occurs.

7. Resume tapping.

Data Analysis

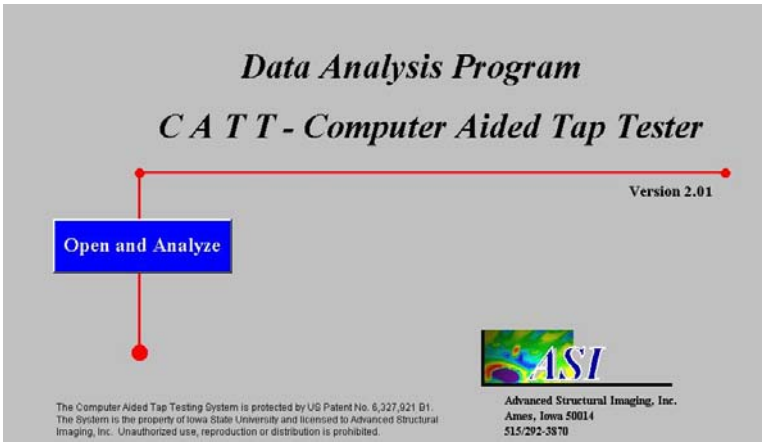
The data analysis program can be used to analyze the current test data or data previously collected with the CATT data collection program. Note that this program is separate from the CATT data collection program. Functions of the data analysis program include several different plot generators and routines for defect size analysis.

Getting Started

1. The data analysis program can be automatically opened at the completion of data collection or it can be opened separately. To open outside of the main CATT program, locate and open Test Analysis program at the following path - C:\TapTest\ASIanalyzeTap.xls.

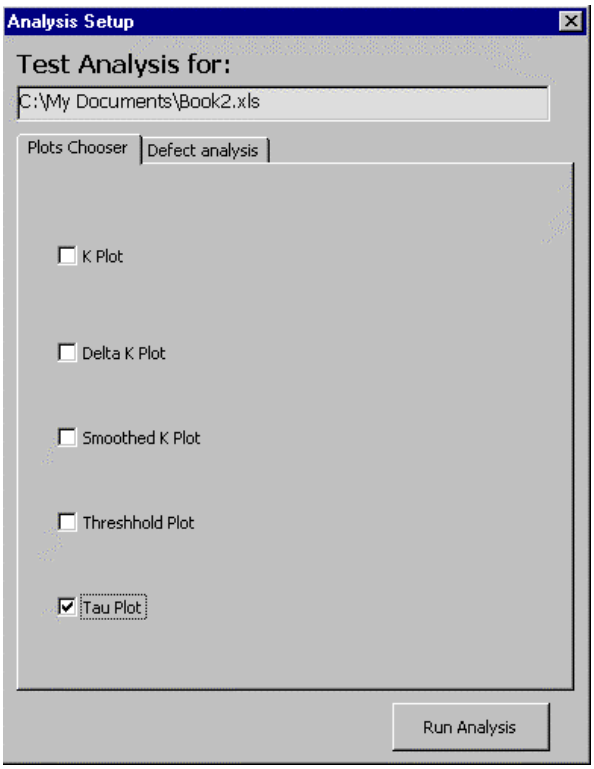
2. The Excel box shown below may appear to indicate that the program contains macros. "**Enable Macros"** must be selected for the program to run properly. (This box will not appear if Excel is set to allow macro to run without warning.)

The Test Analysis startup screen shown below will then appear.



Note: Several sheets in addition to the main program sheet will be visible at the bottom of the window. These additional sheets are used by the program and should not be altered. Initially, there is no user data on the sheets, but after new plots have been generated or the data analyzed, these sheet will be replaced with the new information.

3. Click the "Open and Analyze" button. A dialog box will open with a list of analysis options.



Plot Options:

K (Stiffness) Plot

This is the plot of local stiffness, K, in MegaNewtons per meter. This number gives an indication of the local rigidity of the part.

> **Note:** This plot can be generated during testing if so desired. There is an optional check box in **Test Setup** specifying this option (Refer to page 9).

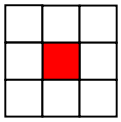
Delta K Plot

This is the plot of local stiffness as a percent of an operator specified "good" value. This extremely useful plot is used to determine relative weakness in parts that are tested.

When this box is checked, the user must specify a value in the **Good Tau Value** dialog box. By clicking **Select Point,** the original "Tau" plot (contact time data) is displayed for the user to select a threshold color for this plot instead of typing a value in.

Smoothed K Plot

This plot is the same as the "K Plot" except that the data is smoothed to lessen the effects of scatter in the data. The smoothing technique calculates an average value for the test cell and its adjacent cells and plots this value. The user can control how "smoothed" the data becomes by weighting the "center" value. The weighting value tells the computer to include the test value multiple times in the averaging. For example, for the schematic representation shown below, a weighting value of three would produce a plotted value that is the average of three times the value of the test cell (in red) and the values of the eight cells surrounding the test cell. Therefore, the larger the number, the less "smoothed" the data will become. The smoothing value can range from 1 to 99.



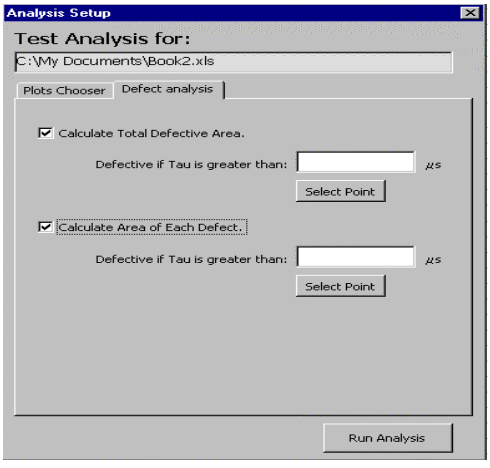
Threshold Plot

This plot is a simple two color, red and green, representation of the contact time, Tau. The user *must* specify a "Threshold Value" in the dialog box. Any areas of Tau that are higher than the threshold value will be shown in red and any areas of Tau that are lower will be shown in green. This plot can be used to show weak (red) regions versus regions that are considered to be of acceptable stiffness (green). The threshold plot is, therefore, a go/no go representation of the test results.

Defect Size Analysis

This portion of the analysis program will analyze specific defects and their sizes.

1. Select the **Defect Analysis** Page to access these features. The dialog box shown below will open.



2. Choose one of the two defect analysis features. These two features are explained in more detail on the following page.

Calculate Total Defective Area

By selecting this check box, the total defective area, as defined by a threshold Tau value, will be calculated. The percent of total area will also be calculated. The operator must input a threshold value for Tau. Alternatively, the operator may choose a Tau threshold value by clicking **Select Point.** Selecting this action will result in the original "Tau" plot being displayed for the operator to select a threshold value for the plot instead of typing in a value.

Calculate Area of Each Defect

By selecting this checkbox, the individual defect sizes will be calculated and displayed in a table. The defects are defined by a threshold value of Tau that *must* be supplied by the operator. Alternatively, the operator may choose a Tau threshold value by clicking **Select Point.** Selecting this action will result in the original "Tau" plot being displayed for the operator to select a threshold value for the plot instead of typing in a value.

3. Click the "Run Analysis" button and new plots will be generated and the data analyzed as specified in the set-up box. The new plots and analysis information can be found in the new worksheets that have been generated in the workbook. To view the results, click on the tabs of the worksheets at the bottom of the screen.

Troubleshooting and Service Information

CATT System

If a software error occurs when attempting to run the CATT software, make sure that the program has been loaded properly. When loaded properly, a folder named "TapTest" should be present on the C drive. The folder should include the files listed on page 2 of this manual.

If the CATT system does not respond to tap input, perform the following troubleshooting:

1. Make sure the serial cable is securely connected to the computer and the computer interface box.
2. Make sure the cable is securely connected to the tap probe and to the computer interface box.
3. Make sure the batteries are fresh and all are oriented with the positive end facing outward in the holders.
4. Check the condition of the fuse, which protects the electronics of the system. The fuse is located on the lower left side of the back panel of the computer interface box.

If the system still does not respond, contact Advanced Structural Imaging, Inc. The system does not contain user serviceable components and opening the computer interface box to attempt unauthorized repairs will void the warranty.

Please be prepared to provide the unit's serial number when contacting ASI. The serial number can be found on the underside of the computer interface box.

CATT Model Number_____

CATT Serial Number_____

Inspection Cart

If the wheel of the semi-automated inspection cart rolls but the cart does not tap, make sure that the black plastic frame in not squeezing on the yoke and preventing it from swinging freely.

Cart Model Number_____

Cart Serial Number_____

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