F-Chart Software

No. 31, Fall 2016

EESy Solutions

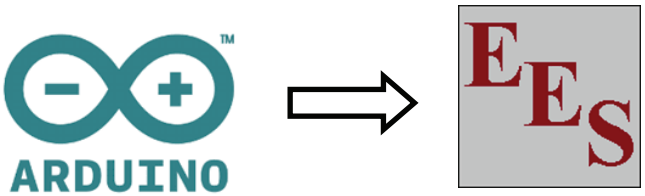
Engineering Equation Solver Newsletter

Inside this issue:

Welcome

This is the 31st issue of EESy Solutions, a newsletter that provides news, tips, and other updates for users of the Engineering Equation Solver software. This issue provides an overview of several new features of EES.

EES has been a commercially available for more than two decades. If you have missed any of the previous issues of EESy Solutions, they can be downloaded from www.fchart.com.



Arduino to EES Communication

Arduino boards are easy-to-use microcontrollers that can read inputs and provide outputs. The board itself is quite inexpensive and the software is free and easy to learn. The accompanying sensors and controllers are cheap enough to make this technology accessible to a wide range of users including students and hobbyists.

Using Arduino boards in the classroom for simple experiments will inevitably require that data taken by an onboard sensor be collected by a computer so that it can be analyzed, plotted, etc. Data collection can be done conveniently through the serial port using an EES macro and the data collected and stored in a Lookup Table for eventual use (perhaps in an EES program).

The Arduino program discussed here measures temperature and time every 1 s and outputs a string to the serial port that includes time and temperature separated by a comma. The EES macro reads these strings from the serial port and uses the information to fill up a Lookup Table.

The Arduino Sketch

Let's start with the Arduino sketch, shown below. Obviously the sketch can be modified to suit your purpose (e.g., you may be reading something other than temperature). However, this sketch should provide a starting point.

```
int val=0;
float Volt=0;
float T=0;
unsigned long Start=0;
unsigned long Now=0;
float Time=0;

void setup() {

Serial.begin(9600);

Start=millis();
}

void loop() {

Volt=0;
int N=100;
for (int i=1; i < (N+1); i++)
  {
  val=analogRead(A0);
  Volt=Volt+(float) val*5/1023;
  }
Volt=Volt/((float) N);

T=(Volt-0.5)*100;

Now=millis();

Time=(float) (Now-Start)/1000;

Serial.print(Time, 8);
Serial.print(',');
Serial.println(T, 4);

delay(1000);
}
```

Initialize variables

open a serial port connection

record the start time

measure voltage on analog pin 0 100 times and average the results together

turn voltage into temperature (note that a TMP36 is connected to analog pin 0)

record the current time

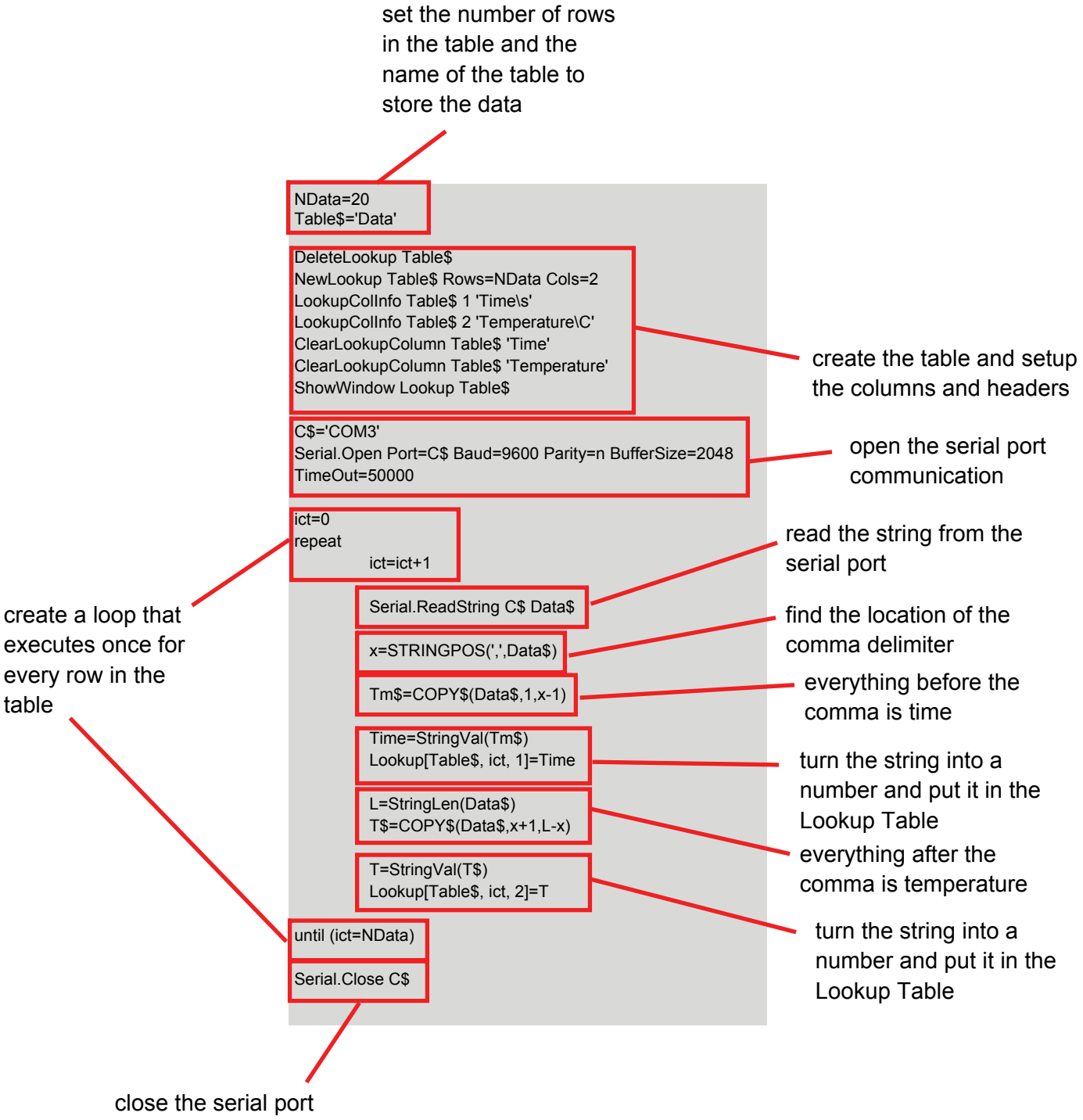
calculate the elapsed time

write a string to the serial point that contains the time (to 8 significant figures), a comma, and the temperature (to 4 significant figures)

wait 1 second before executing again

The EES Macro

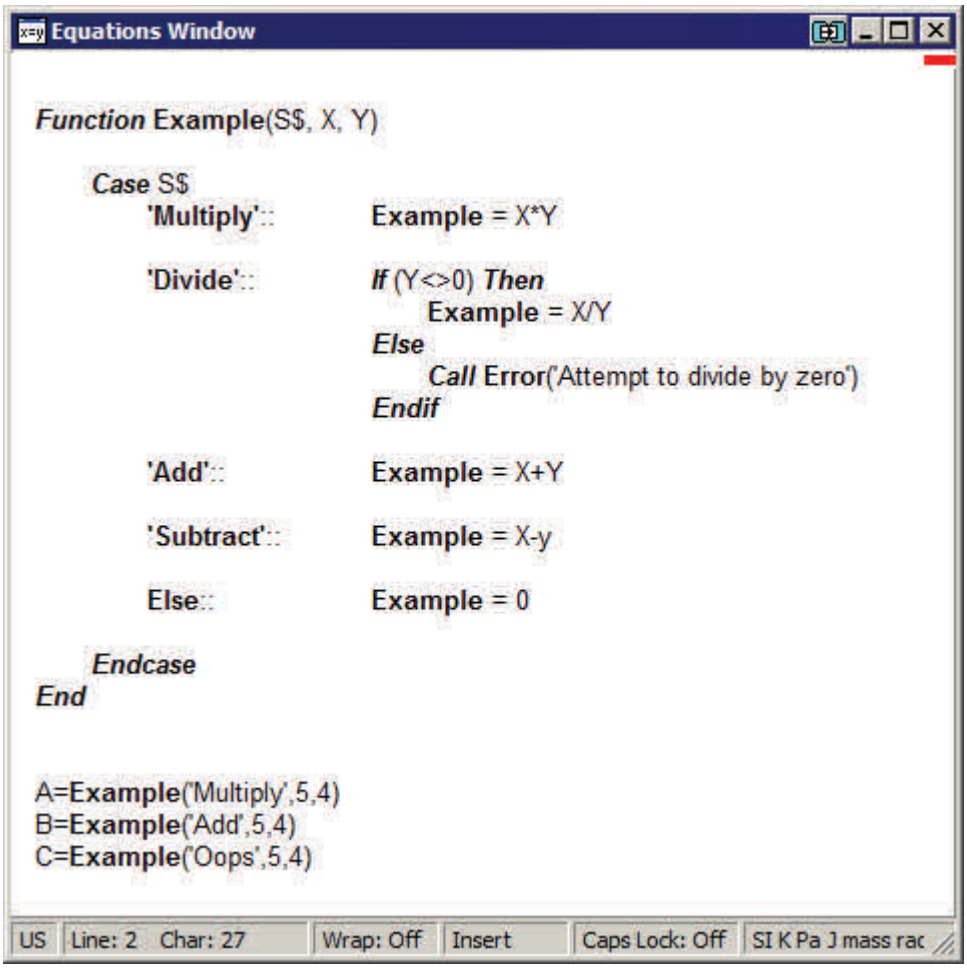
Once you've uploaded your Arduino sketch and it is successfully running, you can run the EES Macro below to take the string information from the serial port and store the data in a Lookup Table.

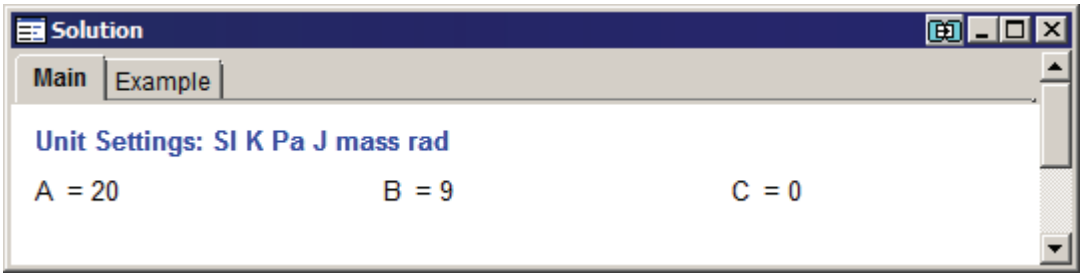


The CASE Statement

Logic statements can be used within Functions and Procedures in EES. These include If-Then-Else, Repeat-Until, and Goto statements. The Case statement extends this capability. Case statements allow several different lines of code to be executed based on a case decision variable. An else statement can be used as well. The Case statement must be terminated with an EndCase statement. The decision variable can be either a numerical variable or a string variable.

An example of a function that employs a Case statement is shown below:



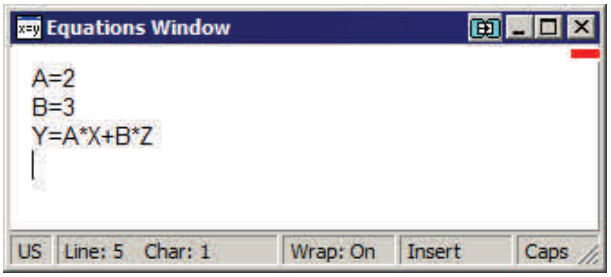


Tabs for Multiple Macro Windows

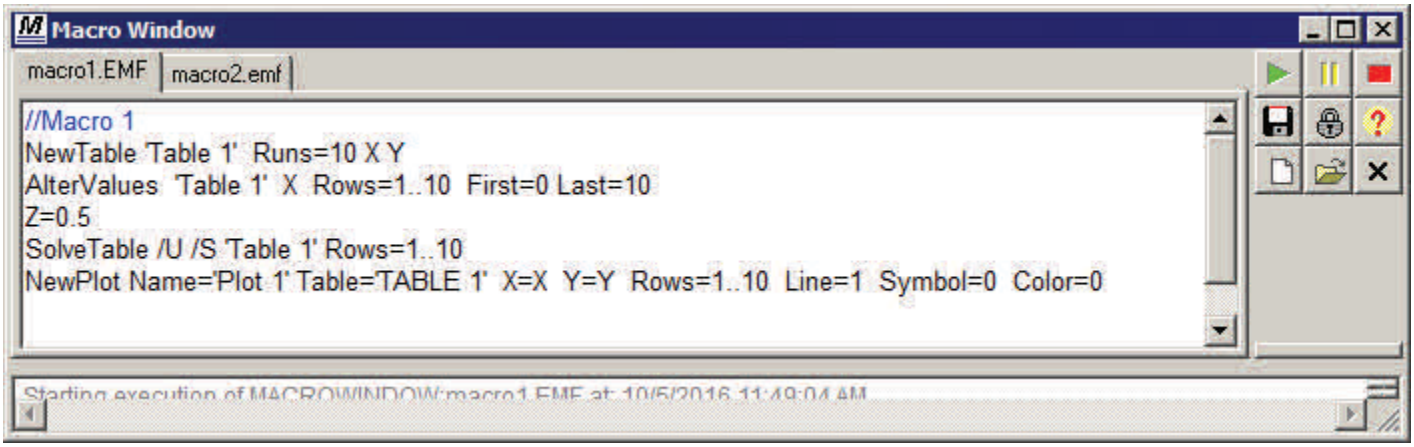
Macros are sets of instructions that EES can read and executed in the Professional version in order to automate the program's operation. For example, the Macro that is shown on pg. 3 of this newsletter automates the process of setting up a Lookup Table, naming each column, and copying data from the serial port to the Lookup table.. These are actions that you can do manually, but probably don't want to have to do more than once.

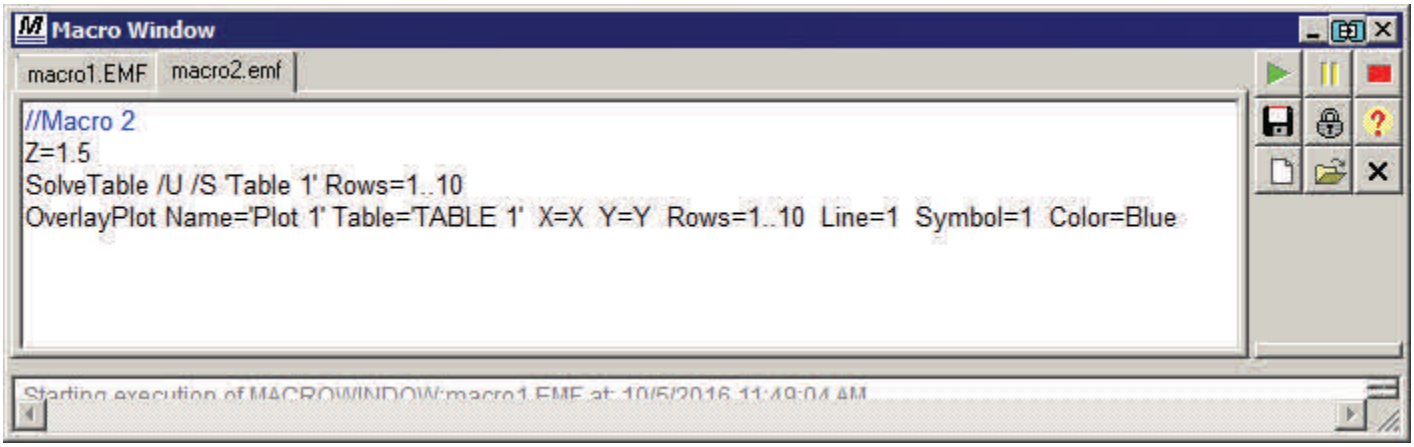
It is now possible to have multiple Macro programs open simultaneously in the Macro window. A tab is placed in the window for each macro, allowing easy navigation between them.

Shown here is an Equations Window and the Macro window with two macros. Macro1 does the following things: (1) sets up a Parametric Table with the variables X and Y, (2) sets the values of X, (3) sets Z to a value, (4) solves the table, and (5) plots the results.



Macro 2 does these additional things: (1) sets Z to a different value, (2) solves the table, and (3) overlays the new results onto the (already created) plot.





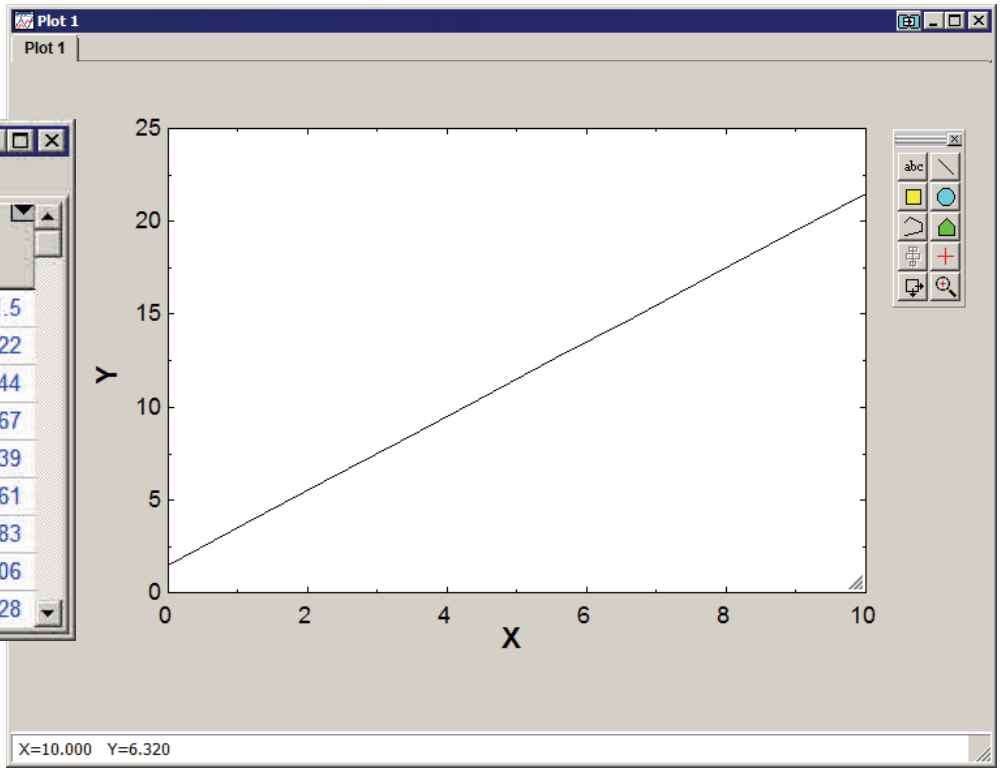
Tabs for Multiple Macro Windows (continued)

Running Macro1 causes the Parametric Table to be setup and populated and the plot to be generated.

Parametric Table

TABLE 1

1..10	X	Y
Run 1	0	1.5
Run 2	1.111	3.722
Run 3	2.222	5.944
Run 4	3.333	8.167
Run 5	4.444	10.39
Run 6	5.556	12.61
Run 7	6.667	14.83
Run 8	7.778	17.06
Run 9	8.889	19.28

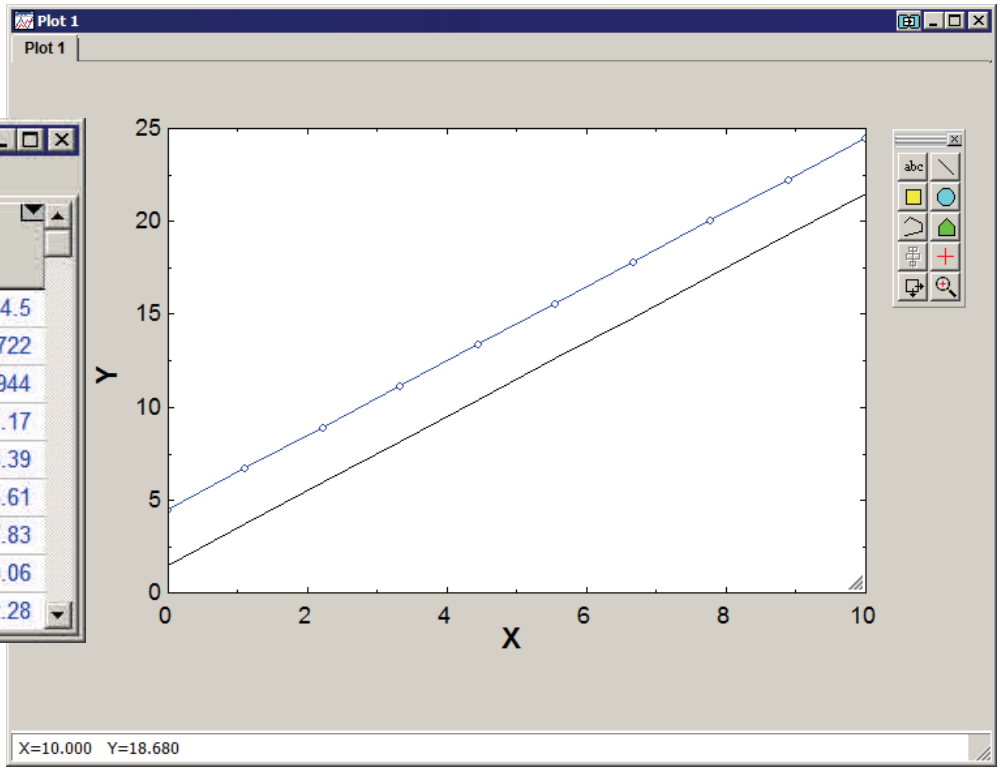


Running Macro2 subsequently causes the Parametric Table to be rerun with a different value of Z and a second plot to be overlayed onto the first.

Parametric Table

TABLE 1

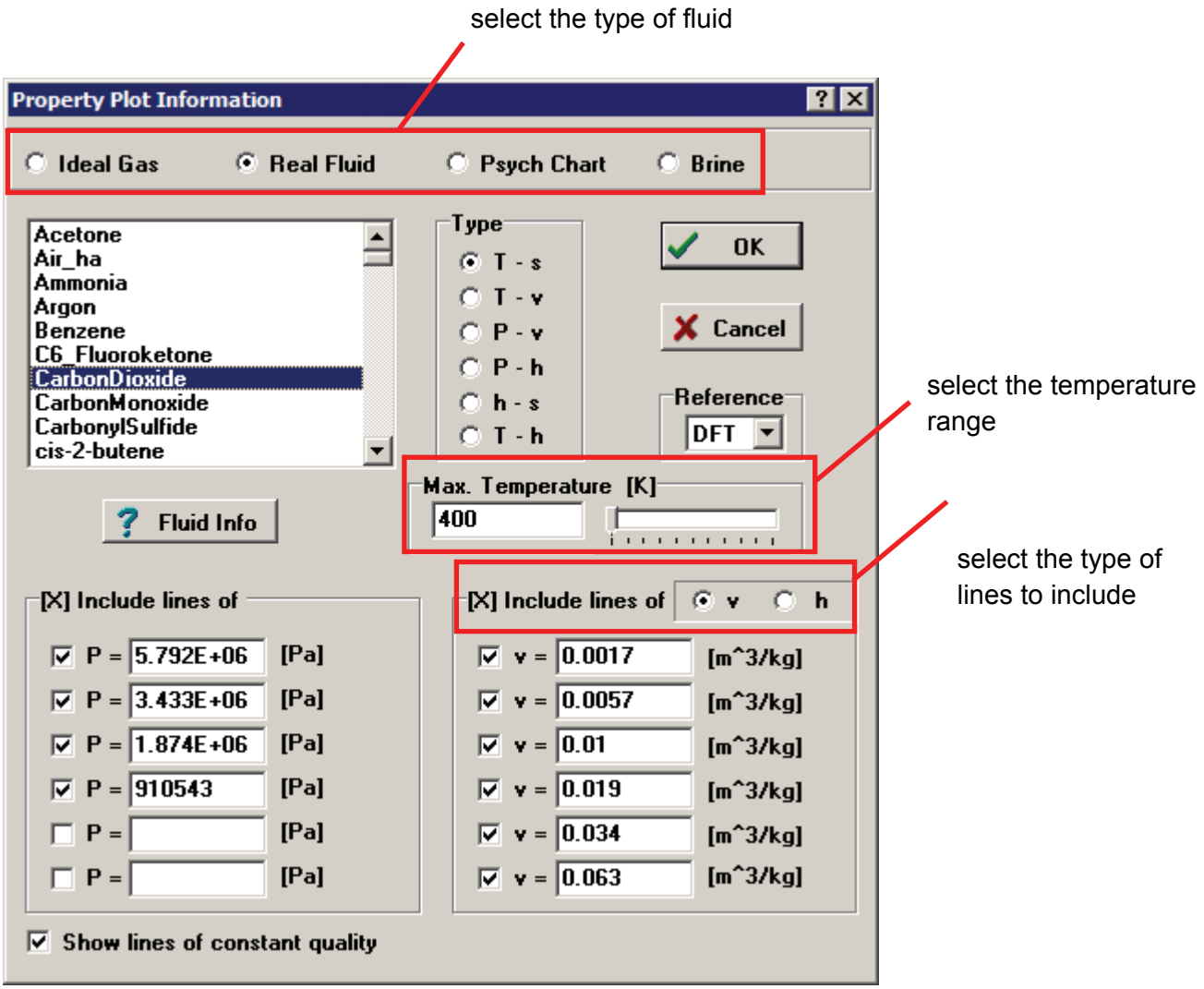
1..10	X	Y
Run 1	0	4.5
Run 2	1.111	6.722
Run 3	2.222	8.944
Run 4	3.333	11.17
Run 5	4.444	13.39
Run 6	5.556	15.61
Run 7	6.667	17.83
Run 8	7.778	20.06
Run 9	8.889	22.28



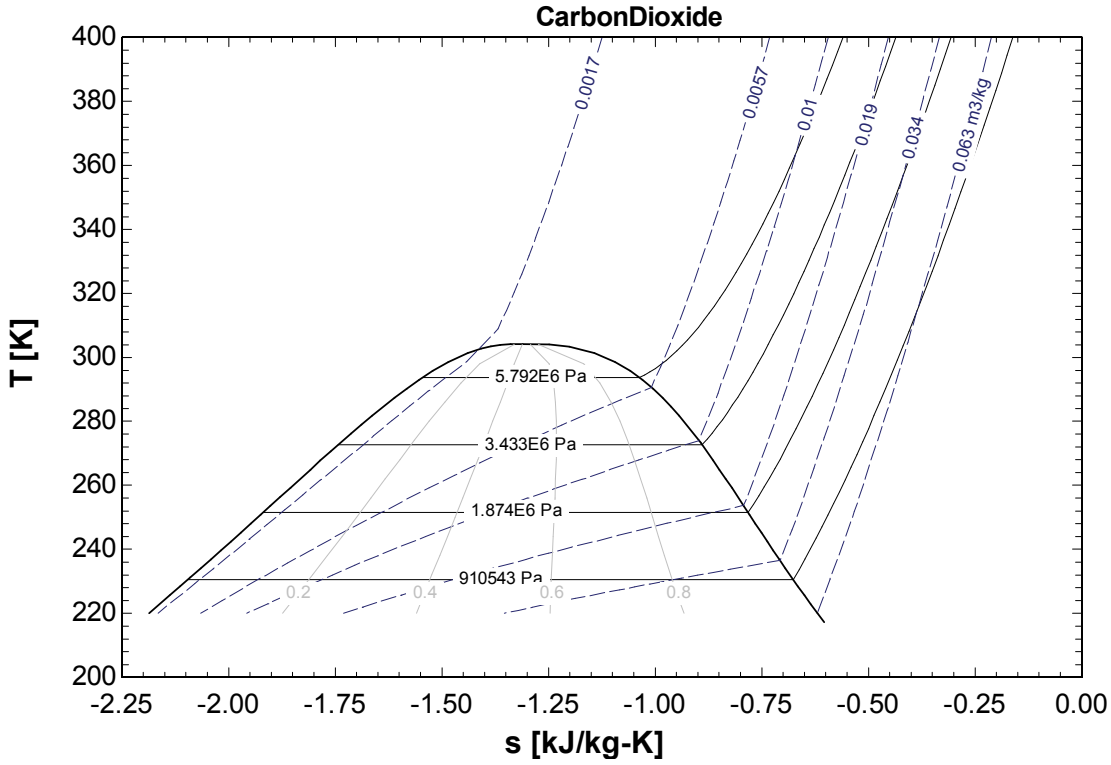
Improved Property Plots

The property plot feature of EES allows commonly used property diagrams, such as P-h or T-s plots, to be automatically created for any of the fluids in EES. Plots of property states from your program can be overlayed on the property plots allowing them to be visualized. Previously these plots were limited to axis ranges that were automatically selected by EES and could not easily be adjusted by the user. Property plots have been improved by allowing the axis range to be selected during the construction.

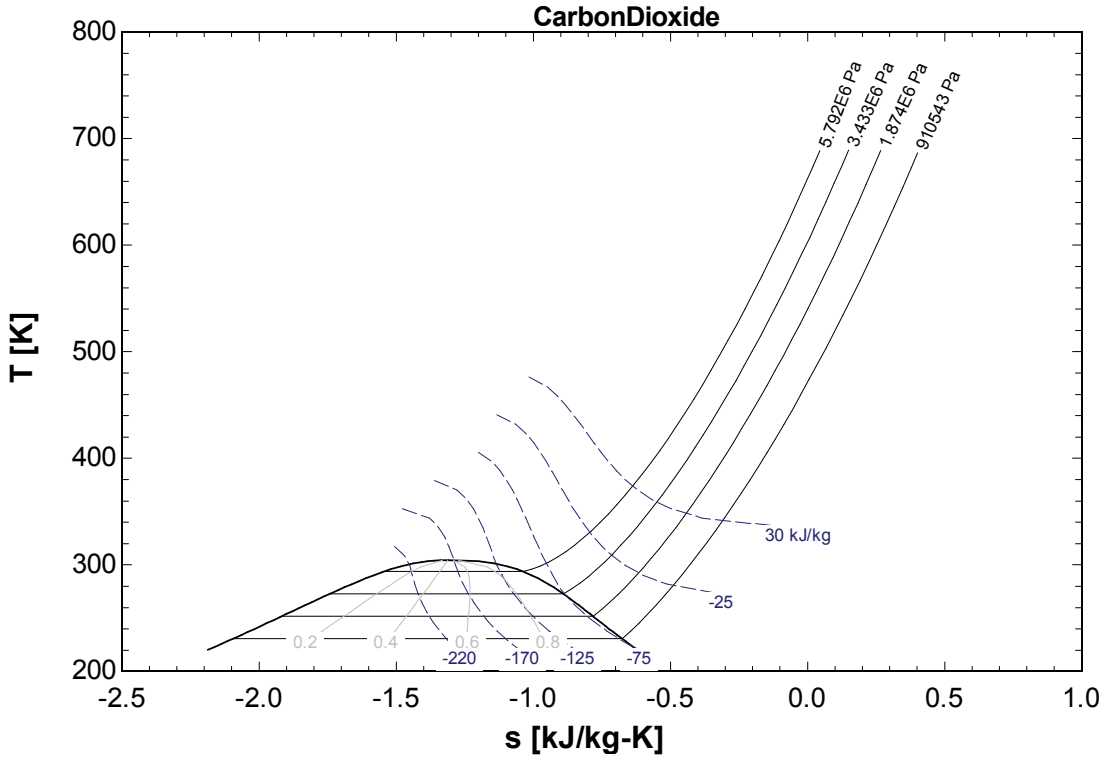
For example, select Property Plot from the Plots menu in order to access the Property Plot Information dialog. Note that you can now choose from the various types of fluids (Ideal Gas, Real Fluid, Psych Chart, or Brines) using the radio buttons along the top of the window. Further, note the slider control that allows you to change the temperature range of the plot. Finally, different lines can be included by selecting between the appropriate property. In the T-s diagram that is being created below it is possible to include either isochores or isenthalps depending on the user selection.



Improved Property Plots (continued)



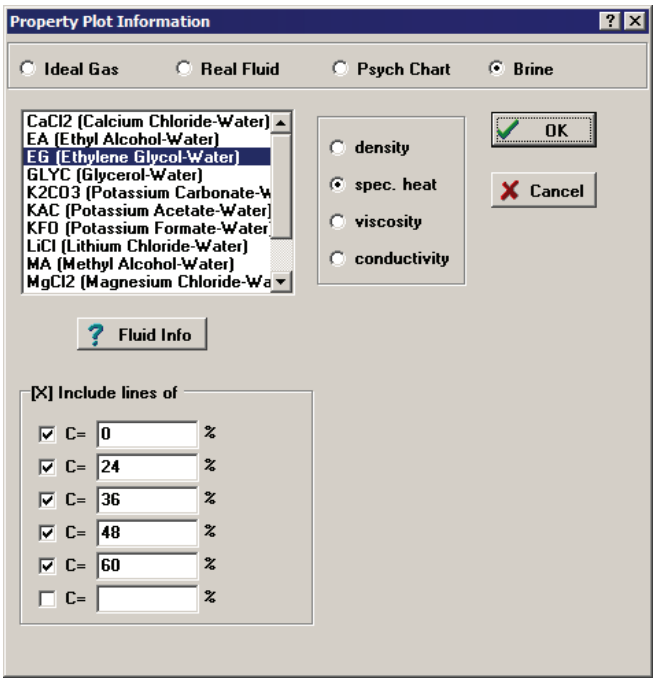
T-s diagram for carbon dioxide showing isochores with a temperature range ending at 400 K

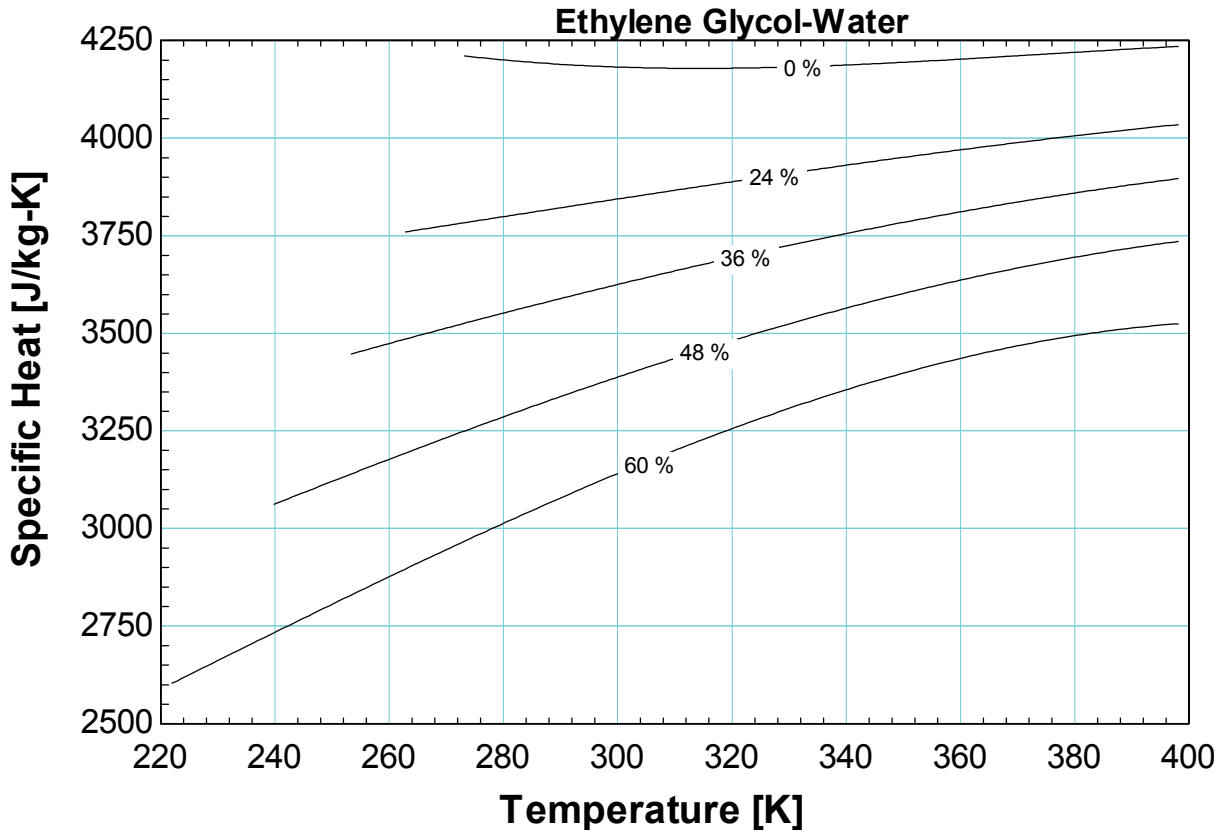


T-s diagram for carbon dioxide showing isenthalps with a temperature range ending at 750 K

Improved Property Plots (continued)

It is also possible to make property plots using brines. Brines are modeled as incompressible substances; however, it is possible to show properties including density, specific heat capacity, viscosity, and conductivity as a function of temperature for various values of concentration.





Additional Changes to EES

- The $VarInfo directive can now be used to set guess values, units, alternate units, etc., for an entire array
- Tabs in the Diagram Window are available to access Child Diagram windows
- The UnitSystem$ directive can be used to set a unit system within functions and libraries
- The Interpolate command can specify a particular range within a Lookup Table to use
- The EES_REFPROP Interface can be used with the $ConvertEESREPROPUnits directive so that inputs and outputs are automatically converted to the same units as those set within EES
- The procedure IdealGasMixtureProps calculates molar mass, enthalpy, entropy, viscosity, and thermal conductivity of a mixture of up to 20 ideal gases
- The $DefaultArraySize resets the maximum size of an array that is defined with an unspecified variable in the header of a function or procedure (e.g., X[1..N]). Without this directive, the maximum size is 100.
- Thermodynamic and viscosity data for HFE7100 and HFE 7500 have been improved.
- The fluids R115, R7000 (HFE-7000), Therminol_55, Therminol_72, and Therminol_LT have been added
- The Critical Heat Flux (CHF) tables for boiling water in vertical tubes (Groeneveld et al., 2007) have been implemented in the Boiling and Condensation section of the Heat Transfer library
- Columns in Lookup Tables can be set to contain strings or numerical values. If a column contains strings containing numbers, then EES will automatically convert then strings into numerical values as needed

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License Issues

We have become aware that a few forgers have figured out how to create fake EES.dft (license) files. We should be pleased that EES is considered valuable enough to steal. However, it has created a problem that impacts legitimate users. Among the many new features and bug fixes, recent versions of EES are programmed to detect and deny use of forged licenses without affecting the legitimate user.

All new licenses of EES are provided with one year of Instant Update and Technical Service (IUTS). Any user who has a current subscription to IUTS can download the latest version at no cost. If your subscription to IUTS is current, we recommend that you download and install the current version now.

If your IUTS has expired, we strongly recommend that you renew this service to prevent interruption of your use of EES. The fee to continue IUTS after the first year is 20% of the current cost of the program per year if renewed within 12 months after expiration of IUTS. The fee increases to 40% of the current cost beyond 12 months after expiration.