Application Note

Using Derived POINTs in SKF Machine Analyst with SKF MARLIN

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Introduction

With the release of SKF Machine Analyst version 3.0 and SKF MARLIN version 4.0 comes a powerful new ODR feature – Derived POINTs. Simply stated, a "derived" POINT automatically calculates its POINT data from a user specified calculation that uses POINT data from other POINTs in the ROUTE.

- Derived POINTs are set up in SKF Machine Analyst software and downloaded to the SKF MARLIN.

Other POINT data used for calculating the derived POINT are typically process-related data, such as temperatures, flows and pressures. As a simple but common case, a derived POINT may calculate a change in pressure (ΔP) between two other POINTs (i.e., Upstream Pressure – Downstream Pressure). These types of process-related inputs are typically used for performance calculations.

In the past, SKF MARLIN users would collect ROUTE data, and then transcribe their readings into a spreadsheet or other program to perform calculations. With derived POINTs, these calculations are performed directly on the SKF MARLIN unit, or in SKF Machine Analyst, without the need for a third party software program. This provides immediate, in-the-field results and eliminates any chance of transcription errors. As with any POINT, derived POINT data may be trended, and results and trends can be included in SKF Machine Analyst reports shared with all who "need to know".

SKF MARLIN vs. SKF Machine Analyst derived POINT calculations

Derived POINTs can be calculated on the SKF MARLIN while the user is in the field, or they can be calculated from within SKF Machine Analyst software.

- Since derived POINT calculations use data already recorded for other POINTs, in a ROUTE list, the derived POINT must follow all POINTs used in its calculation.

When calculated in SKF Machine Analyst, derived POINTs are calculated after recorded data has been uploaded. The calculation is performed according to its schedule, or alternatively, the user can manually initiate the calculation. To initiate the calculation without having to wait for the "measurement due" schedule, simply select SKF Machine Analyst's **File** menu's **Edit** option, then select **Calculate derived POINTs**.

Creating the derived POINT

In general, the following three steps set up a derived POINT:

- Add the new derived POINT to the database hierarchy and specify its general POINT setup parameters appropriately (**DAD type/ Sensor type** fields).
- Using its **POINT Properties/Expressions** tab, specify which **Variables** (other POINTs) will be used in the derived POINT's calculation.
- Again using the **Expressions** tab, specify the derived POINT's expression formula (calculation).

Initiating the process for creating a derived POINT is the same as with any other POINT type, except the **DAD type** must be set to **Derived POINT (→fig. 1)**.

Also in the dialog **(→fig. 1)**, the **Sensor type** setting determines whether the derived POINT's calculation is performed on the SKF MARLIN or in SKF Machine Analyst. If **Sensor type** is set to **Calculated**, the calculation occurs in SKF Machine Analyst; if set to **MARLIN**, the calculation is made on the SKF MARLIN.

- Except for the **POINT Properties/Expressions** tab, other POINT Properties tabs function similarly to normal POINT types.

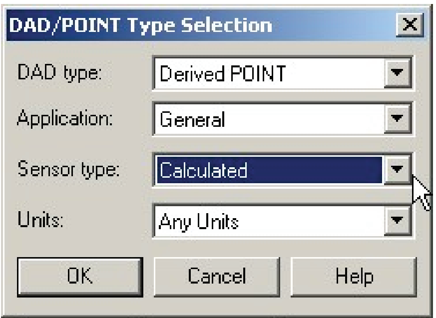

Figure 1. Specifying a Derived POINT.

POINT Properties/Expressions tab

Use **Expressions** tab fields and actions to identify the derived POINT's variables and to create or edit its expression (calculation) **(→fig. 2)**.

At the top of the dialog, the **Expressions** dropdown list displays all previously created "shared" expression formulas (calculations) and a **<Private Expression>** option. Use this dropdown list to specify whether you wish to set up a unique **<Private Expression>** for the current derived POINT only, or specify a previously defined "shared" expression formula (selected by name). If you specify a shared expression, its settings display in subsequent fields.

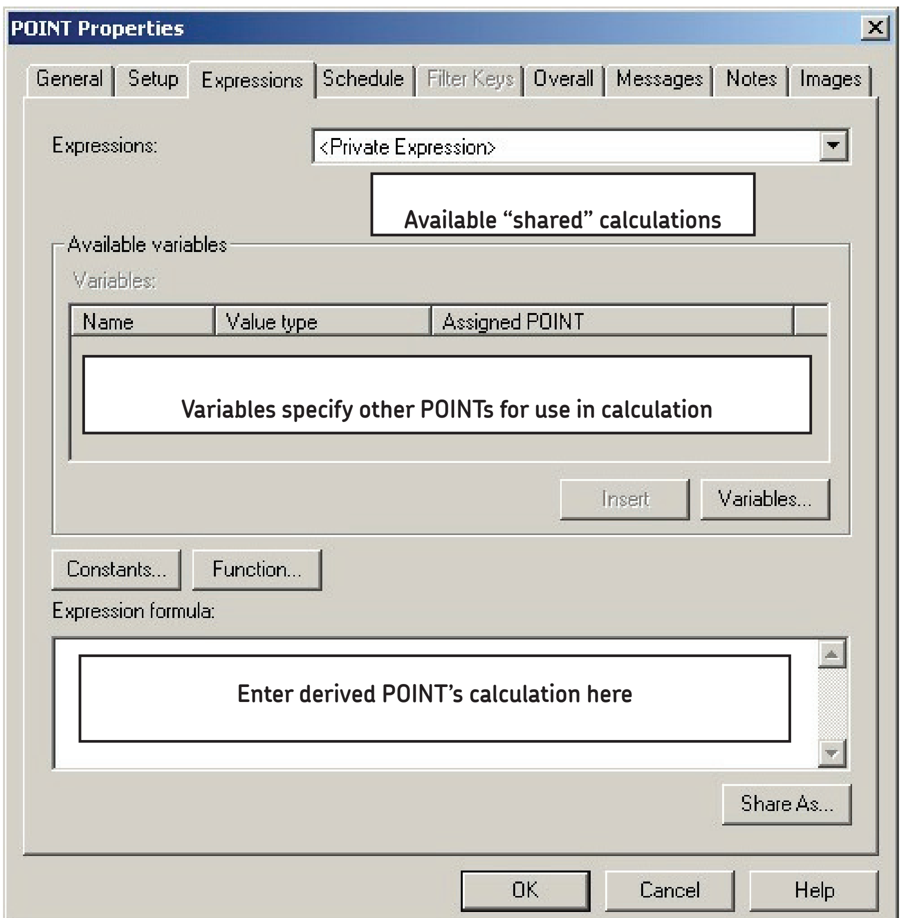

Figure 2. Expressions tab's fields and settings.

Variables

Other POINTs used in the derived POINT's calculation are identified as "variables". Once assigned to the derived POINT, assigned variables list in the **Available Variables** area.

To assign variables for a derived POINT, click the **Variables** button. The **Variables** dialog displays, allowing you to select and name POINTs (variables) for use in the derived POINT's expression.

Follow this procedure to add a new variable:

- Press the **Add** button.
- Enter a **Name** for the variable.
- Check the **Select POINT assignment** button and select the new variable's POINT from the hierarchy.
- Click the **Save** button.
- Repeat the above steps for each required variable.
- Click **Close** to return to the **Expressions** tab.

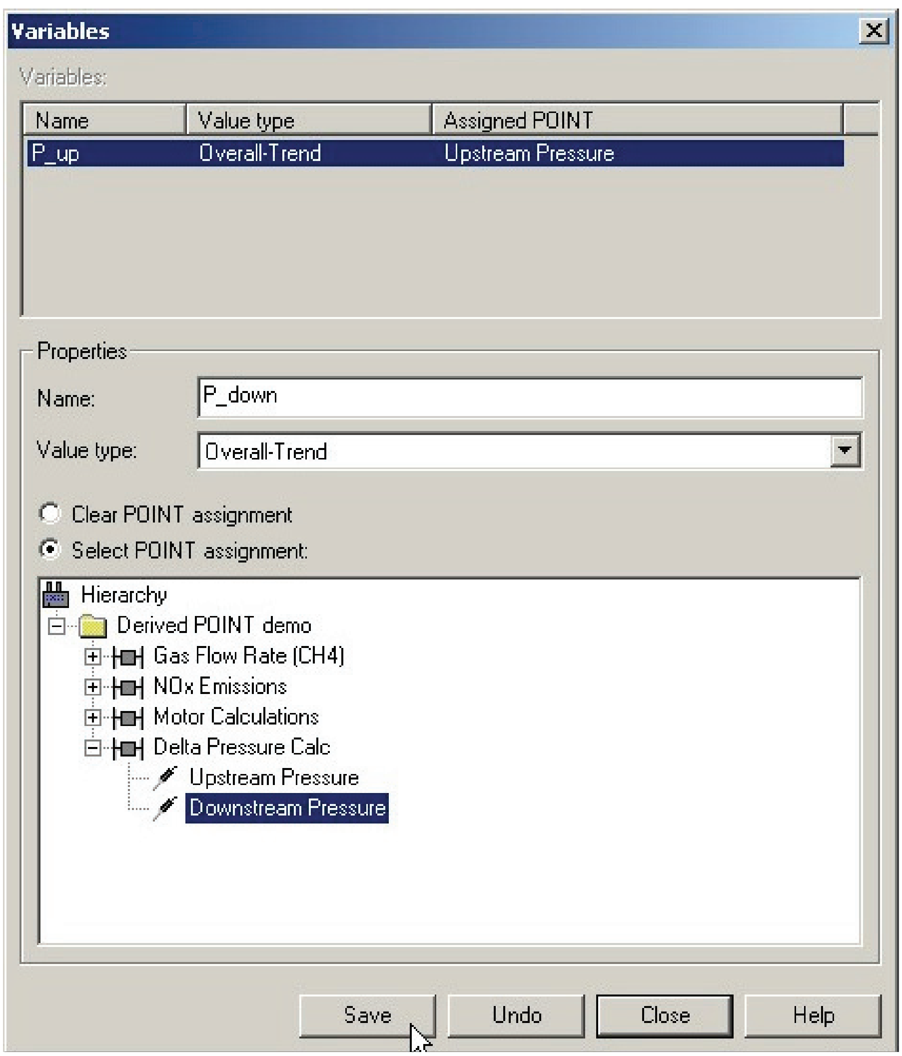

Figure 3. The Variables dialog used to create new variables.

Thinking back to our simple ΔP calculation, and referring to **fig. 3**, a variable named **P_up** has been created and was assigned the POINT named **Upstream Pressure** (reference the Variables area). The figure also shows that a new variable named **P_Down** is being created and is being assigned the POINT named **Downstream Pressure** (reference the Properties area).

After all the required variables are assigned to the derived POINT, click **Close** to return to the **Expressions** tab and proceed to specify the POINT's calculation expression.

To create the expression for our ΔP example:

- An expression formula must contain at least one variable and may also contain constants and functions. Insert mathematical operators (e.g., +, –, /, *) as necessary.
- Select the variable **P_up** from the list of **Available Variables**.
- Press the **Insert** button. The variable is inserted at the cursor position in the **Expression Formula** text box.
- Type in a minus sign to indicate subtraction, then repeat the process for the **P_down** variable, as shown in **fig. 4**.

Of course, this is a very simple derived POINT example. More complicated equations can also be created, like those used for calculating flow, friction loss, etc. To assist in creating more complex equations, a set of mathematical **Constants** and **Functions** are available from **Expressions** tab buttons **(→fig. 4)**.

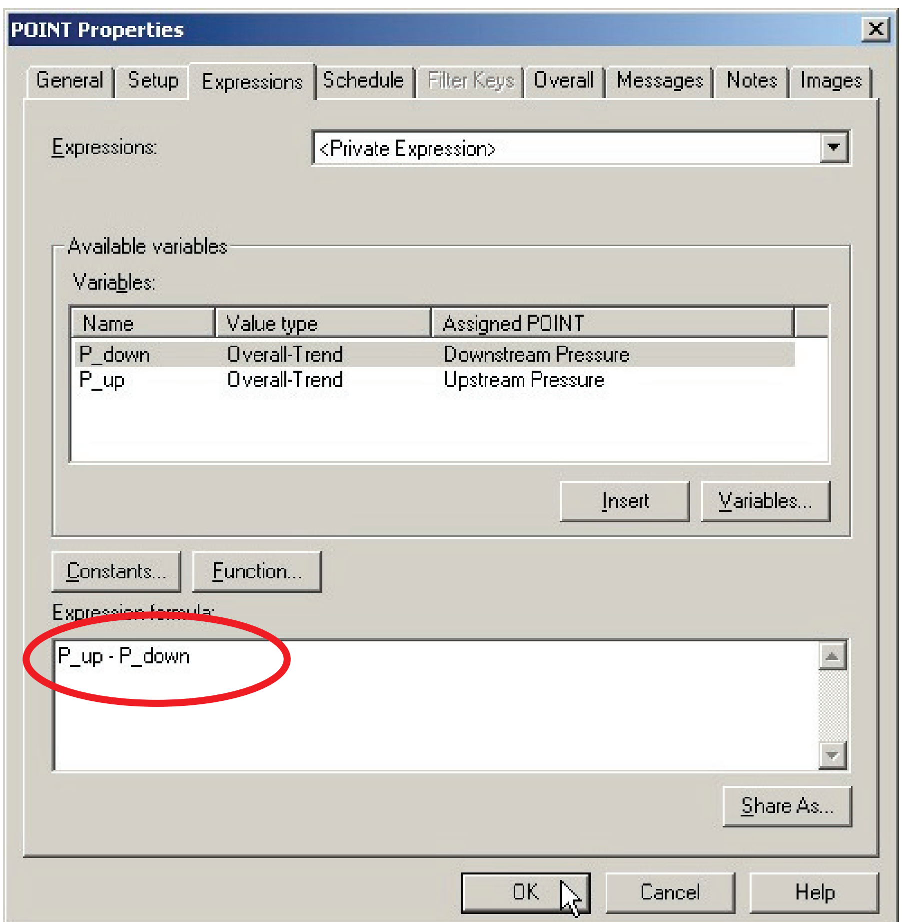

Figure 4. The finished expression.

Inserting mathematical constants and functions in the expression

To add a mathematical constant to the expression formula:

- In the **Expression formula** field, position the cursor where you would like to insert the constant.
- Click the **Constants** button to display the **Constant** dialog.

A variety of constants are provided, e.g., Pi (3.14159), the acceleration of gravity (provided in various units) and other commonly used constants.

- Select a constant from the list and click **OK** to insert it in the expression, or create a new constant by clicking the **Add** button (for example, the highlighted constant in **fig. 5** was created for use in Methane gas flow rate calculations).

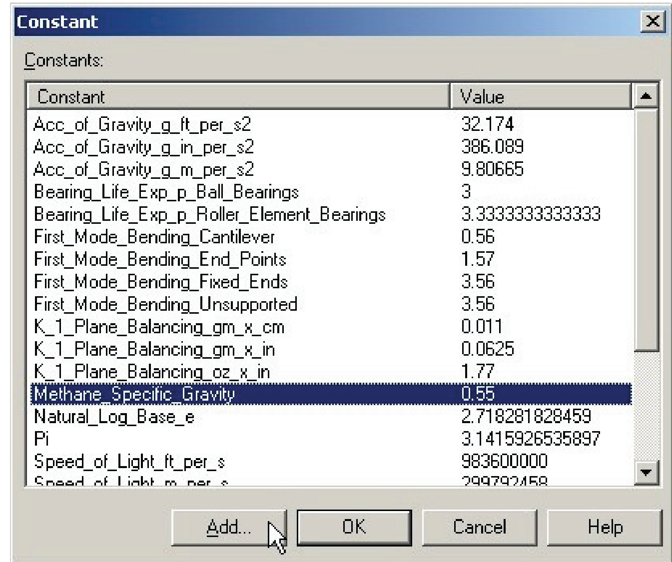

Figure 5. The Constant dialog.

To add a mathematical function to the expression formula:

Another useful feature with derived POINTs is the availability of pre-defined mathematical functions. These functions are similar to those found on scientific calculators (e.g., Sin, Cos, Tan, etc.).

- In the **Expression formula**, click to position the cursor where you wish to insert the function.
- Click the **Function** button to display the **Function** dialog.

Available functions include algebraic and trigonometric functions.

- Select the required function and click **OK**. The function is inserted in the expression, at the cursor location.

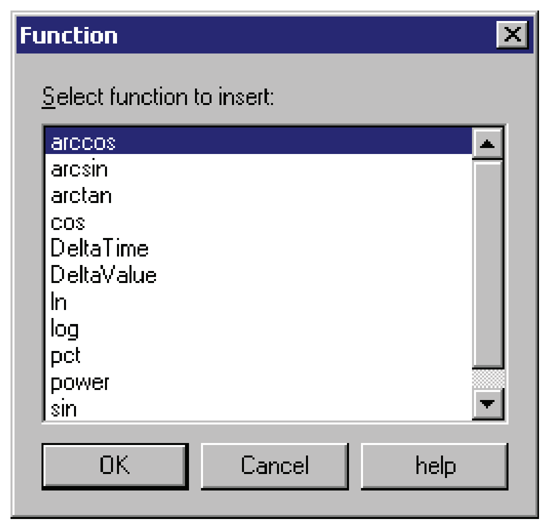

Figure 6. The Function dialog.

Once the function is inserted, some additional modifications may be required. For example, to express 5^3 in an expression, you can use the POWER function, as opposed to 5 × 5 × 5. When first inserted into your expression, the POWER function appears as:

- POWER(<BASE> ,<EXPONENT>)

For our example, this needs to be modified to:

- POWER(5 , 3)

It is also possible to use constants within the function; for example:

- POWER(Pi , 2)

Variables created from measurement values can also be used in these functions. The following example illustrates this.

Example

Assume we wish to perform radiation heat transfer calculations using the Stefan-Boltzmann Law. The input required is a temperature measurement, raised to the fourth power, then multiplied by the Stefan-Boltzmann constant. We will assume that the input measurement is in °F.

We can calculate the emissive power in Watts/meter^2 using the following expression:

- STEFAN-BOLTZMANN * POWER((Temperature + 273.15), 4)

Where STEFAN-BOLTZMANN is a user-created constant equal to 5.66×10^{-8} W / (m^2 K^4), and 273.15 is added to the Temperature variable to convert from °F to Kelvin (K).

Tech tip

As some calculations can be somewhat complicated, it may be advantageous to test your expressions with a derived POINT calculated in SKF Machine Analyst, prior to collecting field data. Using this method, it is easy to test your calculation by manually entering variable POINT data used for calculating the derived POINT. To manually enter data, select SKF Machine Analyst's **File** menu's **Insert** option, then select **Manual Entry**. After manually entering data for each variable POINT, you can manually calculate the derived POINT as described earlier.

Inherent arithmetic functions

In addition to the more complicated functions, it is worth noting that all of the basic arithmetic functions are simply typed into your expression directly, using the standard symbols on your computer's keyboard:

- Addition: +
- Subtraction: –
- Multiplication: *
- Division: /

For clarity, and for more complicated expressions, you may also use parenthesis and nested parenthesis in the same manner used to enter an equation into a spreadsheet.

Conclusion

SKF Machine Analyst version 3.0 and SKF MARLIN version 4.0's derived POINT feature provides the ability to automatically calculate useful plant process equations using recorded process MARLIN POINT data.

Examples of typical applications include automatically calculating flow rates, motor efficiency, Nitrous Oxide emissions, ΔT and ΔP. As with other POINT types, derived POINT results can be trended and shared in SKF Machine Analyst reports.

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