USER'S GUIDE

MACHINIST CALC™ PRO

ADVANCED MACHINING MATH AND REFERENCE TOOL

Model 4089

CALCULATED INDUSTRIES®

FAST. ACCURATE. RELIABLE.

MACHINIST CALC™ PRO

The *Machinist Calc™ Pro* Advanced Machining Math and Reference Tool (Model 4089) provides fast, precise solutions for your every day machining calculations. With the *Machinist Calc Pro* you will spend less time looking up your most-needed calculations on charts, in books or on the Internet and more time machining.

The *Machinist Calc Pro* gives you hundreds of machining-specific calculations, including:

- Cutting Speed, Spindle Speed (RPM)
- Feed Rate, Cutting Feed, Feed per Tooth (Chip Load)
- Built-in Drill and Thread Size reference tables
- Drill Point Cut Depth solutions
- Wire Sizes and 3-Wire Measurements
- Bolt Pattern hole layouts with center x, y coordinate
- Right triangle math
- Trigonometric solutions
- Work in and convert between U.S. and Metric units, including:
    - m, mm, cm
    - Decimal Inches/Mils
    - Feet-Inch-Fractions
    - Area, Volume and Weight

Note: *The* Machinist Calc Pro *calculator Model 4089 and User's Guide are designed for machinists who work with metric drill, screw and thread sizes and metric thread tolerance classes. The calculator can be used for non-metric applications, so some examples for working in U.S. units – numeric, letter, and inch drill sizes and numeric and fractional thread sizes and classes – are included in the Appendix of this User's Guide.*

TABLE OF CONTENTS

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GETTING STARTED

KEY DEFINITIONS

Basic Function Keys

On/C	***On/Clear Key —*** Turns on power. Pressing once clears the last entry and the display. Pressing twice clears all non-permanent values.
Off	***Off —*** Turns all power off. Clears all non-permanent values.
+ − × ÷ =	Arithmetic operation keys.
0 - 9 and •	Keys used for entering numbers.
Conv	***Convert —*** Used with the dimensional keys to convert between units or with other keys to access special functions.
Stor	***Store —*** Used for storing values.
Stor 1 - 9	***Storage Registers M1 through M9 —*** Used to store values in Memory registers 1 through 9.
Rcl	***Recall —*** Used with other keys to recall stored values and settings.
Conv Rcl	***Memory Clear (M-R/C) —*** Clears Accumulative Memory without changing current display.
Rcl Rcl	***Memory Clear —*** Clears Accumulative Memory and displays total.
M+	***Accumulative Memory —*** Adds displayed value to Accumulative Memory.
Conv M+	***M- —*** Subtracts displayed value from Accumulative Memory.

Dimensional Function Keys

mm ***Millimeters —*** Identifies entry as millimeters, with repeated presses toggling between linear, area and volume units. Converts dimensional value to units of millimeters, with repeated presses toggling between millimeters and meters.

Conv **5** ***Centimeters (cm) —*** Identifies entry as centimeters, with repeated presses toggling between linear, area and volume units.

Conv **9** ***Meters (m) —*** Identifies entry as meters, with repeated presses toggling between linear, area and volume units.

Conv **7** ***Feet —*** Identifies entry as Feet, with repeated presses of **Conv** **7** toggling between linear, area and volume units. Also used with **Inch** and **/** for entering Feet-Inch values. Repeated presses of **Conv** **7** during conversions toggle between fractional Feet-Inch and decimal Feet.

Inch ***Inch —*** Identifies entry as Inches, with repeated presses toggling between linear, area and volume units. Entry can be whole or decimal numbers. Also used with **/** for entering fractional Inch values (e.g., **9** **Inch** **1** **/** **2**). Repeated presses during conversions toggle between fractional and decimal Inches.

/ ***Fraction Bar —*** Used to enter fractions. Fractions can be entered as proper (1/2, 1/8, 1/16) or improper (3/2, 9/8). If the denominator (bottom) is not entered, the calculator's fractional accuracy setting is automatically used. Results are always shown in typical dimensional fractional format.

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/1000" ***1/1000" (mils) —*** Multiplies a dimensionless entry by 0.001 Inch and displays the result as Inches. Converts a linear entry to decimal Inches. For both methods, the result is rounded and displayed to three decimal places

Weight and Volume Function Keys

Conv 6 ***Tons —*** Enters or converts a weight or volume value to tons.

Conv 4 ***Pounds (lbs) —*** Enters or converts a weight or volume value to pounds.

Conv 3 ***Tonnes (tonne) —*** Enters or converts a weight or volume value to tonnes.

Conv 2 ***Grams —*** Enters or converts a weight or volume value to grams.

Conv 1 ***Kilograms (kg) —*** Enters or converts a weight or volume value to kilograms.

Conv 0 ***Weight per Volume (wt/vol) —*** Stores a new weight per volume as pounds per cubic foot or other format as shown below. Default value is 490 pounds per cubic foot of steel.

- Pounds per cubic foot
- Pounds per cubic inch
- Tonnes per cubic meter
- Kilograms per cubic meter

Trigonometric Function Keys

Conv z ***Sine (Sin) —*** Calculates the Sine of an entered degree or unitless value.

Conv x ***Arcsine (Sin^{-1}) —*** Calculates the angle for the entered or calculated Sine value.

Conv f_z ***Cosine (Cos) —*** Calculates the Cosine of an entered degree or unitless value.

Conv y ***Arccosine (Cos^{-1}) —*** Calculates the angle for the entered or calculated Cosine value.

Conv f_n ***Tangent (Tan) —*** Calculates the Tangent of an entered degree or unitless value.

Conv r ***Arctangent (Tan^{-1}) —*** Calculates the angle for the entered or calculated Tangent value.

Miscellaneous Functions

Conv • ***Degrees:Minutes:Seconds (dms◄► deg) —*** Converts between D:M:S and decimal degree formats; repeated presses will toggle between the two formats.

% ***Percentage —*** Used to find a given percent of a number.

Conv % ***x^2 —*** Squares the value on the display.

⬅ ***Backspace Function —*** Used to delete entries one keystroke at a time (unlike the On/C function, which deletes the entire entry).

Conv ⬅ ***Square Root ($\sqrt{x}$) —*** Calculates the Square Root of the number on the display.

Conv ÷ ***Reciprocal (1/x) —*** Finds the Reciprocal of a number (e.g., 8 Conv ÷ = **0.125**).

Conv × ***Clear All —*** Returns all stored values to the default settings. Does not affect Preference Settings.

Conv − ***Change Sign (+/–) —*** Toggle displayed value between negative and positive value.

Conv + ***Pi —*** Displays value of **π** (3.1415927).

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Conv **=** ***Paperless Tape (Tape) —*** Accesses the Paperless Tape mode (see ***Paperless Tape*** section), which keeps track of your past 30 entries. Useful for checking strings of numbers.

Conv **Stor** ***Preference Settings (Prefs) —*** Accesses various customizable settings, such as dimensional answer formats (see ***Preference Settings*** section).

Machinist Function Keys

v_c ***Cutting Speed —*** Enters or calculates Cutting Speed. Unitless entries assumed meters per minute in Metric mode; feet per minute in U.S. mode. Calculates Cutting Speed given entered Diameter and RPM (Spindle Speed). Result is displayed as a whole number.

Conv **v_c** ***Radial Chip Thinning (RCT) —*** Enters a Cut Depth and calculates a Radial Chip Thinning factor to increase the Feed Rate given Feed Per Tooth, Tool Diameter and a Cut Depth that is less than one-half the Tool Diameter. Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode.

π ***Revolutions per Minute —*** Enters or calculates RPM (Spindle Speed). Calculates RPM given entered Diameter and Cutting Speed. Result is displayed as a whole number.

Conv **π** ***3-Wire Measurement (3-W Measure) —*** Enters or calculates a Three-Wire Measurement. Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode. Calculates the minimum and maximum Three-Wire Measurements and Pitch Diameters given entered Thread Size and Wire Size, assuming an External thread type. If a Three-Wire Measurement value is entered, the Pitch Diameter calculation is based on this entered measurement.

Feed Rate — Enters or calculates Feed Rate. Unitless entries assumed millimeters per minute in Metric mode; inches per minute in U.S. mode. Calculates Feed Rate given values for Cutting Feed and RPM (Spindle Speed) or Feed per Tooth (Chip Load), RPM and Number of Teeth.

Wire Size — Enters or calculates Wire Size for 3-Wire Measurements. Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode. Calculates the recommended Ideal, Maximum and Minimum Wire Sizes given an entered Thread Size.

Bolt Pattern — Enters the number of holes in a Bolt Pattern. Calculates the hole Center-to-Center Spacing and the x and y coordinates for each hole in a Bolt Pattern given entered Diameter, Number of Bolt Holes, Starting Angle (optional) and Center x and y coordinates (optional).

Thread Classification (Thread Class) — Used to select the Tolerance Class for metric Threads and the Thread Class for numeric and fractional Threads. The default Tolerance Class for metric Thread Sizes is 6H (Internal). The default Class for numeric and fractional Thread Sizes is 2B (Internal). See ***Thread Sizing*** section for further details on available Classes.

Thread Size — Enters a metric, numeric or fractional Thread Size and provides Thread characteristics such as Cut Tap Drill Size, Minimum Major Diameter, etc. See ***Thread Sizing*** section for further details on entry format, valid entries and a listing of the resulting Thread characteristics.

% Thread — Enters a non-standard Thread Grip Percentage for use in determining screw Tap Drill Sizes. Default value is 75%.

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Drill Size — Enters a metric, numeric, letter or fractional Drill Size, displaying the millimeter (Metric mode) or decimal Inch (U.S. mode) equivalent of the Drill Size. The next smaller Drill Size is displayed if the entered value doesn't match a Drill Size. Repeated presses of or ⊞ toggle through Drill Sizes in increasing order. Presses of ⊟ toggle through Drill Sizes in decreasing order. Selected Drill Size is stored upon exiting function.

Conv ***Drill Point —*** Enters the Cutting Angle of a Drill Point. Calculates the Drill Point Cut Depth that needs to be taken into account when it's necessary to maintain a specific full diameter depth.

Number of Teeth — Enters the Number of Teeth on a tool. Default value is 1.

Feed per Tooth — Enters or calculates Feed per Tooth (Chip Load). Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode. Calculates Feed per Tooth given entered Cutting Feed and Number of Teeth or RPM (Spindle Speed), Feed Rate and Number of Teeth.

Cutting Feed — Enters or calculates Cutting Feed. Unitless entries assumed millimeters per revolution in Metric mode; inches per revolution in U.S. mode. Calculates Cutting Feed given entered Feed per Tooth (Chip Load) and Number of Teeth or Feed Rate and RPM (Spindle Speed).

Diameter — Enters a Diameter. Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode. Calculates circle Area and Circumference given entered Diameter. Calculates Diameter given entered Radius.

Conv Ø ***Radius —*** Enters or calculates a Radius. Unitless entries assumed millimeters in Metric mode; Inches in U.S. mode. Calculates Radius given entered Diameter.

Conv 8 ***Alpha —*** Enters alphabet character selection mode. While in this mode, a letter can be selected and used with ⇆ to enter a letter Drill Size. Entering this mode with a unitless entry between 1 and 26 will display the corresponding letter of the alphabet (i.e. 5 Conv 8 displays the letter **E**). While in Alpha mode, presses of 8 or + toggle forward through the alphabet, while presses of − toggle backward.

x ***Adjacent —*** Enters or calculates the Adjacent (horizontal) leg of a right triangle. Calculates Adjacent value given two other right-triangle values. Also enters the Center x-coordinate of a Bolt Pattern.

y ***Opposite —*** Enters or calculates the Opposite (vertical) leg or height of a right triangle. Calculates Opposite value given two other right-triangle values. Also enters the Center y-coordinate of a Bolt Pattern.

r ***Hypotenuse —*** Enters or calculates the Hypotenuse (diagonal) of a right triangle. Calculates Hypotenuse value given two other right-triangle values.

∠ ***Angle —*** Enters or calculates an Angle, providing the Adjacent Angle for both instances. Calculates an Angle given two other right-triangle values. Also enters the Starting Angle of the first hole of a Bolt Pattern, with 0° being the three o'clock position and the rotation going counterclockwise.

PREFERENCE SETTINGS

Press Conv, then Stor to access the Preferences menu. Continue pressing Stor to toggle through different Preferences. Press + or − keys to toggle between options of the different Preferences. Press On/C to exit Preferences. Your calculator will keep your Preference Settings until a Full Reset alters your settings to the default values (see ***Appendix*** for more information).

KEYSTROKE	DISPLAY
Conv Stor Stor *(Prefs)*	**F-RND 0.0000**
(Functional Result Rounding)	
+	**F-RND 0.000**
+	**F-RND FLOAT**
+ *(repeats options)*	**F-RND 0.0000**
Third press of Stor:	
(Default Unit Format)	**METRC UnITS**
+	**US UnITS**
+ *(repeats options)*	**METRC UnITS**
Fourth press of Stor:	
(Area Answer Format)	**AREA Std.**
+	**AREA 0. SQ FEET**
+	**AREA 0. SQ INCH**
+	**AREA 0. SQ M**
+ *(repeats options)*	**AREA Std.**
Fifth press of Stor:	
(Volume Answer Format)	**VOL Std.**
+	**VOL 0. CU FEET**
+	**VOL 0. CU M**
+	**VOL 0. CU INCH**
+ *(repeats options)*	**VOL Std.**

KEYSTROKE	DISPLAY
Sixth press of Stor : *(Fractional Mode)*	**FRAC Std.**
+	**FRAC COnST**
+ *(repeats options)*	**FRAC Std.**
Seventh press of Stor : *(Mathematical Operation)*	**MATH OrDEr**
+	**MATH CHAIn**
+ *(repeats options)*	**MATH OrDEr**

ENTERING DIMENSIONS

Linear Dimensions

Examples of how linear dimensions are entered (press On/C after each entry):

DIMENSIONS	KEYSTROKE
201 meters	2 0 1 Conv 9
95 millimeters	9 5 mm
23 mils	2 3 /1000"
4.5 Inches	4 • 5 Inch
1 320 Feet	1 3 2 0 Conv 7

Square and Cubic Dimensions

Examples of how square and cubic dimensions are entered (press On/C after each entry):

DIMENSIONS	KEYSTROKE
11 square millimeters	1 1 mm mm
1.5 cubic meters	1 • 5 Conv 9 9 9
14 square Inches	1 4 Inch Inch
3 cubic Feet	3 Conv 7 Conv 7 Conv 7

CONVERSIONS

Linear Conversions

Convert 3.2 meters to other dimensions:

KEYSTROKE	DISPLAY
On/C On/C	0.
3 • 2 Conv 9 *(m)*	3.2 M
Conv mm	3200. MM
Conv 5 *(cm)*	320. CM
Conv Inch	125.98425 INCH
Conv 7 *(Feet)*	10.498688 FEET

Square and Cubic Conversions

Convert 0.05 cubic meters to other dimensions:

KEYSTROKE	DISPLAY
On/C On/C	0.
• 0 5 Conv 9 9 9 *(m)*	0.05 CU M
Conv mm	50000000. CU MM
Conv 5 *(cm)*	50000. CU CM
Conv Inch	3051.1872 CU INCH
Conv 7 *(Feet)*	1.7657333 CU FEET

Weight Conversions

Convert 1.5 tonnes to kilograms, pounds and tons:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 • 5 Conv 3 *(tonne)*	1.5 MTON
Conv 1 *(kg)*	1500. KG
Conv 4 *(lbs)*	3306.9339 LBS
Conv 6 *(tons)*	1.653467 TON

Weight per Volume and Volume Conversions

Convert 0.006 cubic meters of stainless steel to kilograms, tonnes, pounds and tons if the steel weighs 7 480 kilograms per cubic meter.

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Store the weight per volume:	
7 4 8 0 Stor 0 0 0 0 * *(wt/vol)*	S **7480. KG/ CU M**
2. Enter steel volume:	
• 0 0 6 Conv 9 9 9 *(m)*	**0.006 CU M**
3. Convert to kilograms, tonnes, pounds and tons:	
Conv 1 *(kg)*	**44.88 KG**
Conv 3 *(tonne)*	**0.04488 MTON**
Conv 4 *(lbs)*	**98.943463 LBS**
Conv 6 *(tons)*	**0.0494717 TON**
4. Change the weight per volume back to the default value:	
4 9 0 Stor 0 0 *(wt/vol)*	S **490. LBS/ CU FEET**

** The number of 0 presses may vary, depending on the last units displayed when wt/vol was last recalled/stored. By default, pounds per cubic foot is displayed first.*

BASIC MATH OPERATIONS

Adding and Subtracting Dimensions

Add the following measurements:
- 1.05 mm
- 1.75 mm
- 4.35 mm

Then subtract 3.50 mm.

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KEYSTROKE	DISPLAY
1 • 0 5 mm +	1.05 MM
1 • 7 5 mm +	2.8 MM
4 • 3 5 mm =	7.15 MM
− 3 • 5 mm =	3.65 MM

Multiplying Dimensions

Multiply 1.6 meters by 2.85 meters:

KEYSTROKE	DISPLAY
1 • 6 Conv 9 ×	1.6 M
2 • 8 5 Conv 9 =	4.56 SQ M

Multiply 1.15 meters by 7:

KEYSTROKE	DISPLAY
1 • 1 5 Conv 9 × 7 =	8.05 M

Dividing Dimensions

Divide 8.75 mm by 4:

KEYSTROKE	DISPLAY
8 • 7 5 mm ÷ 4 =	2.1875 MM

Calculating Percentages

The % key can be used for finding a given percent of a number or for working add-on, discount or division percentage calculations. It can be used with any type of number, in any dimension (millimeter, meter, Feet, Inch, etc.) and any type of convention (non-dimensioned, linear, square or cubic).

Find 18% of 15.25 meters:

KEYSTROKE	DISPLAY
On/C On/C	0.
1 5 • 2 5 Conv 9 × 1 8 %	2.745 M

Take 20% from 5.35 meters:

KEYSTROKE	DISPLAY
5 • 3 5 Conv 9 − 2 0 %	**4.28 M**

MEMORY OPERATION

Whenever the M+ key is pressed, the displayed value will be added to the Memory. Other Memory functions:

FUNCTION	KEYSTROKE
Add to Memory	M+
Subtract from Memory	Conv M+
Recall total in Memory	Rcl M+
Display/Clear Memory	Rcl Rcl
Clear Memory	Conv Rcl

Memory is semi-permanent, clearing only when you do one of the following:

– turn off the calculator
– press Rcl Rcl
– press Conv Rcl
– press Conv ⊠ *(Clear All)*.

When Memory is recalled (Rcl M+), consecutive presses of M+ will display the calculated Average and total Count of the accumulated values.

Using M+

KEYSTROKE	DISPLAY
3 5 5 M+	**M+ 355. M**
2 5 5 M+	**M+ 255. M**
7 4 5 Conv M+ *(M-)*	**M- 745. M**
Rcl M+	**TOTAL -135. M**
M+	**AVG -45. M**

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KEYSTROKE	DISPLAY
M+	COUNT 3. M
Rcl Rcl	M+ - 135.

Using Memory Storage Keys (M1- M9)

In addition to the standard cumulative Memory (as previously described), your calculator has nine independent Storage Registers – M1 through M9 – that can be used to permanently store single, noncumulative values. The following example shows the use of M1 (Stor 1). To use M2 - M9, replace the presses of the 1 key with presses of the corresponding number key (2-9).

You can replace a value in one of these Memory registers by storing a new value in place of the stored value.

FUNCTION	KEYSTROKE
Store single value in M1	Stor 1
Clear M1	0 Stor 1
Recall M1	Rcl 1

Store 175 into M1, recall the value, and then clear the value:

KEYSTROKE	DISPLAY
1 7 5 Stor 1	MEM-1 S 175.
Off On/C	0.
Rcl 1	MEM-1 S 175.
0 Stor 1	MEM-1 S 0.

PAPERLESS TAPE OPERATION

The Paperless Tape allows you to display and review the last thirty entries of a regular math or basic dimensional math sequence.

To access this mode after entering values, press Conv =. Then, press + or − to scroll forward or backward through the entries.

While in the Paperless Tape mode, the display will show the previously entered or calculated value, along with the sequential number of the entry (e.g., 01, 02, 03, etc.) and the math operator (+, –, x, ÷, %) in the upper left corner of the display.

Note: *If (=) has been used in the middle of a sequence, SUB (for Subtotal) will display in the upper left. If (=) was the last operation performed, the display will show TTL (Total) as the last entry.*

To exit this mode, press (=) to exit and maintain the last entry on the display. When exiting, the last entry (or TTL) will be displayed, allowing you to continue using the last tape value for another operation, if desired.

Note: *The Paperless Tape is cleared when you do one of the following:*
- On/C is pressed twice
- upon a new calculation (new equation string is started)
- when the calculator is shut off.

Add a sequence of values and access Paperless Tape mode to review your entries. Then, add another value to your total.

KEYSTROKE	DISPLAY
1. Add a sequence of values:	
On/C On/C	**0.**
1 0 0 mm +	**100. MM**
1 9 0 mm +	**290. MM**
1 5 0 mm +	**440. MM**
9 5 mm =	**535. MM**
2. Access the Tape function:	
Conv =	**TTL = 535. MM**
3. Scroll from first value to total:	
+	**01 100. MM**
+	**02+ 190. MM**

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KEYSTROKE	DISPLAY
[+]	03+ 150. MM
[+]	04+ 95. MM
[+]	TTL = 535. MM

4. Scroll last two values:

[−]	04+ 95. MM
[−]	03+ 150. MM

5. Exit Tape function and add another value to your total:

[=]	TTL = 535. MM
[+]	535. MM
[8] [5] [mm] [=]	620. MM

USING THE *MACHINIST CALC PRO*

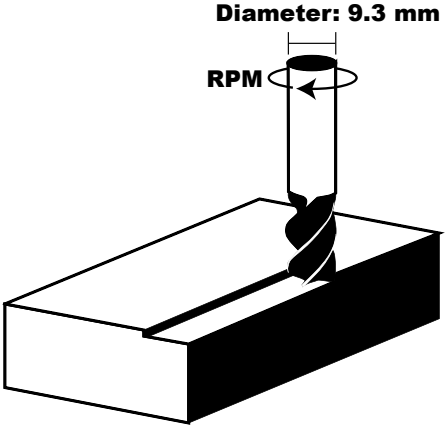
IMPORTANT: *All examples are based on the default metric units mode, displaying entries and calculations in metric units. Also note that if an attempt is made to find a solution (using the Machinist functions) without having stored the minimum required values, the calculation will not be performed. Instead, the currently stored value for the selected function will be displayed. See* **Key Definitions** *section for function requirements.*

RPM (SPINDLE SPEED)

RPM is the rotational speed of the spindle in revolutions per minute. In a milling machine or drill, the Spindle Speed is the rotation of the attached cutting tool. In a turning machine, it is the rotation of the attached workpiece. RPM can be calculated given values for Diameter and Cutting Speed.

RPM – *Milling*

Calculate the Spindle Speed (RPM) when milling with a 9.3 mm bit at a Cutting Speed of 90 smm (surface meters per minute):



KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the bit Diameter:	
9 • 3 Ø	**DIA S 9.3 MM**
2. Enter the Cutting Speed:	
9 0 V_c	**CUT S 90. M/MIN**
3. Calculate the Spindle Speed (RPM):	
π	**RPM 3080.**
π	**CUT S 90. M/MIN**
π	**DIA S 9.3 MM**
Rcl π *	**RPM S 3080.4183**

** The calculated RPM is displayed as a rounded, whole number value.*
Rcl π displays the stored RPM value in decimal floating point format.

RPM – *Turning*

Calculate the Spindle Speed (RPM) needed to turn a piece with a 125 mm Diameter at a recommended Cutting Speed of 200 smm:

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the bit Diameter:	
1 2 5 Ø	DIA S 125. MM
2. Enter the Cutting Speed:	
2 0 0 v_c	CUT S 200. M/MIN
3. Calculate the Spindle Speed (RPM):	
n *	RPM 509.

** Repeated presses of n will toggle through the inputs and outputs, starting with the entered Cutting Speed.*

RPM – *Drilling*

Calculate what the RPM (Spindle Speed) should be set to when drilling into material with a recommended Cutting Speed of 25 smm using a 17 mm bit:

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the Diameter:	
1 7 Ø	DIA S 17. MM
2. Enter the Cutting Speed:	
2 5 v_c	CUT S 25. M/MIN
3. Calculate the RPM:	
n *	RPM 468.

** Repeated presses of n will toggle through the inputs and outputs, starting with the entered Cutting Speed.*

FEED RATE

Feed Rate is the speed of the cutting tool's movement relative to the workpiece as the tool makes a cut. You can calculate Feed Rate given values for Cutting Feed and RPM (Spindle Speed). If you don't know the Cutting Feed, you can calculate Feed Rate with Feed per Tooth (Chip Load), Number of Teeth and RPM.

Feed Rate – *Based on Cutting Feed and RPM (for Turning)*

Calculate the Feed Rate if you are turning a 25 mm steel round stock down with a Cutting Feed of 0.80 millimeters per revolution (mm/rev) and a rotational speed of 900 RPM (Spindle Speed):

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the Cutting Feed:	
• 8 f_n	CUT S 0.8 MM/REV
2. Enter the RPM:	
9 0 0 π	RPM S 900.
3. Calculate the Feed Rate:	
v_f	FEED 720.0000 MM/MIN
v_f	RPM S 900.
v_f	CUT S 0.8 MM/REV

Feed Rate – *Based on Cutting Feed and RPM (for Drilling)*

Calculate the Feed Rate for a drilling operation that is using a recommended Cutting Feed of 0.10 millimeters per revolution at 800 RPM (Spindle Speed):

KEYSTROKE	DISPLAY
On/C On/C	0.

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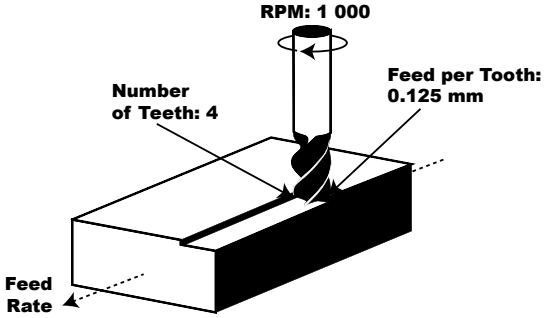
KEYSTROKE	DISPLAY
1. Enter the Cutting Feed:	
• 1 f_n	**CUT S 0.1 MM/REV**
2. Enter the RPM:	
8 0 0 n	**RPM S 800.**
3. Calculate the Feed Rate:	
v_f *	**FEED 80.0000 MM/MIN**

** Repeated presses of v_f will toggle through the inputs and outputs, starting with the entered RPM (Spindle Speed).*

Feed Rate – *Based on Feed per Tooth, RPM and # of Teeth*

Calculate the Feed Rate for a four-fluted end mill using a Feed per Tooth (Chip Load) of 0.125 millimeters turning at 1 000 RPM (Spindle Speed):



KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Feed per Tooth:	
• 1 2 5 f_z	**FPT S 0.125 MM**
2. Enter the Number of Teeth:	
4 z	**TEETH S 4.**

KEYSTROKE	DISPLAY
3. Enter the RPM:	
1 0 0 0 n	**RPM S 1000.**
4. Calculate the Feed Rate:	
v_f	**FEED 500.0000 MM/MIN**
v_f	**RPM S 1000.**
v_f	**CUT S 0.5 MM/REV***

** This Cutting Feed is calculated based on the entered Feed/Tooth and Number of Teeth. It, along with RPM, is then used to calculate the Feed Rate.*

CUTTING SPEED

Cutting Speed is the speed of the workpiece surface relative to the edge of the cutting tool during a cut, typically measured in surface meters per minute. You can calculate Cutting Speed by entering the Diameter of the tool or material you're using and the RPM (Spindle Speed).

Cutting Speed – *Milling*

Calculate the Cutting Speed for a mill using a 15 mm tool running at 1 250 RPM (Spindle Speed):

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Diameter of the tool:	
1 5 Ø	**DIA S 15. MM**
2. Enter the RPM:	
1 2 5 0 n	**RPM S 1250.**
3. Calculate the Cutting Speed:	
v_c *	**CUT 59. M/MIN**
v_c	**DIA S 15. MM**
v_c	**RPM S 1250.**

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KEYSTROKE	DISPLAY
Rcl v_c *	**CUT S 58.904862 M/MIN**

** The calculated Cutting Speed is displayed as a rounded, whole number value. Rcl v_c displays the stored Cutting Speed value in decimal floating point format.*

Cutting Speed – *Turning*

Calculate the Cutting Speed when turning a 100 mm rod at 300 RPM (Spindle Speed):

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Diameter of the rod:	
1 0 0 Ø	**DIA S 100. MM**
2. Enter the RPM:	
3 0 0 π	**RPM S 300.**
3. Calculate the Cutting Speed:	
v_c *	**CUT 94. M/MIN**

** Repeated presses of v_c will toggle through the inputs and outputs, starting with the entered Diameter.*

Cutting Speed – *Drilling*

Calculate the Cutting Speed using a 10.5 mm drill bit with the Spindle Speed set to 750 RPM:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Diameter of the hole to be drilled:	
1 0 • 5 Ø	**DIA S 10.5 MM**
2. Enter the RPM:	
7 5 0 π	**RPM S 750.**

KEYSTROKE	DISPLAY
3. Calculate the Cutting Speed:	
v_c *	**CUT 25. M/MIN**

** Repeated presses of v_c will toggle through the inputs and outputs, starting with the entered Diameter.*

FEED PER TOOTH (CHIP LOAD)

Feed per Tooth, or Chip Load, is the thickness of material removed by each cutting surface. You can calculate Feed per Tooth given values for Number of Teeth and Cutting Feed. If the Cutting Feed is not known, the Feed per Tooth can be calculated given values for Number of Teeth, Feed Rate and RPM (Spindle Speed).

Feed per Tooth – *Based on Cutting Feed and # of Teeth*

Calculate Feed per Tooth (Chip Load) with a Cutting Feed of 0.60 millimeters for 4 Teeth:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Cutting Feed:	
• 6 f_n	**CUT S 0.6 MM/REV**
2. Enter the Number of Teeth:	
4 z	**TEETH S 4.**
3. Calculate the Feed per Tooth:	
f_z	**FPT 0.1500 MM**
f_z	**TEETH S 4.**
f_z	**CUT S 0.6 MM/REV**

Feed per Tooth – *Based on Feed Rate, RPM and # of Teeth*

Calculate Feed per Tooth (Chip Load) with a 325 millimeters per minute Feed Rate, 4 Teeth and a Spindle Speed of 800 RPM:

(cont'd)

(cont'd)

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the Feed Rate:	
3 2 5 v_f	FEED S 325. MM/MIN
2. Enter the Number of Teeth:	
4 z	TEETH S 4.
3. Enter the Spindle Speed (RPM):	
8 0 0 n	RPM S 800.
4. Calculate the Feed per Tooth:	
f_z *	FPT 0.1016 MM

** Repeated presses of f_z will toggle through the inputs and outputs, starting with the entered Number of Teeth.*

RADIAL CHIP THINNING

In a Milling operation when the depth of a cut is less than half the diameter of the tool, you can use the Radial Chip Thinning to determine a new, faster and more efficient Chipload or Feed/Tooth value.

Radial Chip Thinning – *Based on Feed per Tooth, Tool Diameter and Cut Depth*

Calculate Radial Chip Thinning value with a Feed Per Tooth of 0.15 millimeters, a 25 millimeter Tool Diameter and a Cut Depth of 2.5 millimeters:

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the Feed per Tooth:	
• 1 5 f_z	FPT S 0.15 MM
2. Enter the Tool Diameter:	
2 5 Ø	DIA S 25. MM

KEYSTROKE	DISPLAY
3. Enter Cut Depth:	
2 • 5 Conv v_c *(RCT)*	**DEPTH S 2.5 MM**
4. Calculate the adjusted Feed per Tooth:	
v_c	**ADJST 0.2500 MM**
5. Calculate the Radial Chip Thinning Factor:	
v_c	**RCTF 1.6667**
v_c	**DIA S 25. MM**
v_c	**FPT S 0.15 MM**

CUTTING FEED

Cutting Feed is the distance the cutting tool or workpiece advances during one revolution of the spindle, typically measured in millimeters per revolution. You can calculate Cutting Feed given values for Feed per Tooth (Chip Load) and Number of Teeth. If these values are unknown, you can calculate Cutting Feed with Feed Rate and RPM (Spindle Speed).

Cutting Feed – *Based on Feed per Tooth and # of Teeth*

Calculate Cutting Feed with a Feed per Tooth (Chip Load) of 0.125 millimeters and 4 Teeth:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Feed per Tooth:	
• 1 2 5 f_z	**FPT S 0.125 MM**
2. Enter the Number of Teeth:	
4 z	**TEETH S 4.**
3. Calculate the Cutting Feed:	
f_n	**CUT 0.5000 MM/REV**
f_n	**FPT S 0.125 MM**

(cont'd)

(cont'd)

KEYSTROKE	DISPLAY
f_n	**TEETH S 4.**

Cutting Feed – *Based on Feed Rate and RPM*

Calculate a Cutting Feed using a 375 millimeter Feed Rate and a Spindle Speed of 800 RPM:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Feed Rate:	
3 7 5 v_f	**FEED S 375. MM/MIN**
2. Enter the Spindle Speed (RPM):	
8 0 0 π	**RPM S 800.**
3. Calculate the Cutting Feed:	
f_n *	**CUT 0.4688 MM/REV**

** Repeated presses of f_n will toggle through the inputs and outputs, starting with the entered Feed Rate.*

DRILL SIZES

The ⇳ key allows the selection of a desired metric Drill Size, which can be entered as a millimeter value (maximum of 78 mm). If the entered value doesn't match a Drill Size, the next smaller size is displayed. To set the displayed Drill Size, press On/C (or any other key).

Note: *You can toggle through the available sizes in increasing order with either the ⇳ key or the + key. The − key displays the available sizes in decreasing order. U.S. drill sizes will be displayed as well, as they are also included within the Drill Size table.*

Enter a 3.7 mm hole size and toggle through the available sizes to view the next larger and next smaller sizes:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the hole size:	
3 • 7 S	**3_70 MM DRILL SIZE S 3.7000 MM**
2. View next larger and next smaller sizes, including U.S. sizes:	
S	**26 DRILL SIZE S 3.7338 MM**
− −	**27 DRILL SIZE S 3.6576 MM**
−	**3_60 MM DRILL SIZE S 3.6000 MM**
−	**9/64 DRILL SIZE S 3.5719 MM**

DRILL POINT

The Drill Point function calculates the Drill Point Cut Depth (length) of the stored Drill Size. By default, the calculation is based on a Cutting Angle of 118°. If a different Angle is desired, it can be stored using the Drill Point function (for example, 1 2 0 Conv S stores 120°).

Find the Drill Point Cut Depth for a 12.5 millimeter drill with a 118° Cutting Angle. Then, find the Cut Depth using a 127° Angle.

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Drill Size:	
1 2 • 5 S	**12_50 MM DRILL SIZE S 12.5000 MM**
2. Enter 118° Angle and calculate the Drill Point Cut Depth:	
1 1 8 Conv S *(Drill Point)*	**DEPTH DRILL 3.7554 MM**
S	**ANGLE DRILL S 118.°**
S	**12_50 MM DRILL SIZE S 12.5000 MM**
3. Enter 127° angle and calculate the Drill Point cut length:	
1 2 7 Conv S *(Drill Point)*	**DEPTH DRILL S 3.1161 MM**

THREAD SIZING

The key allows you to enter a Thread Size and then toggle through the various available Thread characteristics, as shown in the tables provided later in this section.

When using the key, the first entry is considered the Thread Size (1 mm to 300 mm). After entering the Thread Size, the Pitch is required (less than or equal to 10). If the entered Thread Size is a standard size, continuous presses of the key will toggle through the available Pitches. Once the desired Pitch is reached, pressing On/C stores the Thread Size. If the Thread Size you enter is not a standard size or if you have a non-common Pitch, you will need to directly enter the Pitch value, pressing after entering it in order to store the Thread Size.

Note: *Entries outside of the ranges mentioned above will result in an Entry Error.*

The following tables list the available Thread characteristics provided by the Thread Size function. Note that there are two separate listings, one for Internal Threads and one for External Threads. The listing shown within the Thread Size function is determined by the set Thread Classification (see ***Thread Classification*** section).

Internal Thread

Thread Size	Minimum Pitch Diameter
Cut Tap Drill Size*	Maximum Pitch Diameter
Roll Tap Drill Size*	Minimum Minor Diameter
Close Fit Drill Size*	Maximum Minor Diameter
Free Fit Drill Size*	Minimum Major Diameter

** If the resulting hole size is greater than 50 mm, the actual hole size will be displayed instead of adjusting to the closest Drill Size.*

External Thread

Thread Size	Minimum Pitch Diameter
Cut Rod Size	Maximum Major Diameter
Roll Shank Size	Minimum Major Diameter
Maximum Pitch Diameter	Maximum Minor Diameter

Thread Classification

With the *Machinist Calc Pro* you can choose between Internal and External Threads.

Thread Type	Metric Thread Tolerance Classes						
Internal	**3G** **3H**	**4G** **4H**	**5G** **5H**	**6G** **6H***	**7G** **7H**	**8G** **8H**	**9G** **9H**
External	**3g** **3h** **3e** **3f**	**4g** **4h** **4e** **4f**	**5g** **5h** **5e** **5f**	**6g** **6h** **6e** **6f**	**7g** **7h** **7e** **7f**	**8g** **8h** **8e** **8f**	**9g** **9h** **9e** **9f**

** Default setting*

Changing a Thread Classification

To display the current Thread Classification, press Conv ✿. You can change the number of a Thread Class by entering the number of the desired grade and pressing Conv ✿. Repeated presses of ✿ will toggle between External and Internal Thread Types.

KEYSTROKE	DISPLAY
Conv ✕	**ALL CLEAREd**
1. Enter a Tolerance Grade of 4:	
4 Conv ✿ *(Thread Class)*	**INT MM 4H**
2. Toggle through the available Tolerance Positions for the entered Grade:	

(cont'd)

(cont'd)

KEYSTROKE	DISPLAY
	EXT MM 4G
	EXT MM 4H
	EXT MM 4E
	EXT MM 4F
	INT MM 4G
	INT MM 4H

3. Enter a Tolerance Grade of 6 and toggle through the available Tolerance Positions for the entered Grade:

6 Conv *(Thread Class)*	**INT MM 6H**
	EXT MM 6G
	EXT MM 6H
*	**EXT MM 6E**

** Repeated presses of will continue to toggle through the available Tolerance Positions of the specified Grade.*

Thread Size

Find the available Internal and External Thread characteristics for a M5 x 0.75 screw with a Tolerance Class of 4H.

Note: *The default Metric Tolerance Class is 6H (Internal). To view the current Tolerance Class, press Conv after entering the desired Metric Thread Size. To change the class, press again.*

KEYSTROKE	DISPLAY
Conv ✕	**ALL CLEARED**
1. Set Tolerance Class to Internal 4H:	
4 Conv *(Thread Class)*	**INT MM 4H**
2. Enter the Thread Size:	
5 mm	**SIZE 5. – MM**
3. Enter the Thread Pitch and store the final Thread Size:	
• 7 5	**THRED SIZE S 5. – 0.75 MM**

KEYSTROKE	DISPLAY
4. Find the available Internal Thread characteristics:	
(Cut Tap Drill Size)	**TAP DRILL SIZE 4.25 MM**
(Roll Tap Drill Size)	**R-TAP DRILL SIZE 14**
(Close Fit Drill Size)	**CLOSE DRILL SIZE 5.3 MM**
(Free Fit Drill Size)	**FREE DRILL SIZE 5.8 MM**
(Min. Internal Pitch Diameter)	**PTCH- SIZE 4.5130 MM**
(Max. Internal Pitch Diameter)	**PTCH+ SIZE 4.5605 MM**
(Min. Internal Minor Diameter)	**MINR- SIZE 4.1880 MM**
(Max. Internal Minor Diameter)	**MINR+ SIZE 4.3060 MM**
(Min. Internal Major Diameter)	**MAJR- SIZE 5.0000 MM**
5. Switch to External 4g Tolerance Class and find the available External Thread characteristics:	
Conv *(Thread Class)*	**EXT MM 4G**
	THRED SIZE S 5. – 0.75 MM
(Rod Size for Thread Cutting)	**ROD SIZE 5.0000 MM**
(Rod Size for Cold Forming)	**CFORM SIZE 4.4520 MM**
(Max. External Pitch Diameter)	**PTCH+ SIZE 4.4910 MM**
(Min. External Pitch Diameter)	**PTCH- SIZE 4.4350 MM**
(Max. External Major Diameter)	**MAJR+ SIZE 4.9780 MM**
(Min. External Major Diameter)	**MAJR- SIZE 4.8880 MM**
(Max. External Minor Diameter)	**MINR+ SIZE 4.1660 MM**

Custom Thread Percentage

The *Machinist Calc Pro* uses a default Thread Grip Percentage of 75% when calculating Tap Drill sizes. With the custom Percentage Thread function, you can enter a different value to calculate Tap Drill sizes.

(cont'd)

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Calculate the Tap Drill Size for a M3.5 x 0.60 screw, then change the Thread Grip Percentage to 50% and calculate the new Tap Drill Size:

KEYSTROKE	DISPLAY
Conv ✕	**ALL CLEAREd**
1. Enter the Thread Size and calculate the Cut Tap and Roll Tap Drill Sizes:	
3 • 5 mm ▭	**SIZE 3.5 – MM**
• 6 ▭	**THRED SIZE S 3.5 – 0.6 MM**
▭ *(Cut Tap Drill Size)*	**TAP DRILL SIZE 2.9 MM**
▭ ** (Roll Tap Drill Size)*	**R-TAP DRILL SIZE 3.2 MM**
2. Change the Thread Grip Percentage to 50% and calculate the new Cut Tap and Roll Tap Drill Sizes:	
5 0 Conv ▭ *(% Thread)*	**THRD% SIZE S 50.**
▭	**THRED SIZE S 3.5 – 0.6 MM**
▭ *(Cut Tap Drill Size)*	**TAP DRILL SIZE 3.1 MM**
▭ ** (Roll Tap Drill Size)*	**R-TAP DRILL SIZE 3.3 MM**

** Repeated presses of ▭ will toggle through the inputs and outputs, starting with the Close Fit Drill Size.*

WIRE SIZES AND 3-WIRE MEASUREMENTS

Wire Size

If you know your Thread Size, you can find the Ideal, Maximum and Minimum Wire Sizes you can use for that size Screw Thread.

Find the Ideal, Maximum and Minimum Wire Sizes for measuring a M1.60 x 0.35 Thread:

KEYSTROKE	DISPLAY
On/C On/C	**0.**

KEYSTROKE	DISPLAY
1. Enter the Thread Size:	
1 • 6 mm	SIZE 1.6 – MM
2. Enter the Pitch and store the final Thread Size:	
• 3 5	THRED SIZE S 1.6 – 0.35 MM
3. Find the Ideal, Maximum and Minimum Wire Sizes:	
Conv v_f *(Wire Size)*	IDEAL SIZE 0.2021 MM
v_f	MAX SIZE 0.3150 MM
v_f	MIN SIZE 0.1960 MM

3-Wire Measurement – *Known Thread Size and Wire Size*

You can find the Minimum and Maximum 3-Wire Measurements as well as the Pitch Diameters if you know the Thread Size and the Wire Size you want to use.

Note: *When solving for 3-Wire Measurements and Pitch Diameters, the calculator assumes the equivalent External Thread Type if an Internal Thread Type is set (i.e., Internal 6H is assumed External 6H for Metric Threads).*

Find the Minimum and Maximum allowable 3-Wire Measurements and Pitch Diameters for a M1.60 x 0.35, Class 6H (External) screw, using 0.10 mm wire:

KEYSTROKE	DISPLAY
On/C On/C	0.
1. Enter the Thread Size:	
1 • 6 mm	SIZE 1.6 – MM
2. Enter the Pitch and store the final Thread Size:	
• 3 5	THRED SIZE S 1.6 – 0.35 MM
3. Set the Thread Class to 6H:	
6 Conv ✿ * *(Thread Class)*	EXT MM 6H

** If necessary, continue pressing ✿ until the desired External Thread Class is displayed.*

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KEYSTROKE	DISPLAY
4. Enter the Wire Size:*	
[•] [1] [Conv] [v_f] *(Wire Size)*	**WIRE SIZE S 0.1 MM**
5. Find the Minimum 3-Wire Measurement:	
[Conv] [π] *(3-W Measure)*	**3WMIN SIZE 1.3069 MM**
6. Find the Maximum 3-Wire Measurement:	
[π]	**3WMAX SIZE 1.3699 MM**
7. Find the Minimum Pitch Diameter:	
[π]	**PTCH- SIZE 1.3100 MM**
8. Find the Maximum Pitch Diameter:	
[π]	**PTCH+ SIZE 1.3730 MM**
[π]	**WIRE SIZE S 0.1 MM**

** If no Wire Size is entered, the calculated Ideal Wire Size will be used to find the 3-Wire Measurement.*

Pitch Diameter – *Known 3-Wire Measurement and Wire Size*

You can also find the measured Pitch Diameter if you know the 3-Wire Measurement and the Wire Size used to obtain the measurement.

Find the Pitch Diameter for a M1.60 x 0.35, Class 6H (External) screw with a 3-Wire Measurement of 10.10 mm obtained using 0.10 mm wire:

KEYSTROKE	DISPLAY
[On/C] [On/C]	**0.**
1. Enter the Thread Size:	
[1] [•] [6] [mm] [▒▒]	**SIZE 1.6 – MM**
2. Enter the Pitch and store the final Thread Size:	
[•] [3] [5] [▒▒]	**THRED SIZE S 1.6 – 0.35 MM**

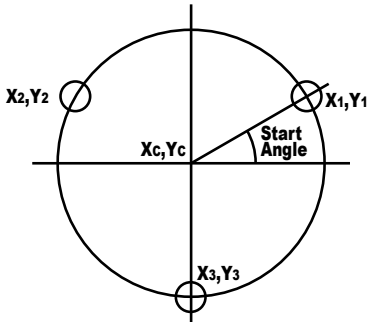
KEYSTROKE	DISPLAY
3. Set the Thread Class to 6H:	
6 Conv ⚙ * *(Thread Class)*	**EXT MM 6H**
** If necessary, continue pressing ⚙ until the desired External Thread Class is displayed.*	
4. Enter the Wire Size:*	
• 1 Conv v_f *(Wire Size)*	**WIRE SIZE S 0.1 MM**
5. Enter the 3-Wire Measurement:	
1 0 • 1 Conv π *(3-W Measure)*	**3WIRE SIZE S 10.1 MM**
6. Find the Pitch Diameter:	
π	**P-DIA SIZE 10.1031 MM**
π	**WIRE SIZE S 0.1 MM**

** If no Wire Size is entered, the calculated Ideal Wire Size will be used to find the Pitch Diameter.*

BOLT PATTERN

With the *Machinist Calc Pro*, you can determine a Bolt Pattern by entering the Bolt Circle Diameter, the Number of Bolt Holes and the Angle of the first bolt hole (optional). You can also enter an optional Center x and y-coordinate of the Bolt Pattern.

In addition to calculating the x and y-coordinates for each bolt hole, the Bolt Pattern function also calculates the hole center-to-center spacing (i.e. on-center distance from hole to hole).



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Bolt Pattern

Calculate the Bolt Pattern for a layout with a 90 mm Diameter, a 20° Start Angle and 3 Bolts. The Center x-coordinate is 250 mm and the center y-coordinate is 380 mm.

Note: *When determining angles, 0° is at the 3 o'clock position and the rotation goes counterclockwise.*

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Center x-coordinate:	
2 5 0 mm x	**ADJ S 250. MM**
2. Enter the Center y-coordinate:	
3 8 0 mm y	**OPP S 380. MM**
3. Enter the Start Angle:	
2 0 ∠	**ANGLE S 20.°**
4. Enter Bolt Circle Diameter:	
9 0 Ø	**DIA S 90. MM**
5. Enter the Number of Bolts:	
3 ⬡	**BOLTS S 3.**
6. Calculate Center-to-Center Spacing and the x and y-coordinates:	
⬡ *(Center-to-Center Spacing)*	**OC-OC 77.9423 MM**
⬡	**X-01 292.2862 MM**
⬡	**Y-01 395.3909 MM**
⬡	**X-02 215.5280 MM**
⬡	**Y-02 408.9254 MM**
⬡	**X-03 242.1858 MM**
⬡	**Y-03 335.6837 MM**
⬡	**DIA S 90. MM**

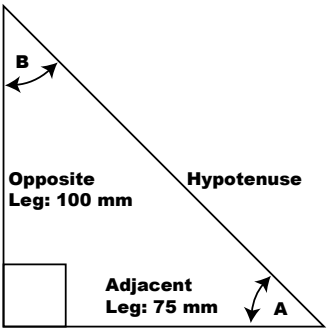
KEYSTROKE	DISPLAY
	Xoc S 250. MM
	Yoc S 380. MM
	ANGLE S 20.°

RIGHT TRIANGLE FUNCTIONS

With the *Machinist Calc Pro*, you can easily solve Right Triangle problems by simply entering two of four variables: Adjacent, Opposite, Hypotenuse or Angle.

Right Triangle – *Based on Adjacent and Opposite Legs*

Calculate the Hypotenuse, Angle and Adjacent Angle of a right triangle with an Adjacent Leg of 75 mm and an Opposite Leg of 100 mm:



KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the Adjacent Leg length:	
7 5 mm x	**ADJ S 75. MM**
2. Enter the Opposite Leg length:	
1 0 0 mm y	**OPP S 100. MM**
3. Solve for the Hypotenuse:	
r	**HYP 125.0000 MM**

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KEYSTROKE	DISPLAY
4. Solve for the Angle (A):	
[⊖]	**ANGLE S 53.130102°**
5. Solve for the Adjacent Angle (B):	
[⊖]	**ADJ<Ø 36.8699°**

Right Triangle – *Based on Hypotenuse and Angle*

Calculate the Adjacent Angle, Adjacent Leg and Opposite Leg of a right triangle with a Hypotenuse of 300 mm and a known Angle of 35.34°:

KEYSTROKE	DISPLAY
[On/C] [On/C]	**0.**
1. Enter the Hypotenuse:	
[3] [0] [0] [mm] [r]	**HYP S 300. MM**
2 Enter the known Angle:	
[3] [5] [•] [3] [4] [⊖]	**ANGLE S 35.34°**
3. Solve for the Adjacent Angle:	
[⊖]	**ADJ<Ø 54.6600°**
4. Solve for the Adjacent Leg:	
[x]	**ADJ 244.7202 MM**
5. Solve for the Opposite Leg:	
[y]	**OPP S 173.52818 MM**

CIRCLE CALCULATIONS

Circumference and Area – *Based on Diameter*

Find the Area, Circumference and Radius of a circle with a Diameter of 275 mm:

KEYSTROKE	DISPLAY
[On/C] [On/C]	**0.**

KEYSTROKE	DISPLAY
2 7 5 Ø	DIA S 275. MM
Ø	AREA 59395.736 SQ MM
Ø	CIRC 863.9380 MM
Conv Ø *(Radius)*	RAD S 137.5 MM

Circumference and Area – *Based on Radius*

Find the Diameter, Area and Circumference of a circle with a Radius of 85 mm:

KEYSTROKE	DISPLAY
On/C On/C	0.
8 5 mm Conv Ø *(Radius)*	RAD S 85. MM
Ø	DIA S 170. MM
Ø	AREA 22698.007 SQ MM
Ø	CIRC 534.0708 MM

BASIC D:M:S AND TRIGONOMETRY EXAMPLES

Converting Degrees:Minutes:Seconds

Convert 23° 42' 39" to decimal degrees:

KEYSTROKE	DISPLAY
On/C On/C	0.
2 3 • 4 2 • 3 9	DMS 23.42.39
Conv • *(dms◄►deg)*	23.710833°

Convert 44.29° to degrees:minutes:seconds format:

KEYSTROKE	DISPLAY
On/C On/C	0.
4 4 • 2 9 Conv • *(dms◄►deg)*	DMS 44.17.24°

Note: *Improperly formatted entries will be redisplayed in the correct convention after any operator key is pressed. For example, 30° 89' entered will be corrected and displayed as 31° 29' 0" or 31.483333°.*

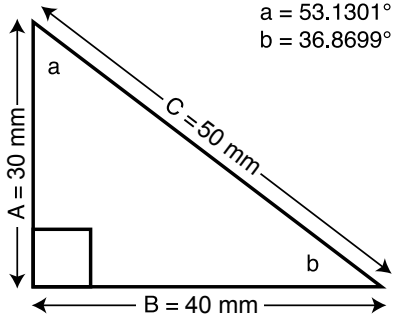
Time Calculations Using D:M:S

Add 7 Hours 45 Minutes 33 Seconds to 11 Hours 16 Minutes 20 Seconds:

KEYSTROKE	DISPLAY
On/C On/C	0.
7 • 4 5 • 3 3 +	DMS 7.45.33°
1 1 • 1 6 • 2 0 =	DMS 19.01.53°

Trigonometric Functions

The following drawing and formulas list basic trigonometric formulas, for your reference:



Given side A and angle a, find:

Side C — A ÷ a Conv f_z *(Cos)* =

(e.g., 3 0 mm ÷ 5 3 • 1 3 Conv f_z *(Cos)* =)

Side B — A × a Conv f_n *(Tan)* =

Angle b — 90° − a =

Given side A and angle b, find:

Side B — A ÷ b Conv f_n *(Tan)* =

Side C — A ÷ b Conv z *(Sin)* =

Angle a — 90° − b =

Given side B and angle a, find:

Side A — B ÷ a Conv f_n *(Tan)* =

Side C — B ÷ a Conv z *(Sin)* =

Given side C and angle a, find:

Side A — C × a Conv f_z *(Cos)* =

Side B — C × a Conv z *(Sin)* =

Given side A and side C, find:

Angle a — A ÷ C = Conv y *(Cos^{-1})*

Angle b — A ÷ C = Conv x *(Sin^{-1})*

Given side B and angle b, find:

Side C — B ÷ b Conv f_z *(Cos)* =

Side A — B × b Conv f_n *(Tan)* =

APPENDIX A – *U.S. MODE EXAMPLES*

The *Machinist Calc Pro*™, Model 4089, is designed for machinists who work with metric drill, screw thread classes and sizes. Below are examples of how the calculator can be used for non-metric applications, with some examples for working in U.S. units – numeric, letter, and inch drill sizes and numeric and fractional thread classes and sizes.

For most *Machinist Calc Pro* calculations, you can work in U.S. mode by simply changing the Units Preference from metric to U.S.

CUTTING SPEED

Calculate the Cutting Speed when using a 1/2" drill at 750 RPM (Spindle Speed):

KEYSTROKE	DISPLAY
On/C On/C	**0.**

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KEYSTROKE	DISPLAY
1. Set the calculator to U.S. Mode:	
Conv Stor Stor Stor +	**US UnITS**
2. Enter the Drill Size:	
1 / 2 ⌫	**1/2 DRILL SIZE S 0.5000 INCH**
3. Store as the Diameter:	
= Ø	**DIA S 0.5 INCH**
4. Enter the RPM:	
7 5 0 π	**RPM S 750.**
5. Calculate the Cutting Speed:	
v_c	**CUT S 98. FEET/MIN**
6. Return calculator to Metric Mode:	
Conv Stor Stor Stor +	**METRC UnITS**

U.S. DRILL SIZES

You can select a U.S. Drill Size, which can be entered as a:

- Numeric value (whole digits 1 through 97)
- Letter between A and Z
- Fractional or decimal Inch value (maximum of 3-1/2 Inches)

After entering a Drill Size, the selected Drill Size is displayed, along with its decimal Inch equivalent. Repeated presses of ⌫ display the next larger Drill Sizes. The + and − keys will toggle forward and backward, respectively, through all available Drill Sizes.

Numeric Drill Size Entry

Enter a #36 Drill and toggle through the next larger available sizes:

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Set the calculator to U.S. Mode:	
Conv Stor Stor Stor +	**US UnITS**

KEYSTROKE	DISPLAY
2. Enter a Numeric Drill Size:	
3 6 ⇳	**36 DRILL SIZE S 0.1065 INCH**
3. Display the next larger available sizes:	
⇳	**2_75 MM DRILL SIZE S 0.1083 INCH**
⇳	**7/64 DRILL SIZE S 0.1094 INCH**
⇳	**35 DRILL SIZE S 0.1100 INCH**

Letter Drill Size Entry

You can enter letter Drill Sizes by selecting an alphabet character via Alpha Mode (Conv 8) and then storing it using the ⇳ key. Select the desired letter by toggling through Alpha Mode until the letter is displayed or by entering the numerical order of the letter within the alphabet prior to entering Alpha Mode.

Select Drill Size E by toggling through Alpha Mode. Then, select Drill Size G by entering the numerical order of the letter (the letter G is 7th in the alphabet).

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter Alpha Mode:	
Conv 8 *(Alpha)*	**ALPHA A**
2. Toggle until the letter E is displayed:	
8 8 8 8	**ALPHA E**
3. Enter as Drill Size:	
⇳	**E DRILL SIZE S 0.2500 INCH**
4. View next larger available sizes:	
⇳	**6_40 MM DRILL SIZE S 0.2520 INCH**
⇳	**6_50 MM DRILL SIZE S 0.2559 INCH**
⇳	**F DRILL SIZE S 0.2570 INCH**

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KEYSTROKE	DISPLAY
5. Enter order of letter G and enter Alpha Mode:	
7 Conv 8 *(Alpha)*	**ALPHA G**
6. Enter as Drill Size:	
⇳	**G DRILL SIZE S 0.2610 INCH**

Inch Drill Size Entry

Enter hole sizes of 0.3", 1" and 1-19/64". After entering each size, toggle through the available sizes to view the next larger and next smaller sizes.

KEYSTROKE	DISPLAY
On/C On/C	**0.**
1. Enter the 0.3" hole size and view next larger and next smaller sizes:	
• 3 Inch ⇳	**7_60 MM DRILL SIZE S 0.2992 INCH**
⇳	**N DRILL SIZE S 0.3020 INCH**
− −	**19/64 DRILL SIZE S 0.2969 INCH**
2. Enter the 1" hole size and view next larger and next smaller sizes:	
1 Inch ⇳	**1 DRILL SIZE S 1.0000 INCH**
⇳	**25_50 MM DRILL SIZE S 1.0039 INCH**
− −	**63/64 DRILL SIZE S 0.9844 INCH**
3. Enter the 1-19/64" hole size and view next larger and next smaller sizes:	
1 Inch 1 9 / 6 4 ⇳	**19/64 DRILL SIZE S 1.2969 INCH**
⇳	**33_00 MM DRILL SIZE S 1.2992 INCH**
− −	**9/32 DRILL SIZE S 1.2813 INCH**
4. Return calculator to Metric Mode:	
Conv Stor Stor Stor +	**METRC UnITS**

U.S. THREAD SIZING

In U.S. mode, the Thread Sizing function provides the same Thread characteristics as the metric mode, but includes Numeric and Fractional Thread Sizes and Threads Per Inch (TPI).

When using the key, the first entry is considered the Thread Size. Upon entering the Thread Size, the Threads per Inch (TPI) is required. If the entered Thread Size is a standard size, continuous presses of the key will toggle through the available common TPI. Once the desired TPI is reached, pressing On/C stores the Thread Size. If the Thread Size you enter is not a standard size or if you have a non-common TPI, you will need to directly enter the TPI value, pressing after entering it in order to store the Thread Size.

The following specifies the entry ranges that the calculator allows for the Thread Size and TPI values for numeric and fractional Thread Sizes:

	Thread Size	TPI
Numeric	0,1,2,3,4,5,6,8,10,12,14	less than 100
Fractional	0.06" to 6"	less than 100

Note: *Entries outside of the ranges mentioned above will result in an Entry Error.*

U.S. Thread Classes

With the *Machinist Calc Pro* you can choose between Internal and External Threads. Entering a U.S. Thread Size will allow you to choose among U.S. Thread Classes as shown below.

Thread Type	U.S. Thread Classes		
Internal	**1B**	**2B***	**3B**
External	**1A**	**2A**	**3A**

** Default setting*

Changing a U.S. Thread Classification

KEYSTROKE	DISPLAY
Conv ✕	**ALL CLEARED**
1. Set the calculator to U.S. Mode:	
Conv Stor Stor Stor +	**US UnITS**
2. Recall the current Thread Classification:	
Conv ⚙ *(Thread Class)*	**INT 2B**
3. Change to U.S. External Thread Class 2:	
⚙	**EXT 2A**
4. Change to U.S. External Thread Class 1:	
1 Conv ⚙ *(Thread Class)*	**EXT 1A**
5. Change to U.S. Internal Thread Class 1:	
⚙	**INT 1B**

Fractional Thread Size Example

Find the available Internal and External Thread characteristics for a 1/4", 28 TPI screw:

KEYSTROKE	DISPLAY
Conv ✕	**ALL CLEARED**
1. Verify Thread Class is set to 2B:	
Conv ⚙ *(Thread Class)*	**INT 2B**
2. Enter the Thread Size:	
1 / 4 ▥	**SIZE 1/4 – INCH**
3. Enter the TPI and store the final Thread Size:	
2 8 ▥	**THRED SIZE S 1/4 – 28 INCH**
4. Find the available Internal Thread characteristics:	
▥ *(Cut Tap Drill Size)*	**TAP DRILL SIZE 3**

KEYSTROKE	DISPLAY
(Roll Tap Drill Size)	**R-TAP DRILL SIZE 5.9 MM**
(Close Fit Drill Size)	**CLOSE DRILL SIZE F**
(Free Fit Drill Size)	**FREE DRILL SIZE H**
(Min. Internal Pitch Diameter)	**PTCH- SIZE 0.2268 INCH**
(Max. Internal Pitch Diameter)	**PTCH+ SIZE 0.2311 INCH**
(Min. Internal Minor Diameter)	**MINR- SIZE 0.2110 INCH**
(Max. Internal Minor Diameter)	**MINR+ SIZE 0.2200 INCH**
(Min. Internal Major Diameter)	**MAJR- SIZE 0.2500 INCH**

5. Switch to Thread Class 2A and find the available External Thread characteristics:

Conv *(Thread Class)*	**EXT 2A**
	THRED SIZE S 1/4 – 28 INCH
(Rod Size for Thread Cutting)	**ROD SIZE 0.2500 INCH**
(Rod Size for Cold Forming)	**CFORM SIZE 0.2239 INCH**
(Max. External Pitch Diameter)	**PTCH+ SIZE 0.2258 INCH**
(Min. External Pitch Diameter)	**PTCH- SIZE 0.2225 INCH**
(Max. External Major Diameter)	**MAJR+ SIZE 0.2490 INCH**
(Min. External Major Diameter)	**MAJR- SIZE 0.2425 INCH**
(Max. External Minor Diameter)	**MINR+ SIZE 0.2065 INCH**

6. Return calculator to Metric Mode:

Conv Stor Stor Stor +	**METRC UnITS**

APPENDIX B – *DEFAULT SETTINGS*

After a Clear All (Conv ⊠), your calculator will return to the following settings:

STORED VALUES	DEFAULT VALUE
Number of Teeth	**1.**
Drill Point Angle	**118°**
Weight per Volume	**490 pounds per cubic foot**
% Thread	**75%**
Thread Classification	
Metric Threads	**Internal 6H**
U.S. Threads	**Internal 2B**

If you replace your batteries or perform a Full Reset* (press Off, hold down ⊠ and press On/C) your calculator will return to the following settings (in addition to those listed above):

PREFERENCE SETTINGS	DEFAULT VALUE
Fractional Resolution	**1/64"**
Functional Result Rounding	**0.0000**
Default Unit Format	**Metric**
Area Answer Format	**Standard**
Volume Answer Format	**Standard**
Fractional Mode	**Standard**
Mathematical Operation	**Order of Operations Method**

** Depressing the Reset button located above the Yc key will also perform a Full Reset.*

APPENDIX C – *PREFERENCE SETTINGS*

The *Machinist Calc Pro* has Preference Settings that allow you to customize or set desired unit formats and calculations. If you replace your batteries or perform a Full Reset* (press Off, hold down ⊠, and press On/C), your calculator will return to the following settings (in addition to those listed on the previous page), with the default setting for each preference listed first:

** Depressing the Reset button located above the γ_c key will also perform a Full Reset.*

PREFERENCE	OPTIONS
1) Fractional Resolution	– **1/64:** displays fractional values to the nearest 64th of an Inch. – **1/2:** displays fractional values to the nearest half Inch. – **1/4:** displays fractional values to the nearest quarter of an Inch. – **1/8:** displays fractional values to the nearest 8th of an Inch. – **1/16:** displays fractional values to the nearest 16th of an Inch. – **1/32:** displays fractional values to the nearest 32nd of an Inch.
2) Functional Result Rounding	– **0.0000:** calculation results using Machinist functions are displayed to four decimal places. – **0.000:** calculation results using Machinist functions are displayed to three decimal places. – **FLOAT:** calculation results using Machinist functions are always displayed to the maximum number of decimal places.

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PREFERENCE	OPTIONS
3) Default Unit Format	– **METRIC:** unitless values stored within the Machinist functions are automatically assigned the corresponding default Metric units of the selected function. – **US:** unitless values stored within Machinist functions are automatically assigned the corresponding default U.S. units of the selected function.
4) Area Answer Format	– **Standard:** if units entered are the same – e.g., Feet x Feet – area answers will remain in this format (Square Feet), but if units entered are different – e.g., Inches x Feet – area answers will be displayed in Square Feet. – **Square Feet:** area answers always displayed in Square Feet, regardless of unit entry – e.g., Inches x Inches = Square Feet. – **Square Inches:** area answers always displayed in Square Inches, regardless of unit entry – e.g., Feet x Feet = Square Inches. – **Square Meters:** area answers always displayed in Square Meters, regardless of unit entry – e.g., Feet x Feet = Square Meters.

PREFERENCE	OPTIONS
5) Volume Answer Format	**– Standard:** if units entered are the same – e.g., Feet x Feet x Feet – the answer will remain in this format (Cubic Feet), but if units entered are different – e.g., Feet x Feet x Inches – volume answer will be displayed in Cubic Feet. **– Cubic Feet:** volume answers always displayed in Cubic Feet, regardless of unit entry – e.g., Inches x Inches x Inches = Cubic Feet. **– Cubic Meters:** volume answers always displayed in Cubic Meters, regardless of unit entry – e.g., Feet x Feet x Feet = Cubic Meters. **– Cubic Inches:** volume answers always displayed in Cubic Inches, regardless of unit entry – e.g., Feet x Feet x Feet = Cubic Inches.
6) Fractional Mode	**– Standard:** fractions are displayed to the nearest fraction. **– Constant:** fractions are displayed in the set Fractional Resolution.
7) Mathematical Operation	**– Order:** the calculator uses the Order of Operations Method (10 + 4 x 5 = 30). **– Chain:** the calculator uses the Chaining Method (as entered: 10 + 4 x 5 = 70).

APPENDIX D – *CARE INSTRUCTIONS*

Please follow the guidelines listed in this section for proper care and operation of your calculator. Not following the instructions listed below may result in damage not covered by your warranty. Refer to the ***WARRANTY*** section for more details.

Do not expose calculator to temperatures outside the operating temperature range of 0ºC – 40ºC.

Do not expose calculator to high moisture such as submersion in water, heavy rain, etc.

APPENDIX E – *ACCURACY/ERRORS, AUTO SHUT-OFF, BATTERIES, RESET*

ACCURACY/ERRORS

Accuracy/Display Capacity — Your calculator has a twelve-digit display made up of eight digits (normal display) and four fractional digits. You may enter or calculate values up to 99,999,999.99. Each calculation is carried out internally to 12 digits.

Errors — When an incorrect entry is made, or the answer is beyond the range of the calculator, an error message will display. To clear an error condition you must press the On/C key once. At this point, you must determine what caused the error and re-key the problem.

Error Codes

DISPLAY	ERROR TYPE
OFLO	Overflow (too large)
MATH Error	Divide by 0
DIM Error	Dimension error
ENT Error	Invalid entry error
NONE	Attempt to access cleared Thread Size or Drill Size Value; invalid RCT calculation

Auto-Range — If an “overflow” is created because of an input and calculation with small units that are out of the standard eight-digit range of the display, the answer will be automatically expressed in the next larger units (instead of showing “**OFLO**”) — e.g., 200,000,000 mm is shown as 200,000 m. Also applies to inches and feet.

AUTO SHUT-OFF

Your calculator is designed to shut itself off after about 8-12 minutes of non-use.

BATTERIES

The *Machinist Calc Pro* uses two LR-44 batteries. Should your calculator display become very dim or erratic, replace the batteries.

Note: *Please use caution when disposing of your old batteries, as they contain hazardous chemicals.*

Replacement batteries are available at most discount or electronics stores.

Battery Replacement Instructions

To replace the batteries, slide open the battery door (at top backside of unit) and replace with new batteries. Make sure the batteries are facing positive side up.

RESET

If your calculator should ever “lock up,” press Reset – a small hole located above the v_c key – to perform a total reset.

REPAIR AND RETURN

RETURN GUIDELINES

1. Please read the ***Warranty*** in this User's Guide to determine if your Calculated Industries product remains under warranty **before** calling or returning any device for evaluation or repairs.
2. If your product won't turn on, check the batteries as outlined in the User's Guide.
3. If you need more assistance, please go to the website listed below.
4. If you believe you need to return your product, please call the dealer who sold the product for additional information.

www.calculated.com/warranty

WARRANTY

Warranty Repair Service

Calculated Industries (“CI”) warrants this product against defects in materials and workmanship for a period of one **(1) year from the date of original consumer purchase.** If a defect exists during the warranty period, CI at its option will either repair (using new or remanufactured parts) or replace (with a new or remanufactured calculator) the product at no charge.

THE WARRANTY **WILL NOT APPLY** TO THE PRODUCT IF IT HAS BEEN DAMAGED BY MISUSE, ALTERATION, ACCIDENT, IMPROPER HANDLING OR OPERATION, OR IF UNAUTHORIZED REPAIRS ARE ATTEMPTED OR MADE. SOME EXAMPLES OF DAMAGES NOT COVERED BY WARRANTY INCLUDE, BUT ARE NOT LIMITED TO, BATTERY LEAKAGE, BENDING, A BLACK “INK SPOT” OR VISIBLE CRACKING OF THE LCD, WHICH ARE PRESUMED TO BE DAMAGES RESULTING FROM MISUSE OR ABUSE.

To obtain warranty service, please contact the dealer who sold the product. A repaired or replacement product assumes the remaining warranty of the original product or 90 days, whichever is longer.

Repair Service

To obtain warranty or non-warranty repair service for goods purchased outside the U.S., contact the dealer through which you initially purchased the product. If you cannot reasonably have the product repaired in your area, you may contact CI to obtain current product repair information and charges, including freight and duties.

Disclaimer

CI MAKES NO WARRANTY OR REPRESENTATION, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT’S QUALITY, PERFORMANCE, MERCHANTABILITY, OR FITNESS

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FOR A PARTICULAR PURPOSE. AS A RESULT, THIS PRODUCT, INCLUDING BUT NOT LIMITED TO, KEYSTROKE PROCEDURES, MATHEMATICAL ACCURACY AND PREPROGRAMMED MATERIAL, IS SOLD "AS IS," AND YOU THE PURCHASER ASSUME THE ENTIRE RISK AS TO ITS QUALITY AND PERFORMANCE.

IN NO EVENT WILL CI BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECT IN THE PRODUCT OR ITS DOCUMENTATION.

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Legal Notes

Looking for New Ideas

Calculated Industries, a leading manufacturer of special-function calculators and digital measuring instruments, is always looking for new product ideas in these areas.

If you have a new product idea, please visit our "Bright Idea" page at www.calculated.com/brightidea.asp. For suggestions about improving this product or other products, please visit us at www.calculated.com under "Contact Us". Thank You.