



**Utility for checking functional expressions
in Field Precision technical programs**

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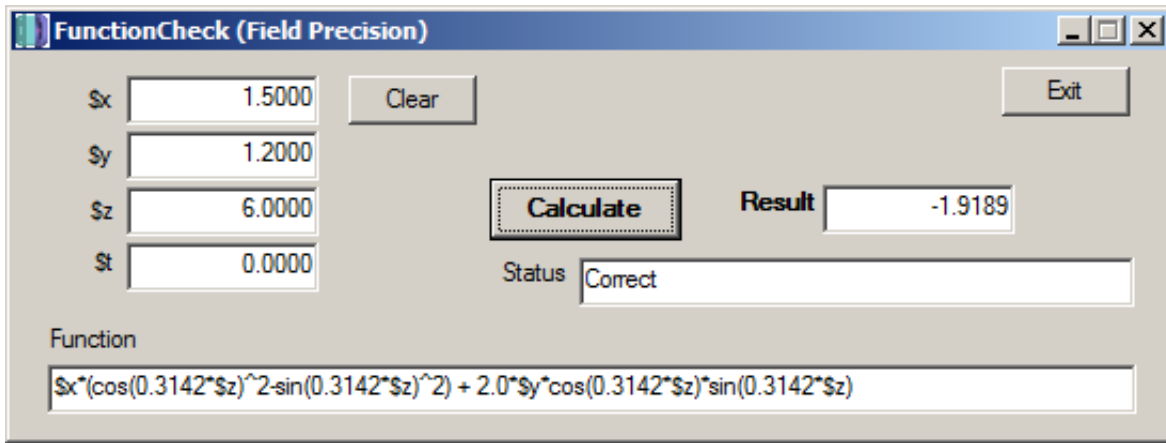


Figure 1: **FunctionCheck** display.

Several Field Precision programs¹ use a function interpreter to define spatial or time variations of quantities like dielectric constants, voltage, thermal conductivity and magnetic permeability. The feature gives users considerable flexibility to specify variations of material properties and waveforms. As an example, these expressions were used in **Mapper** to create a three-dimensional map of a twisted electrostatic quadrupole transport system:

$$\begin{aligned}
 E_x &= \$x * (\cos(0.3142 * \$z)^2 - \sin(0.3142 * \$z)^2) + 2.0 * \$y * \cos(0.3142 * \$z) * \sin(0.3142 * \$z) \\
 E_y &= \$y * (\sin(0.3142 * \$z)^2 - \cos(0.3142 * \$z)^2) + 2.0 * \$x * \cos(0.3142 * \$z) * \sin(0.3142 * \$z)
 \end{aligned}$$

For such complex functions, it's useful to check the syntactical and logical validity before using them in a full simulation. To help, we developed the **FunctionCheck** utility, shown in Fig. 1.

Operation of the program is straightforward. Type or paste any function into the string field at bottom following the syntax described below. Enter values for the variables that appear in the function. Press the *Calculate* button to evaluate the function for the current inputs. The numerical value appears in the *Result* field, and syntax errors are listed in under *Status*. Press the *Clear* button to set all input fields to 0.0.

A function contains up to 230 characters and that may include the following components:

- Spatial variables: $\$x$, $\$y$, $\$z$ and $\$t$,
- Real and/or integer numbers in any valid format (*e.g.*, 3.1415, 476, 1.367E23, 6.25E-02, 8.92E+04,...). Integers are converted to real numbers for evaluation.
- Binary operations: + (addition), - (subtraction), * (multiplication), / (division) and ^ (exponentiation).
- Functions: `abs` (absolute value), `sin` (sine), `cos` (cosine), `tan` (tangent), `ln` (normal logarithm), `log` (base 10 logarithm), `exp` (normal exponent) and `sqrt` (square root).

¹**EMP, EStat, PerMag, TDiff, Aether, HeatWave, HiPhi, Magnum, OmniTrak, GenDist and Mapper.**

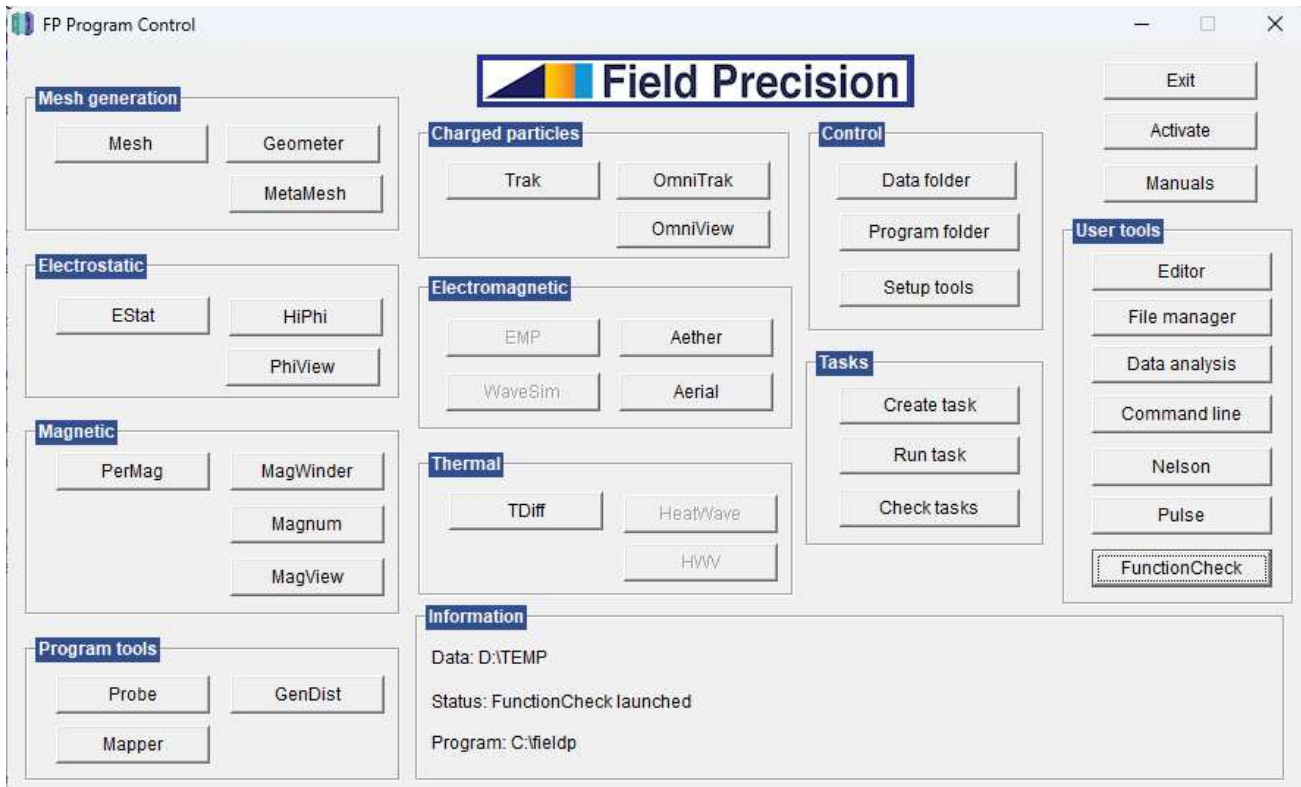


Figure 2: **FunctionCheck** added to **FPControl** as a user button.

- Up to 20 sets of parentheses to any depth.
- Any number of space delimiters.

Input to trigonometric functions is in radians. The parser conforms to the standard algebraic rules and features comprehensive error checking. Errors may include unbalanced parentheses, unrecognized characters and sequential binary operations. To illustrate a valid example, the expression

$$1 - \exp(-1.0*((\$x^2 + \$y^2)/24))$$

corresponds to

$$1.0 - \exp \left[- \left(\frac{x^2 + y^2}{24.0} \right) \right]. \quad (1)$$

The file `functioncheck.exe` is included with all Field Precision packages in the directory `C:\fieldp\TextbooksAndReference`. Figure 2 shows the program added as a user function button in **FPControl** using the `Setup tools` button.