

EEL Standard Procedure ----- 001

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PROTOMAT C100IHF (K045) – CALIBRATION PROCEDURE

1. INITIAL REQUIREMENTS

- a. Ensure the Compressor Log Sheet is up to date and all Moisture Traps are dry.

The compressor shall be drained at regular intervals of no more than 7 days and the Compressor Log Sheet updated to provide a maintenance record. The Log Sheet is situated next to the compressor enclosure.

- b. Ensure the Protomat Maintenance Log Sheet is up to date.

*Depending upon the type of materials being milled, the **Collet(1)**, **Scanning Ring(2)** and the **Internal Thread(3)** of the High Speed Spindle will require regular cleaning as per the following table:-*

MATERIAL	CLEANING REQUIREMENTS
DUROID	Upon Completion of Each Job
FR4	Intervals of no more than 14 days

- (1) The **Collet** shall be immersed and thoroughly cleaned using SafeWash. Finally, degrease with Isopropyl Alcohol.
- (2) The **Scanning Ring** should be thoroughly cleaned using an Isowipe. Pay particular attention to the underside of this assembly!
- (3) The **Internal Thread** of the High Speed Spindle shall be thoroughly cleaned with Isopropyl Alcohol only. A brush is provided specifically for this purpose.

Ensure all parts are thoroughly clean and dry then, align the keyway and carefully insert the Collet into the High Speed Spindle.

The Log Sheet is situated next to the Protomat and shall be updated to provide a maintenance record.

- c. Switch on computer RPF00 ----- SEE GPO's MARKED PC, MONITOR and SPEAKERS
- d. Switch on Compressor and Vacuum --- SEE GPO's MARKED COMPRESSOR and VACUUM
- e. Switch on Protomat and Enable Air - SEE GPO's MARKED PROTOMAT and ENABLE AIR
- f. Switch on the Calibration Camera - SEE GPO MARKED CAMERA K081
- g. Ensure Compressor regulator is set to not less than 8 Bars - See Indicator(PI-00)
- h. Ensure Protomat regulator is set to 7 Bars - See Indicator (PI-01)
- i. **CAUTION! This manual has been written assuming Protel 99 SE to be the preferred CAD package. If working with Altium Designer files, please refer to the appropriate user manual for further information.**
- j. **CAUTION! This manual has been written assuming Boardmaster 4 to be the preferred software package for operating the Protomat. Boardmaster 5 has minor variations.**

2. BOARDMASTER PROGRAM

- a. Start BoardMaster program --- Ignore FIFO message.

3. SECURING UNDERLAY AND PCB MATERIALS

- a. Select > [Goto]
> [Pause] --- Positions Head allowing room to secure PCB and Underlay material
- b. > **Ensure bed is thoroughly clean before proceeding** --- Use Isowipes

It is extremely important that the bed is dry and all traces of swarf and grease are removed before securing the Underlay and PCB materials in place.

Failure to comply may result in inconsistent and poor quality results

3.01 UNDERLAY MATERIALS

- a. > **IS THE MATERIAL TO BE MACHINED LESS THAN 1mm THICK**

No > **GOTO 3.01b >**

Yes > **Clean the Underlay Support (EEL Part# K088) with an Isowipe**
> **Ensure the Underlay Support is dry then place in position**

This item was manufactured from Underlay Material 81-01-02 and is designed to raise the normal Underlay sheet by approx 0,6mm
- b. > **Clean the Underlay Material (EEL Part# 16-00-11) with an Isowipe**
> **Ensure the Underlay Material is dry then place in position**

ALWAYS USE NEW MATERIAL IF BOARD IS TO BE DRILLED PRIOR TO PLATING

*Fixing holes should be drilled in the Underlay Material using a 3,05mm dia drill in conjunction with the special Protomat Drilling Template (EEL Part# K075) provided. **Open holes up to 3,10mm before fitting!***

NEVER ATTEMPT TO USE A 3,10mm DRILL WITH THE DRILLING TEMPLATE K075!

3.02 PCB MATERIALS

- a. > **Select the appropriate PCB material for the project**

See EEL Data Sheet #7 for 2Layer PCB options

See EEL Data Sheet #5 for 4Layer PCB options

See EEL Data Sheet #6 for 6Layer PCB options

Fixing holes should be drilled in the PCB Material using a 3,05mm dia drill in conjunction with the special Protomat Drilling Template (EEL Part# K075) provided.
- b. > **Thoroughly clean the selected PCB material using an Isowipe.**
- c. > **Ensure PCB material is thoroughly dry then secure in position ready for machining.**

4. SELECT CALIBRATION OPTION

- a. > SELECT WHICH CALIBRATION METHOD IS TO BE EMPLOYED

Manual > GOTO SECTION 7 > --- Recommended option

*This is the **recommended** method and allows the user to manually mill an Insulation Channel and quickly check it's dimensions.*

File > GOTO SECTION 5 > --- See comments below

This method requires loading a calibration file and milling a calibration pattern. Although accurate, this method is far more time consuming and consequently not the recommended method.

5. LOAD CALIBRATION FILE

- a. Select > [File]
> [Import]
> [LMD/LPR]

b. Path > [G:\RPFUser00\Protomat Cal Files] --- All Cal Files are located here
> Calibration files are available for checking tools in various configurations SEE SECTION 17 FOR DETAILS

- c. Select > [CheckUni020mm.LMD] - Will check Unicutter set to standard 8 mil cut
Example only!
> [Open]

6. PLACEMENT OPTIONS

- a. > In BoardMaster, move the project to the required position on workplace, allowing for clearances required by the Protomat Tool Head and taking into account available free space on the PCB material.

See Manual K045A.SM2 Page 40 (Para 5.3) for Placement Function Info

7. INSERT TOOL AND PLACE IN "SAFE MODE"

- a. Select > [Goto]
> [Exchange]

b. > Fully insert cutting tool to be calibrated into the collet
> Tighten the Spindle Knob
> PULL KNOB UP BEFORE CONTINUING

- c. Select > [Universal Cutter 0.2mm (8mil)] from check box --- See comment below
> [OK]

Example Only! This selection must match the tool fitted in the collet

- d. > Adjust the Milling Depth Control [UP/DOWN Knob] so that tool is not protruding below bottom face of the scanning ring

Place a piece of pcb material against the bottom face of the scanning ring to establish the position of the cutting tool.

TAKE CARE NOT TO DAMAGE THE CUTTING EDGE OF THE TOOL!

8. ADJUST TOOL DEPTH TO ZERO POSITION

- a. > Position Tool Head to a convenient position over the pcb material
- b. > Ensure Head Auto Control button is cancelled
> Start Motor
> Ensure operating speed is achieved before continuing
> Lower Head
- c. > Adjust Milling Depth Control [UP/DOWN Knob] until the tool is barely in contact with the surface of the pcb material

Use the Calibration Camera K081 to establish the correct position

- d. > Raise Head
> Stop Motor

ALL MILLING DEPTH CALCULATIONS SHALL BE REFERENCED TO THIS POSITION

9. CALCULATE TOOL MILLING DEPTH (z)

- a. > To calculate the distance (z) the tool must protrude beyond the bottom surface of the scanning ring to produce insulation channels of the required width (w) the following formula shall be used

$$z = t + (w / 2 \tan \theta) \quad \text{--- All dimensions are in Mil (0.001")}$$

Where z = Tool Milling Depth
 θ = Tool Cutting Angle
 t = Thickness of PCB Copper
 w = Width of cut required (Insulation Channel)*

* The width of cut as measured at the copper/substrate interface

- > SEE SECTIONS 14 & 15 FOR DETAILED INFORMATION ON ABOVE PARAMETERS

10. CALCULATE NUMBER OF (MILLING DEPTH CONTROL) STEPS

- a. > To convert the Milling Depth (z) into the number of steps required on the Milling Depth Control [UP/DOWN Knob] the following formula shall be used

$$n = z / x$$

Where n = Required Number of [UP/DOWN Knob] Steps
 z = Tool Milling Depth
 x = Milling Depth Control Increment (MDC) --- See Section 16!

- b. > SEE LOOKUP TABLE 01 (Next Page) FOR MILLING DEPTH CONTROL SETTINGS!
- c. > Adjust the Milling Depth Control as required.

FOR THIS PAGE : PLEASE REFER TO [admin66.xlsx](#) or [admin66.pdf](#)

11. SELECT CALIBRATION OPTION

- a. > SELECT WHICH CALIBRATION METHOD HAS BEEN SELECTED
- Manual > GOTO SECTION 12 >
- File > GOTO SECTION 13 >

12. MANUAL CALIBRATION

- a. > Set the Protomat to Step by 100 mil increments
- b. > Ensure Head Auto Control button is cancelled
 - > Start Motor
 - > Ensure operating speed is achieved before continuing
 - > Lower Head
- c. > Use Cursor Controls to mill a 100 mil x 100 mil (L) shaped Insulation Channel.
 - > RECORD TOOL USAGE ON JOB SHEET
- d. > Raise Head
 - > Stop Motor
- e. > Use the Microscope (EEL Part # K077) to confirm the width and consistency of both cuts at the copper/substrate interface.

Re-adjust milling depth and repeat calibration if required!
- f. > GOTO SECTION 14 >

13. FILE CALIBRATION

- a. > Ensure Head Auto Control button is active
- b. Select > [MillingBottom] from List Box --- Depends on Cal File
or > [MillingTop] from List Box ----- Depends on Cal File
 - > [All+]
 - > [Start]
 - > Follow prompts
 - > RECORD TOOL USAGE ON JOB SHEET
- c. > Use the Microscope (EEL Part # K077) to confirm the width and consistency of both cuts at the copper/substrate interface.

Re-adjust milling depth and repeat calibration if required!
- d. > GOTO SECTION 14 >

14. PCB DATA

- a. > 70um PCB Copper (t) = 2.75590 Mil (0.00275590") = 2oz
- b. > 35um PCB Copper (t) = 1.37795 Mil (0.00137795") = 1oz
- c. > 18um PCB Copper (t) = 0.70866 Mil (0.00070866") = 1/2oz
- d. > 09um PCB Copper (t) = 0.35433 Mil (0.00035433") = 1/4oz
- e. > 05um PCB Copper (t) = 0.19685 Mil (0.00019685") = 1/8oz

15. TOOL DATA

- a. > Uni Cutter (Part# 80-01-16) 0.20-0.50mm (8-20 mil) $\theta = 45^\circ > (\tan 45^\circ = 1.0000)$
- b. > Micro Cutter (Part# 80-01-15) 0.10-0.15mm (4-6 mil) $\theta = 30^\circ > (\tan 30^\circ = 0.5774)$

16. PROTOMAT DATA

- a. > MILLING DEPTH CONTROL

THE ORIGINAL DOCUMENTATION RECEIVED WITH THE PROTOMAT STATES THE MILLING DEPTH CONTROL MOVEMENT AS 0.125 Mil PER STEP. CALCULATIONS USING THIS FIGURE SEEM TO RESULT IN INSULATION CHANNELS INCONSISTENT WITH THE INTENDED WIDTH!

THE CURRENT VALUE OF THE (MDC Increment x) IS TO BE FOUND IN LOOKUP TABLE 01 OF THIS PROCEDURE.

- b. > HOME COORDINATES [x = 1.9685039"], [y = 4.0429"]
- c. > COORDINATES OF LOCATION PINS (Ref to Home Position)

Location Pin0 = - 0.96750" --- Left as viewed from above
Location Pin1 = + 4.46575" --- To suit A6 Material
Location Pin2 = + 6.90000" --- To suit A5 Material
Location Pin3 = +10.34500" --- To suit A4 Material

- d. > CAMERA OFFSET [x = 1.959"], [y = 0.650"]
- e. > PAUSE [x = 13.687188"], [y = 8.0853125"]

17. CALIBRATION FILES

- a. > CheckUni020mm.LMD --- Cal UniCutter for 7.87 Mil Ins Channels
> CheckUni022mm.LMD --- Cal UniCutter for 8.66 Mil Ins Channels
> CheckUni024mm.LMD --- Cal UniCutter for 9.45 Mil Ins Channels
> **EwsCalUni10x10.LMD** -- Cal UniCutter for 10.0 Mil Ins Channels
- b. > CheckMicro010mm.LMD - Cal MicroCutter for 3.93 Mil Ins Channels
> CheckMicro013mm.LMD - Cal MicroCutter for 5.12 Mil Ins Channels
- c. > CheckRF015mm.LMD ---- Cal RFCutter for 5.95 Mil Ins Channels
> CheckRF025mm.LMD ---- Cal RFCutter for 9.84 Mil Ins Channels
> CheckRF04mm.LMD ----- Cal RFCutter for 15.74 Mil Ins Channels
- d. > CheckDepthOfTools.LMD --- ?
- e. > CheckHome.LMD ----- Used for checking "Home Position"

NOTE: **Bold** type indicates Electronics Engineering Lab generated files

18. FURTHER INFORMATION

- a. > SEE K045 SERIES DOCUMENTATION