GE VERNOVA

Learning & Development
Learning Module

G500/G100 Calculator

Learning Module Objective

At the completion of this module you will be able to identify and recite all concepts presented.

If you are viewing this as part of a structured training program *PLEASE* complete the associated assessment test. You are required to score above 80%.

Here’s What is Covered in this Module

1. Introduction to Calculator
2. Mapped Points and Calculator Points
3. Application Parameters and Basic Syntax Rules
4. Expressions
5. Evaluations
6. Timers
7. Analog Assignments
8. Digital Assignments
9. Quality Conversions
10. Type Conversions
11. Averages
12. Output to Input Conversion

Introduction to Calculator

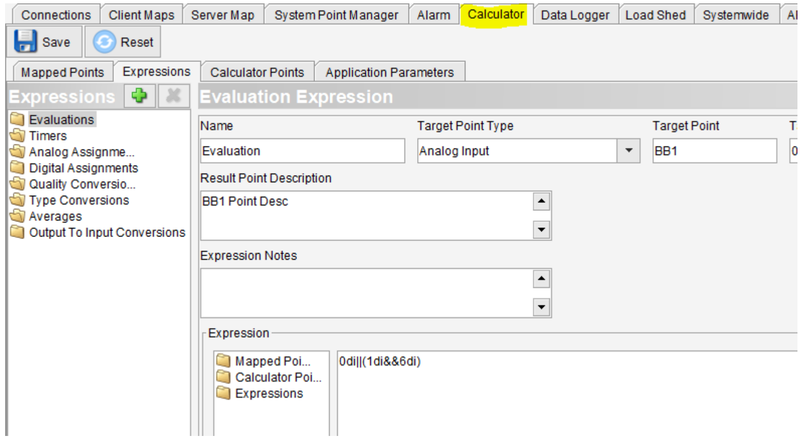
Calculator is a built-in mathematical control logic tool to perform basic math functions on MCP data points to automate substation procedure, typically used to carry out the following functions:

- Perform Mathematical, Logical, or Timer based operations on selected system data points
- Automatically operate one or more digital or analog outputs when certain conditions are met

To Configure:

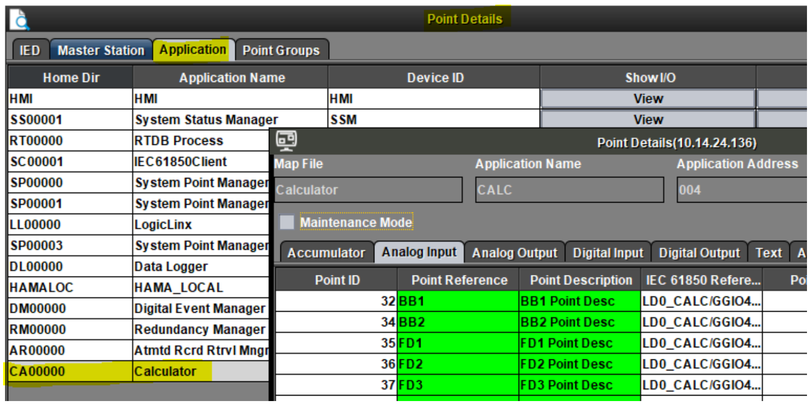
On the **Calculator** tab on the DSAS Editor's Configuration page, you configure the Calculator automation application by:

- Selecting data points referenced in expressions (called mapped points)
- Building expressions



To View:

During runtime, calculated point values are presented to the operator on the **Application** tab on the Runtime HMI - **Point Details** page.



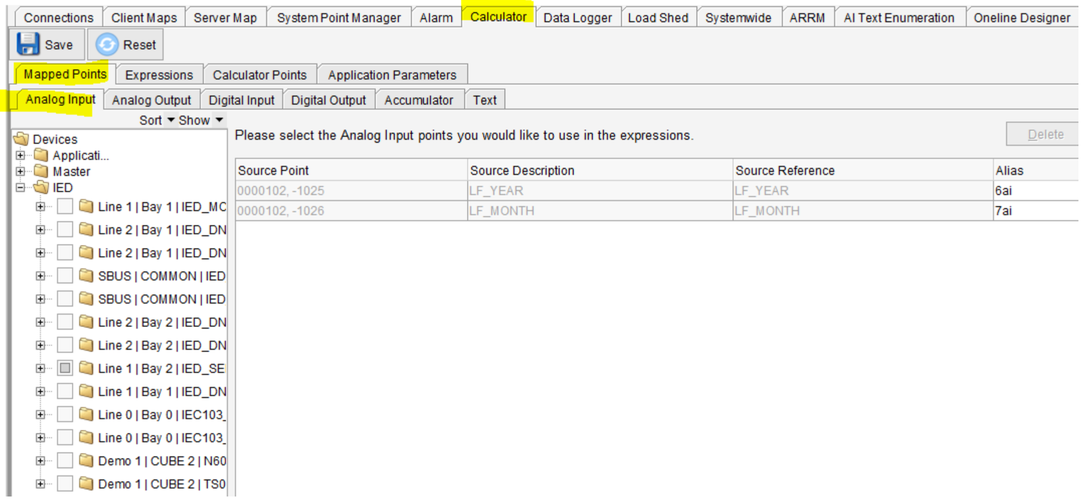
Data points must already be configured in the MCP before they can be selected as mapped points in the Calculator.

Mapped Points and Calculator Points

Mapped Points:

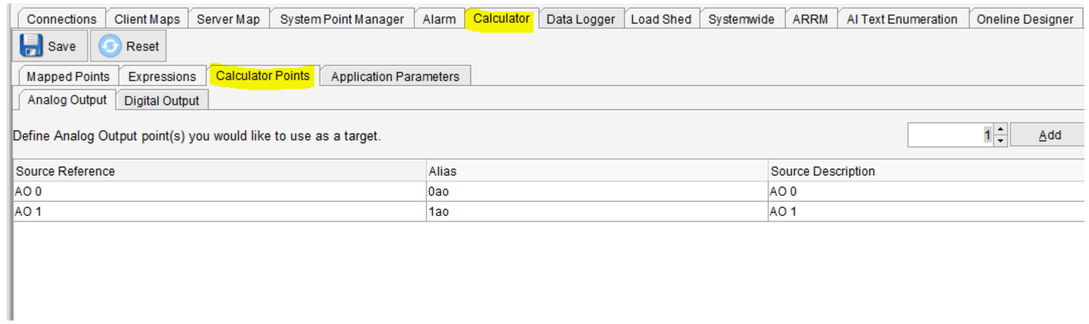
Mapped points are those selected system points to be used as variables within Calculator expressions. The following data types are supported for use in expressions.

- Analog Input (AI)
- Digital (binary) Input (DI)
- Analog Output (AO)
- Digital (binary) Output (DO)
- Accumulators
- Text



Calculator Points:

Calculator points can be used to provide input into one or more expressions. Once defined on the Calculator Points page, these analog output and digital output points are shown within the point picker tree on the Expression Builder.



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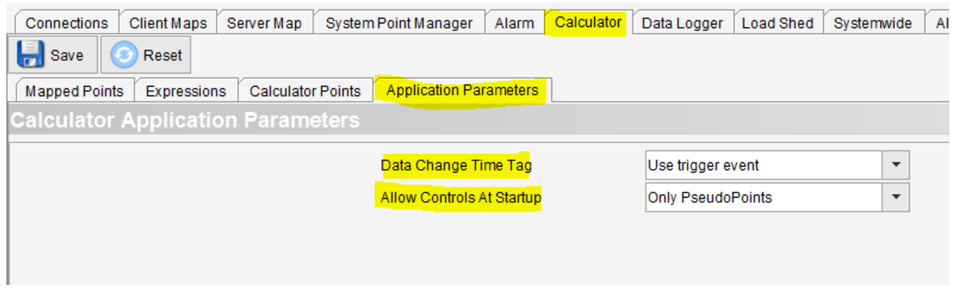
Alias: A short name to reference the point within Calculator and must be unique across all data types. The alias is used as point description in available points list and is only used within the Calculation application. The alias can be 1 to 126 ASCII characters.

Calculator-Owned Points include (1) points defined on **Calculator Points** page as input into expressions, and (2) points auto-created based on the results of the configured expressions.

Application Parameters and Basic Syntax Rules

The following **Calculator Application Parameters** can be set to allow you to change the way that time stamps are recorded by the Calculator and whether controls are allowed at Calculator startup

- **Data Change Time Tag** (Use Evaluation Time / Use Trigger Event)
- **Allow Controls At Startup** (Only Pseudo Points / All Points / Disabled)



Basic Syntax Rules:

To create a valid expression, the following syntax rules of the Calculator must be followed (in addition to the format of the specific operation types)

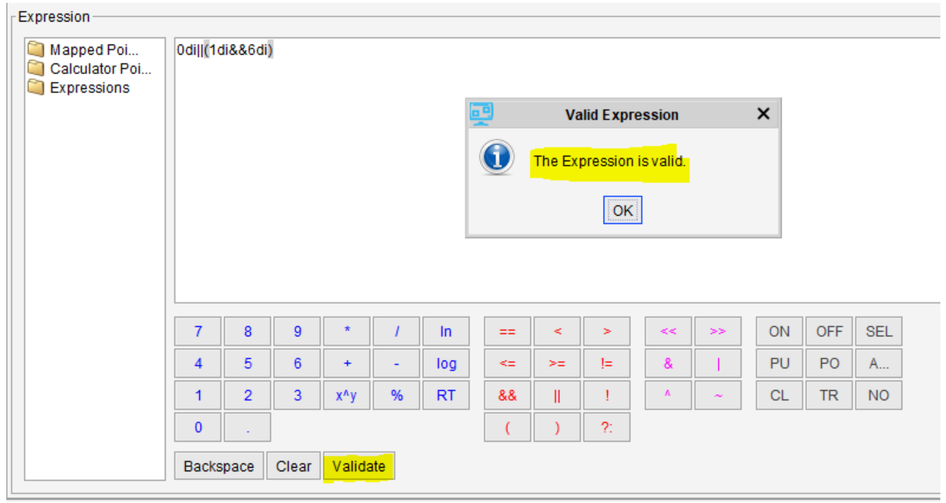
Order of precedence

- No special precedence is enforced on any Calculator expression, except where parentheses have been used

White space

- You may insert any number of spaces between operators and operands; the Calculator ignores these spaces

To validate the created expression, click **Validate** button to ensure the expression is valid



The default settings for Data Change Time Tag is Use Trigger Event.

The default value for Allow Controls At Startup is Only Pseudo Points.

Expressions

Up to 10000 Calculator Expressions can be created.

Expressions are constructed by combining operands and operators to produce a resulting point.

Operands

- Constants
- Any defined reference points
- Quality attributes

Operators

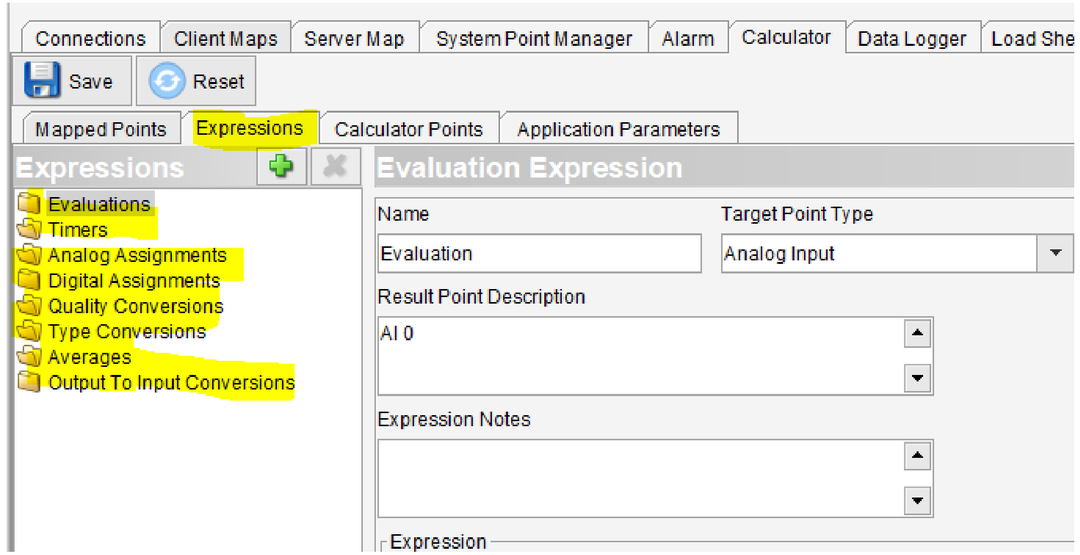
- Mathematical
- Logical
- Bit-wise

Resulting Point

- Point Name
- Data Type

The following expressions can be performed to configure:

- Evaluations
- Timers
- Analog assignments
- Digital assignments
- Quality conversions
- Type conversions
- Averages
- Output to Input conversions



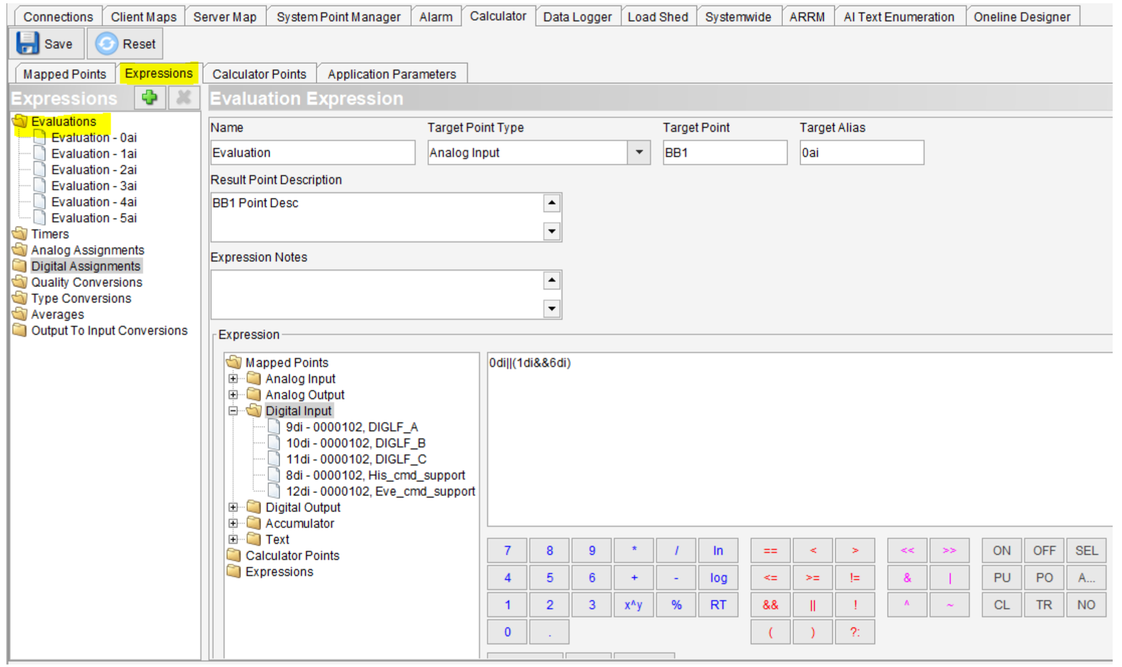
Evaluations

Evaluation expressions perform operations on referenced points and store the result in a Calculator-owned input point.

- Re-evaluated whenever a data change event is issued on a referenced point.
- Quality changes on referenced points only cause re-evaluation if
  - The expression is converting the changed quality flag into a digital input, or
  - The quality change indicates that the referenced point is coming online or has communication restored.

The following operations are supported in evaluation expressions:

- Math operations
- Logical operations
- Bit-wise operations
- Request Type operations
- If-Then-Else construct



The Calculator monitors the quality of referenced points for changes in the Questionable and Invalid quality flags. If any referenced point becomes Invalid or Questionable, the resulting point for any expression that includes that referenced point becomes Invalid.

Timers

When the result of a binary expression changes, Calculator starts a timer based on the defined hold times. If the value of the binary expression stays constant for the entire timer duration, then the value of the timer expression evaluates to TRUE.

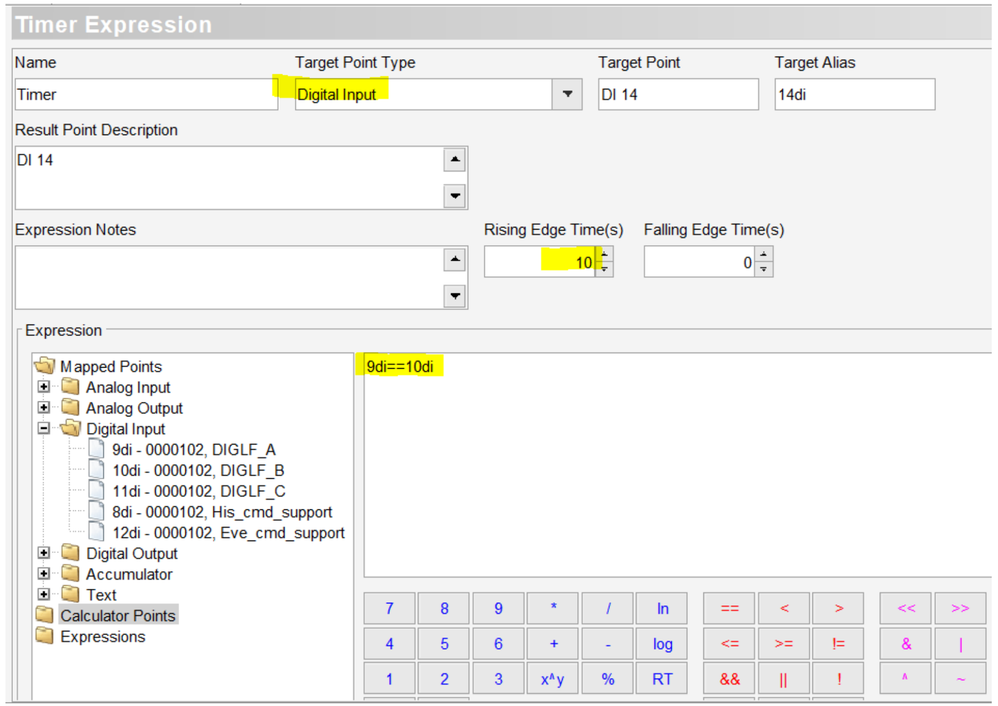
- Timer resolution: 1 second
- Defined by two hold times: rising edge (FALSE to TRUE) and falling edge (TRUE to FALSE).
- Hold times can be positive or zero.

Example

If you want a Calculator-owned Digital Input 14 to turn ON when digital inputs DI9 and DI10 are the same value for more than 10 seconds, use the following settings:

- Target Point Type: Digital Input
- Target Point: DI 14 (Alias: 14di)
- Expression: 9di==10di
- The Rising Edge Time: 10s
- The Falling Edge Time: 0

Result: The output of Calculator-owned digital input will turn ON after 10 seconds.



Target Point Type for timer expression:

- Digital Input
- Analog Input

Analog Assignments

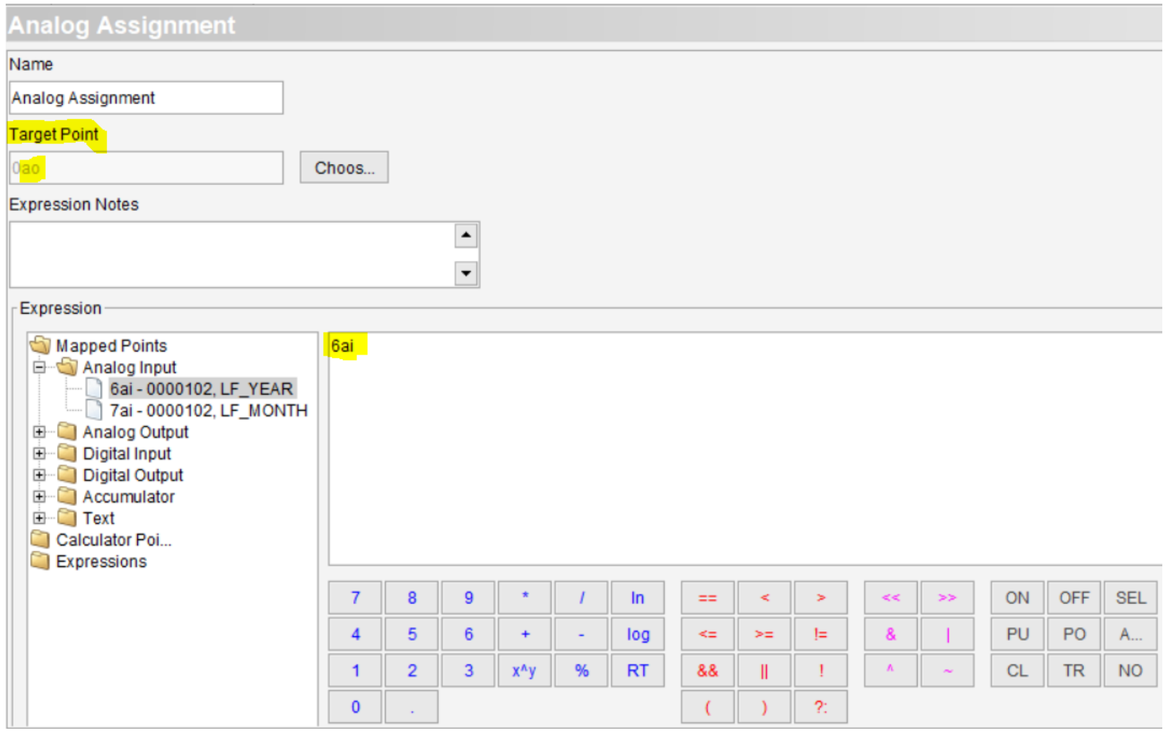
Analog Assignment expressions receive output of operations on referenced analog output and input points and translate them into operations on **Mapped Analog Output** points.

- Quality changes on the referenced points are monitored.
- Support the same syntax as evaluation expressions

Example

If you want to send a Setpoint command on say Analog Output AO 0 (mapped in Calculator) if an event occurs on Analog Input point AI 6 (also mapped in Calculator), use the following settings:

- Target Point: 0ao (Alias of AO 0)
- Expression: 6ai (Alias of AI 6)



It is recommended to use brackets around negative numbers in the expressions. e.g., (-1234).)

Digital Assignments

Digital Assignment expressions receive output of operations on referenced digital output and input points and translate these into operations on **Mapped Digital Output** points.

- Quality changes on the referenced points are monitored.
- Support the same syntax as evaluation expressions

Override Operation

- None
- Direct Operate
- Direct Operate NoAck
- Select Before Operate

Control Routing

- None
- ON Target Point
- OFF Target Point
- Both Target Points

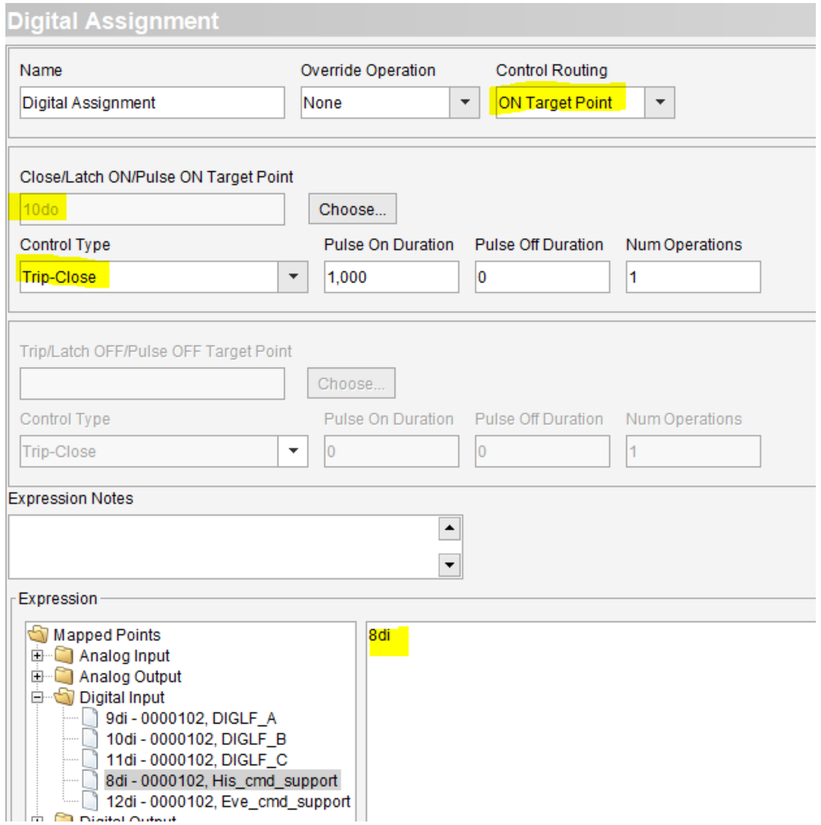
Control Type

- Inverted Latch
- Latch
- Pulse
- Trip-Close

Example

If you want to send a Trip-Close command on the mapped point DO 10 on receiving an ON event on the mapped point DI 8, use the following settings:

- ON Target Point: 10do
- ON Target Control Type: Trip-Close
- Control Routing: ON Target Point
- Override Operation: None
- Expression: 8di



When Control Routing is set to “Both Target Points”, the resulting actions will be a combination of configuration of ON Target Point Control Type and OFF Target Point Control Type.

Quality Conversions

Converted points are a special class of pseudo points that are created based on an actual system point

Quality conversions take a mapped system point and report a binary TRUE or FALSE based on a certain quality flag within that point. The MCP provides the following quality conversion flags:

- ALARM_INHIBIT
- CHATTER
- COMM_LOST
- LOCAL_CONTROL_ACTIVE
- LOCAL_FORCE – Commonly used to test expressions
- OFFLINE
- OLD_DATA
- OUTPUT_INHIBIT
- OVER_RANGE
- OVERFLOW
- QUESTIONABLE – Ceases evaluating the expression while Questionable is asserted
- REF_CHECK
- REMOTE_CONTROL_ACTIVE
- REMOTE_FORCE
- RESTART
- SCAN_INHIBIT – Asserts Questionable and Old Data flags
- SECONDARY_SOURCE
- SECONDARY_SOURCE_OFFLINE
- TAGGED
- TEST
- TIME_SYNC
- ZOMBIE – Asserts when the Zombie quality attribute of the mapped point is set

Example

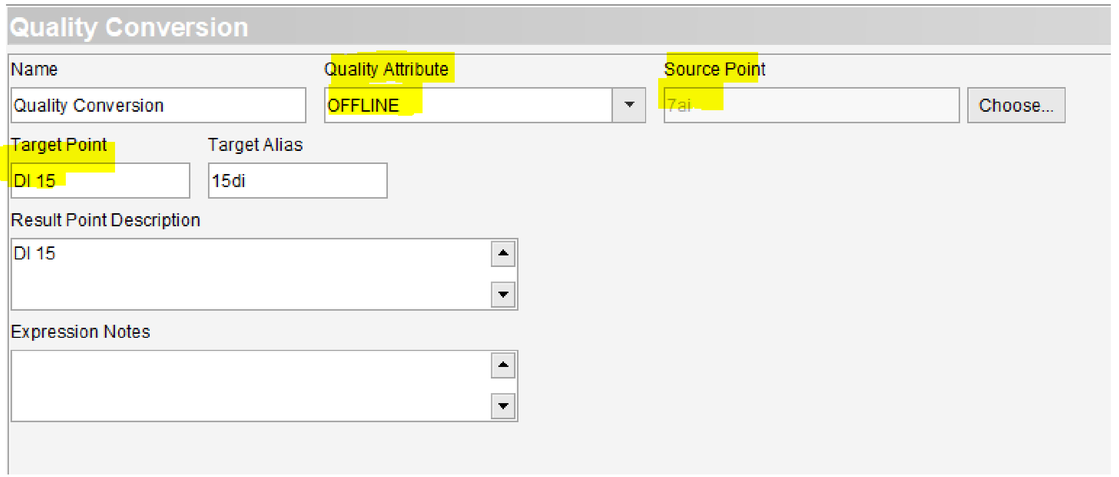
if you want to set the created Calculator-owned Digital Input point DI 15

to TRUE whenever the mapped Analog Point AI 7 is Offline

And

to FALSE when AI 7 is Online, use the following settings:

- Quality Attribute: OFFLINE
- Source Point: 7ai
- Target Point: DI 15 with Alias: 15di



Type Conversions

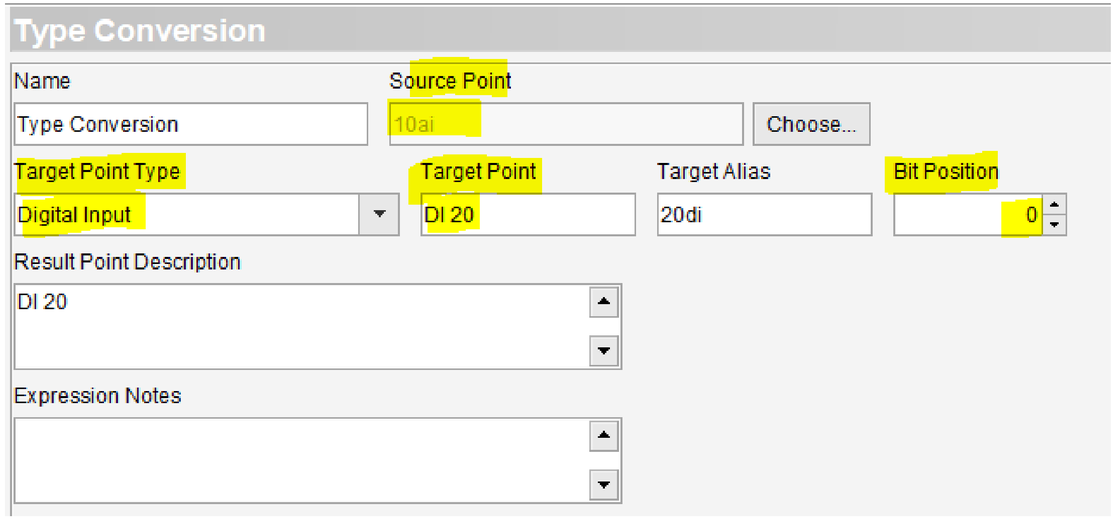
Type conversion points change mapped system points from binary input to analog input, or from analog input to binary input, or from output to input, or from accumulator to binary / analog input, or from text to binary:

- Analog Input to Digital Input
- Digital Input to Analog Input
- Analog Output to Analog Input
- Digital Output to Digital Input
- Accumulator to Analog Input
- Accumulator to Digital Input
- Text to Digital Input

Example

if you want to create an Analog Input to Digital Input type conversion, a new Calculator-owned Digital Input point DI 20 is created where the value of the source mapped Analog Input point AI 10 is converted to a binary TRUE or FALSE, use the following settings:

- Source Point: 10ai
- Target Point Type: Digital Input
- Target Point: DI 20 with Alias: 20di
- Bit Position: 0



Bit Position: The integer within the value returned from the source point used to determine the state of the Digital Input. (For Analog Input to Digital Input and Accumulator to Digital Input only)

Averages

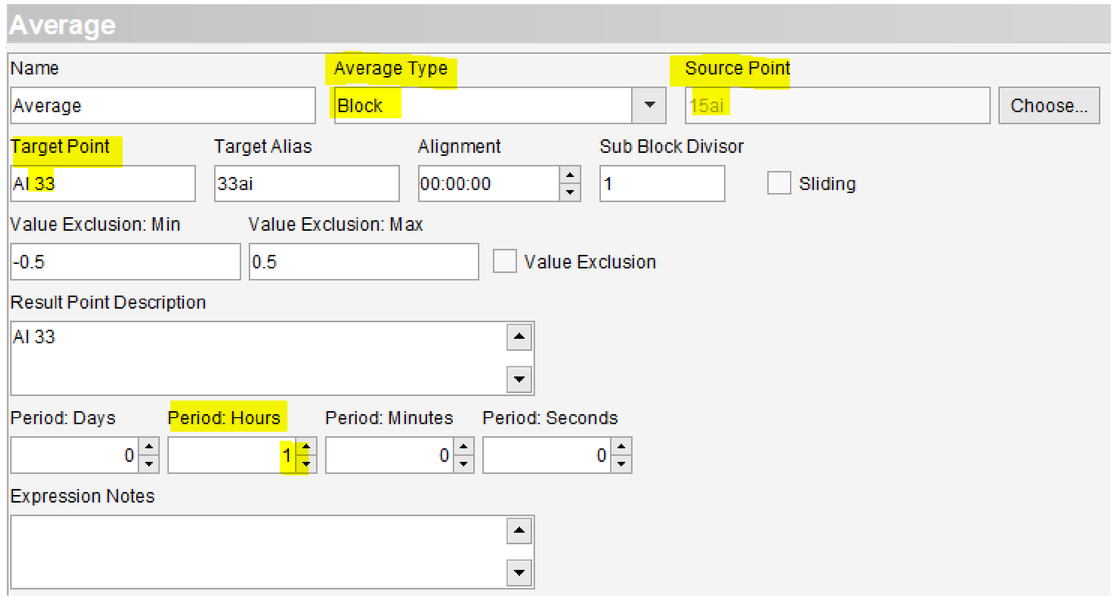
Calculator supports both standard and time-weighted averaging on selected mapped Analog Inputs:

- Block: A standard basic arithmetic averaging
- Time-Weighted: An average that considers the amount of time the point remains at each value. Used to reduce the influence of infrequent outliers

Example

if you want to calculate and report Block average to a Calculator-owned Analog Input point AI 33 for the source mapped Analog Input point AI 15 for every hour, use the following settings:

- Source Point: 15ai
- Average Type: Block
- Target Point: AI 33 with Alias: 33ai
- Alignment: 00:00:00
- Sub Block Divisor: 1
- Sliding: Not Selected
- Value Exclusion: Not Selected
- Period: 1 hour



Alignment:
The time of day to align with the period. Periods are positioned such that a new period begins each day at the alignment time

Sub Block Divisor:
How many segments to divide the period into

Sliding:
Select if a sliding window should be used. If not selected, Calculator reports the average at every full averaging interval

Value Exclusion:
An enable/disable flag for excluding or not excluding the range of sample values for the averaging

Period:
The size of the averaging interval. The size of the period must divide evenly into the alignment interval

Output to Input Conversions

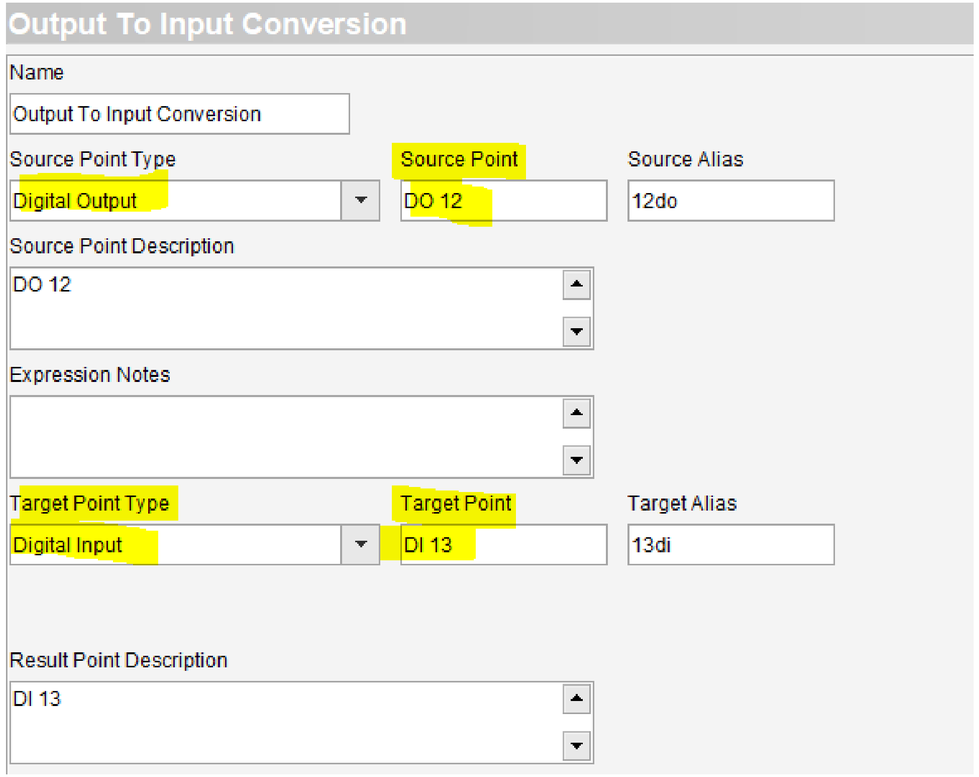
Output to input conversion expressions enable master stations to communicate with each other by converting two types of **Calculator-owned** points:

- Digital Output to Digital Input
- Analog Output to Analog Input, Digital Input or Accumulator

Example

if you want to convert the Calculator-owned source Digital Output point DO 12 to the Calculator-owned target Digital Input point DI 13, use the following settings:

- Source Point Type: Digital Output
- Source Point: DO 12 with Alias: 12do
- Target Point Type: Digital Input
- Target Point: DI 13 with Alias: 13di



To convert inputs belonging to external applications and devices, use Type Conversion expressions

Bits to Map (AO to DI only):
The number of input points to concatenate as the expression's Digital Input

Thank You for Watching this Module.

If you are watching this as part of a structured learning program, please don’t forget to take the test.

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