HANDBOOK ©

C53

53kg TESTING MACHINE

For: -

TABLET HARDNESS TESTING

and

COMPRESSION TESTING

by
ENGINEERING
SYSTEMS (NOTTM) Ltd

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Please note: *This handbook version contains the latest information for machines running firmware 1.24. Some functions, options and peripheral support may not be present in older firmware. Later firmware versions may include additional features.*

1 INTRODUCTION TO THE C53

1.1 DESCRIPTION OF THE C53

The Engineering Systems C53 is a horizontal loading, mechanical strength testing machine. Easy to use, it has been specifically designed for tablet hardness testing in a factory environment. However the ability to alter many of the test parameters such as % fracture detect etc. make the machine more versatile and suitable for use in research and development departments. For extra sensitive measurements a 5 kg load cell, with a resolution of 1 gram, is available.

1.2 FEATURES

- Automatic sizing of new tablets
- Wipe clean front panel
- Digital display of tablet count
- USB & RS232 outputs are provided as standard
- Statistical Analysis
- Time & Date output
- Firmware* updates available online
- Maximum load (Hardness) 53 kg
- Maximum jaw opening of 38 mm
- 30 column printer with easy to change paper roll
- Choice of units: kg, kp, N or lb.
- Loading by Test button or Guard
- Automatic diagnostics of common faults

1.3 ADDITIONAL INFORMATION

The C53 was introduced in August 2006.

Internal wiring and connections have been minimised to increase reliability and ease of maintenance.

The integral printer is flush mounted on the front panel of the main casing and the paper roll is housed within the body of the machine. The paper roll can be changed via a sliding door located underneath the machine.

Overload and over-travel protection is incorporated into the control electronics. The loading plunger is automatically reversed if a load in excess of 53 kg is detected or the end of travel is reached.

Fracture is detected when the instantaneous load detected by the load cell falls to a set % of the maximum (peak held) load that has been reached during a particular test. This is typically set to 70% but can be changed if the tablet or specimen characteristics are unusual.

* The Firmware is the operating software contained within the machine.

1.4 OPERATION OF THE C53

The tablet is placed between the two jaws (platen and plunger). The left hand platen is stationary and is attached to a precision strain gauged load cell. The

right hand plunger is motorised and crushes the tablet between the jaws when the test is commenced. Tablet fracture is automatically detected and the fracture load (hardness) is displayed on the digital display. Meanwhile the plunger returns to its preset position and the printer prints the hardness data. The tablet fragments are collected in a drawer situated underneath the loading platform. When testing of the batch is complete the STATISTICS button can be pressed to print out statistical data.
A new tablet size can be pre-set by pressing the NEW TABLET SIZE button and inserting a tablet. The new size is automatically detected and the machine is then ready to test the new batch. The plunger operates at two speeds, test speed and full speed. Test speed is adjustable and can be set to a number of speeds between 4 and 30 mm/min. Full speed is approx. 130 mm/min.

When testing, the test sequence is: -

Full forward speed is applied to the plunger until the tablet diameter is reached, test speed is then applied until tablet fracture is detected, full reverse speed is then applied to the plunger and it returns to its preset test position. The result is then printed out.

If required, the safety guard can be set (via the setup menu) to automatically start the test, this disables the operation of the TEST button.

1.5 USING THE C53 FOR THE FIRST TIME

The machine's controls are situated on the front panel with the exception of the paper feed button, which is mounted on the rear panel along with all connections.
For normal use, only the front panel buttons are used; for entering batch numbers, accessing the setup menu and use of advanced features, requires a QWERTY keyboard to be connected to the machine. A compact keyboard is available that can be stored underneath the machine. Alternatively, a standard PC keyboard can be temporarily used for setting up.

When the machine is first delivered the settings are as follows: -

- Load display / output in kg.
- Test Speed of 6 mm/min.
- Test Mode set to Test Button (manual start).
- Printer is ON.
- Weight measurement is set to off (WEIGH BALANCE = NO BALANCE).
- Thickness measurement is turned off (CALLIPER = NO CALLIPER).

If a weigh balance and / or calliper were purchased with the C53, the weight / thickness measurement will have been switched on as appropriate.

The front panel looks like this: -

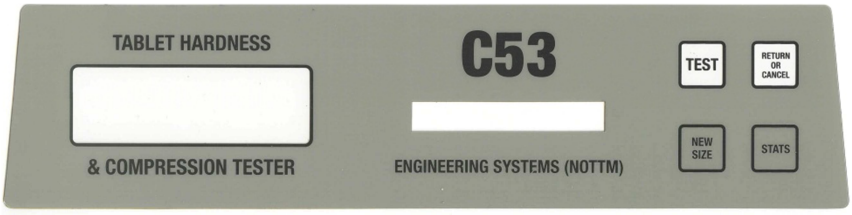


Figure 1 - Front Panel

To operate the machine for the first time: -
Check that the mains supply voltage is correct. Refer also to section 3.1. Plug in the IEC/MAINS connector. Note that **THIS APPLIANCE MUST BE EARTHED**.

It is important that any tablet or other obstruction is removed from the loading area. Any obstruction in this area, will prevent the machine from initialising correctly. Opening the guard (except as below) during the startup routine will cause the routine to restart.

Switch on the rear panel mounted mains switch.
Initialisation starts and the LCD will show "C53 TABLET HARDNESS TESTER". The loading plunger also reverses, to its fully retracted position – and stops. A message appears on the LCD, prompting a check that the platens are clean and that there are no objects within the loading area. If it is necessary to clean the area, open (if shut), clean area, then close the guard.
Initialisation continues and the LCD will show the version number of the installed firmware, also the calibration number (see section 7).
The plunger will move forward to double touch the load cell then return to the last preset test position. This procedure zero's the tablet diameter measuring facility.
The printer will print out the message:

C53
TABLET HARDNESS
TESTER
(SERIAL NUMBER)
(TIME / DATE)
LPR: ###

When the printing has finished the LCD will show its default display with the current load, time, date and tablet count. Throughout the test procedure where possible instructions are shown on the bottom line of the LCD as to which button to press.

Note: LPR stands for Lost Passcode Reset. This number indicates how many times a lost passcode reset has been performed. Details of how to perform a reset are supplied separately with the machine, or can be obtained from Engineering Systems. This number cannot be reset, and can be used to check if an unauthorised reset has been performed.

Have a 'new size tablet' ready for placement onto the loading platform. Press the NEW TABLET SIZE button, the loading plunger will return i.e. move to the right and to the extremity of its travel. During the return motion, position the new tablet onto the loading platform. When the plunger reaches its extreme position, it changes direction and travels at its FAST FORWARD speed until it approaches and touches the tablet. If diameter measurement is set to 'On New Size' the plunger will then back off and approach the tablet slowly, to accurately measure the diameter. The plunger will stop, and then reverse approximately 5 mm to its preset test position.

The machine is now set up for the new tablet size. Place a tablet onto the loading platform and press TEST. The plunger will fast forward to approximately 0.2 mm from the tablet and then change to the set test speed. When the plunger reaches the tablet, loading commences and the load display can be seen to increase. Fracture is detected automatically, then the plunger stops, and reverses to its preset return position. The test result is then printed out. Further tablets from the batch can then be tested by placing a new tablet onto the loading platform and pressing the TEST button.

Note: - If the diameter measurement option is set to 'On Every Test', the plunger will touch the tablet then back off slightly and touch it again slowly.

When the batch is complete, and the statistical information is required, press the STATISTICAL ANALYSIS button. The statistical data will be printed out. When printing is complete, TABLET COUNT is automatically re-set to zero and a further batch of tablets can be tested. If the next batch of tablets is a different size, the NEW TABLET SIZE procedure will have to be followed, if they are the same size as the previous batch, no resetting of the size is required.

2 DESCRIPTION OF THE FRONT PANEL DISPLAY & CONTROLS

The four push button membrane switches, situated on the front panel, control the normal operation of the machine. In addition and LCD and printer are also mounted on the front panel.

2.1 LCD

The LCD shows information about the current operation of the machine, including results data, instruction messages and setup menu. Main features of the LCD are: -

Load Display: During a test or when the machine is idle the hardness is displayed. Tablet weight & thickness are also displayed during and shortly after a test routine. When the standard 50 kg load cell is fitted the maximum load (hardness) is 53 kg and the resolution is 0.01 kg. In addition to reading in kg the units of load can be changed (see setup menu, section 4) to read in kp, Newton's or lbs.

Tablet Count: The tablet count is shown at the end of a test or when the machine is idle and shows the number of successful tests completed in the current batch. The tablet count counter is set to zero when the machine is switched on for the first time, also, after statistics have been printed. The counter is incremented each time a genuine fracture is detected. A genuine fracture can only occur during loading at test speed. If an object e.g. a tablet that is too large is encountered during the fast forward plunger motion, the plunger will touch the object and return to its preset position, the tablet count will not be incremented and a warning message will be shown.

Units can only be changed when the tablet count = 0 (see section 4).
Tablet count is saved when the machine is switched off and restored when it is next switched on.

2.2 TEST BUTTON

A tablet test is started using the TEST button. The exact sequence of the test depends whether the weigh balance and thickness gauge are enabled (see section 4). The sequence is a follows: -

- With the machine showing its default display (load, tablet count & time / date) press TEST. The display will now show 'WEIGHT:' and a flashing cursor if the weigh balance is enabled. If not proceed to the next step. Place the tablet on the balance, **wait for it to stabilise** and press TEST. The weight will be shown on the LCD.

- The LCD will now show ‘THICKNESS:’ and a flashing cursor if the thickness gauge is enabled. If not proceed to the next step. Place the tablet in the calliper jaws and press TEST. The thickness will be shown on the LCD.
- The display will now show ‘HARDNESS’ and a flashing cursor. Place the tablet onto the loading platform, close the guard and press TEST (if guard mode is set to AUTO-START the test will begin automatically). The plunger will travel fast forward to within approximately 0.2 mm of the tablet then change to test speed until fracture is detected. The plunger then reverses to its preset rest position, the peak load (hardness) will be printed (if the printer is switched on) and the tablet count incremented.

Note: - The LCD will return to its default display approximately 30 seconds after a completed test. This shows the current load, time and tablet count. If the C53 is unable to read data from the weigh balance or calliper, or if the units are set wrongly, an appropriate message will be shown on the LCD. Press TEST to retry or RETURN / CANCEL to cancel the test cycle.

2.3 GUARD

Whilst not strictly a front panel control, the guard can be used to start a test instead of the TEST button. If the GUARD MODE is set to AUTO-START then the TEST button will not work, only lowering the guard will start the hardness test cycle. The TEST button still needs to be pressed to measure the weight and thickness. AUTO-START is most useful if the weigh balance and calliper are disabled, as it allows tests to be conducted without pressing any buttons. The GUARD MODE can be set via the setup menu (see section 4).

Regardless of the GUARD MODE setting the hardness test will not start if the guard is raised. Pressing the TEST button with the guard raised displays the message ‘CLOSE GUARD & RETRY’ on the LCD. Raising the guard during a test will cancel the test and the plunger will return to test position.

2.4 RETURN / CANCEL BUTTON

This illuminates to indicate that the plunger is returning. The plunger can be returned and the test cancelled at any point during the test cycle by pressing the RETURN button. Pressing this button immediately following a successful test cancels the last result. The tablet count is decremented and a message is printed to indicate that the test results have been cancelled. The original tablet number is reused for the next tablet to be tested. The button can only be used to cancel the immediately previous result.

2.5 NEW SIZE BUTTON

This button is used to start the automatic sizing procedure for a new batch of tablets.

Setting up for a new size: Have a 'new size tablet' ready for placement onto the loading platform. (The loading platform is situated underneath the Perspex guard). Lift up the Perspex guard and press the NEW SIZE button; 'NEW SIZE' will be displayed on the LCD. The loading plunger will return i.e. move to the right and to the extremity of its travel. During the return motion, place the new tablet onto the loading platform in line with the axis of the plunger. When the plunger reaches its extreme position, it changes direction and travels at its FAST FORWARD speed until it pushes the tablet along to touch the loading platen. The platen detects the touch, then returns approximately 5 mm to its preset return position. The printer prints the message New Size Set. The new size sequence is then complete and the LCD shows its normal display. The machine is ready for testing the new batch of tablets.
It is not necessary to carry out this procedure if the new batch is the same size as the previous batch.

Note: - If small tablets are being sized, it is not necessary to wait until the plunger has fully returned; pressing the TEST button at any time during the return motion will set the plunger moving forwards. Press the CANCEL button at any time before the plunger touches the tablet to cancel the new size routine.
If statistics data is available (tablet count >=2) 'PRINT STATS FIRST' will be shown on the LCD. Press the STATS button to print the statistics, then press NEW SIZE again.

2.6 STATISTICS BUTTON

When the correct batch size is reached and the STATISTICAL ANALYSIS button is pressed, the statistical data is printed out on the printer. This data is also sent to the rear RS232 or USB output (depending which is currently selected) and the tablet counter is zeroed. The maximum batch size is 500. If the batch size reaches this, the statistical data is automatically printed out and the counter is reset to zero.
The Standard Deviation (STD.DEV.) is calculated by using the 'SAMPLE STANDARD DEVIATION' calculation. A typical printout is shown below and includes the Time and Date.
By default, only load statistics are printed. If a calliper and / or balance are connected, thickness & weight statistics can also be calculated and printed; see section 4. Diameter statistics will also be printed if the diameter measurement option is set to 'On Every Test'.

Tab No.	Weight (mg)	Thick (mm)	Hard (kg)
1	379	3.25	5.19
2	379	3.25	5.31
3	380	3.24	4.54
LAST RESULT CANCELLED			
3	379	3.25	5.11
4	380	3.24	5.47

BATCH STATISTICS

Batch No. 1
Batch Size: 4
Min: 5.11 kg
Max: 5.47 kg
Mean: 5.27 kg
Std. Dev: 0.15
Time: HH:MM DAY DD/MM/YY
Serial No: ###-###
Calibration No: 00004

The printout shows that reading No. 3 was manually cancelled. The result is overwritten by the next result, which is then called No.3.
To change the Time & Date, see section 4.

Note: - To print statistical information the tablet count must be at least two. If there is insufficient data the LCD will show 'NO RESULTS' or 'ONLY 1 RESULT' as appropriate, and statistics will not be printed. If batch mode is enabled then statistics will automatically be printed out when the correct batch size is reached.

2.7 DEFINITION OF STANDARD DEVIATION

The sample standard deviation σ_{n-1} is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

Where: n=sample size & x=test result(s)

3 REAR PANEL CONTROLS & CONNECTIONS

The rear panel looks like this: -

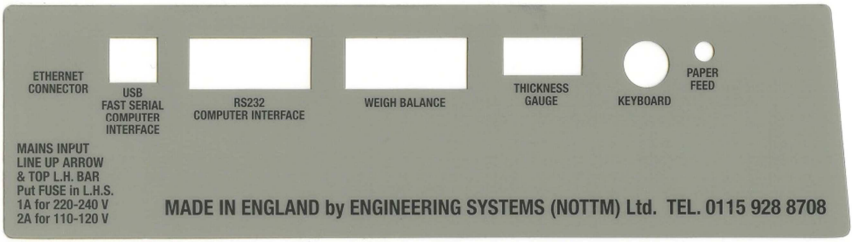


Figure 2 - Rear Panel

The following sections explain the rear panel control and connections in more detail.

3.1 MAINS INPUT

This is not shown above. This comprises an IEC plug, rocker switch and push-in fuse / voltage selector. An IEC/MAINS connection lead is supplied with the machine and should be fitted with a 5A fuse if applicable.
The mains input voltage is normally supplied set to 220 - 240 VAC, this can be changed to 110 - 120 VAC using the following procedure:

- With the IEC lead disconnected remove the fuse holder, complete with fuse.
- Reverse the orientation of the fuse holder such that the arrow on the fuse holder corresponding to the correct voltage aligns with the top left-hand bar on the inlet body.
- Insert the correct value fuse in the left-hand side of the holder and reinsert the holder.

For 220 - 240V operation a 1A SLOW BLOW (T) mains fuse should be fitted, for 110 - 120V operation this should be changed to a 2A SLOW BLOW (T) fuse.

WARNING – THIS APPLIANCE MUST BE EARTHED

3.2 ETHERNET CONNECTOR

The Ethernet expansion space will allow for an RJ45 Ethernet connection to be added to the C53 through a plug-in board in the future.

3.3 USB DATA INPUT/OUTPUT

The USB type 'B' connector provides a USB interface for connection to a PC. Connection to a PC should be made using a standard USB 2.0 type 'A' to type 'B' cable.

With the cable connected and drivers installed the machine will be shown in Windows as a virtual COM port that can be accessed in the same way as the RS232 output, e.g. using HyperTerminal. A driver for the interface, along with installation instructions, can be downloaded from Engineering Systems web site, www.engsys.co.uk.

DO NOT PLUG THE MACHINE INTO A USB PORT UNTIL THE DRIVER HAS BEEN INSTALLED!

Data transmitted on the USB interface is the same as that printed on the C53's printer. The USB interface must be selected in the setup menu (see section 4). Only one of the RS232 or USB interfaces is available at any one time.

3.4 RS232 DATA INPUT/OUTPUT

The 9 way 'D' type female connector provides an RS232 output, transmitting the same data as printed on the internal printer. Data is transmitted even when the internal printer is switched off.

The data is transmitted in the format: -

19200 baud, No parity, 1 Start bit, 8 Data bits, 1 Stop bit, No flow control.
The pin connections of the 9-way female 'D' connector are:

- Pin 2: RS232 output (TXD)
- Pin 3: RS232 input (RXD)
- Pin 5: GROUND.

The remaining pins on the 9-way connector are not connected. The C53 should be connected to a PC using a standard (straight) serial cable, NOT a null-modem cable.

3.5 RS232 / USB DATA FORMAT & COMMANDS

By default the RS232 and USB output data is in the same format as the printer output; however it is possible for the format to be changed. Customised outputs are available to suit individual requirements. Contact Engineering Systems for details.

Limited functions of the machine can be controlled via the RS232 or USB connection. The available commands are as follows. All characters are lower case:

Character sent to C53	Function
't'	Same as pressing TEST button
'r'	Same as pressing RETURN / CANCEL button
's'	Same as pressing STATISTICS button
'n'	Same as pressing NEW SIZE button
'p'	Same as pressing PAPER FEED button

More control characters may be available in later firmware versions.

3.6 WEIGH BALANCE

The RS232 output of a supported weigh balance can be connected here. A reading from the balance can be taken as part of the test routine and the results shown on the LCD and sent to the printer. The type of balance connected must be selected via the setup menu (see section 4). If no balance is connected then NO BALANCE should be selected for the balance type; readings from the balance will be omitted from the test routine. The balance must be set to display weight in milligrams (mg). The only exception to this is the OHAUS VP interface – 2 versions are available, one for use with the balance set in milligrams, and one for use with the balance set in grams. In either case the weight will be shown in milligrams on the C53 display and printouts. Weights of 0 – 30g can be accepted from the balance; an error will be given if the weight is negative or over range.

The pin connections of the 9-way male 'D' connector are:

- Pin 2: RS232 input (RXD)
- Pin 3: RS232 output (TXD)
- Pin 5: GROUND.

The connecting cable required will depend on the type of balance:

For an Adam PGW-153e balance a standard straight-wired male-female cable is required.

Older Adam balances require a null-modem female-female cable.

For the OHAUS VP balance a custom made cable is required since the pin connections are non-standard on the balance. The supplied cable must be connected the correct way around; the black connector should connect to the C53 and the blue connector to the balance.

Most other balances require a standard straight-wired male-female cable.

3.7 THICKNESS GUAGE (CALLIPER)

A Mitutoyo type calliper can be connected here. To disable the calliper select 'NO CALLIPER' from the setup menu (see section 4). Thickness measurements will be omitted from the test routine. Callipers or micrometers with 2DP or 3DP resolution can be used; readings will be converted to 2DP. Values in the range 0 – 99.9 mm are acceptable, an error will be given if a negative or over range value is received.

3.8 KEYBOARD

A standard or compact PS/2 QWERTY keyboard can be connected into the rear connector. This can be used to enter a batch number or name, or to access the setup menu and advanced functions of the C53. The C53 should be switched off before connecting or disconnecting the keyboard.

3.9 PAPER FEED

Pressing the paper feed button whilst the machine is idle (i.e. not during a test routine) will feed a short length of paper out of the printer. To feed more paper press the button repeatedly.

4 SETUP MENU

Whilst basic operation of the C53 is possible, using only the front-panel buttons, advanced features and test parameters are only accessible via the setup menu. To access the setup menu, a QWERTY keyboard must be connected to the machine. The menu is passcode protected to prevent unauthorised changes to settings.

To access the setup menu make sure the machine is idle (not in a test) and press F1 on the keyboard. Enter the 4-digit pass-code (the default is 1234, this can be changed once in the menu). If the code is correct the setup menu will be displayed. If not 'INCORRECT!' will be shown; press ENTER and type the code again, or press ESC to cancel.

4.1 MENU NAVIGATION

The keys used to navigate around the menu are common throughout the menu. Use the up and down arrow keys to scroll through the menu items. Press ENTER to select a menu item. Press ESC to return to the next level up the menu structure, or to quit the top level of the menu.

4.2 MENU STRUCTURE

The following table shows the layout of the menus. Refer to the section number in the table for an explanation of each menu item.

Top Level Menu		Next Menu Level		Next Menu Level
Print Options (4.3)		Printer On / Off		On
				Off
		Results Print		On
				Off
		Startup Print		On
				Off
		Rotated Print		On
				Off
		Batch Number		On
				Off
Batch Options (4.4)		Batches On / Off		On
				Off
		First Batch Size		Select Size (2-500)
		Other Batch Size		Select Size (2-500)

		Reset Batch Number		Confirm (ENTER) or cancel (ESC)
PC Interface (4.5)				USB
				RS232
Set Units (4.6)				Kg
				Kp
				N
				Lb
Set Test Speed (4.7)				List of test speeds (4 – 50 mm/min)
Weigh Balance (4.8)				No Balance
				List of supported balances
Calliper (4.9)				No Calliper
				Mitutoyo Absolute
Diameter (4.10)				Off
				On New Size*
				On Every Test*
Product Details (4.11)				Start of New Batch
				After New Size
				Off
Statistics (4.12)				Load Only
				Load + Weight
				Load + Thickness
				All
Set Guard Mode (4.13)				Manual
				Auto Start
Set Date / Time (4.14)				Set Time & Date Routine
Show Seconds (4.15)				On
				Off
LCD Backlight (4.16)				Off
				5 mins
				10 mins
				On
Calibration (4.17)		Calibrate		Calibration Routine

		Restore Calibration		Restore Calibration Routine
		Auto Load Check		Once A Day
				Every Start-up
				Never
		Change Code		Change Calibration Code
Fracture % (4.18)				Select % (30-90%)
Change Code (4.19)				Change Setup Menu Access Code

4.3 PRINT OPTIONS

Printer On / Off – Setting this to 'OFF' disables all printing. Data is still transmitted from the RS232 or USB port, and results are saved. Statistical data can still be printed if the printer is switched on again before the 'STATS' button is pressed. *Firmware V1.23 or later automatically enables the printer during calibration, regardless of this setting.*

Results Print – Enables or disables the printing of individual test results. Statistical analysis and other messages are still printed.

Startup Print – Enables or disables the message printed when the machine is switched on.

Rotated Print – Rotate printing 180 degrees to make it easier to read as it exits the printer. Note that the print-out will appear 'upside down' – i.e. the first line to be printed will be at the bottom of the paper, with subsequent lines above it. This is unavoidable in this mode since data is printed in real time. Calibration certificates will always be printed without rotation, regardless of this setting.

Batch Number – Enables or disables printing of the batch number on statistics. This can be disabled if not needed, or if a separate incompatible system of batch numbering is used.

4.4 BATCH OPTIONS

Batches On / Off – Enables or disables the fixed batch size functions. With this option switched off the machine continues testing until the 'STATS' button is pressed or the tablet count reaches 500. Statistics are then printed; the tablet count is reset and a new batch is started.

With fixed batch size enabled the machine will continue testing until the set batch size is reached, and will then print statistics, reset the tablet count and start a new batch. If desired, the first batch can be a different size to the subsequent batches.

First Batch Size – Sets the first batch size, between 2 and 500. Use the arrow keys to select the required number. This is the size of the first batch tested after the batch number has been reset.
Other Batch Size – Sets the size of other batches tested after the first one, again between 2 and 500.
Reset Batch Number – This deletes all stored test results & statistics and resets the batch number to 1. Press ENTER to confirm the deletion, or ESC to cancel without deleting data. If fixed batch size mode is enabled, the size of the next batch tested will be 'First Batch Size' (see above).

4.5 PC INTERFACE

Sets the interface to use either RS232 or USB. See sections 3.4 - 3.5 for an explanation of the connections and data output format. Only one interface can be enabled at a time.

4.6 SET UNITS

Selects the hardness measurement units to use. Choices are Kilograms (kg), Kiloponds (kp), Newtons (N) or Pounds (lb). The choice of units can only be changed when the tablet count = 0 and the batch number has been reset, since statistical analysis cannot be performed on data of mixed units.

4.7 SET TEST SPEED

Sets the speed at which the tablet is crushed during a test. Choices are 4, 6, 10, 16, 20, 25, 30 or 50 mm/min. To ensure consistent results the speed can only be changed when the tablet count = 0 and the batch number has been reset.

4.8 WEIGH BALANCE

Selects the type of weigh balance connected to the machine. Choose the make and model of balance from the list, or select 'NO BALANCE' to disable weight measurement. If your balance isn't listed contact Engineering Systems to check if a firmware update is available to accommodate it.

4.9 CALLIPER

Enables or disables the Mitutoyo thickness measurement calliper. Select 'NO CALLIPER' to disable thickness measurement.

4.10 DIAMETER

Enables or disables diameter measurement. When enabled, the nominal diameter of the tablet will be measured using the platen-plunger. 3 options are available *:

Off – Diameter measurement is disabled

On New Size – Diameter is measured during the New Size procedure, and is shown on the LCD and printed out below the 'NEW SIZE' message.
On Every Test – Diameter is measured before every test. This is printed in a column on the test results, and diameter statistics are also printed.

** Firmware V1.16 or older only has 2 diameter options, 'On' or 'Off'. 'On' measures the diameter during New Size.*

Note: - To ensure accurate diameter measurement, ensure that the loading area is completely clear of debris during machine start-up.

4.11 PRODUCT DETAILS

Enables the entry and printing of batch details after using 'new size', or at the start of each batch. When enabled the machine will prompt the operator to enter a product name, batch ID and operator ID. A QWERTY keyboard must be connected to use this option. 3 options are available:

Start of New Batch – product details are requested before the first test of a new batch, i.e. when TEST is pressed and the tablet count is 0.
After New Size – product details are requested after a 'NEW SIZE' operation and are printed out.
In either of the above 2 modes, batch details are stored to memory as well as being printed, and can be recalled along with the test results & statistics (see section 5).
Off – product details are never requested.

Note: - Firmware versions 1.17 or earlier only saved details to memory if 'Start of New Batch' was selected.
Version 1.18 or later will show the details from the last batch during batch detail entry. To copy the details to the new batch simply press ENTER. Alternatively start typing new details; the previous details will disappear as soon as a new character is entered.

4.12 STATISTICS

Enables or disables printing of statistics for weight and thickness. Options are 'Load Only', 'Load + Weight', 'Load + Thickness' or 'All' (load + weight + thickness). All statistics are printed together when the STATS button is pressed. Weight and thickness statistics will only be printed if a balance or calliper is enabled respectively. For example to print weight statistics, the STATISTICS option must be set to 'Load + Weight' or 'All', and the WEIGH BALANCE option must **not** be set to 'NO BALANCE'.

4.13 SET GUARD MODE

Set the guard mode to 'MANUAL' to start a test only by pressing the TEST button. Set the mode to 'AUTO START' to start the hardness measurement test when the guard is closed. See section 2.3 for full details.

4.14 SET TIME / DATE

Sets the time & date. The current time & date will be shown on the LCD, enter the new hour, minute, date, month & year using the keyboard. The seconds will automatically be zeroed, and the day of the week calculated. Press the right arrow key to skip any digits that are already correct, and press ENTER at any time to save the displayed time / date. Press ESC to cancel without saving changes.

4.15 SHOW SECONDS

Enables or disables the display and printing of seconds on the LCD and printouts. When 'OFF' is selected only minutes & hours will be shown.

4.16 LCD BACKLIGHT

Controls the behaviour of the LCD backlight. Select 'ON or 'OFF' to turn the backlight permanently on or off. Select 5 or 10 mins (minutes) to allow the backlight to stay on for the selected time after a key is pressed or the guard raised or lowered, and then turn off to save power until further use.

4.17 CALIBRATION

The calibration menu can only be accessed by entering the calibration passcode. Enter this in the same way as the setup menu passcode. The default code is '1234' and can be changed once in this menu.
Calibrate – Start the calibration procedure. See section 7.1 for details
Restore Calibration – Allows a previous calibration to be recalled. See section 7.5.
Auto Load Check – Selects when the automatic load check will be run. Options are 'once a day' (check runs the first time the machine is switched on each day), 'every start-up (check runs every time the machine is switched on) and 'never' (check is disabled).
Change Code – Changes the calibration menu passcode. The procedure for this is the same as for changing the setup menu passcode, described in section 4.19.

4.18 FRACTURE %

This option allows the fracture detect percentage to be altered. Fracture is detected and the plunger motion is stopped when the instantaneous load measured by the load cell falls below a preset % of the maximum load attained during testing. This % can be changed in the range 30-90%. Typical values

are 60%-70%. Use the arrow keys to change the value. See Appendix A for a further discussion of this.

4.19 CHANGE CODE

Select this option to change the passcode used to enter the setup menu. Enter the new 4-digit code (the only characters allowed in this code are between 0 & 9) as prompted on the LCD, then re-enter the new code to confirm it. If a mistake is made at any point press ESC and start again. If the new code and confirmed new code don't match 'INCORRECT!' will be shown; press ENTER to start again, or ESC to cancel.

If either the setup menu code or calibration code is forgotten, a lost passcode reset will need to be carried out. Instructions for doing this are supplied separately with the machine or can be obtained by contacting ENGINEERING SYSTEMS. Performing a lost passcode reset will increment the LPR number printed when the machine is started up – this cannot be reset.

5 RECALL OF STORED BATCH RESULTS

Each time a test is completed, test results are stored to the internal memory. Details are stored for each batch (a batch is completed when the STATS are calculated) and can be recalled for re-printing on the internal printer or a PC. To use the recall functions you will need a QWERTY keyboard connected.

To access the recall menu make sure that the machine is idle (not in a test) and press F2 on the keyboard. This will display a menu similar to the setup menu described in section 4; the same keys are used to navigate through the menu.

Note: - Only completed batches (i.e. those for which statistics have been printed) can be recalled. A partly completed batch (where some tests have been carried out but the statistics not yet printed) will not be shown in the menu.

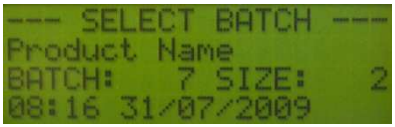
5.1 MENU STRUCTURE

The following table shows the layout of the menus. Refer to the section number in the table for an explanation of each menu item.

Top Level Menu	→	Next Menu Level	→	Next Menu Level
Reprint Single Batch (5.2)		Select Batch		Print Results
				Print Statistics
				Print All Data
Reprint All Batches (5.3)				
Send Batches To PC (5.4)				
Clear All Batch Data (5.5)				Clear results & result batch number (ENTER) or cancel (ESC)

5.2 REPRINT SINGLE BATCH

Test results and / or statistics can be printed for a single batch. Use the UP / DOWN arrow keys to select the batch to reprint. The LCD will show the following information for each batch selected:



Product Name – The name entered when the product details were requested for the selected batch. This line will be blank if the 'Batch Details' option was set to 'Off' when the batch was stored (see section 4).
Batch – The batch number, starting at 1 each time the stored results are cleared, and incrementing for each batch.
Size – The number of tests performed in the batch (i.e. the tablet count)
Time / Date – The time & date at which the batch was finished & the statistics calculated (NOT the time the batch was started).

Press ENTER to select the required batch. This will display a further menu with the following options:
Print Results – reprints just the test results for the selected batch
Print Statistics – reprints just the statistics for the selected batch
Print All Data – reprints both the test results & statistics for the selected batch

5.3 REPRINT ALL BATCHES

Results and statistics for all stored batches will be printed out. Depending on the number of batches stored this could give a large printout! Press ESC to cancel printing; printing will stop after the current batch has been printed.

5.4 SEND BATCHES TO PC

This is similar to 'Reprint All Batches', however the printout is only sent to the USB or RS232 interface and not to the internal printer. A terminal program such as HyperTerminal can be used to receive the data on the PC.

5.5 CLEAR ALL BATCH DATA

This deletes the stored test results & statistics and resets the batch number to 1. Press ENTER to confirm the deletion, or ESC to cancel without deleting data. This function is also accessible through the setup menu – see 'Batch Options' in section 4.

6 PRINTER

6.1 THE PRINTER

The printer prints the tablet weight and thickness (when applicable) and the peak reading at fracture (hardness), as shown on the LCD. Printing occurs automatically at the end of a successful test cycle. The printer also prints out the statistical data when the STATISTICAL ANALYSIS button is pressed or a set batch size is reached.

Print options can be set, or the printer can be disabled completely, via the setup menu using the keyboard (see section 4). Paper can be fed though the printer by pressing the rear-panel paper feed button whilst the machine is idle. Multiple presses of the button may be necessary.

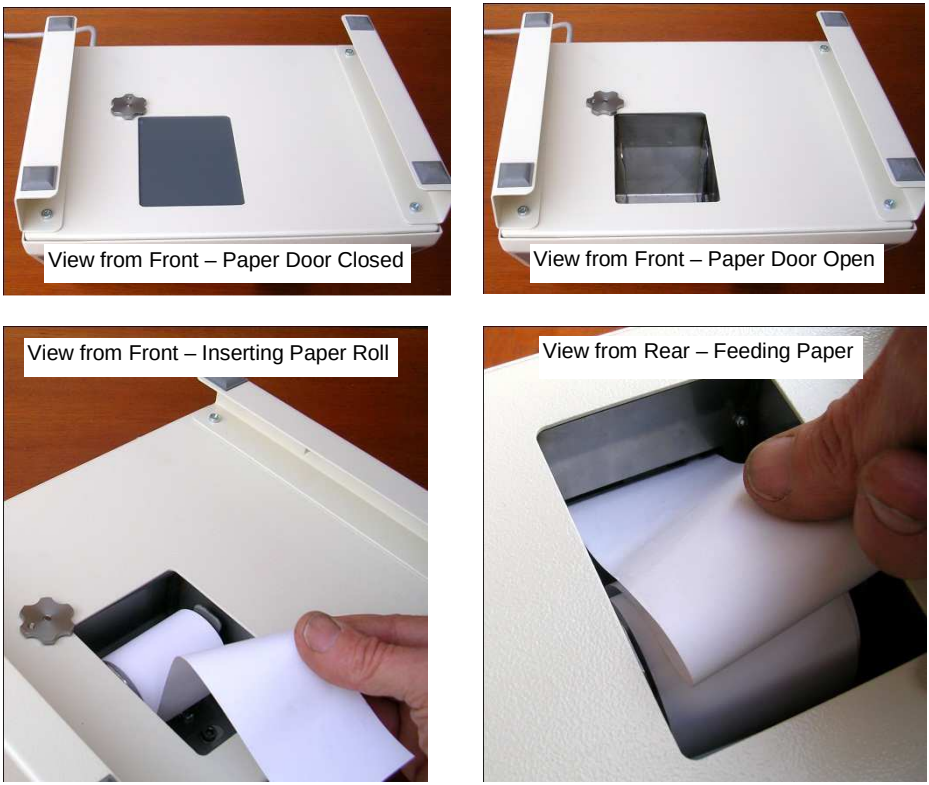


Figure 3 - Paper Roll Replacement

6.2 OPERATING THE MACHINE WITHOUT A PAPER ROLL

If the machine is switched on without a paper roll the printer will be temporarily switched off. To re-enable the printer once the roll is replaced switch the machine off and back on.

If the paper runs out whilst the machine is switched on it will operate slowly as it will wait for the printer each time it tries to print. Either replace the paper roll, or if a new roll is not immediately available, switch off the printer in the setup menu. In this case it will be necessary to re-enable the printer via the setup menu once the roll has been replaced.

6.3 PAPER ROLL REPLACEMENT

With the machine switched ON, turn it upside down and rest it on its top. Take care not to scratch the case or damage the Perspex guard when doing this.

Open the paper door on the base of the machine by turning the lever anti-clockwise (top pictures).

Remove the old paper roll by gently pulling out any remaining paper. Pull the spindle upwards to remove it from the machine and discard the remains of the old roll. Remove any remaining scraps of paper from the front of the printer.

Take a new roll of paper and separate the end from the rest of the roll. Slide the roll onto the spindle and replace the spindle into the machine such that the paper feeds from the reel at the bottom of the paper housing, towards the printer (bottom-left picture).

With the machine switched ON, insert the end of the paper into the printer mechanism (bottom-right picture). After a short delay the printer will automatically feed the paper through and out of the front of the machine. If necessary, use the paper feed button on the rear of the machine to feed more paper though.

Check that the paper is straight then close the paper roll door. If the paper is not straight gently pull paper through to straighten it. If the edge of the paper is folded over remove the paper and re-insert it.

The printer mechanism used is a CP 205-MRS manufactured by APS. Paper rolls should be available from local suppliers worldwide.

Use 57 mm wide x 25 metre, 45 mm maximum diameter, 13 mm internal diameter thermal paper rolls.

NOTE: THERMAL PAPER MUST BE USED. PAPER DESIGNED FOR USE IN IMPACT PRINTERS (SUCH AS THOSE USED IN OLDER ENGINEERING SYSTEMS MACHINES) IS NOT SUITABLE!

For U.K. users paper rolls are available from: -

- Farnell Electronic Components Tel. 08447 11 11 11, www.farnell.com, Order code 391-6170
- Able Systems Ltd. Tel. 01606 48621, www.able-systems.com, Order code 04-A05860TPR1

Details correct January 2014

7 CALIBRATION

Before the C53 is delivered, it is calibrated to conform to the ASTM standard E4-07 (Force Verification of Testing Machines). A calibration certificate accompanies each machine and shows that it has been loaded up to 50 kg, with 5 x 10 kg weights.
If the user requires re-calibration conforming to the above standard then the same procedure should be followed.
Whilst it is best to use the specially shaped weight hanger manufactured by Engineering Systems, users may wish to purchase their own weights locally (because of carriage costs). Preferably use ∅150 mm (6") Cast Iron slotted weights with a slot that is at least 12 mm (1/2") wide.

7.1 CALIBRATION BY DEAD WEIGHT LOADING

The calibration procedure is normally carried out using kg weights.
Regardless of the units currently in use the machine will change to kg when calibration mode is entered and will revert to the selected units when finished. The displayed load will still be valid in the selected units.
The machine can be calibrated using weights as shown in the photograph.

Figure 4 – Calibration

Safety note:- Hanging 50 kg of weights onto the C53 loading platform is a hazardous operation. Great care is needed when performing this procedure. If the machine is not correctly positioned during the loading of the calibrating weights, there is a danger of the weights and the machine falling over. If the correct procedure is not followed, damage to personnel and equipment is likely. Because of the danger of hanging 50 kg of weights onto the C53, it is strongly recommended that the C53 Calibration Cradle, Ref. No. C53CC, and the specially shaped weight hanger, Ref. No. C53WHCAL are both used. Both are available from ENGINEERING SYSTEMS. Always wear safety shoes during calibration.

It is recommended that calibration using dead weight loading is carried out periodically. A 6-month period between calibrations is suggested.

1.) Ensure a QWERTY keyboard is connected. If not then switch off the machine, connect the keyboard then switch back on. If a printed calibration

certificate is required, ensure that the printer is enabled. *Firmware 1.23 or later will automatically enable the printer during calibration.*

2.) Remove the waste drawer. Turn the machine to rest on its left hand side and position near to the edge of a solid bench that has a clear space underneath (as shown in the photograph). For accurate calibration, the load cell platen should be horizontal. Using the Calibration Cradle ensures that the machine is held vertical and cannot slip sideways during calibration.

3.) Enter the setup menu (see section 4) and select 'CALIBRATION' then press ENTER. Enter the calibration passcode and select "CALIBRATE'. If you enter the code incorrectly press ENTER then re-enter it. Wait for the plunger to return to its maximum position.

4.) The LCD will show the load applied to the platen. Don't worry if it isn't reading zero at the moment. Remove any load as instructed on the LCD then press ENTER. The load display should now read zero.

IMPORTANT: - The calibration procedure assumes a calibrated weight hanger is used, i.e. the hanger weight is included in the applied dead weight. If an uncalibrated hanger is used the machine must be zeroed with the hanger applied. To do this, keep the hanger in place whenever instructed to remove the load.

5.) Using a suitably shaped hanger (see previous page) and set of weights (as suggested above) load the machine to 50 kg with the weights hanger resting on the loading platen, wait for the reading to stabilise then press ENTER. An error will be displayed if insufficient load is applied at this stage.

NOTE: - Up to this stage the calibration can be cancelled by pressing ESC on the keyboard. From this stage onwards the calibration cannot be cancelled and must be completed.

6.) Remove the weights and press ENTER. After a short delay the machine will store a new electronic load check value (see section 7.3).

7.) The calibration value will now be verified and a certificate printed. Load the platen as instructed on the LCD in steps of 10 kg, pressing ENTER each time once the load has stabilised. Now remove the load in 10 kg steps, again pressing ENTER each time as instructed. Once complete the load cell linearity will be calculated and a hard copy printed, along with the new calibration number, time, date and firmware version.

8.) 'Remove Hanger' will be displayed on the LCD. **Remove the hanger** and press ENTER; the plunger will return to the test position. The calibration procedure is now completed.

9.) Press ESC twice to exit the setup menu.

7.2 CALIBRATION CERTIFICATE

The hard copy print of the calibration values does not contain all the details necessary for a Full Calibration Certificate. To produce a full certificate, the Hard Copy details are manually copied into the Full Certificate (C53 LOAD CALIBRATION CERTIFICATE). This provides a certificate that complies with ASTM E43.

7.3 ELECTRONIC LOAD CHECK

The C53 incorporates an automatic load check routine that can be run once a day when the machine is first switched on, or at every switch-on (see section 4.17). This connects a high stability resistor into the load cell circuit to give a simulated load reading on the LCD.

During the previous dead-weight calibration procedure a reading was taken with the resistor in circuit. This was stored and is compared to the reading obtained during the load check routine. This reading is used to give a daily calibration check. This is approximate and should not be taken as a definitive calibration value. Periodic dead weight calibration is necessary to ensure continuing accuracy of the C53.

When the machine is switched on the routine will wait 30 seconds to allow voltages and temperatures to stabilise, and then read the simulated load with the resistor in circuit. The simulated load and the difference between this and the value stored at the last calibration will be displayed on the LCD.

If the difference is greater than approximately 0.20 kg, re-calibration should be performed as described in section 7.1. Note however that the load check is sensitive to temperature changes, so if the machine is excessively warm or cold the difference may be higher.

7.4 CALIBRATION NUMBER

The calibration number can be used to track the calibration certificate related to a printed set of test results, or check whether the machine has been calibrated without authorisation. Each time the machine is calibrated the number is incremented. The number is printed after calibration, on statistical analysis data and when the machine is switched on. The number is unique to the specific calibration for that machine, and will only roll over after 65,536 calibrations.

7.5 REVERTING TO A PREVIOUS CALIBRATION

In addition to the most recent calibration, 2 previous calibration values are stored and can be recalled. This could be useful if, say, the machine is calibrated accidentally and the previous good calibration needs to be restored. The list of calibrations available can be accessed via the setup menu (see

section 4). Select ‘CALIBRATION’ from the menu and press ENTER. Enter the calibration passcode and select ‘RESTORE CALIBRATION’. Use the up and down arrow keys to select the calibration value required. The value currently in use will be marked ‘(IN USE)’. Calibration values are stored by date, followed by a number allowing multiple calibrations on the same day. e.g. 21/06/06-2 would be the second calibration carried out on 21/06/2006.

Press ‘ENTER’ to confirm the choice and use the calibration value selected. The printer will print ‘CALIBRATION RESTORED’, along with the date as shown on the LCD, and the calibration number.

8 MAINTENANCE & TROUBLESHOOTING

WARNING: - Removal of the bottom cover of the machine exposes mains voltage connections. Always disconnect the IEC mains cable before removing these covers. Only qualified personnel should be allowed to check for faults if any of the outer casings have been removed and the mains supply is connected. The mains connections within the machine are confined to those between the IEC input module and the transformer; no mains voltages are present on the circuit boards. DC voltages within the machine do not exceed 24V.

Be aware that static electricity present in the human body can damage sensitive electronic components. Do not work on the electronic circuit boards in the vicinity of nylon carpets etc. If the electronic boards have to be removed first touch an earthed metal appliance and try to hold them at their edges without touching tracks or components. It is advisable to wear an anti-static wristband whilst handling any boards or components.

Part numbers referred to in this section are show on the diagrams in section 10.

8.1 ROUTINE MAINTENANCE

- **Empty the Waste Drawer** (left hand side of the machine) **regularly.**
- **The small space** between the bottom of the plunger and the loading platform can become filled with powder etc. and in severe cases could slow down or stop the motor from operating. A thin steel strip (similar to a feeler gauge) should occasionally be used to clear out this region.
- **Powder etc.** can sometimes build up between the loading platform and the load cell platen. This could affect the accuracy of the test results. This area should occasionally be cleared, using the same tool as above.
- **Routine mechanical maintenance** involves removing the outer casings and cleaning any powder, dust etc. from the inside of the machine.

If faults cannot be easily traced, contact Engineering Systems.

Users or customers are advised to contact Engineering Systems before any returns are made, as problems can often be solved by telephone, e-mail or fax.

The serial number can be found on a sticker on the rear of the machine, or on the print-out when the machine is switched on. This number should be quoted in any correspondence regarding the machine.

8.2 REMOVING AND REPLACING BOTTOM & TOP COVERS

Turn the machine upside down to rest on its top cover. Remove the 2 screws at the back of the machine and lift off the bottom cover, sliding it backwards.

If the top cover needs to be removed unscrew the 2 screws inside the bottom part of the case (part 11) and lift the machine off the top cover. Take care not to damage any components when handling the machine. If required the machine can be placed in the upright position.

Replacing:-
Refit the top cover first by placing it over the machine, then resting the machine on its top and replacing the 2 screws. Ensure these screws are tight.

Refit the bottom cover by placing it over the machine and tightening the 2 fixing screws. Check that the printer paper door opens correctly.

Check the operation of the machine.

8.3 SPECIFIC FAULTS (TROUBLESHOOTING)

Please check the following list of common problems before contacting Engineering Systems or attempting repairs:

- **Machine malfunctions when switched ON after switching OFF:** A gap of at least 5 seconds must be left between switching the machine OFF and ON again.
- **LCD or buttons do not light up:**
  - Check plug fuse (where applicable), wall socket and main lead
  - Check mains fuse, see section 9.
  - Check internal fuses, see section 9.
  - Check all fuses are of the anti-surge (T) or slow- blow type.
  - Check connectors and cables between the main board, LCD, front board, power supply board and printer.
- **Machine pauses for a long time at start-up and after each test:** Check that the printer has paper and that it is correctly inserted.
- **Motor does not start:**
  - Check internal fuses
  - Check motor connector
  - Check plunger zero microswitch & connector
  - Check encoder connector
- **Motor starts but no plunger movement:** Mechanical fault, Gears slipping. Tighten or replace gears as necessary.
- **Motor will not start:**
  - Faulty power supply board.

- Faulty motor drive transistors.
- Faulty motor
- Has the plunger travelled too far forward or back? If so, the plunger can be released by turning the gear wheel situated at the right hand end of the loading frame (after removing the bottom & top covers).

- **Motor Drive Faults:** Usually this is a fault with the power transistors that drive the motor and not the motor itself. If possible test the 4 FET power transistors on the power supply board and replace any faulty ones.
- **Fuses blow at switch-on:** Check that anti-surge (slow blow) fuses are being used, and that the correct voltage is selected on the fuseholder. If the internal fuses repeatedly blow, refer to section 9.
- **Load Display will not zero:**
  - Check load cell platen is not obstructed.
  - Fault with load cell, is there a possibility that the load cell has been overloaded? Check for linearity etc. with weights.
- **Load Display reads full scale or fluctuates wildly:**
  - Load cell not plugged in or leads damaged.
  - Load cell power supply fault
  - Main board fault.
- **Displays will not settle to a constant value:**
  - Main board faulty.
  - Load cell or connections faulty.
- **Printer not working correctly:**
  - Check the printer is turned on in the setup menu.
  - Make sure that the printer has paper and that the paper is not trapped inside the printer body or machine case.
  - Check that the correct thermal paper has been used, and is inserted the correct way up.
  - Check that the internal printer connector is connected correctly.

TIME & DATE incorrect: Reset the clock via the setup menu (see section 4). If the time & date are incorrect again after the machine has been switched off, the internal battery needs replacing. Remove the bottom cover and replace the CR1616 coin cell on the main board (part 9 on the diagram in section 10).

8.4 ERROR MESSAGES.

The C53 will automatically diagnose a range of faults. Error messages are shown on the LCD. The meaning of these and possible cure is shown below: -

MOTOR POWER ERROR	24V motor power supply is too low. Check fuses on power supply board.
BALANCE COMMS. ERROR	Unable to communicate with the weigh balance. Check a balance is connected and switched on, and that the correct balance type has been selected in the setup menu.
BALANCE: INCORRECT UNITS	The measurement units are set wrongly on the weigh balance. Check the setting on the balance (refer to weigh balance handbook for instructions).
BALANCE: NEGATIVE	A negative reading has been received from the balance. Check that it is zeroed correctly.
BALANCE: OVERRANGE	The reading from the balance is greater than 30g.
CALLIPER COMMS ERROR	Unable to communicate with the calliper. Check the calliper is connected and switched on.
CALLIPER: INCORRECT UNITS	The measurement units are set wrongly on the calliper. Press 'in/mm' on the calliper to set the units to mm.
CALLIPER: NEGATIVE	A negative reading has been received from the calliper. Check that it is zeroed correctly.
CALLIPER: OVERRANGE	The reading from the calliper is greater than 99.99 mm.
KBOARD ERROR 1 / 2	An error occurred communicating with the QWERTY keyboard. Check the connector is pushed in completely and try again. If the problem persists try a different keyboard.
LOAD IS TOO LOW	Insufficient dead weight was applied during the calibration procedure. Apply the correct load as instructed on the LCD and press ENTER to retry.

8.5 FIRMWARE UPDATES

The operating firmware in the machine can be updated using a PC via a USB or RS232 connection. Contact Engineering Systems or visit www.engsys.co.uk to check if new firmware is available. Instructions for updating the firmware are supplied with the firmware updates.

9 REPAIR

WARNING: - Removal of the bottom cover of the machine exposes mains voltage connections. Only qualified personnel should be allowed to check for faults if any of the outer casings have been removed and the mains supply is connected. The mains connections within the machine are confined to those between the IEC mains input module and the transformer; no mains voltages are present on the circuit boards. DC voltages within the machine do not exceed 24V.

The C53 is built from mechanical and electronic modules. Instrument mechanics and/or electronic engineers should have no difficulty in replacing any of the major modules, all of which are available as spares.

Part numbers referred to in this section are show on the diagrams in section 10.

If faults cannot be easily traced, contact Engineering Systems, quoting the serial number and firmware version.

9.1 FAULTS/SYMPTOMS/CURES etc.

Sometimes faults are very simple to cure!
Faults such as - 'nothing happens when the machine is switched on' can sometimes be cured by anyone who knows how to change a fuse.
However, more serious faults can sometimes occur and the machine can either be returned to ENGINEERING SYSTEMS for repair or the following notes may help to make an in-house repair possible.

The ability to cure the more subtle or elusive faults requires some understanding of how the machine works. The diagram overleaf shows, in outline, how the C53 operates.

Power is supplied to the machine by the mains input (comprising IEC connector, fuse, switch, filter & voltage selector), transformer and power supply board. Applied load is measured by the load cell and fed to the main board, along with position signals from the motor encoder. The motor is switched via the H-bridge on the power supply board, controlled by signals from the main board. The front panel buttons, LCD and printer all connect to the main board, along with rear-panel connectors to the weigh balance, calliper, computer and keyboard.

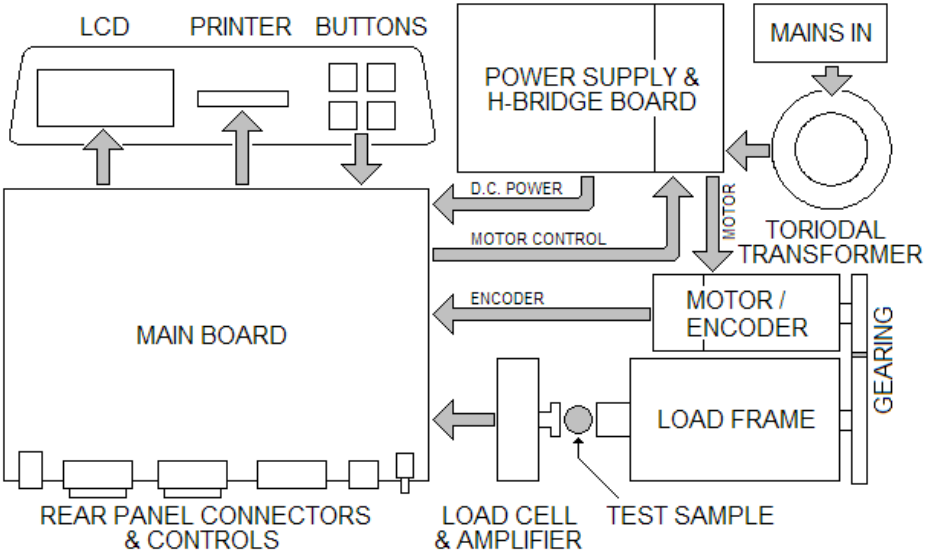


Figure 5 - Module Block Diagram

The machine is MODULAR i.e. built of larger easily replaceable units onto which the many smaller components are mounted. There are approx. 9 easily replaceable main modules fitted to the top & bottom of the machine, to which the wiring and other fixed (but replaceable) items are attached. There are basically two types of faults that can occur - MECHANICAL or ELECTRICAL.

The main replaceable modules are: -

- **MECHANICAL:** Load Frame mechanism, including the sub-modules, Motor + Encoder, Load Cell.
- **ELECTRICAL:** Toroidal Transformer.
- **ELECTRONIC:** Main board, LCD, Front board, Power Supply board, Printer.

9.2 FIRST STEPS IN FAULT FINDING

Start by checking the list of specific faults (section 8). Also check for any obvious damage to mechanical parts or burnt / damaged components.

9.3 FURTHER STEPS IN FAULT FINDING

Consider whether the fault is likely to be electrical or mechanical. Faults can usually be isolated into small areas.

9.4 ELECTRICAL & ELECTRONIC FAULTS

One does not necessarily need to be an expert in electronics to cure 'modular electronic faults'. For example, if the printer is not working correctly it may simply a matter of removing the case and screwing in a new printer mechanism. However, fault finding is not always straightforward and to cure those subtle faults an awareness of electronics will be needed.

Personal STATIC DISCHARGE can damage some of the electronic circuitry and care should be observed when handling the electronic boards. Ideally static free areas should be used, but in practise this is not always possible. Minimum handling, of the edges only, of the boards should help to overcome the static discharge problem. AVOID AREAS IN THE VICINITY OF NYLON CARPETS etc, and where possible use an anti-static wrist strap when handling the boards or components.

9.5 MAINS FUSE

This is mounted on the rear panel. This fuse can be replaced by pulling out the fuse holder once the IEC mains connector has been disconnected. Replace with a 1A fuse for 220-240V or a 2A fuse for 110-120V, both 20 mm anti-surge (T) or slow blow type fuses. See section 3 for full details.

9.6 MAINS FILTER

The mains voltage is filtered when it enters the machine. However large power supply fluctuations or interference from other nearby electrical equipment switching on or off could cause the machine to malfunction. Additional filtering may be necessary.

9.7 INTERNAL FUSES

Two internal fuses are also situated on the Power supply board; this is fitted underneath the top cover (part 19). To gain access to these fuses remove the top cover as described in section 8.

The values which should be installed are:-

- F20: 3.15A slow blow or anti-surge (T)
- F21: 1.6A slow blow or anti-surge (T)

F20 supplies the 5V and 6.5V outputs from the power supply board, whilst F21 supplies the 10V and 24V outputs.

If a fuse repeatedly blows, unplug connectors 16, 18 & 21 as shown in section 10, and test again. If either of the internal fuses still blow this indicates a fault on the power supply board. If not, reconnect connectors 16, 21 and 18 in turn until the fuse blows again. The machine should be switched off before altering connections. Report findings to Engineering Systems for further diagnosis.

9.8 POWER SUPPLY

Check the voltages. Are the correct voltages being supplied to, and from, the power supply board? A voltmeter will be needed to check this. Refer to the wiring diagram, and the next section.

9.9 CHECKING THE POWER SUPPLY VOLTAGES

To aid diagnostics, test points are available at the output of the power supply board, and input of the main board. If the voltages measured are not correct and the fuses are intact, unplug connectors 16, 18 & 21. If the voltages are now correct, the fault is on the main board or a component connected to it (LCD, printer etc.), otherwise the fault is with the power supply. In this case check the ac voltages from the transformer; if these are wrong and the mains fuse and plug fuse are intact then the transformer is faulty. If these are correct the power supply board is faulty.

If the fault is with not with the power supply check if any components on the main board and front board are hot. Note that some of the power supply components such as voltage regulators normally get warm or hot.

The dc voltage test points on the power supply board are marked as follows:

- GND: Ground, black wires
- 5V: Logic supply, red wire
- 6.5V: Printer supply, yellow wire
- 10V: Load cell / analogue supply, purple wire
- 24V: Motor supply (test point on right of board near transformer connector)

The test points around the input on the main board can be seen from the bottom of the machine just behind the paper feed button. They are marked with the corresponding voltages. Note that the 24V motor supply doesn't appear on the main board, this is supplied directly from the power supply board to the motor.

The ac voltages can be tested on connector 17. These should be as follows:

- Red wires:7.5V ac
- Yellow wires: 17V ac

9.10 CONNECTIONS

Check, visually and by wiggling, that all electrical connections, plugs, sockets and board inter-connections etc. are properly connected. Check also for loose wires and poor soldered connections. Check for loose foreign bodies, especially of metal, which may short out a circuit board. Check for continuity between connectors and boards.

9.11 BOARD CHANGING

If a board has failed it may be that an internal supply voltage fault caused the failure; therefore all power supply voltages should be checked before changing boards.
If it is suspected that a fault lies within a particular board, replace it with a spare board (module). However if a spare is not available and an electronics workshop is available, it may be possible to repair boards 'in house'. Otherwise a spare will have to obtained from the Engineering Systems or the machine sent back for repair.

9.12 REPLACING THE MAIN CIRCUIT BOARD

The main electronic circuit board is mounted in the bottom part of the main casing.

Remove the bottom and top covers. Figure 6 in section 10 shows the view from underneath the machine and identifies the various components and connectors.

Disconnect any cables connected to the rear panel. Unplug all 9 connectors shown in the diagram. Some of the connectors have a small lever on the side, which must be pressed to enable disconnection. Ensure all connectors including those on the top of the machine under the motor and next to the load cell are disconnected before removing the board.

Now remove the 2 pozidrive screws that mount the board onto the main casing. The board can now be removed, taking care not to damage the rear panel connectors.

Fit the new board in the reverse order to removing the old one. Make sure all 9 connectors are re-connected and are the correct way around.

Now refit the top and bottom covers and check that the machine works correctly. It will be necessary to re-calibrate the machine and re-set the time & date and any other settings via the setup menu. Any stored results will be lost.

9.13 REPLACING THE POWER SUPPLY BOARD

Remove the bottom & top covers. The power supply is located under the top cover. Unplug the transformer from the power supply board (part 17), the 2 connectors to the main board (16 & 21), and the motor connector (18). Remove the 3 pozidrive screws securing the board. To fit the new board reverse the above procedure.

9.14 REPLACING THE TRANSFORMER

Remove the top & bottom covers. Unplug the transformer from the power supply board (part 17) and withdraw the lead and connector into the bottom of the case. Disconnect the mains wiring from the back of the IEC mains input connector (11) **noting the order and colour coding**. Remove the nut from the top of the earth bolt and remove the solder tag connected to the transformer wiring. Remove the bolt from under the motor to release the transformer. To fit the new transformer reverse the above procedure, ensuring that the mains wiring is routed away from other wiring and circuit boards and that the earth connections are fully tightened. The electrical safety of the machine should be re-tested.

9.15 REMOVING THE LOAD FRAME

Remove the main board as described in section 9.12. Disconnect the motor connector from the power supply board (part 18).

Unscrew the 3 hexagon screws that attach the load frame to the casing. Note that one of these screws is located within the waste drawer compartment.

9.16 CHANGING THE LOAD CELL

Remove the bottom & top covers as described in section 8.
Unplug the load cell from the main circuit board (part 14).
Unscrew the two Load cell rubber seal retaining grub screws.
Unscrew the 2 hexagon load cell retaining screws and remove the load cell / rubber seal assembly, taking care not to damage the rubber seal.
The new load cell can now be installed by reversing the above procedure.

Calibrate the load cell as described under CALIBRATION PROCEDURE. **It is important this is done since the calibration procedure also sets the overload limit. Failure to re-calibrate the machine could result in the load cell being overloaded.**

9.17 MECHANICAL FAULTS

These are usually easier to find than electronic faults. Unplug the mains supply and remove the outer cover(s). A close visual inspection quite often reveals the fault which may be minor and easy to cure, or major and disastrous! Check the tightness of all 'nuts & bolts' etc., check the gears for tightness. Whilst the main casing is removed, try connecting the mains supply and starting a test Listen for, and isolate, any peculiar noises.

10 PARTS

10.1 COMPONENT PARTS

The following parts list and component layout shows only the major parts. Small items such as individual screws etc. are not listed.

10.2 PARTS LIST

Numbers in this parts list refer to the diagrams on the next page.

1. LCD Module
2. Front board
3. Main board
4. Printer module (Able Systems ASL CP205-MRS) & paper holder assembly
5. Toriodal transformer (Lintron 27205)
6. LCD connector
7. Front board connector
8. Printer connector
9. Clock battery (CR1616)
10. Mains input connector
11. Top cover mounting screw positions
12. Geared motor & encoder unit
13. Load frame
14. Load cell, amplifier board & load cell connector
15. Encoder connector
16. H-bridge control connector
17. Transformer secondary connector
18. Motor connector
19. dc fuses
20. Power supply board
21. Power supply board connector

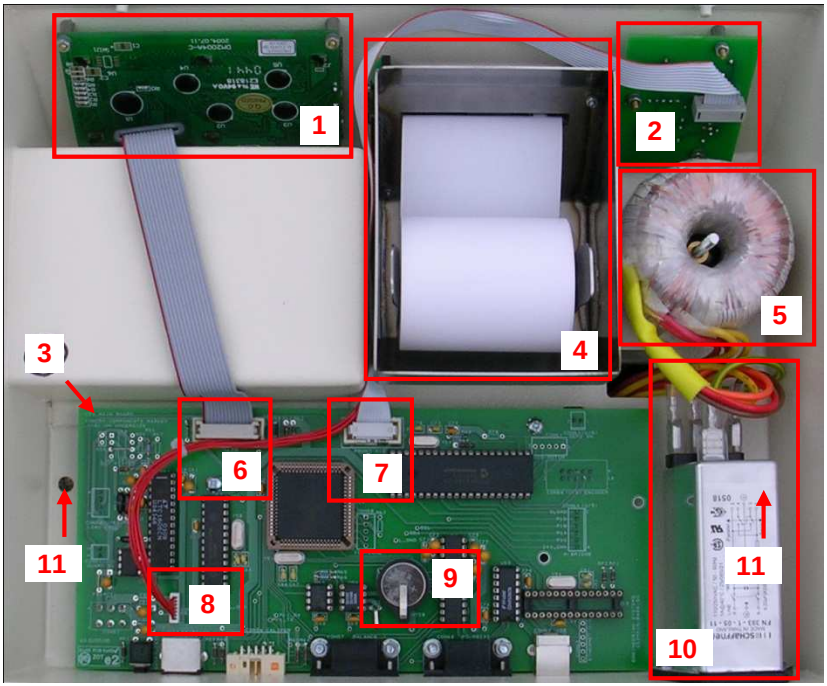


Figure 6 - Bottom View From Rear

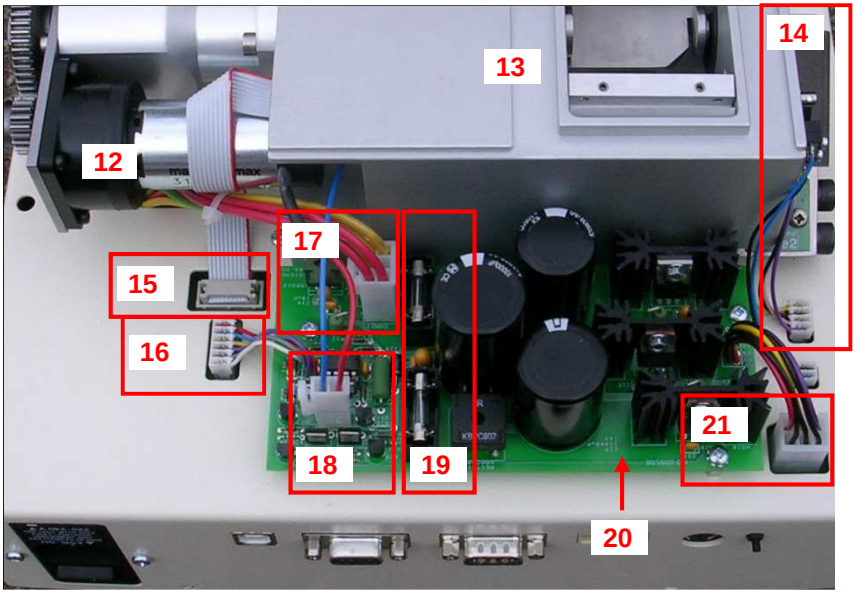


Figure 7 - Top View From Rear

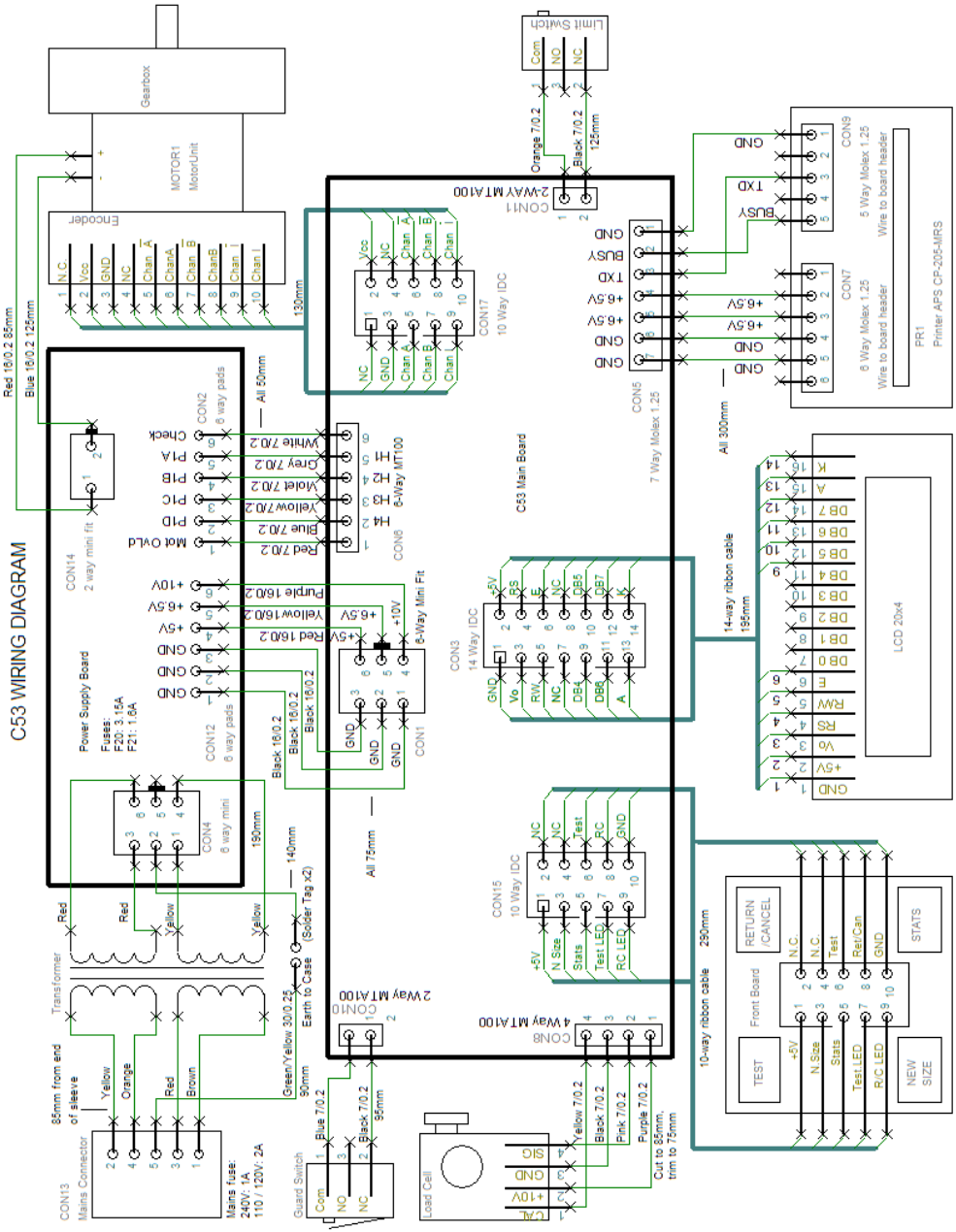


Figure 8 - Wiring Diagram

10.3 ELECTRONIC BOARDS FITTED

There are 4 printed circuit boards fitted to the C53 machine, these boards are identified by a name and number, composed as follows: -

- C53 stands for Compression 53 kg Load Cell
- The type of board, e.g. MAIN for the main PCB
- Numbers ‘yy’ giving the year the board was designed (e.g. 06)
- Numbers ‘ww’ giving the week the board was designed (e.g. 10)
- Letters ‘ii’ are the initials of the designer (e.g. SC)

Boards fitted: -

Main Board:	C53MAIN-yyww-ii
Display board:	C53FRONT-yyww-ii
Power Supply / H-Bridge board:	C53PSU-yyww-ii
Load Cell Amplifier board:	C53LOAD-yyww-ii

The toroidal transformer fitted is manufactured to Engineering Systems specifications. Toroidal transformers are more efficient, smaller, and give less electromagnetic interference than conventional transformers.

Toroidal Transformer: Lintron 27215

10.4 MACHINE SERIAL NUMBER

The serial number can be found on a label on the back of the machine. This number should be quoted in any correspondence regarding the machine.

10.5 SPARES SUPPLIED

Paper rolls

11 SPECIFICATION OF STANDARD C53 MACHINE

Choice of 4 output units	Kilogram (kg), Kilopond (kp), Newton (N) or Pound (lb)
Maximum load (Hardness)	53 kg, 53 kp, 520N or 116 lb respectively
Load resolution	0.01 kg, 0.01 kp, 0.1N or 0.01 lb respectively
Minimum detectable fracture load.	0.3 kg
Load indication	Display on front LCD, Internal printer output
Inputs & Outputs	USB RS232 Ethernet (option)
Inputs only	PS/2 Keyboard Mitutoyo digital calliper Adam milligram balance or other supported balances with RS232
Choice of 8 test speeds	4, 6, 10, 16 20, 25, 30 or 50 mm/min
Fast forward and return speed	130 mm/min
Maximum tablet diameter	36 mm
Calibration	Dead weights in kg.
Power requirements	110/120 VAC 2.0A or 220/240 VAC 1.0A (External selection via fuse holder)
Machine dimensions	Width 283 mm, Depth 235 mm, Height 160 mm
Machine weight (without accessories)	8.5 kg
Shipping size	360 mm x 360 mm x 260 mm
Shipping weight	11 kg

ILLUSTRATIONS & SPECIFICATION NOT BINDING TO DETAIL AS IMPROVEMENTS MAY BE INCORPORATED FROM TIME TO TIME.

The C53 is :-

Designed and Manufactured in Nottingham, England by: -
ENGINEERING SYSTEMS (NOTTM) Ltd
1 Loach Court, Radford Bridge Road,
Nottingham. NG8 1NA. ENGLAND
Tel: (0115) 928 8708 Fax: (0115) 928 8715
E-mail: info@engsys.co.uk Web: www.engsys.co.uk

APPENDIX A

FURTHER CONSIDERATION OF THE % FRACTURE DETECT SETTING AND LOW LIMIT.

The following graph shows the relationship between Low Limit load, % Fracture Detect, Peak Hold load, Test Load, Load Cell Load and Fracture point during a typical test. (Time is proportional to test speed.)
On loading the peak held load follows the load cell load up to the point of fracture, at this point the load cell load drops to zero (unless the test object is spongy or crumbly) and the peak held load remains constant. Fracture is detected by the electronic circuitry when the load cell load drops below the % peak hold load line (or setting).

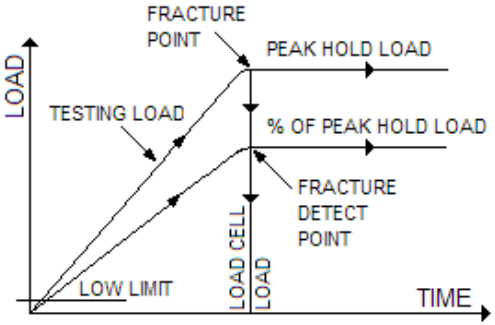


Figure 9 - Fracture Detect

The usual % setting for this 'line' is 60-70% but the material properties of some test objects may demand a revised setting before meaningful test results can be obtained.

When using the machine for general purpose testing, the following discussion may prove useful: -

Soft crumbly objects may require a lower % setting because the testing load may drop momentarily (causing a fracture detect) during loading, due to localized surface crumbling prior to the object fracturing or substantially failing. Some experimentation will be required to obtain a satisfactory % setting for these 'difficult' materials. A fracture may not be detected at all if too low a % setting is used, the test object may just be gradually crushed into a powder. Different platen geometries e.g. convex may have to be considered.

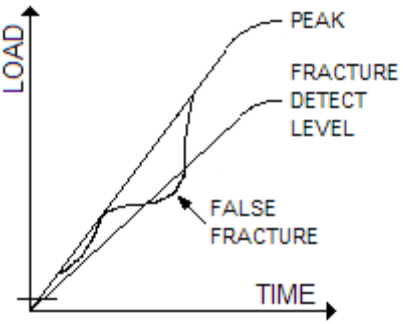


Figure 10 - False Fracture

Hard objects in compression may fracture but leave some of the fractured test object in the test position between the loading platens. If the % setting is too low a fracture will not be detected. If the setting is too high, small departures of the load cell load from the peak held load, especially at the start of a test, (see Low Limit Fracture Detect Suppression, 3.13) will give a fracture detect and the test will be halted.

CHANGING THE % SETTING.

See section 4 for details of changing the fracture detect percentage using the setup menu.

LOW LOAD LIMIT

A low load limit is included below which fractures are not detected. This is to prevent false fractures occurring the start of the test when the difference between the current and peak load readings is very small. This limit is fixed at 0.3 kg; experience has shown adjustment of this is not necessary.

APPENDIX B

SETTING UP THE CIRCUIT BOARDS FOR THE C53

This is the procedure for setting up the circuit boards during manufacture, and should not be used for setting up an existing machine.

- Connect the transformer plug to the power supply board but leave all other connectors unplugged. Do not fit any ICs to their sockets.
- Fit the mains fuse in the IEC connector and switch on. Check the AC voltages on the transformer connector.
- Switch off and insert the fuses on the power supply board. Switch back on and check the DC voltage at the test points on the power supply board.
- Switch off and connect the power supply connector to the main board Switch back on and check the DC voltages at the test points on the main board.
- Switch off and insert all ICs, including the FET driver on the power supply board. Switch on and re-check the DC voltage on the main board.
- Switch off and install the RTC RAM battery on the main board. Connect all connectors to the main board. Connect the motor to the power supply board. Connect a QWERTY keyboard to the rear panel. Connect a PC to the RS232 connector and start the software to display data from the machine. Switch the machine back on.
- Insert the paper roll as described in section 6
- The diagnostic routine will run to check that all hardware is working. Follow the instructions on the LCD. When the diagnostic routine is complete the machine will restart.
- After starting up as normal the LCD will show a message warning that the RTC RAM contents are invalid. Press TEST and use the keyboard to set the time & date when prompted (see section 4).
- The auto load check will now run.
- Press F1 on the keyboard and enter the passcode '1234'. Select 'CALIBRATION' and press ENTER. Enter the calibration passcode '1234' and press ENTER. The plunger will return to the right and the calibration procedure will start. Carry out the pre-calibration procedure as described in section 7.1 to set the load range, but skip the certification stage by repeatedly pressing ENTER until it is complete. Discard the printed calibration certificate.
- Press ESC once to exit the calibration menu and return to the main menu. Press and hold the paper feed button. Press and hold the TEST and RETURN buttons then release the paper feed button to

enter the manufacturers menu. Release the TEST and RETURN buttons.

- Select ‘SET BRAND’ and press ENTER. Select the required brand and press ENTER again.
- Select ‘CYCLE LOAD CELL’ and press enter to start the load cell cycling routine. Press RETURN on the front panel to stop load cell cycling.
- Press ESC to exit the manufacturers menu. Select ‘CALIBRATION’ and again enter the passcode ‘1234’. Select ‘CALIRATE’ and perform a full calibration.

APPENDIX C

HOW TO START USING THE C53 WITHOUT READING THE HANDBOOK

Key Features are: -

Automatic sizing of new tablets
Maximum load (Hardness) 53 kg
Maximum jaw opening of 36 mm

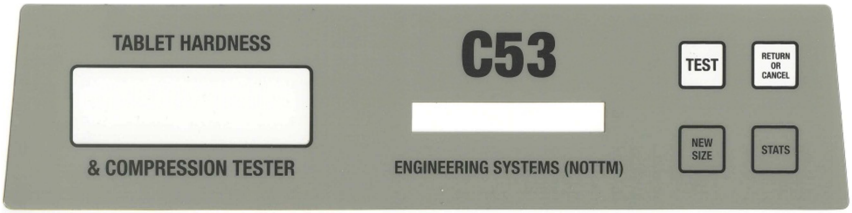
Discovering the C53

The machine's main controls are situated on the front panel. Advanced functions and setup menu can be accessed by connecting a standard QWERTY keyboard to the rear-panel connector. In addition a paper feed button is mounted on the rear panel.

For normal use, only the front panel membrane switches (buttons) are used. When the machine is first delivered the default settings are: -

- Load display / output in kg.
- Test Speed of 6 mm/min.
- Test Mode set to Test Button.
- Printer is ON.
- Weight measurement is set to off (unless supplied with weigh balance).
- Thickness measurement is turned off (unless supplied with calliper).

The front panel looks like this:-



Switching on the C53

Check that the mains supply voltage is correct. If the voltage needs to be changed refer to section 3 of the handbook.

Plug the IEC/MAINS connector into the rear of the machine and connect it to the mains supply. Switch on the rear panel mounted mains switch below the input connector. The LCD will show a start-up message, while the loading plunger reverses to its fully retracted position. A message appears on the LCD, prompting a check that the platens are clean and that there are no objects within the loading area. Open then close the guard; the plunger will

move forward to double touch the load cell then return to the last preset test position. This procedure zero's the tablet diameter measuring facility.
The printer will print out the message:

C53
TABLET HARDNESS
TESTER
(SERIAL NUMBER)
(TIME / DATE)
LPR: ###

After a short delay the LCD will show the current load, time, date and tablet count, which should read '0'.

Setting up for a new size: Have a 'new size tablet' ready for placement onto the loading platform. (The loading platform is situated underneath the Perspex guard) Lift up the Perspex guard and press the NEW SIZE button; 'NEW SIZE' will be displayed on the LCD. The loading plunger will return i.e. move to the right and to the extremity of its travel. During the return motion, place the new tablet onto the loading platform in line with the axis of the plunger. When the plunger reaches its extreme position, it immediately changes direction and travels at its FAST FORWARD speed whence it approaches and pushes the tablet up to touch the loading platen. The platen detects the touch and then returns approximately 5 mm to its preset return position. The printer prints the message New Size Set'. The new size sequence is now complete.

Testing the first tablet: Place a tablet onto the loading platform in line with the plunger, lower the guard and press TEST. The plunger will fast forward up to approximately 0.2 mm of the tablet and then change to the set test speed (6 mm/min). When the plunger reaches the tablet, loading commences and the digital load display can be seen to increase. Fracture is detected automatically and the plunger stops and reverses to its preset return position. At this stage the test result is printed out on the printer. Further tablets from the batch can be tested by placing a new tablet onto the loading platform and pressing the TEST button.

End of batch, Statistical Analysis: When at least 2 tablets have been tested, press the STATISTICAL ANALYSIS button. The statistical data will be printed out. When the printing is complete the tablet count is automatically re-set to zero and a further batch of tablets can be tested.

Next Batch: If the next batch of tablets is a different size, then the NEW SIZE procedure will have to be followed, if they are the same size as the previous batch then no resetting of the size is required.

APPENDIX D

NOTES: -

The C53 is

Designed and Manufactured in Nottingham, England

by

ENGINEERING SYSTEMS (NOTTM) Ltd.
1 Loach Court, Radford Bridge Road,
Nottingham. NG8 1NA. ENGLAND
Tel: 0115 928 8708 Fax: 0115 928 8715
E-mail: info@engsys.co.uk
Web: www.engsys.co.uk