

Map File Maker

A tool to create map files for
Calibration Management

What is a map file and why do we need it.

- All the information to calibrate a device is available through DDL
- Unfortunately, each device has named those parameters & enumeration values different.
- We need to map those DDL parameters and enumerations to a standard so we can calibrate devices.

Categories of devices

- Temperature Transmitters
- Pressure Transmitters
- Flow Transmitters
- Analytical Transmitters (pH, O₂, etc...)
- Valves

What “Map File Maker” does well

- Temperature Transmitters
- Pressure Transmitters
- Analytical Transmitters
- (most) Flow Transmitters

This is true for HART, FF or wirelessHART

What “Map File Maker” does NOT do well

- HART Valves
(input: mA output: % or throw)
- (some) Vortex Flow Transmitters
(Input: Hz output: Flow or mA)
- HART Multi-variable Transmitters
(input: ? output: mA)

Most common calibrations

- Temperature and pressure transmitters are the most commonly calibrated.
- Creating a map file for a temperature transmitter is probably the hardest.

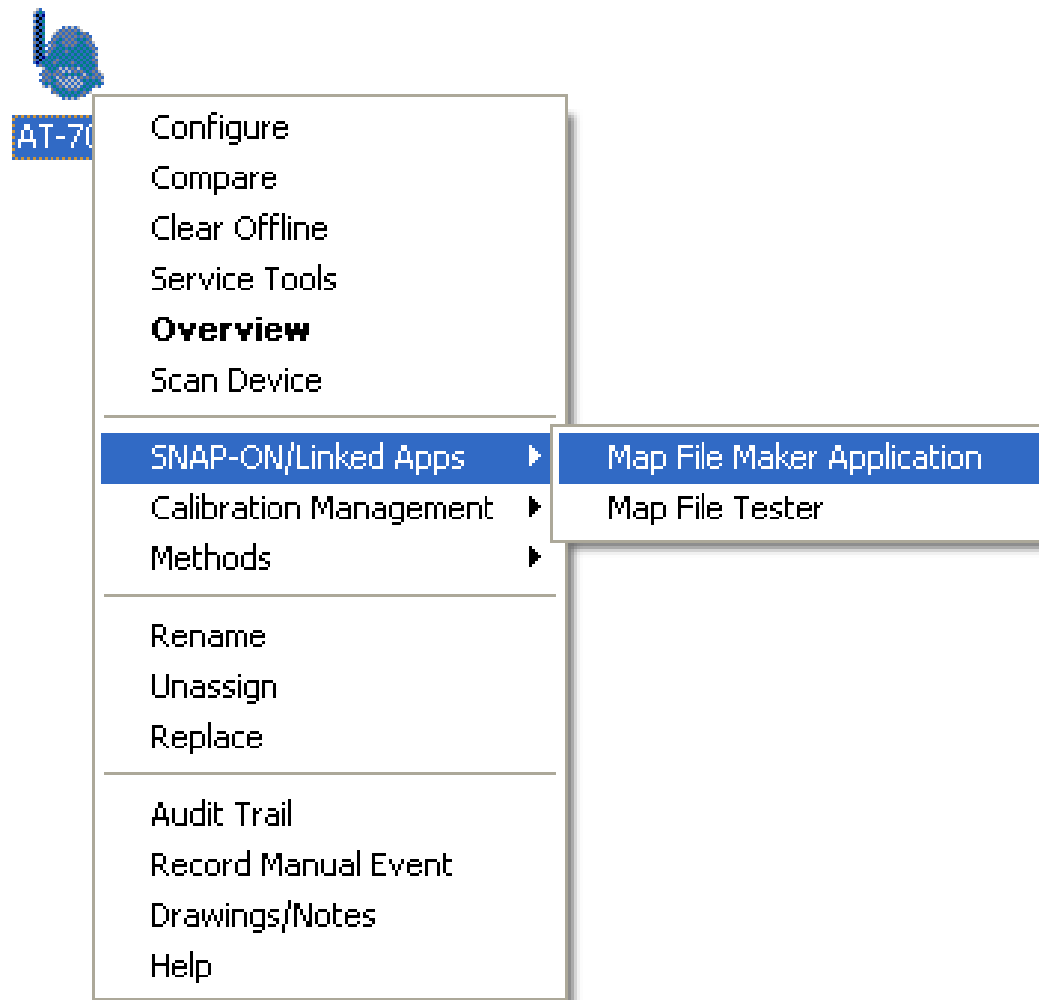
Temperature

- Calibrators will often simulate temperature probes to verify the operation of a temperature transmitter.
- We need to identify enough parameters and values (in a standard format) to allow that calibrator to simulate the current temperature probe.

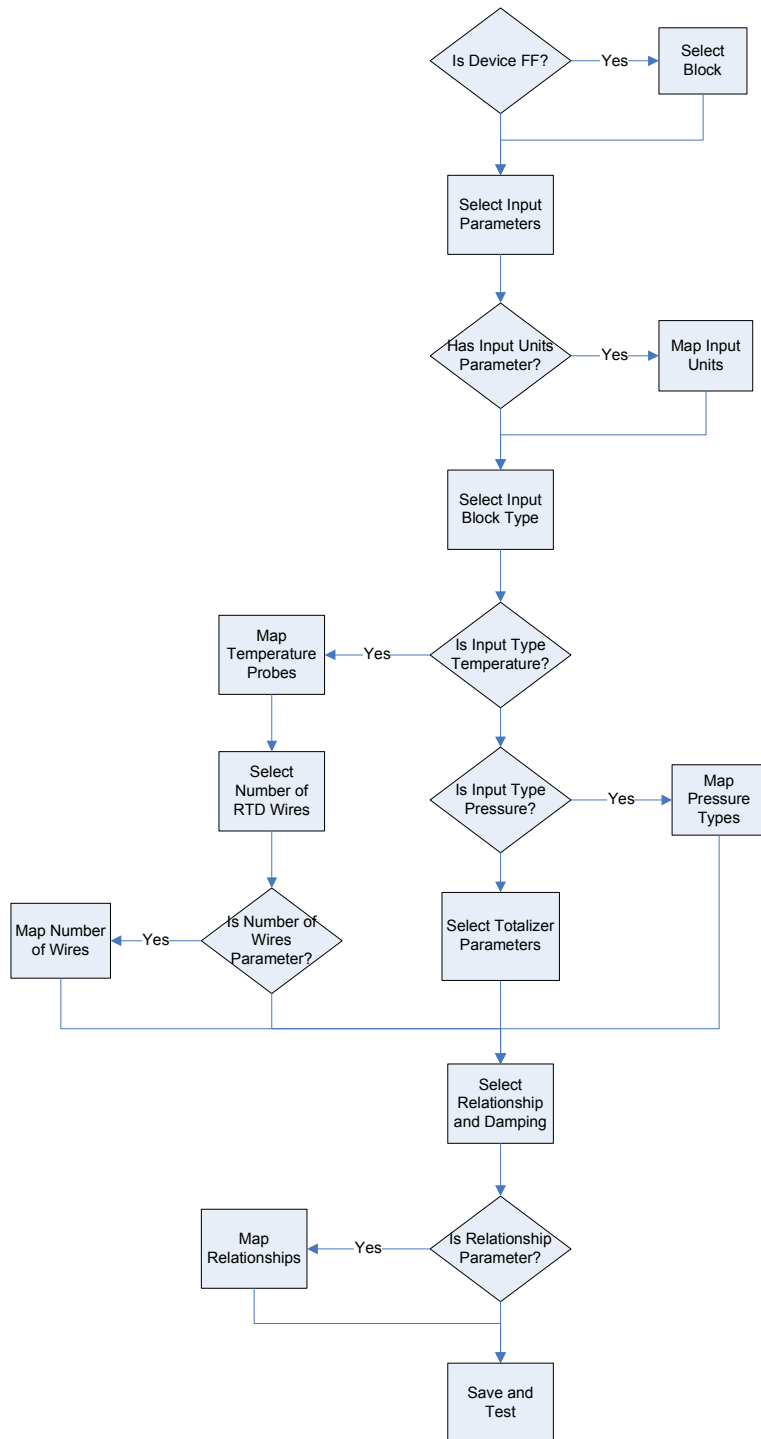
How do I create a map file for a temperature transmitter?

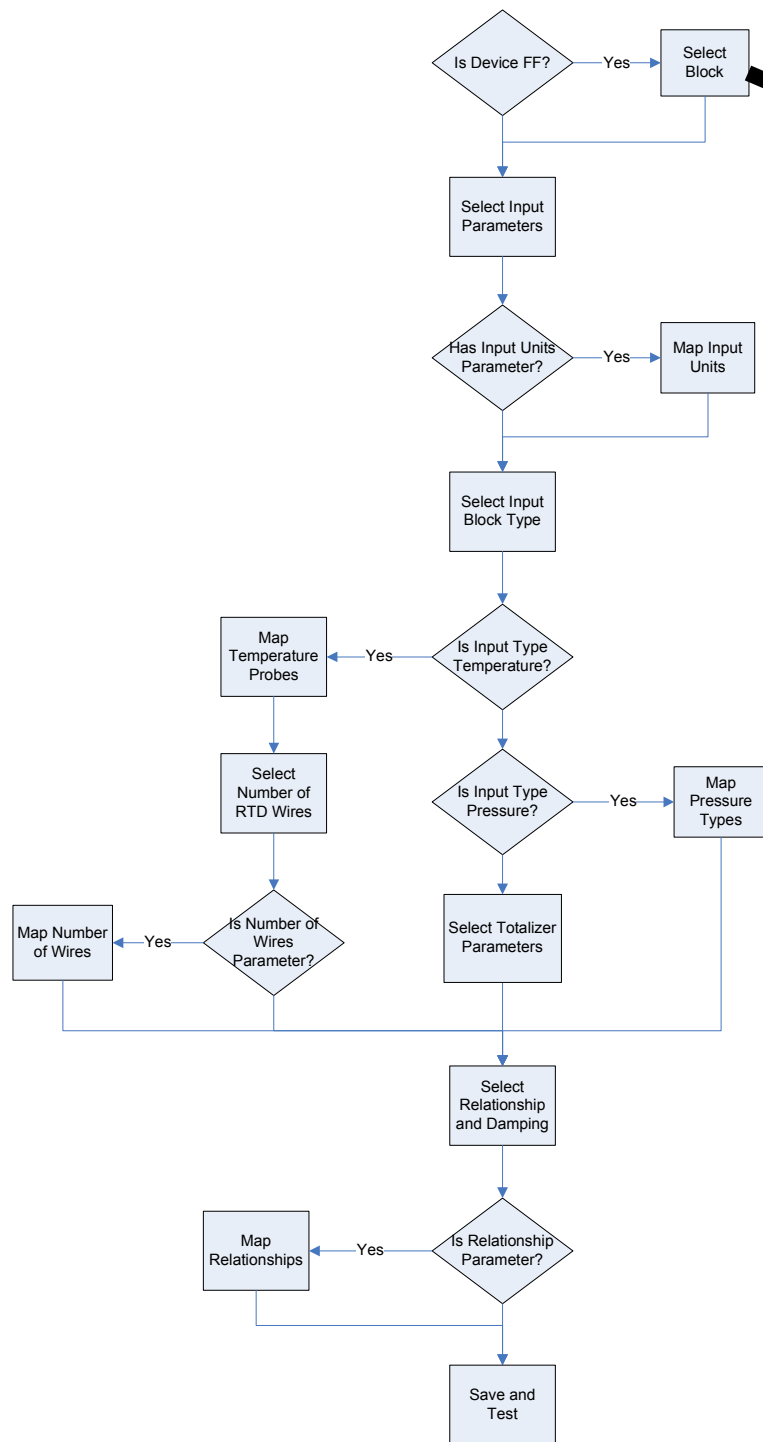
- Map File Maker will step the developer through identifying the parameters needed to calibrate this device type.
- I will run through the screens to create a Foundation Fieldbus temperature transmitter.

Launch “Map File Maker from the Device Context menu



This is the flow diagram of the screens of Map File Maker.



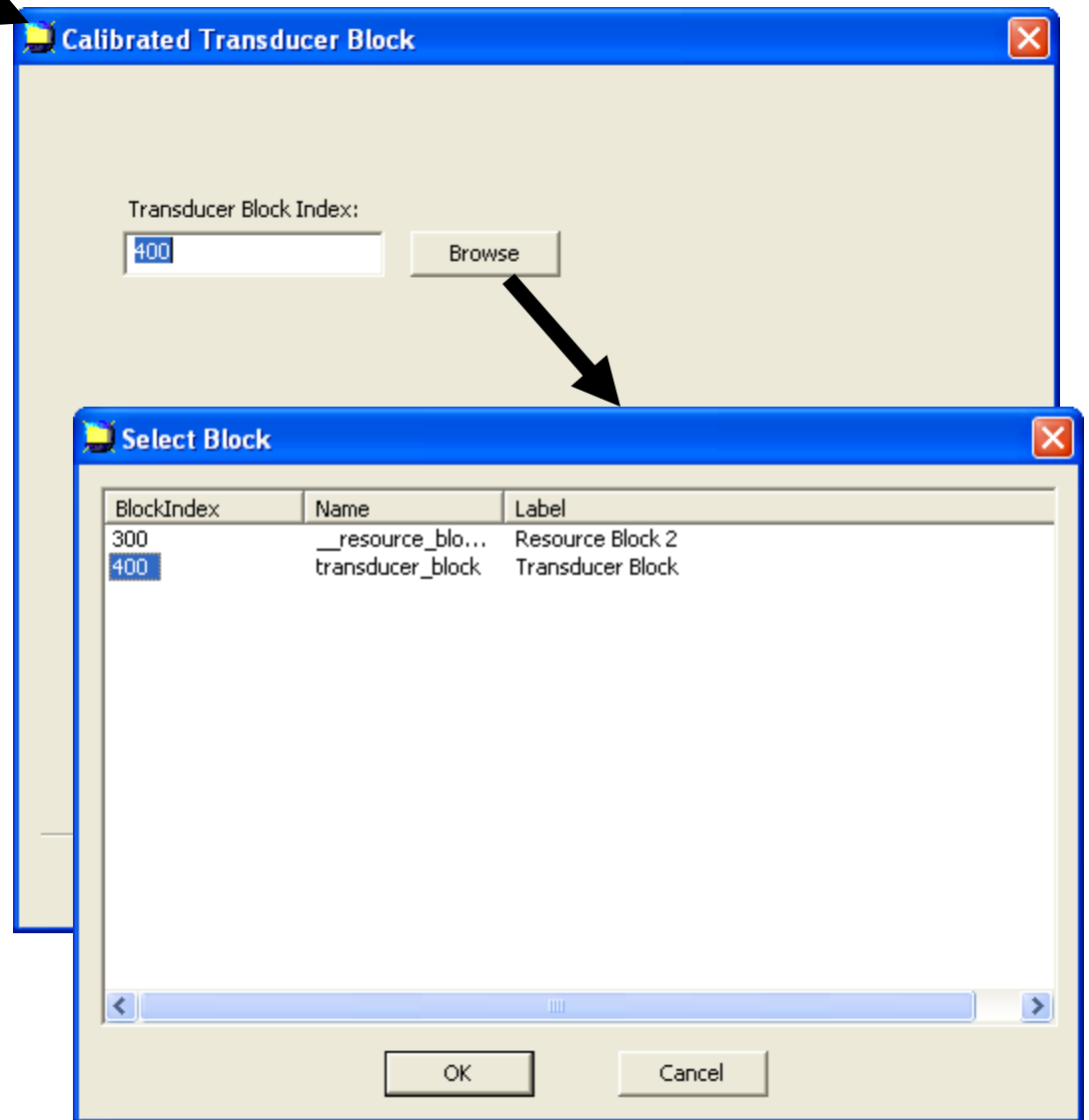
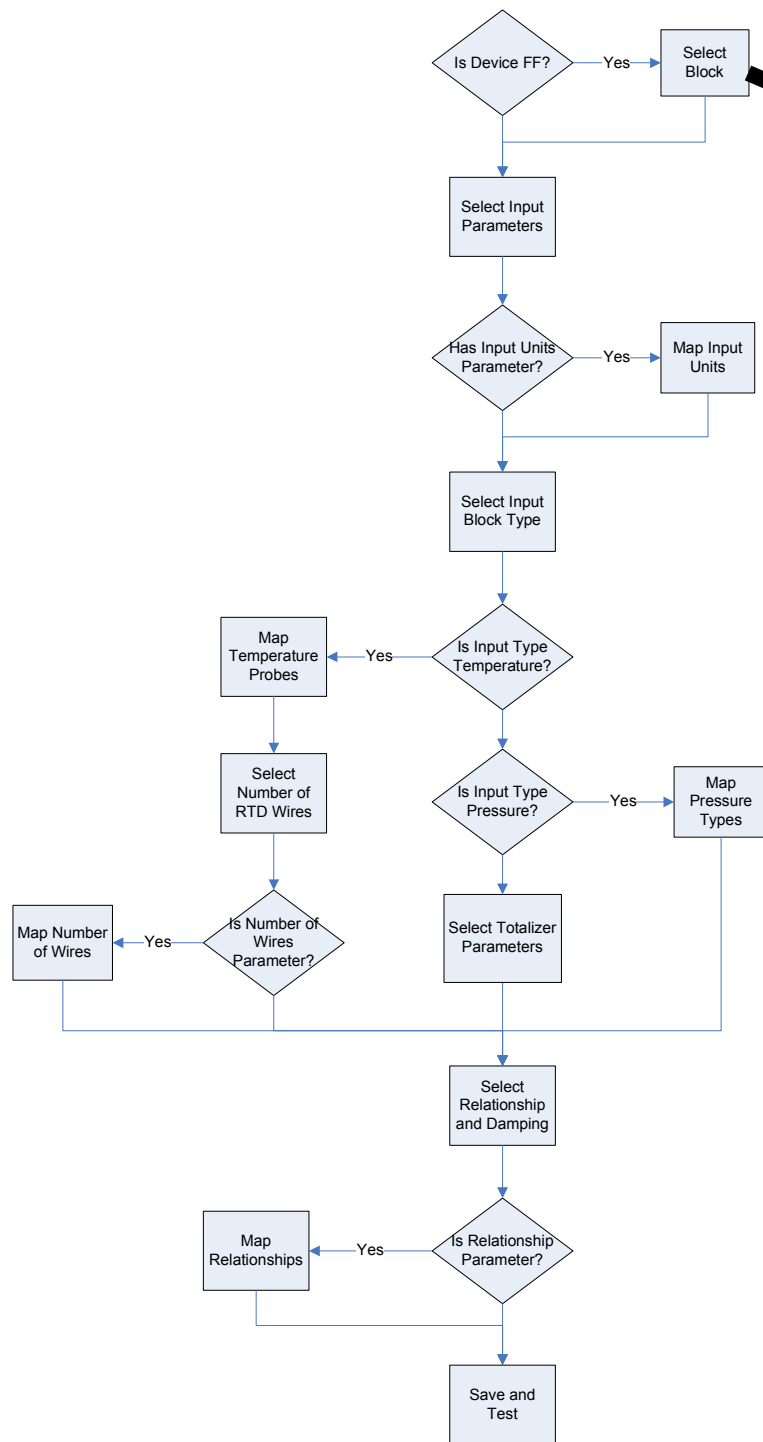


Calibrated Transducer Block

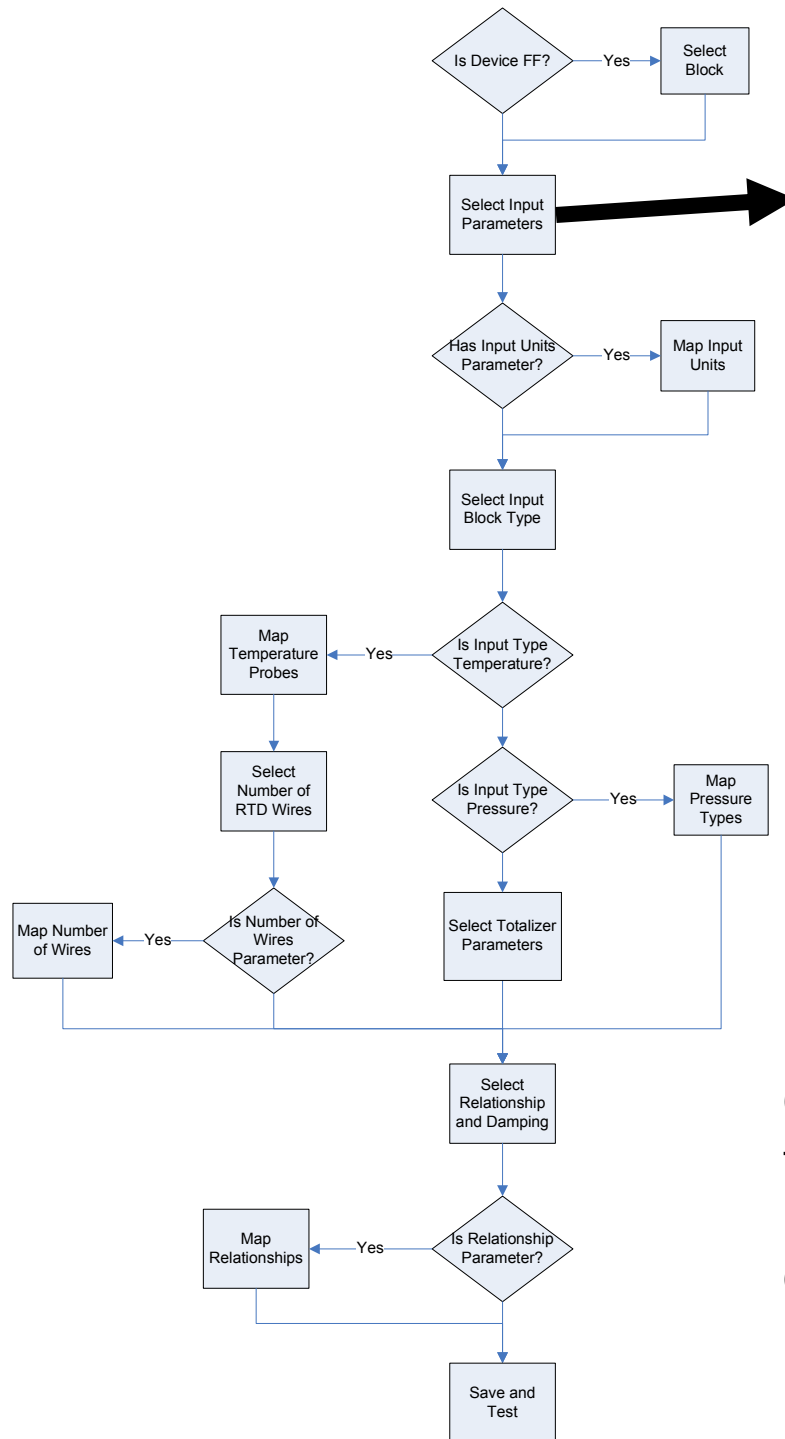
Transducer Block Index:

< Back Next > Cancel

If the device is a Fieldbus Device the first screen displays the Block that will be calibrated.



The Browse button will launch the user into a list of blocks to select from.



The 'Input Parameters' dialog box is shown with a blue title bar and a close button. It contains three sections for calibration parameters:

- Calibration Hi point:** A text field containing 'Param!cal_point_hi' and a 'Browse' button. Below it is a 'Default To:' checkbox and an empty text field.
- Calibration Lo Point:** A text field containing 'Param!cal_point_lo' and a 'Browse' button. Below it is a 'Default To:' checkbox and an empty text field.
- Calibration Units:** A text field containing 'Param!cal_unit' and a 'Browse' button. Below it is a 'Default To:' checkbox and a dropdown menu.

At the bottom of the dialog are three buttons: '< Back', 'Next >', and 'Cancel'.

Once a block is selected the user needs to identify the cal_point_hi, cal_point_low and cal_unit. For FF the param names are usually some variation on these names. Otherwise, you can use range_values.100 range_values.0 and range_values.units

Selecting
Browse gives a
list of all relevant
parameters

Input Parameters

Calibration Hi point

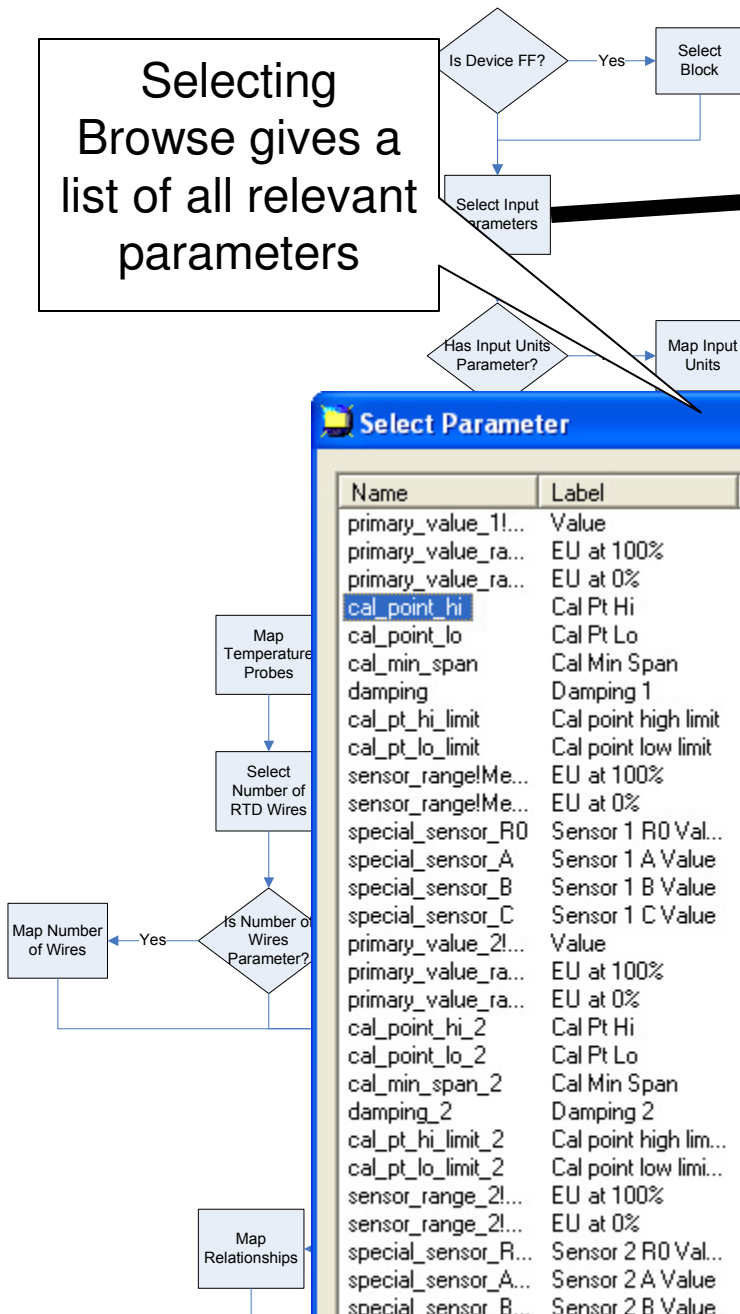
☐ Default To:

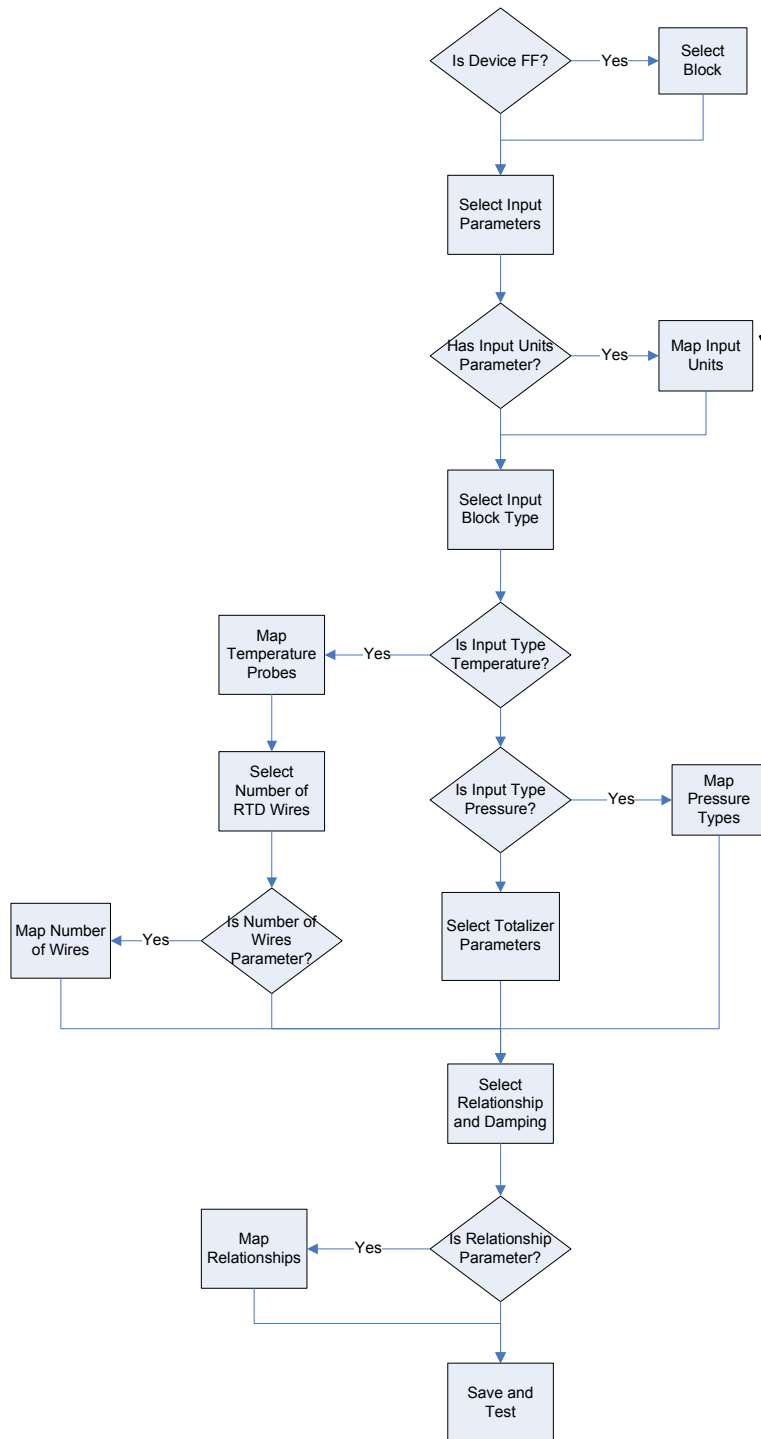
Calibration Lo Point

Select Parameter

Name	Label	Help	Unit
primary_value_1!	Value	A numerical quantity entered by a user or calculated by the ...	deg
primary_value_ra...	EU at 100%	The engineering unit value which represents the upper end...	deg
primary_value_ra...	EU at 0%	The engineering unit value which represents the lower end ...	deg
cal_point_hi	Cal Pt Hi	The highest calibrated value.	deg
cal_point_lo	Cal Pt Lo	The lowest calibrated value.	deg
cal_min_span	Cal Min Span	The minimum calibration span allowed. Ensures that the tw...	deg
damping	Damping 1	Damping 1	s
cal_pt_hi_limit	Cal point high limit	Cal point high limit	deg
cal_pt_lo_limit	Cal point low limit	Cal point low limit	deg
sensor_range!Me...	EU at 100%	The engineering unit value which represents the upper end...	deg
sensor_range!Me...	EU at 0%	The engineering unit value which represents the lower end ...	deg
special_sensor_R0	Sensor 1 R0 Val...	Sensor 1 Special Sensor Matching Coefficient R0 Value	deg
special_sensor_A	Sensor 1 A Value	Sensor 1 Special Sensor Matching Coefficient A Value	deg
special_sensor_B	Sensor 1 B Value	Sensor 1 Special Sensor Matching Coefficient B Value	deg
special_sensor_C	Sensor 1 C Value	Sensor 1 Special Sensor Matching Coefficient C Value	deg
primary_value_2!	Value	A numerical quantity entered by a user or calculated by the ...	deg
primary_value_ra...	EU at 100%	The engineering unit value which represents the upper end...	deg
primary_value_ra...	EU at 0%	The engineering unit value which represents the lower end ...	deg
cal_point_hi_2	Cal Pt Hi	The highest calibrated value.	<Un
cal_point_lo_2	Cal Pt Lo	The lowest calibrated value.	<Un
cal_min_span_2	Cal Min Span	The minimum calibration span allowed. Ensures that the tw...	<Un
damping_2	Damping 2	Damping 2	s
cal_pt_hi_limit_2	Cal point high lim...	Cal point high limit #2	<Un
cal_pt_lo_limit_2	Cal point low limi...	Cal point low limit #2	<Un
sensor_range_2!	EU at 100%	The engineering unit value which represents the upper end...	deg
sensor_range_2!	EU at 0%	The engineering unit value which represents the lower end ...	deg
special_sensor_R...	Sensor 2 R0 Val...	Sensor 2 Special Sensor Matching Coefficient R0 Value	deg
special_sensor_A...	Sensor 2 A Value	Sensor 2 Special Sensor Matching Coefficient A Value	deg
special_sensor_B...	Sensor 2 B Value	Sensor 2 Special Sensor Matching Coefficient B Value	deg
special_sensor_C...	Sensor 2 C Value	Sensor 2 Special Sensor Matching Coefficient C Value	deg

Type
☐ All
☐ Enumeration
☒ Floating Point
☐ String



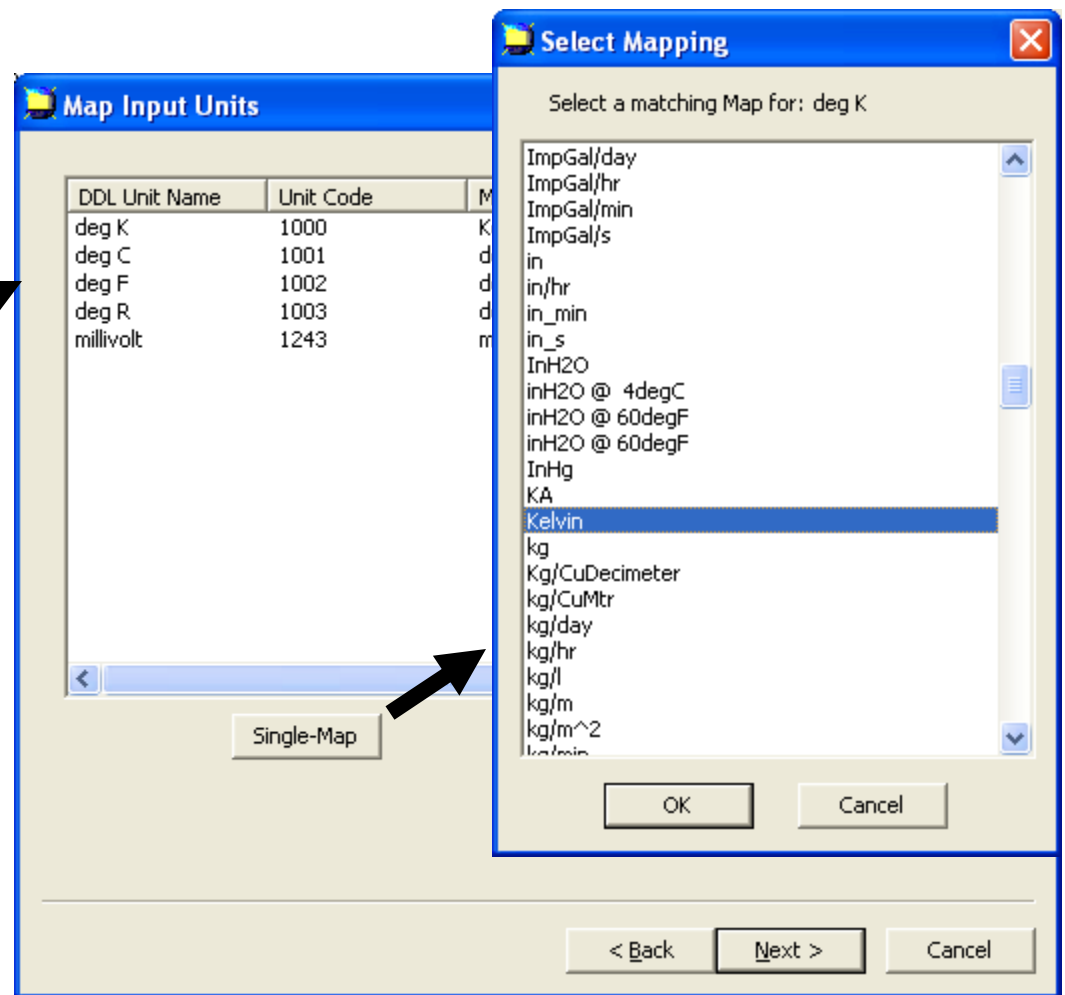
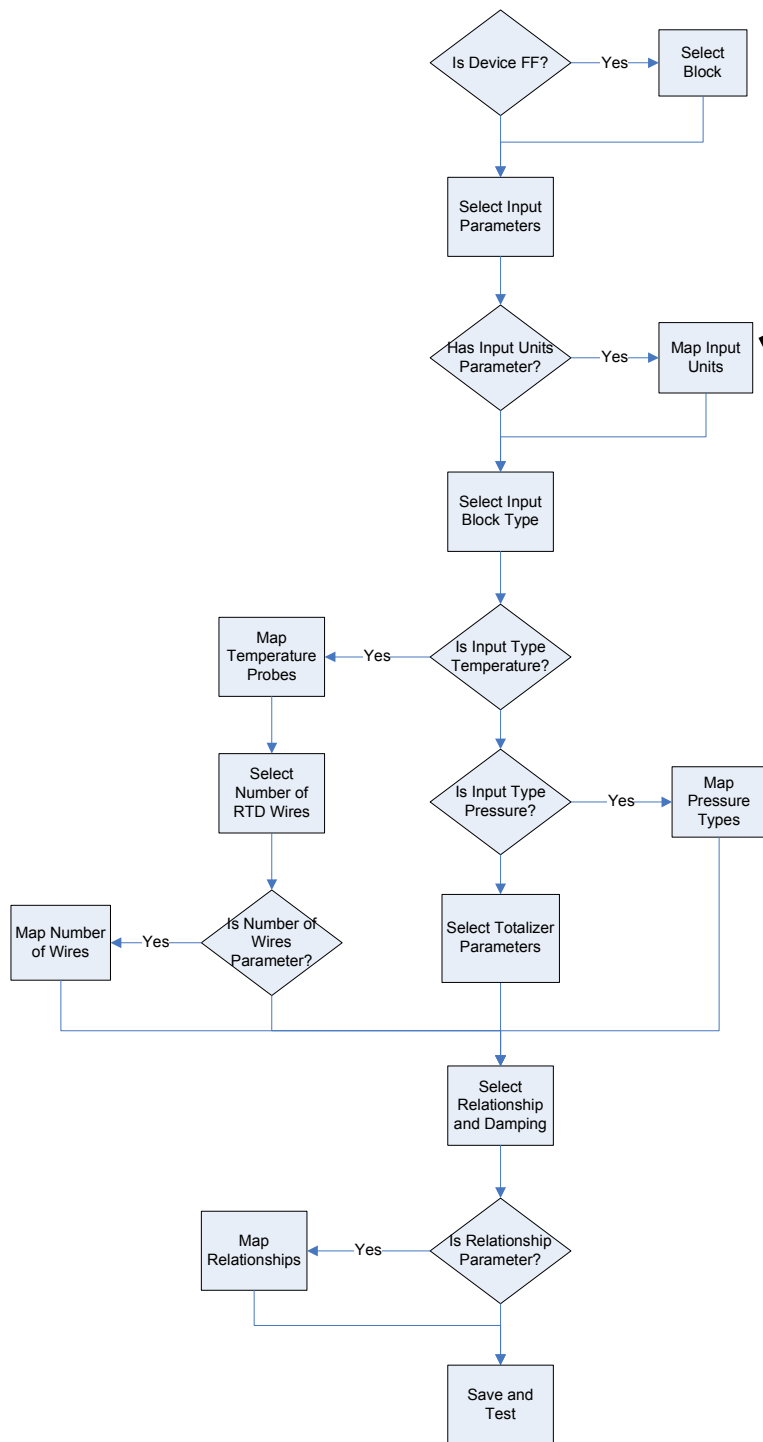


DDL Unit Name	Unit Code	Map File Unit Name
deg K	1000	Kelvin
deg C	1001	degC
deg F	1002	degF
deg R	1003	degR
millivolt	1243	mV

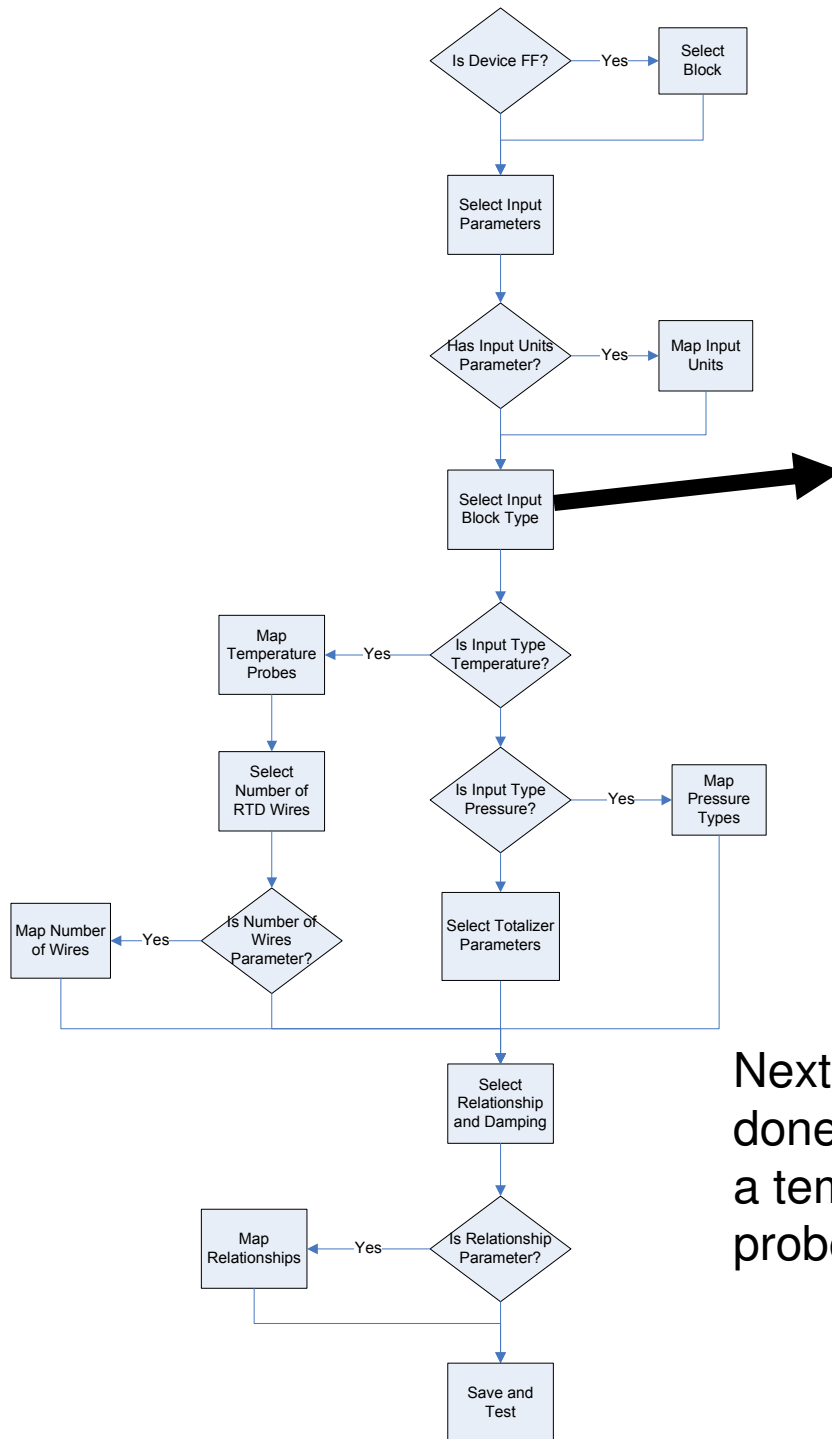
Single-Map Auto-Map

< Back Next > Cancel

The “Auto-Map” feature works well for FF devices. Otherwise you need to click the “Single-Map” to map each DD unit to a standard unit.



This is the standard list of units, if you cannot find the correct match... select "Unused".



Input Block Type

Temperature

☐ Generic (ie not temperature or pressure)

☐ Pressure

Pressure Type Parameter (Gage, Absolute, differential)

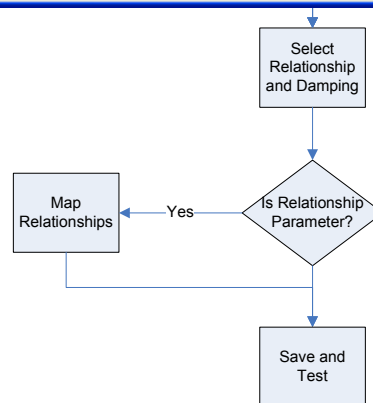
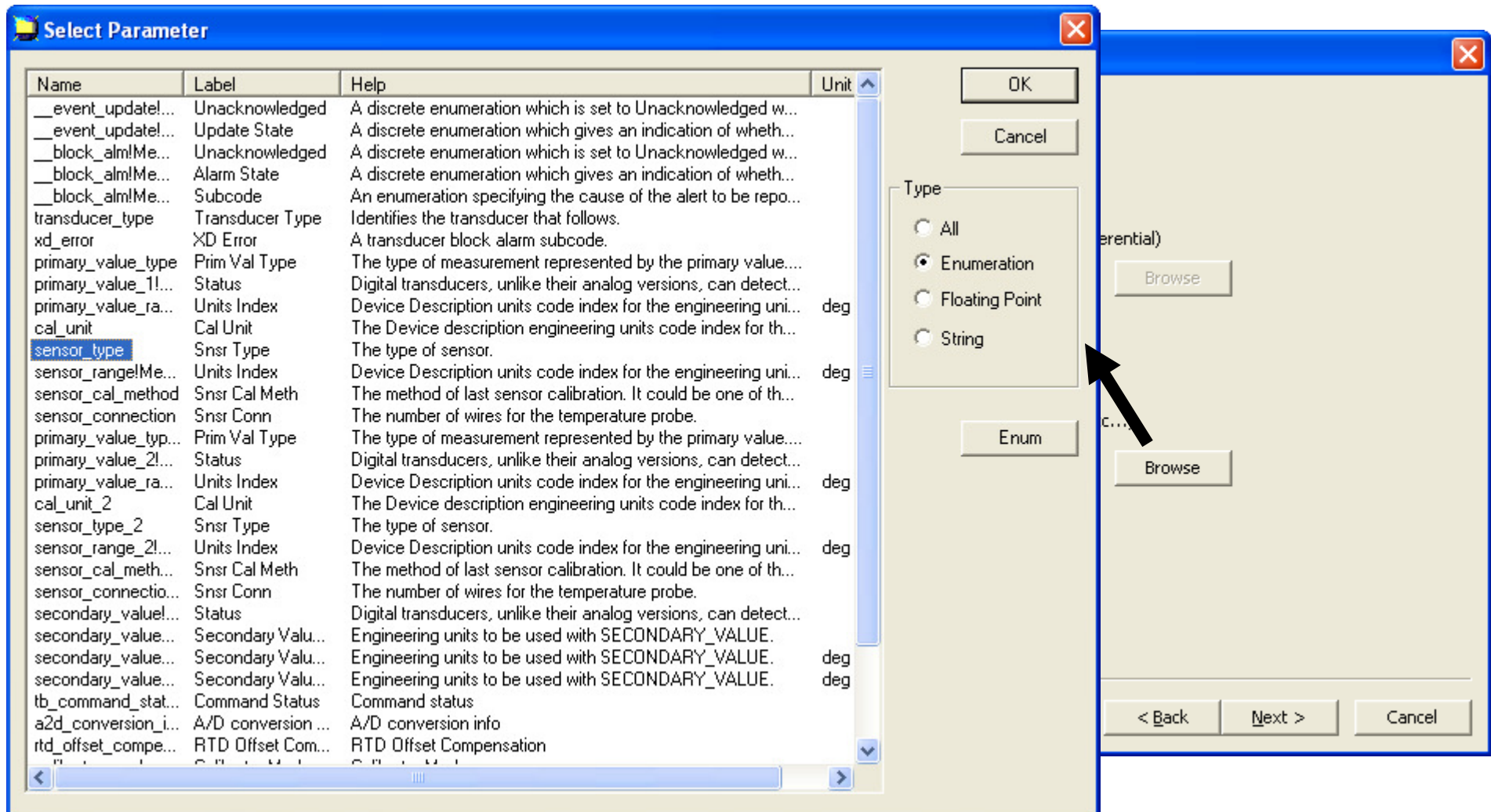
☒ Use Default:

☒ Temperature

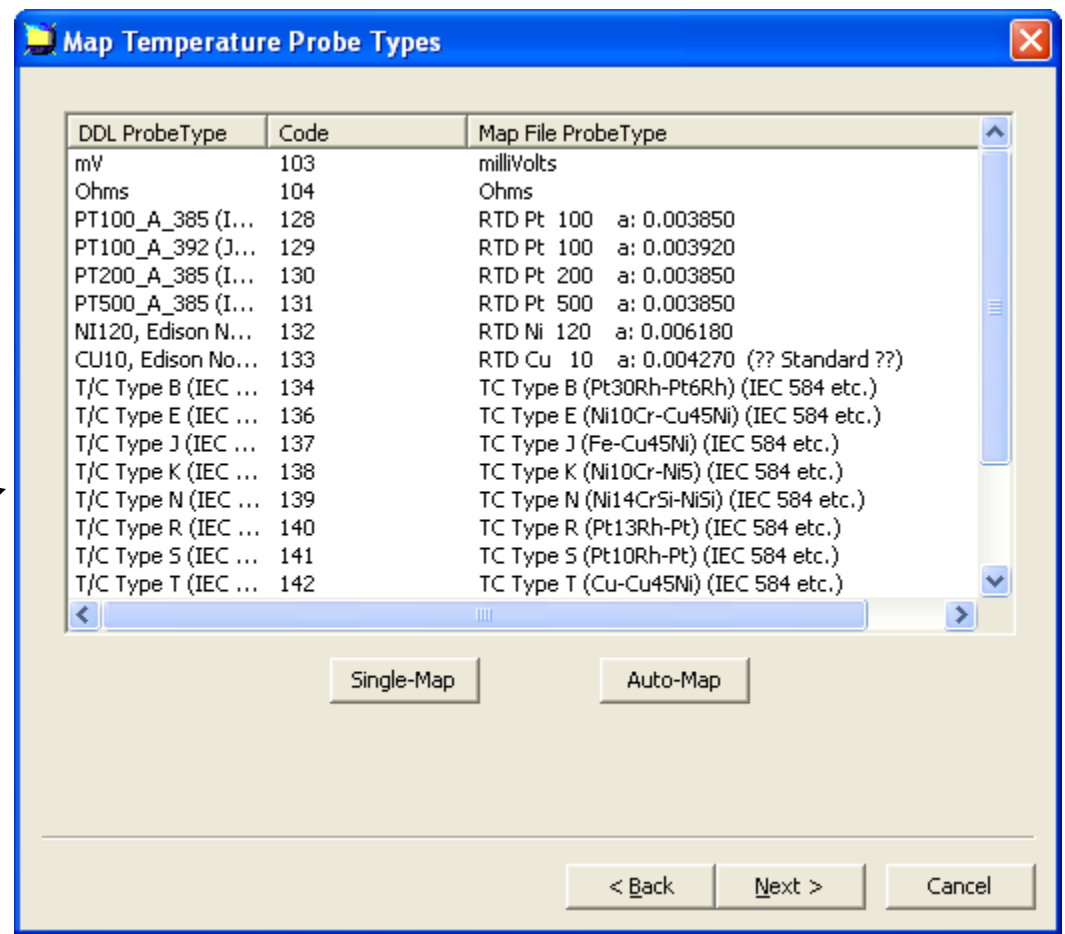
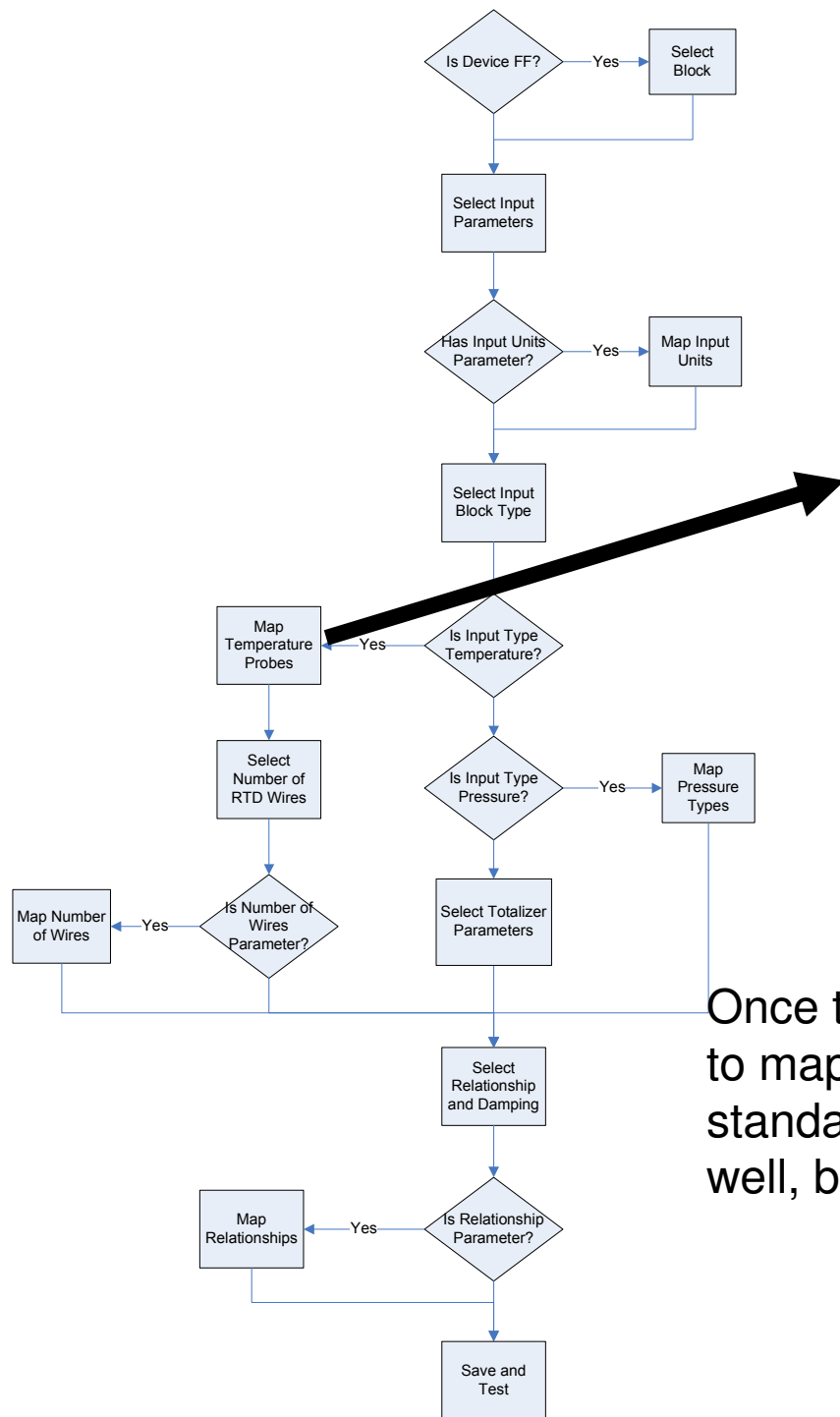
Temperature Probe parameter (PT-100, TC-J etc...)

< Back Next > Cancel

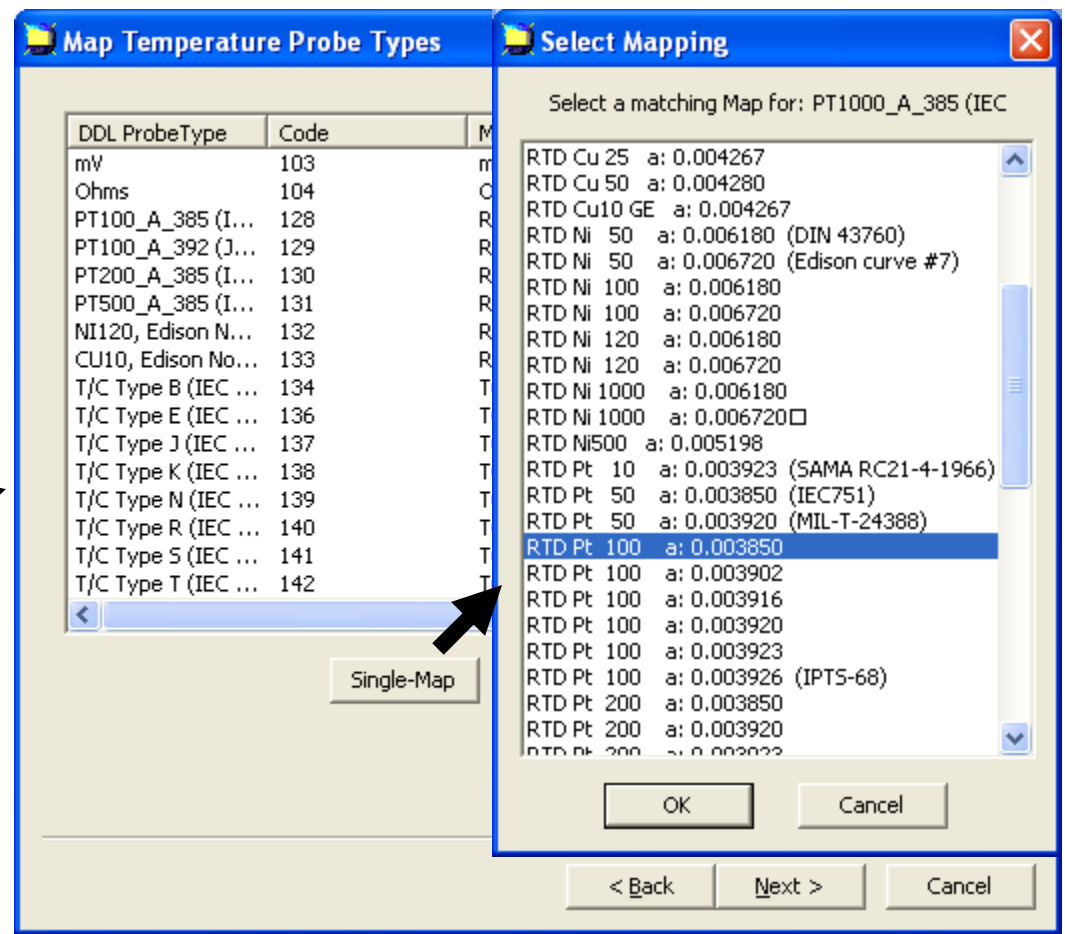
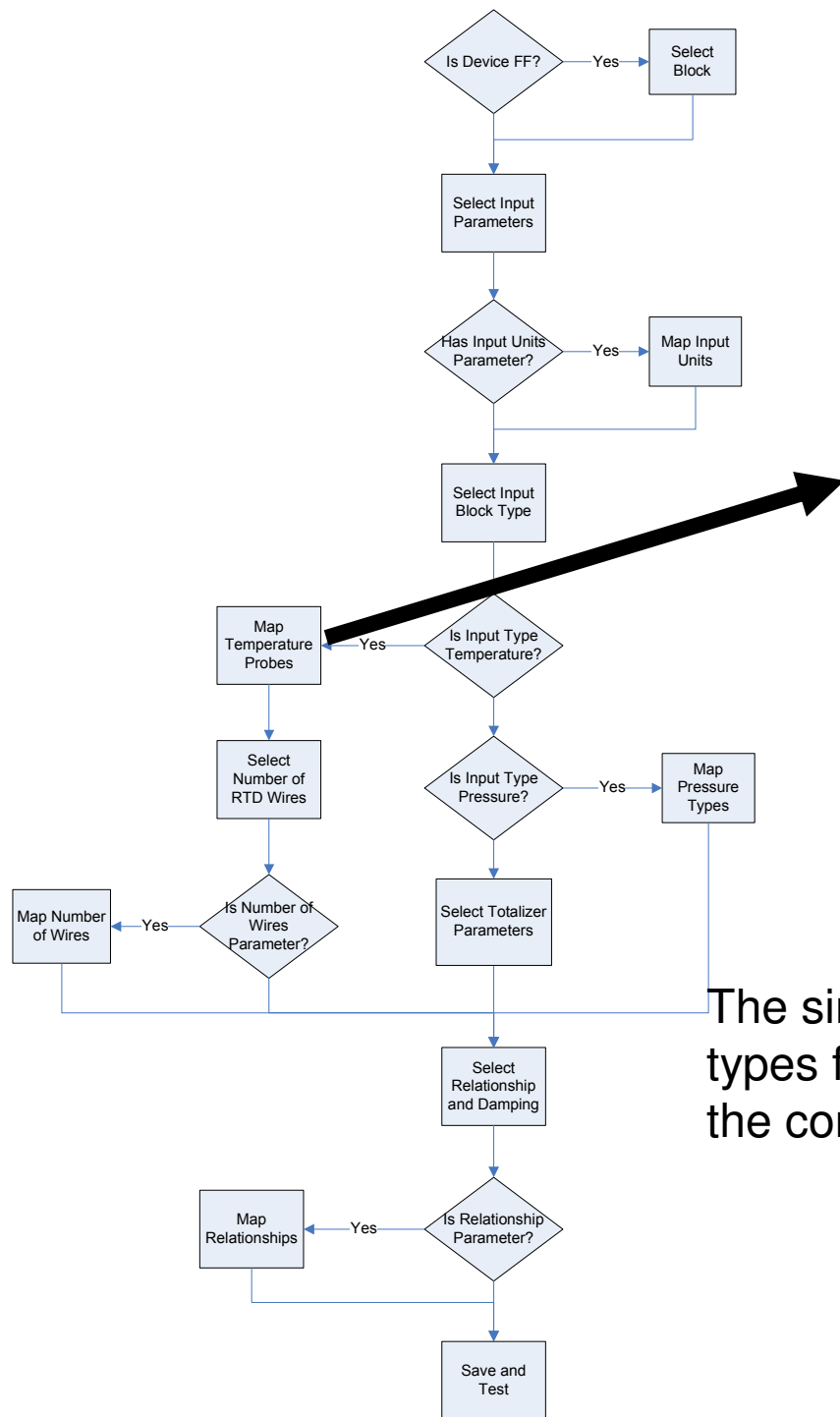
Next, select the “type” of the input, after having done the units, you probably know. If the device is a temperature transmitter, you need to select the probe_type (sensor_type) parameter.



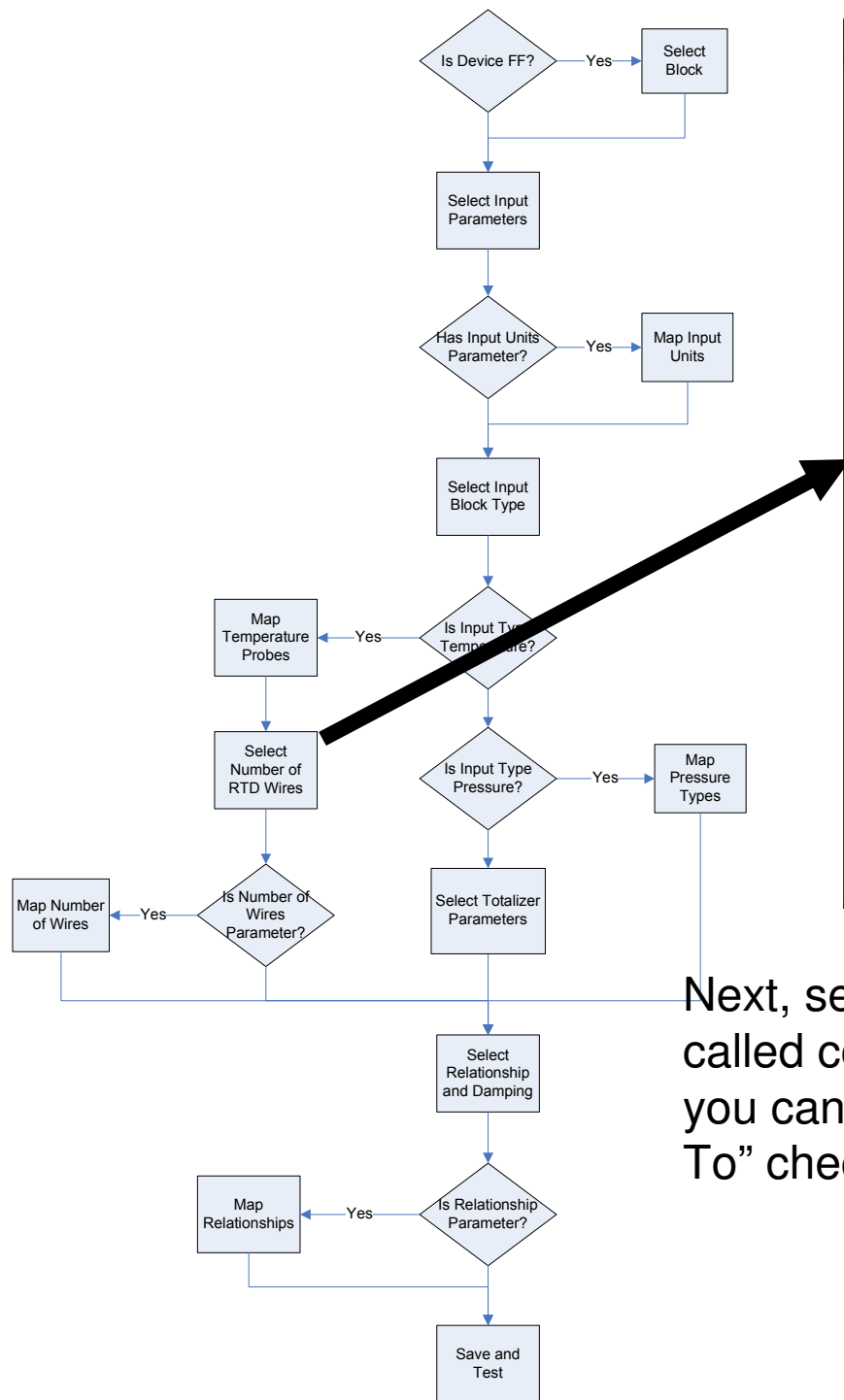
Again, the user has to sift through the list of parameters. Clicking the “Enum” button will also show you the list of enumerations for a selected enumeration variable



Once the probe_type parameter is selected you need to map all of the enumerated values to known standards. The "Auto-Map" button does not work well, but sometimes we get lucky.



The single map displays the list of supported probe types for AMS Device Manager. If you cannot find the correct value select "Unused".



Number of Wires

This is also called connection_type. It is used for RTD temperature probes to tell how many connections their are to the probe. it is usually 2, 3 or 4 wire.

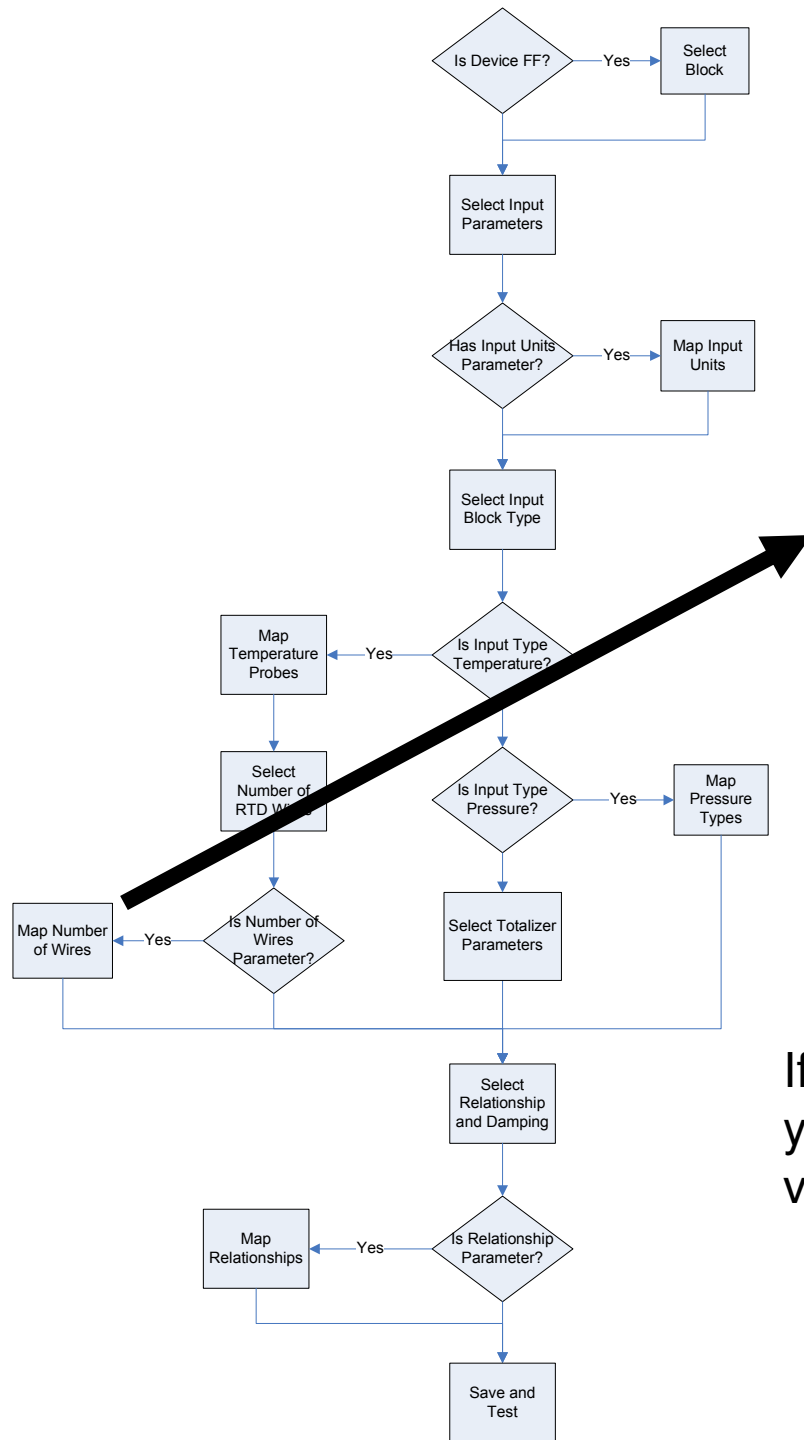
Number of Wires

Param!sensor_connection

☐ Default To: 2

< Back Next > Cancel

Next, select the sensor_connection (sometimes called connection_type parameter) if it does not exist you can assume a 2 wire by clicking on the "Default To" checkbox.



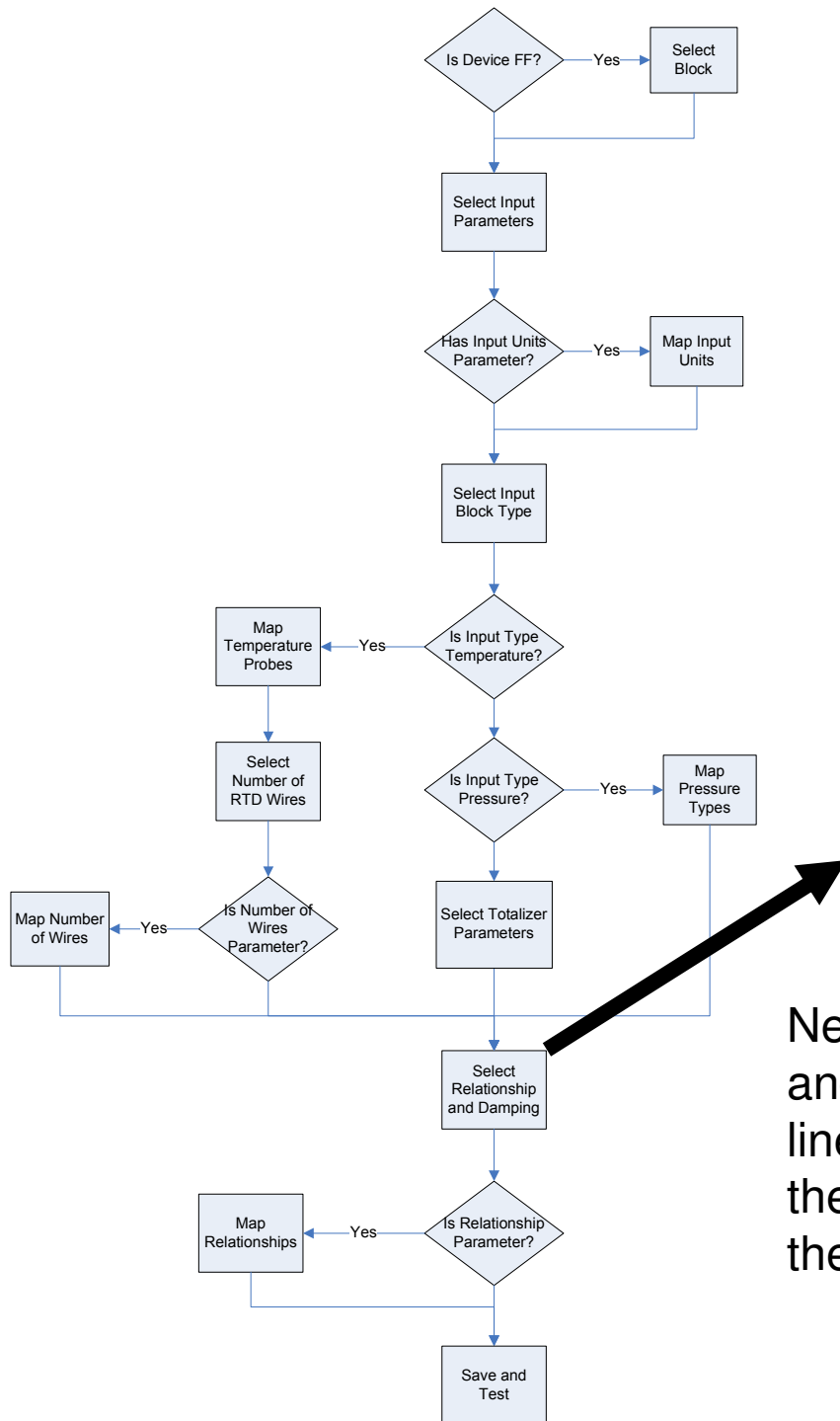
Map Number of Wires

DDL NumWires	Code	Map File NumWires
2-wire	2	2 wires
none	250	None

Single-Map

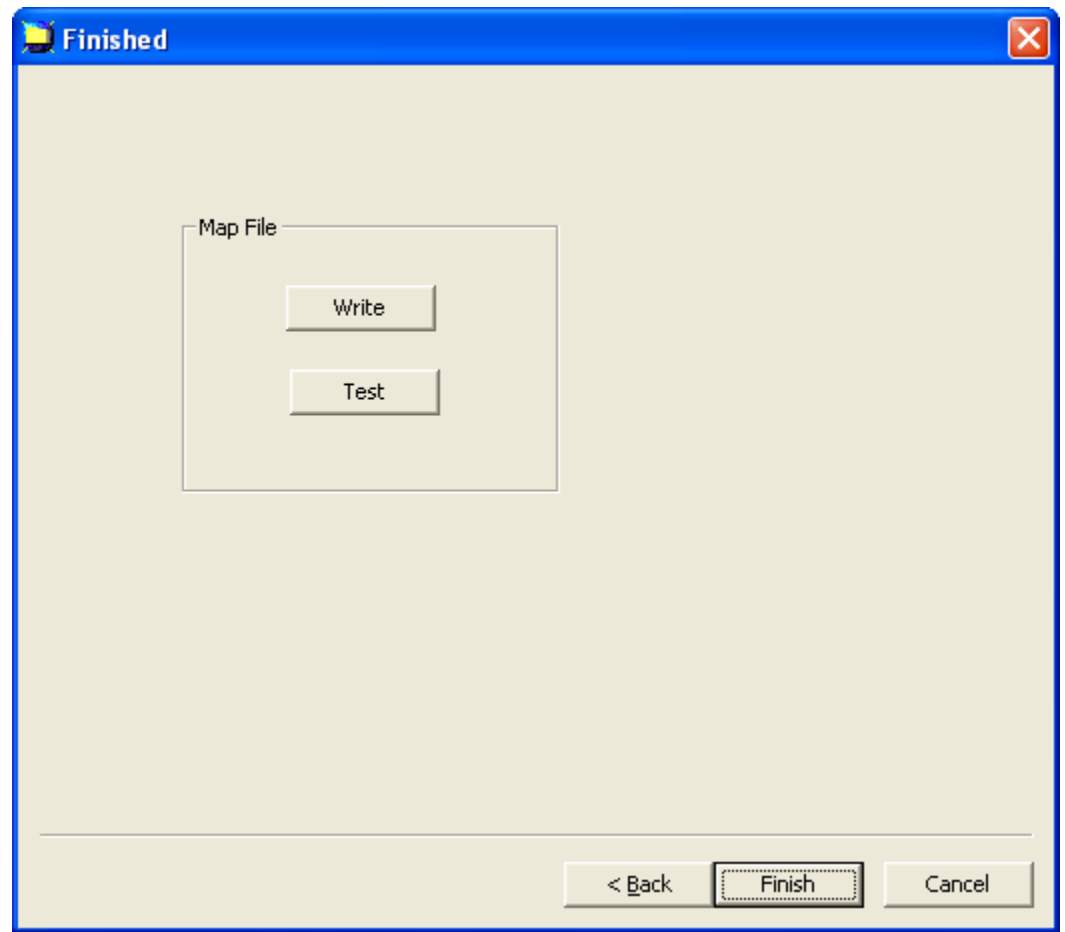
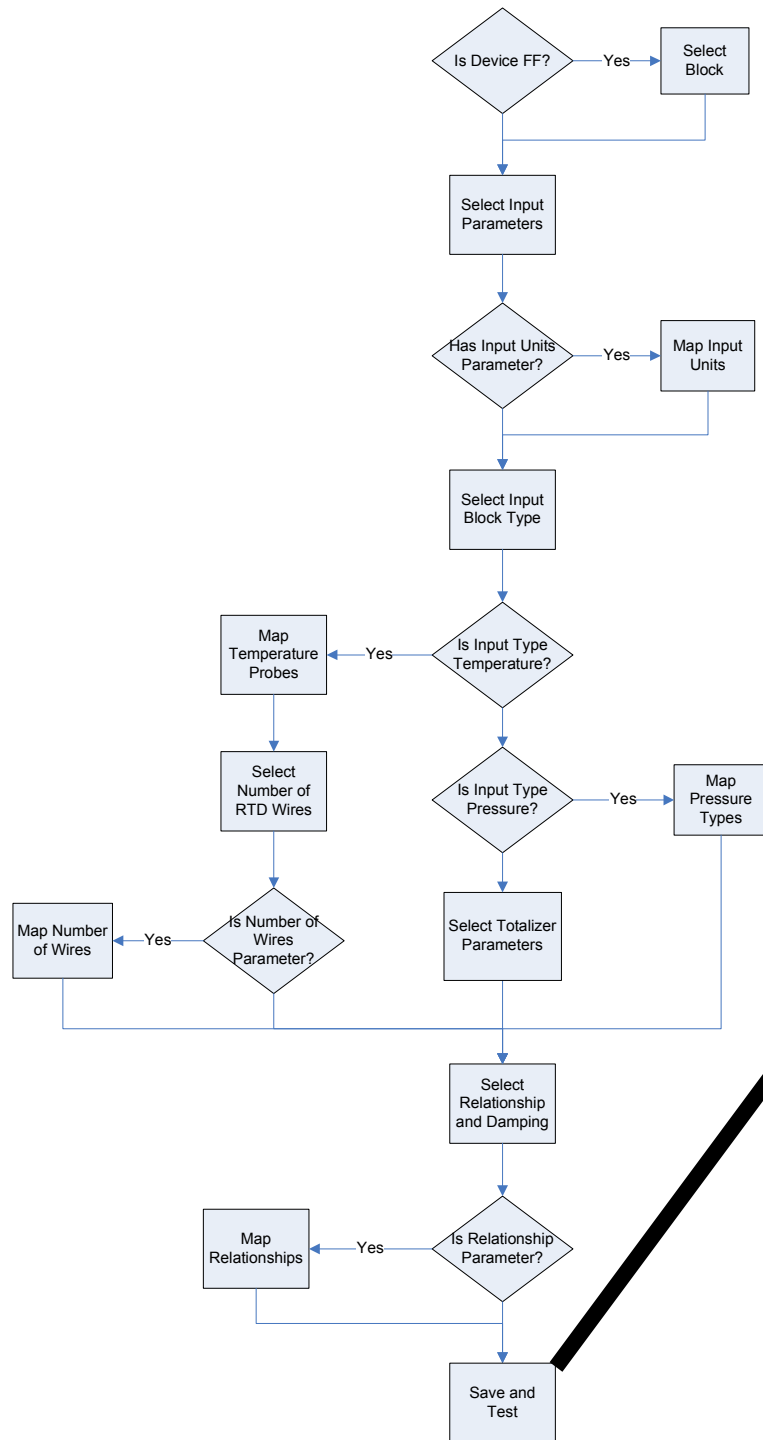
< Back Next > Cancel

If you selected the sensor_connection parameter you need to map the DDL values to the standard values.



The screenshot shows the 'Input/Output Relationship' dialog box. It has a blue title bar with the text 'Input/Output Relationship' and a close button. The dialog is divided into two main sections: 'Relationship' and 'Damping'. The 'Relationship' section contains a text field for the relationship name, a 'Browse' button, a checked 'Default To:' checkbox, and a dropdown menu currently set to 'Linear'. The 'Damping' section contains a text field for the damping parameter (labeled 'Param!damping'), a 'Browse' button, and an unchecked 'Default To:' checkbox. At the bottom of the dialog are three buttons: '< Back', 'Next >', and 'Cancel'.

Next, select the relationship between the input and the output. For Fieldbus this will always be linear. Damping is the amount of delay between the input being applied and the value changing at the output.



Success, you have reached the final page. press the “Write” button. This will save the map file in the devices directory. Clicking the Test button will launch the map file tester application.


```
MapFileTestResults.txt - Notepad
File Edit Format View Help
XXXXXXXXXXXXXXXXXXXXXXXXXXXX Start of Test XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Rosemount 3244MV Fieldbus Temperature Transmitter Rev. 4 (1151 3244 4)
The test was conducted at 10:14:39 on 12-5-2008
Map file is D:\ams\code\devices\FF\001151\3244\0401.map
***** Test results *****

Input block unit
DD Code, DD String, Common Code, Common String in English, Common String
WARNING: Non-exact "DD String" <-> "Common String" comparison found
1000' deg K' 35' kelvin' kelvin
WARNING: Non-exact "DD String" <-> "Common String" comparison found
1001' deg C' 32' degC' degC
WARNING: Non-exact "DD String" <-> "Common String" comparison found
1002' deg F' 33' degF' degF
WARNING: Non-exact "DD String" <-> "Common String" comparison found
1003' deg R' 34' degR' degR
WARNING: Non-exact "DD String" <-> "Common String" comparison found
1243' millivolt' 36' mv' mv
*****

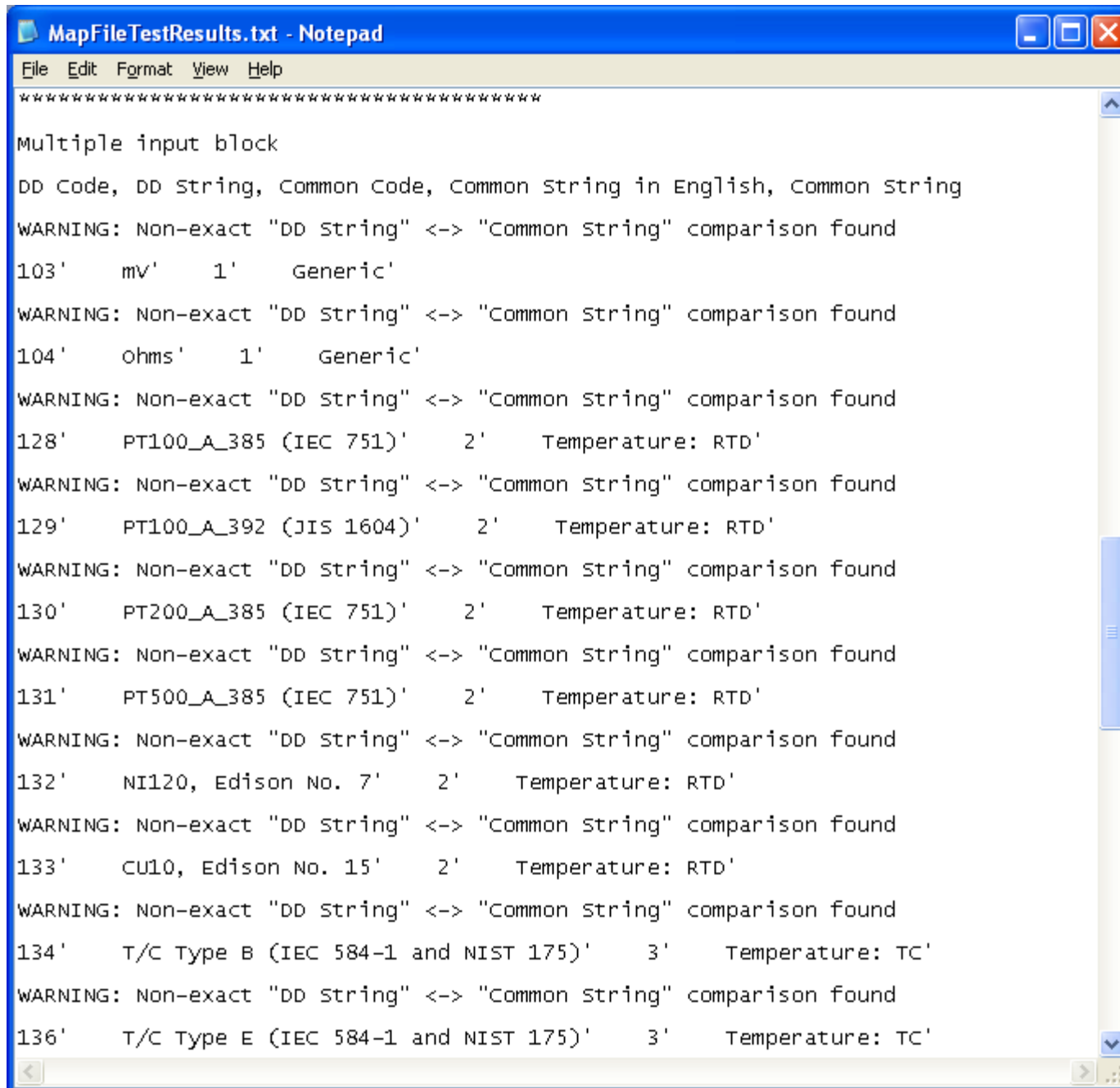
Input Block Upper Range Value
No errors or warnings detected.
*****

Input Block Lower Range Value
No errors or warnings detected.
```

The most confusing part of this application is all the warnings that are displayed.

MapFileTester will do string compares between what the DD says and what the standard string is.

Surprise, “degC” and “deg C” are not an exact match.



```
MapFileTestResults.txt - Notepad
File Edit Format View Help
*****
Multiple input block
DD Code, DD String, Common Code, Common String in English, Common String
WARNING: Non-exact "DD String" <-> "Common String" comparison found
103'    mv'    1'    Generic'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
104'    ohms'   1'    Generic'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
128'    PT100_A_385 (IEC 751)'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
129'    PT100_A_392 (JIS 1604)'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
130'    PT200_A_385 (IEC 751)'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
131'    PT500_A_385 (IEC 751)'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
132'    NI120, Edison No. 7'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
133'    CU10, Edison No. 15'    2'    Temperature: RTD'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
134'    T/C Type B (IEC 584-1 and NIST 175)'    3'    Temperature: TC'
WARNING: Non-exact "DD String" <-> "Common String" comparison found
136'    T/C Type E (IEC 584-1 and NIST 175)'    3'    Temperature: TC'
```

Even harder to discern is which probe types are:

Generic
RTD
TC

You need to know the category of probe types but this screen has helped to find issues.

Rules of Thumb

- “degC” and “°C” represent the same thing and so is NOT an issue.
- If you are not sure if you know the correct mapping of an enumeration, select “Unused” or “Not Used”.
- For Fieldbus transmitters, the relationship between input and output will always be Linear (digital). HART devices may have a parameter for non-linear selections.

Issues

- This application defaults CJC (Cold Junctions Compensation) to “Internal”.
- The user needs to know which temperature probes are Thermocouples and which are RTD to interpret the map file tester results.

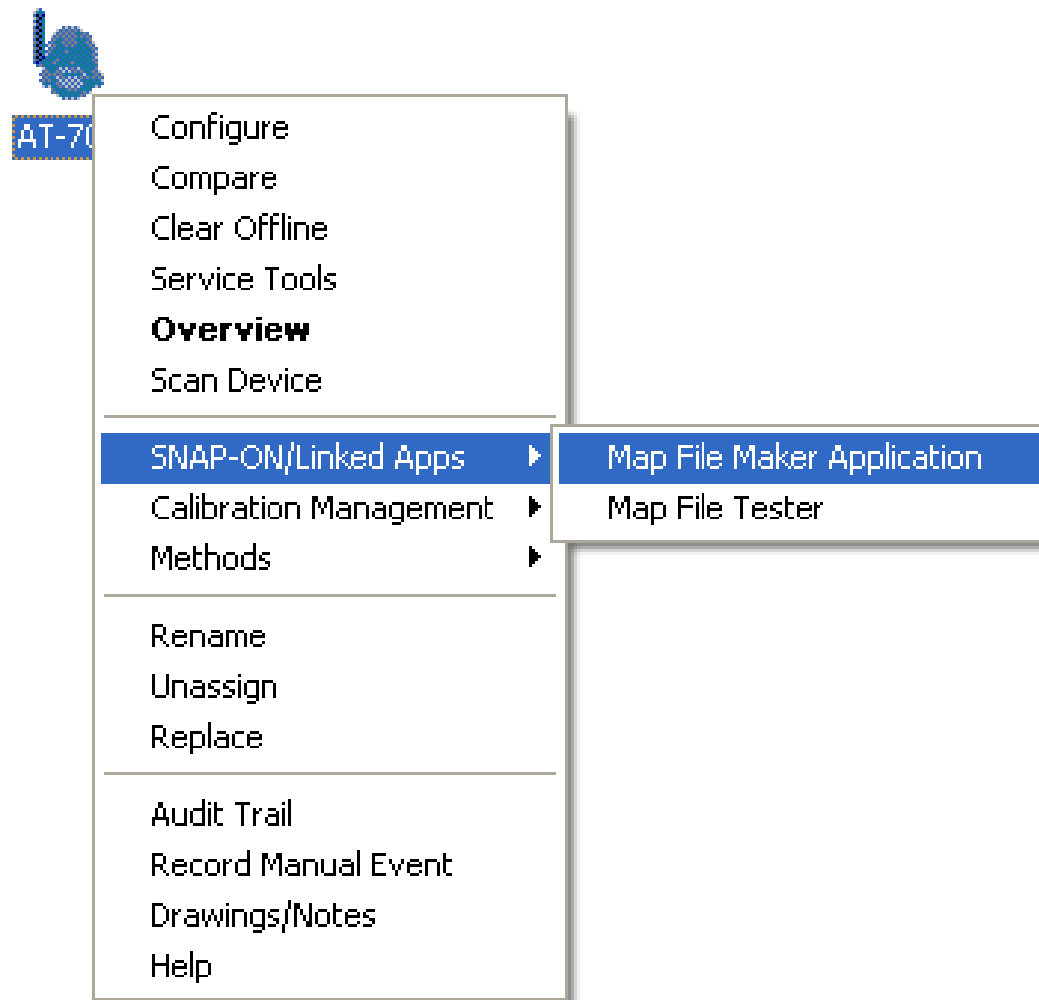
Pressure

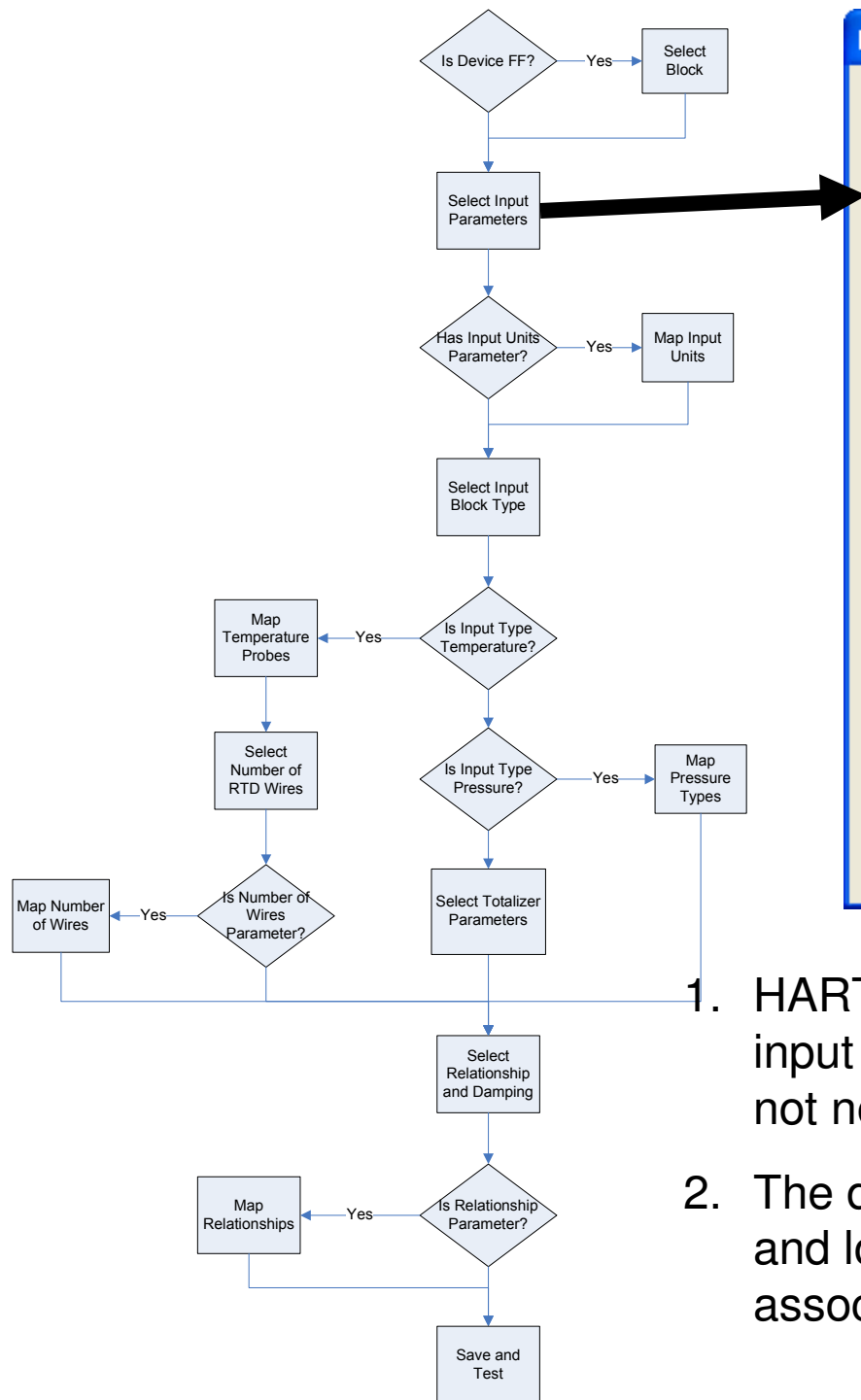
- Calibrators will often measure pressure applied to the input of a pressure transmitter and then read the transmitter output to verify its operation.
- We need to identify enough parameters and values (in a standard format) to allow that calibrator to know what kind of pressure that transmitter is configured for (i.e. Absolute, Differential or Gauge).

How do I create a map file for a pressure transmitter?

- Map File Maker will step the developer through identifying the parameters needed to calibrate this device type.
- I will run through the screens to create a HART pressure transmitter.

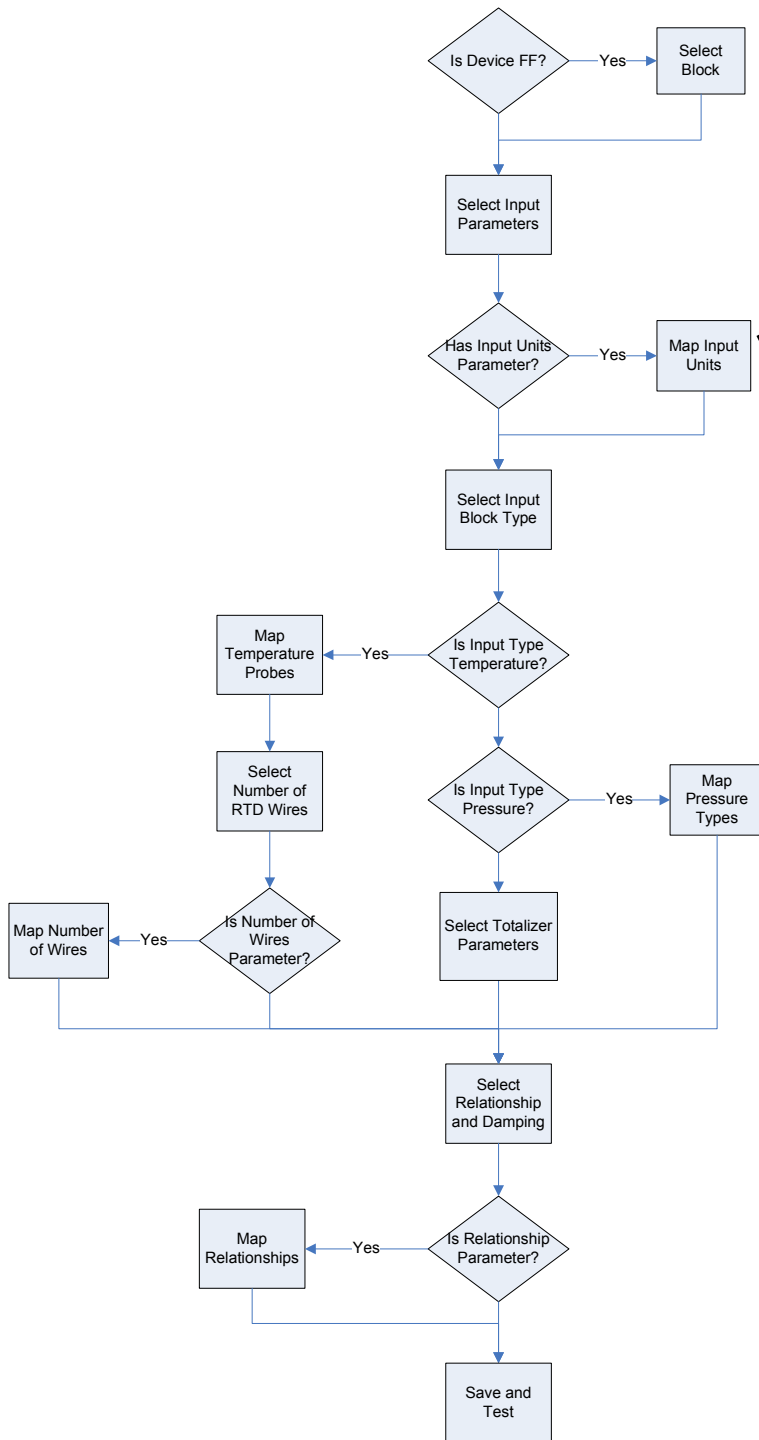
Launch “Map File Maker” from the Device Context menu





The 'Input Parameters' dialog box is shown with a blue title bar and a close button (X) in the top right corner. It contains three sections for calibration parameters, each with a text input field and a 'Browse' button. The first section is 'Calibration Hi point' with the text 'Param!upperRange_value' in the input field. The second section is 'Calibration Lo point' with the text 'Param!lowerRange_value' in the input field. The third section is 'Calibration Units' with the text 'Param!pressure_units' in the input field. Each section also has a 'Default To:' checkbox and an empty input field. At the bottom of the dialog are three buttons: '< Back', 'Next >', and 'Cancel'.

1. HART devices will immediately bring the user to the input Parameter selection screen (Block index does not need to be selected).
2. The device developer needs to identify the upper and lower RANGE values (i.e. the values that are associated with the 4 – 20 mA signal).

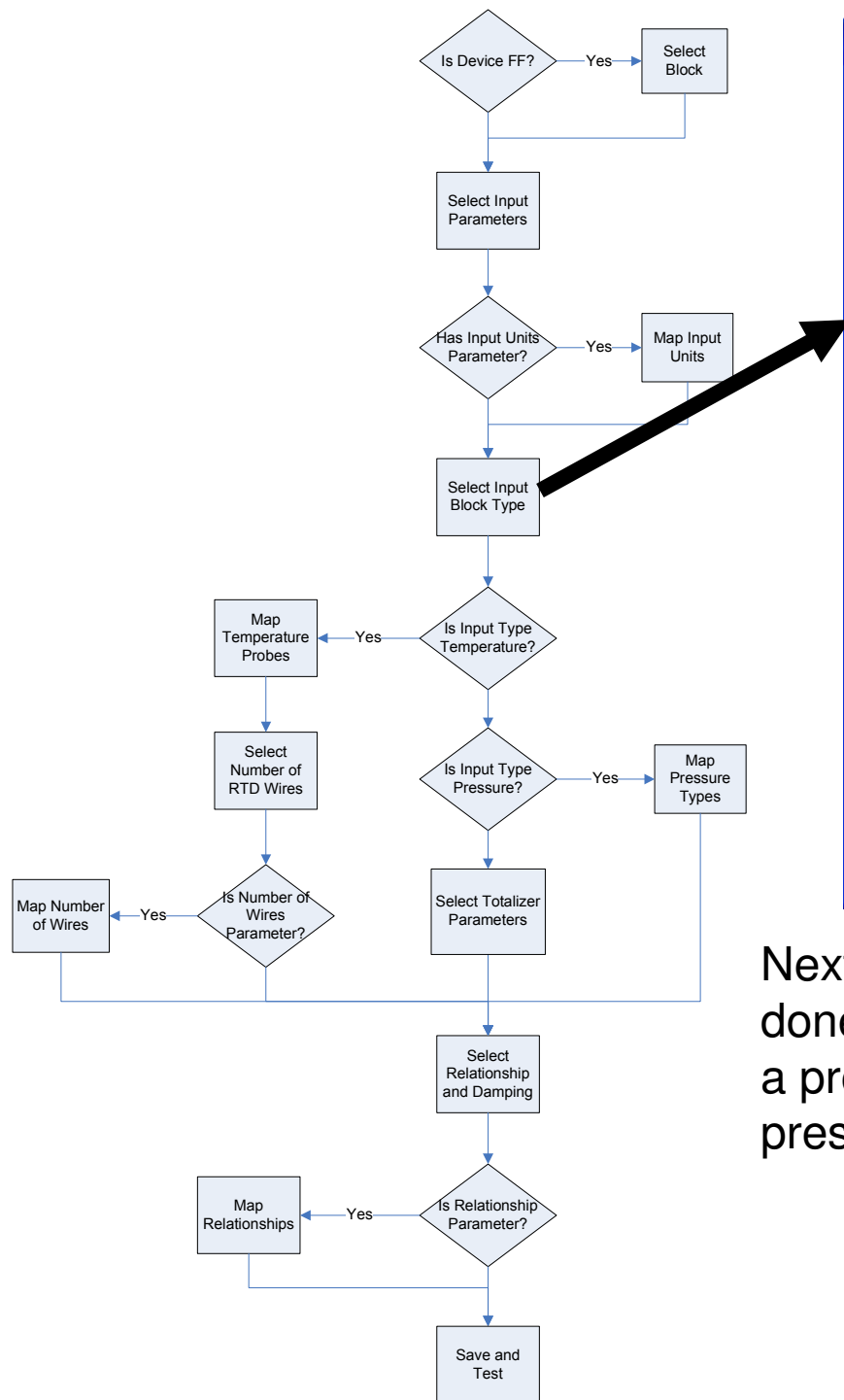


DDL Unit Name	Unit Code	Map File Unit Name
inH2O	1	InH2O
inHg	2	InHg
ftH2O	3	FtH2O
mmH2O	4	mmH2O
mmHg	5	mmHg
psi	6	psi
bar	7	bar
mbar	8	mbar
g/Sqcm	9	g/SqCm
kg/Sqcm	10	kg/SqCm
Pa	11	PA
kPa	12	kPA
torr	13	torr
atm	14	ATM
MPa	237	mega_pascals
inH2O @4DegC	238	inH2O @ 4degC

Single-Map Auto-Map

< Back Next > Cancel

The “Auto-Map” works well for pressure units for HART devices. Otherwise you need to click the “Single-Map” to map each DD unit to a standard unit.



Input Block Type

Unknown

☐ Generic (ie not temperature or pressure)

☒ **Pressure**

Pressure Type Parameter (Gage, Absolute, differential)

Param!module_type_code

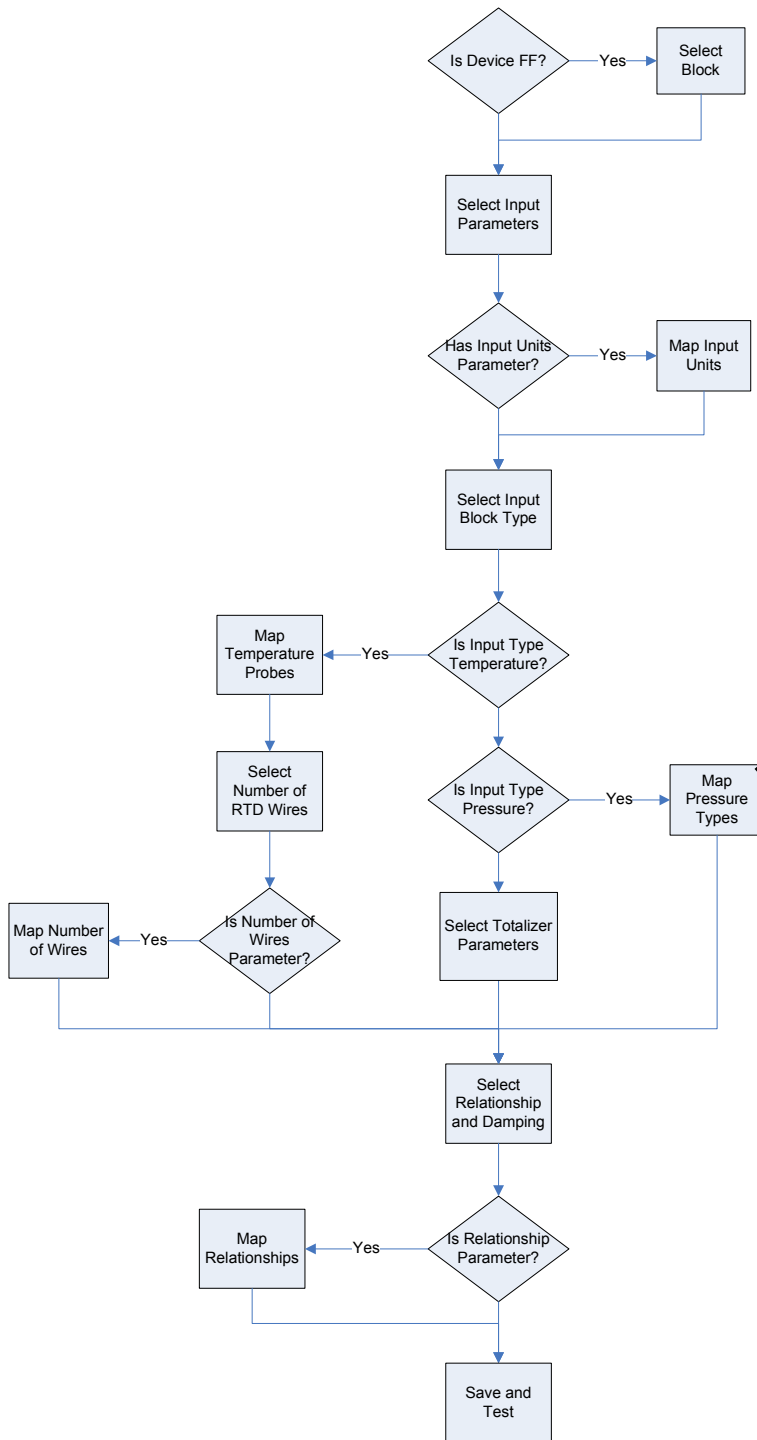
☐ Use Default: Gauge

☐ Temperature

Temperature Probe parameter (PT-100, TC-J etc...)

< Back Next > Cancel

Next, select the “type” of the input, after having done the units, you probably know. If the device is a pressure transmitter, you need to select the pressure_type (sensor_type) parameter.



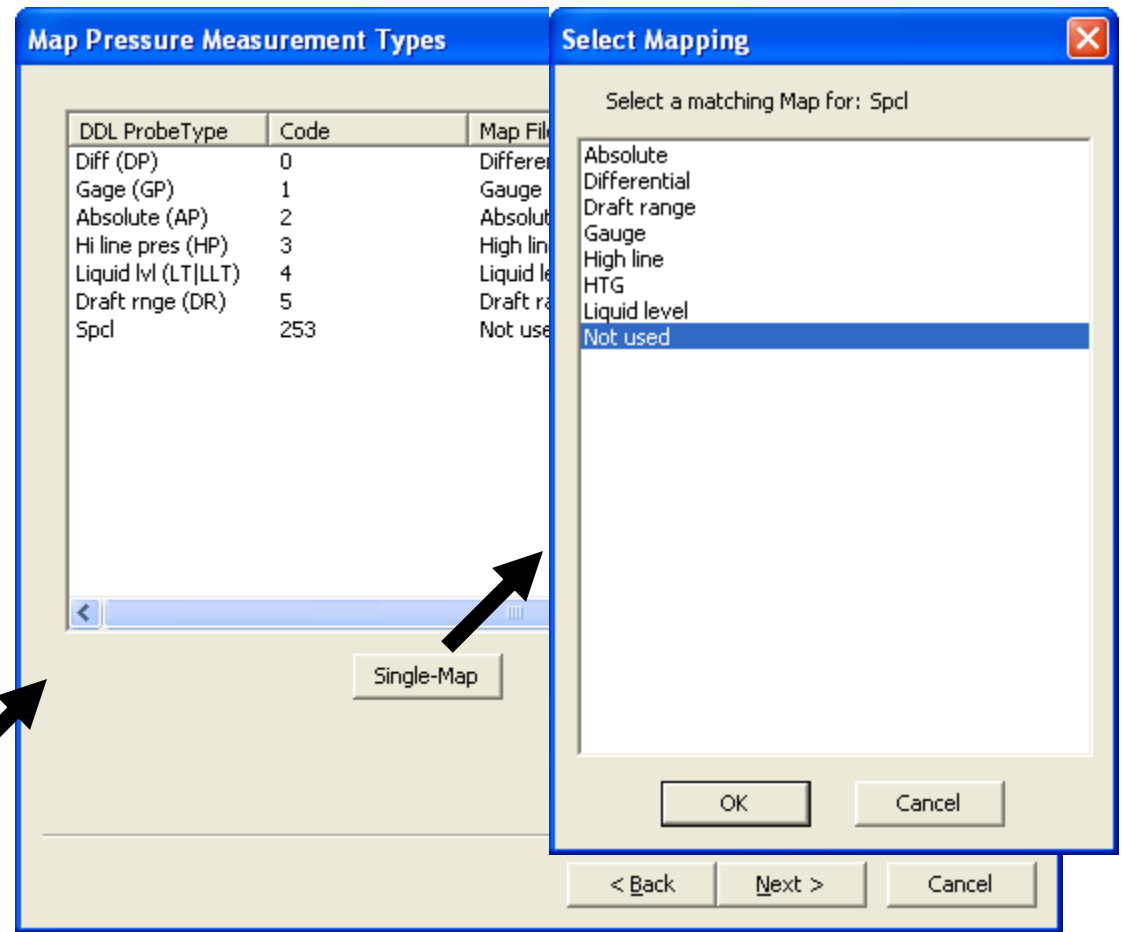
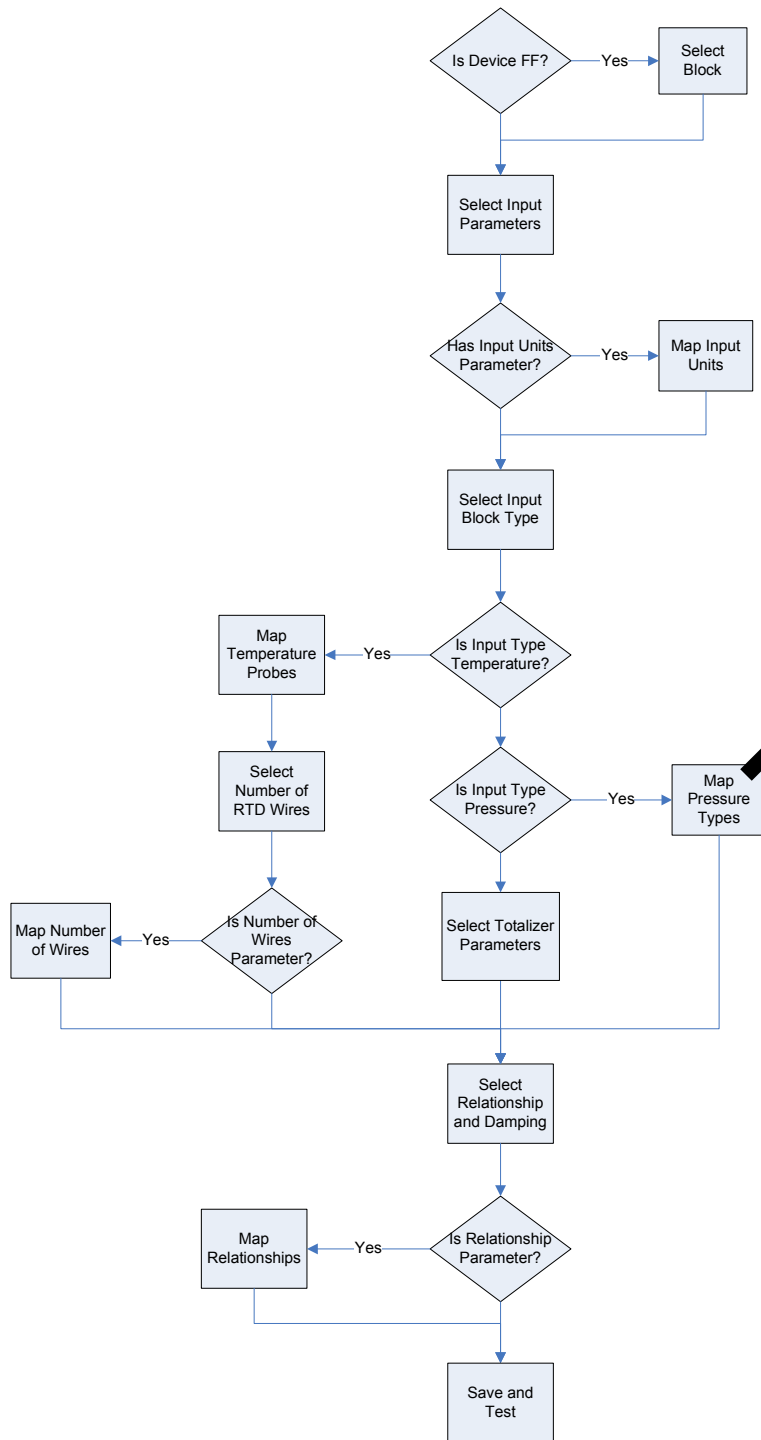
Map Pressure Measurement Types

DDL ProbeType	Code	Map File ProbeType
Diff (DP)	0	Differential
Gage (GP)	1	Gauge
Absolute (AP)	2	Absolute
Hi line pres (HP)	3	High line
Liquid lvl (LT LLT)	4	Liquid level
Draft rng (DR)	5	Draft range
Spcl	253	Not used

Single-Map Auto-Map

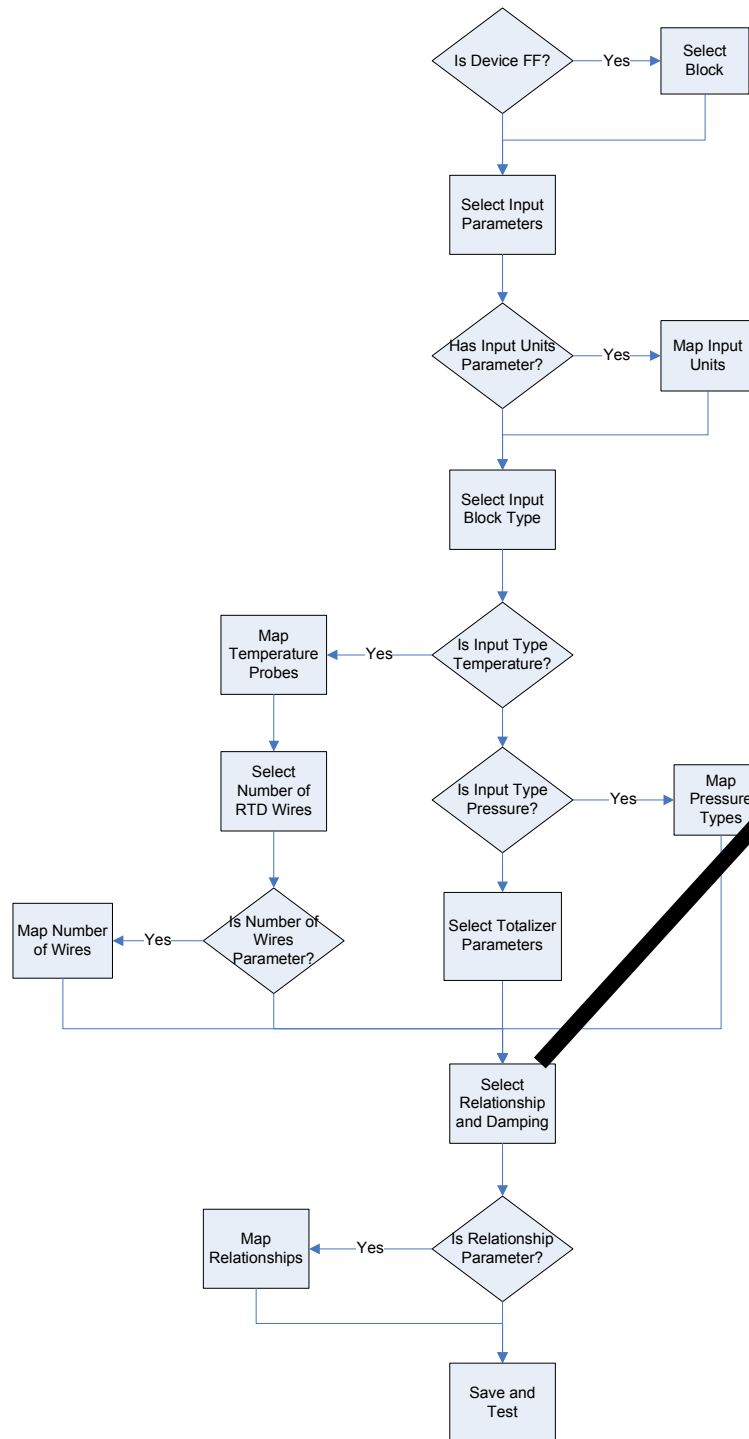
< Back Next > Cancel

Next, Map the pressure types defined in the DD to the defined pressure types. The Auto-Map feature only gets this completely right about 50% of the time.



The “Single-Map” only has a limited amount of standard selections.

Note: HighLine, HTG, DraftRange and LiquidLevel are variations on Gauge pressure (where pressure is used to measure water levels – or is extremely high pressure).



The screenshot shows a software window titled "Input/Output Relationship" with a blue title bar and a close button in the top right corner. The window contains two main sections: "Relationship" and "Damping".

Relationship Section:

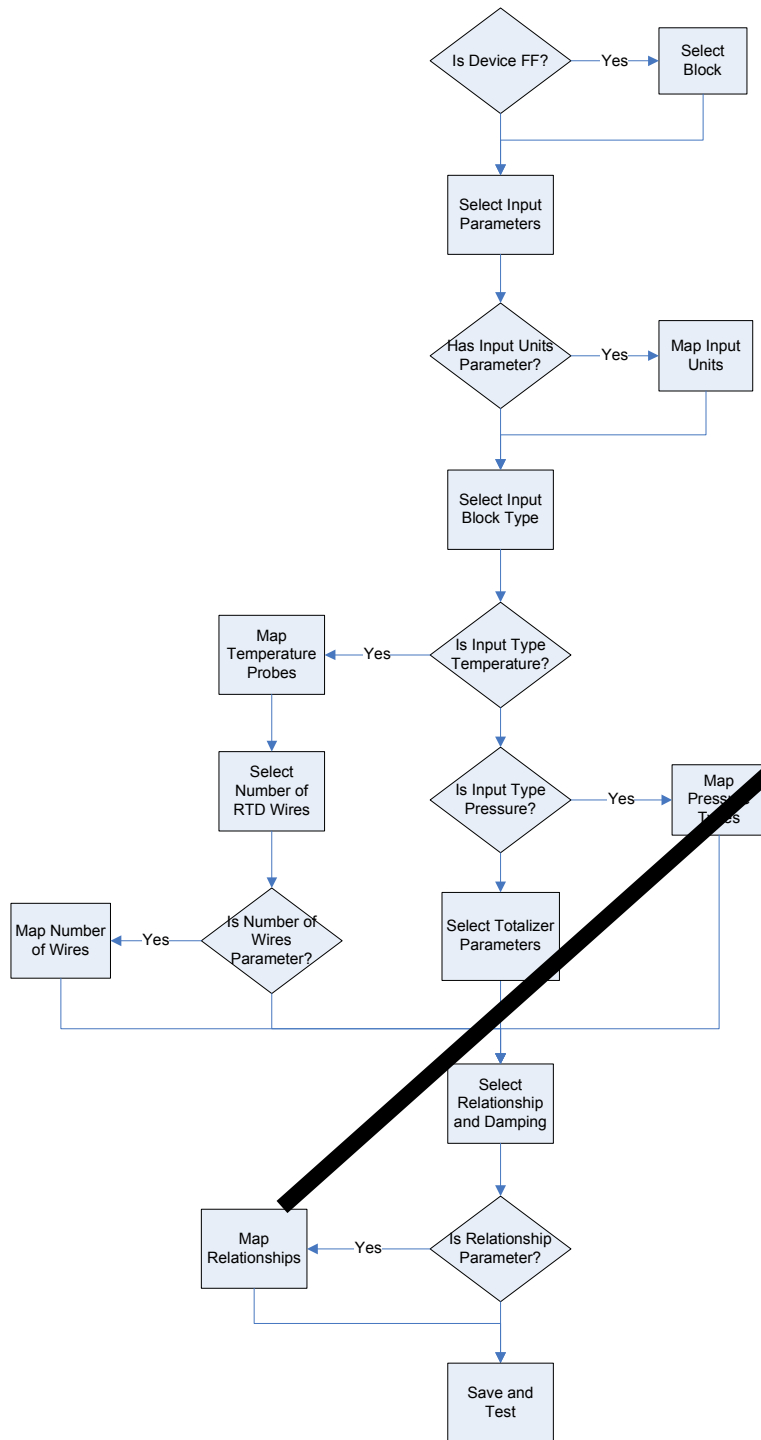
- A text field containing "Param!transfer_function" with a "Browse" button to its right.
- A checkbox labeled "Default To:" followed by a dropdown menu currently showing "Linear".

Damping Section:

- A text field containing "Param!pressureDampingValue" with a "Browse" button to its right.
- A checkbox labeled "Default To:" followed by an empty text field.

At the bottom of the window, there are three buttons: "< Back", "Next >", and "Cancel".

Many HART devices (especially pressure) have multiple transfer-functions or (relationships) between input and output. So it is important to identify a transfer-function parameter. Many pressure transmitters have a square-root-relationship in cases where a pressure transmitter is used to measure flow.



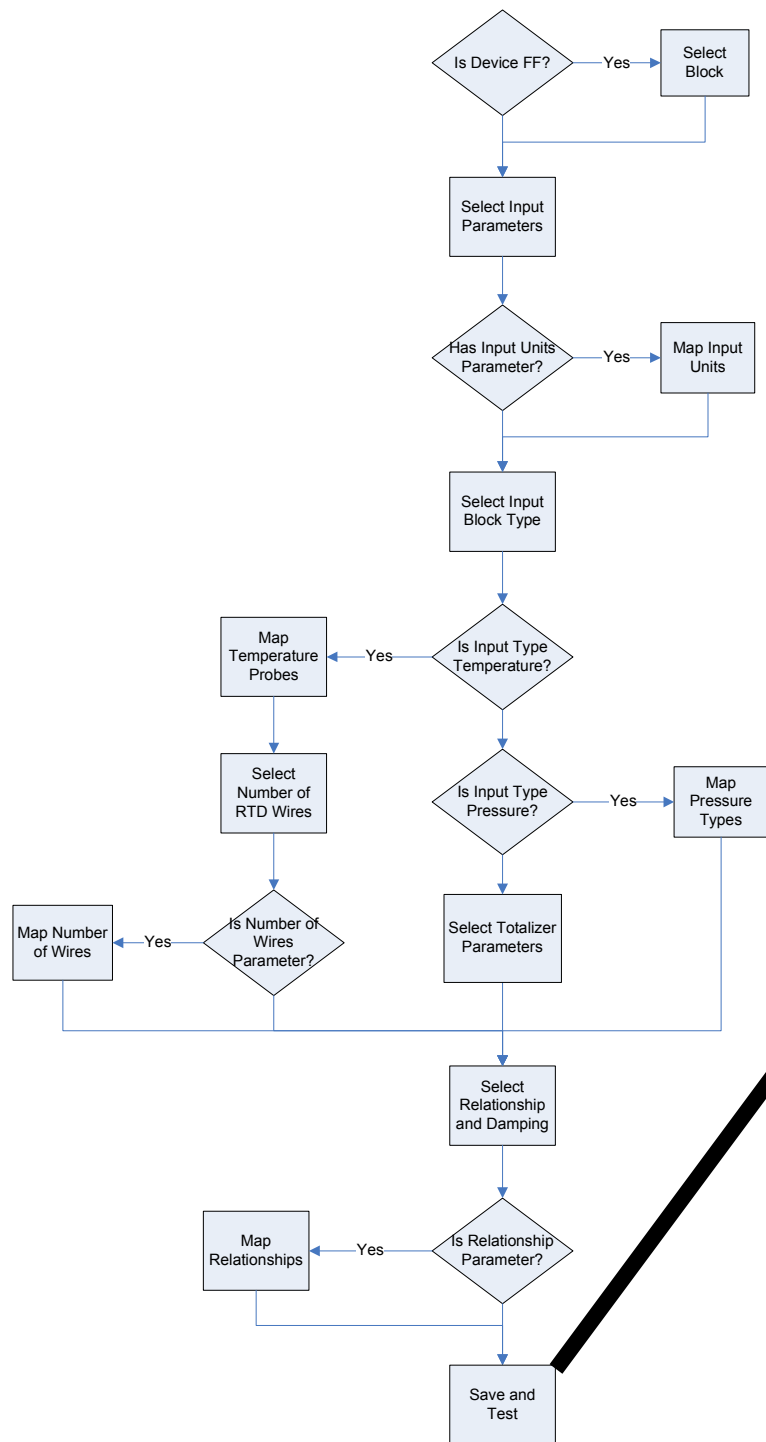
Transfer Function Codes

DDL Relationship	Trans Func Code	Map Relationship Name
Linear	0	Linear
Sq root	1	Square root

Single-Map

< Back Next > Cancel

You need to map the DD values to the standard values.

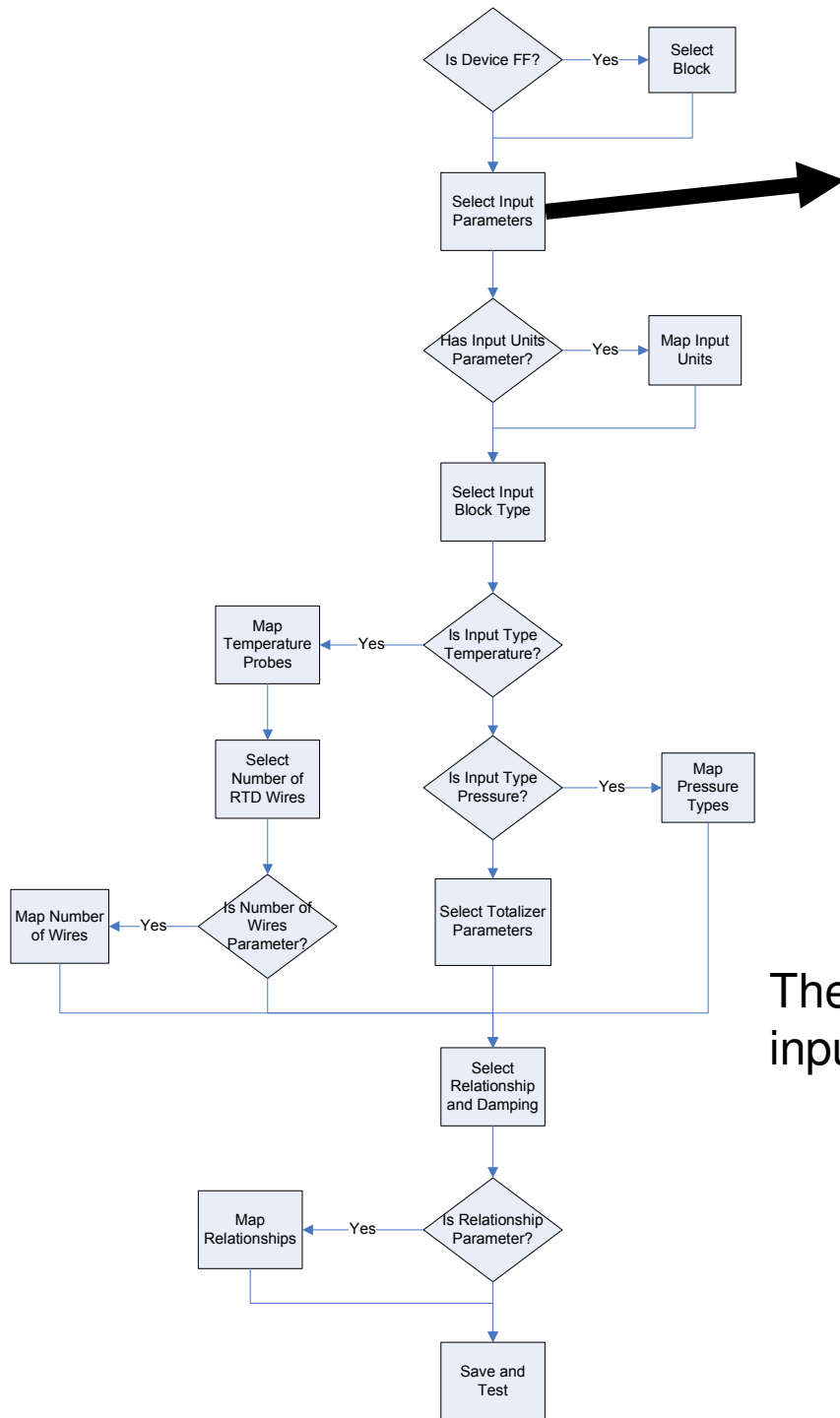


The screenshot shows a window titled "Finished" with a close button (X) in the top right corner. Inside the window, there is a checkbox labeled "Is This Wireless HART?" which is checked. Below this checkbox is a section titled "Map File" containing two buttons: "Write" and "Test". At the bottom of the window, there are three buttons: "< Back", "Finish" (which is highlighted with a dashed border), and "Cancel".

For HART devices there is also the possibility that this is wireless. If it is NOT wireless, the output is 4 – 20 mA. If it is wireless the output is the digital values set in the input page.

Easy map file creation

- We have just covered the two most difficult map files to create: Temperature and Pressure.
- Now step through the easiest case. This is the guaranteed - I just need to get it done solution (I use this for valves and multiplexers, but you could use this for motor controller etc...).

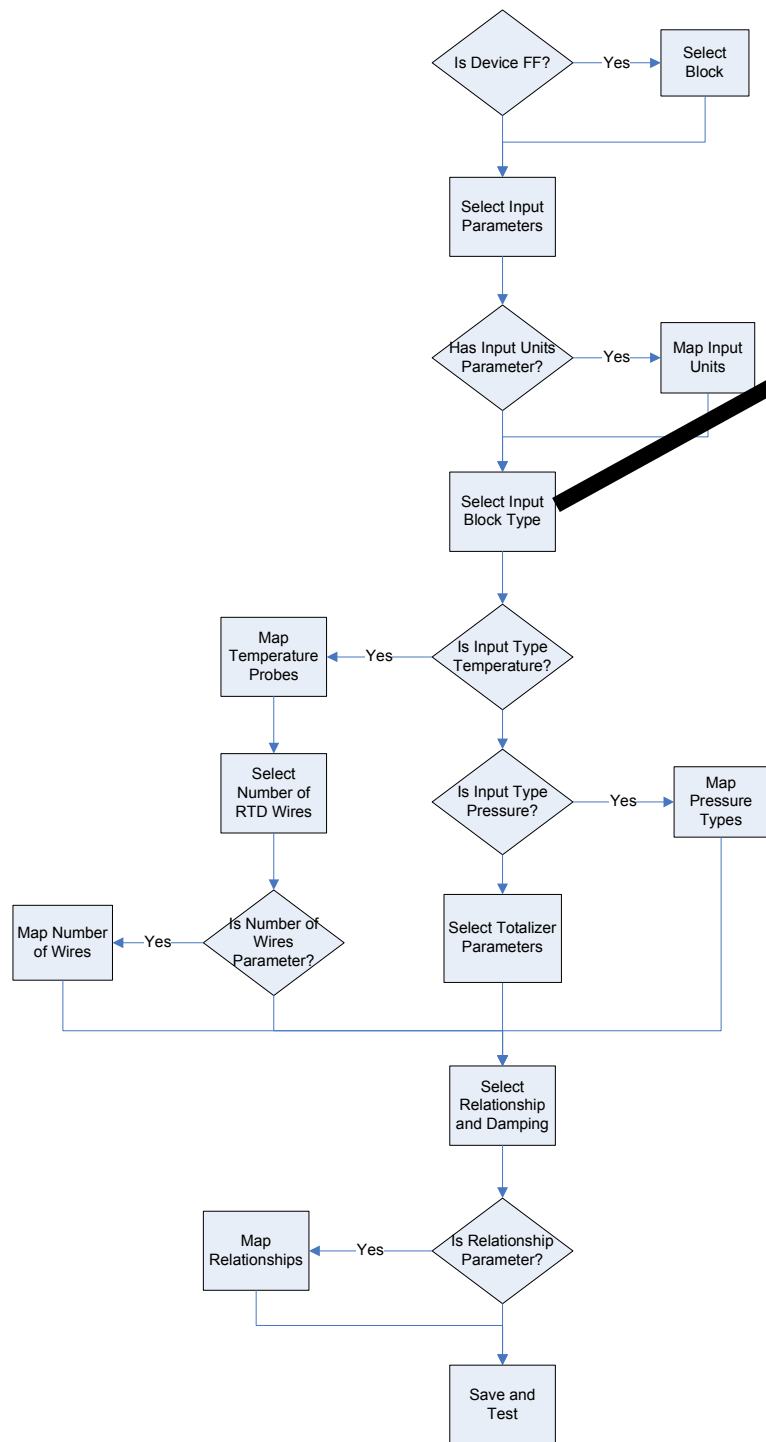


The 'Input Parameters' dialog box is shown. It has a blue title bar with a close button (X). The dialog contains three sections for calibration parameters:

- Calibration Hi point:** A text input field with a 'Browse' button. Below it, a checked checkbox 'Default To:' is followed by a text input field containing '100'.
- Calibration Lo Point:** A text input field with a 'Browse' button. Below it, a checked checkbox 'Default To:' is followed by a text input field containing '0'.
- Calibration Units:** A text input field with a 'Browse' button. Below it, a checked checkbox 'Default To:' is followed by a dropdown menu showing 'Percent'.

At the bottom of the dialog, there are three buttons: '< Back', 'Next >', and 'Cancel'.

The Dirt simple solution is just to hard code the input to be 0 – 100 %



Input Block Type

Unknown

☒ Generic (ie not temperature or pressure)

☐ Pressure

Pressure Type Parameter (Gage, Absolute, differential)

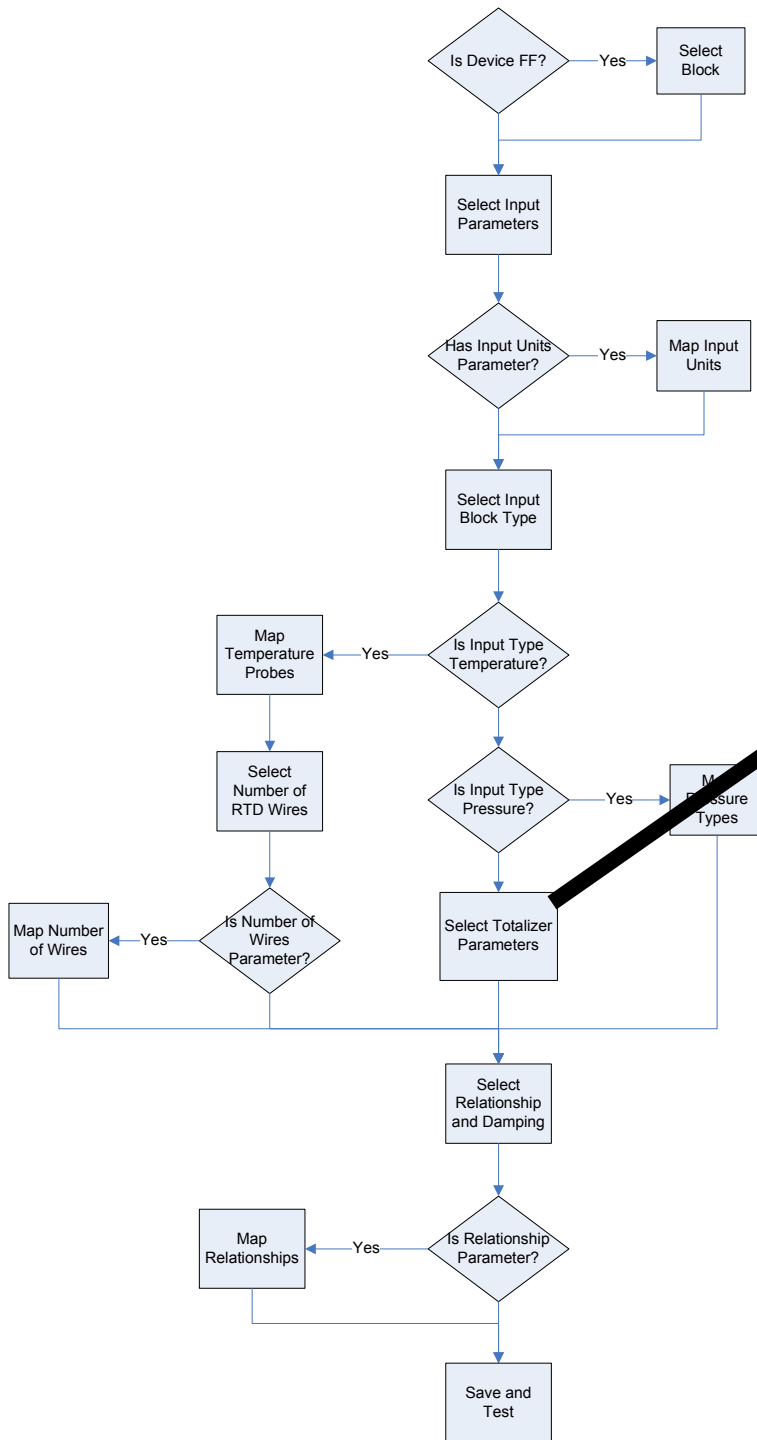
☐ Use Default:

☐ Temperature

Temperature Probe parameter (PT-100, TC-J etc...)

< Back Next > Cancel

Select Generic for the input type.



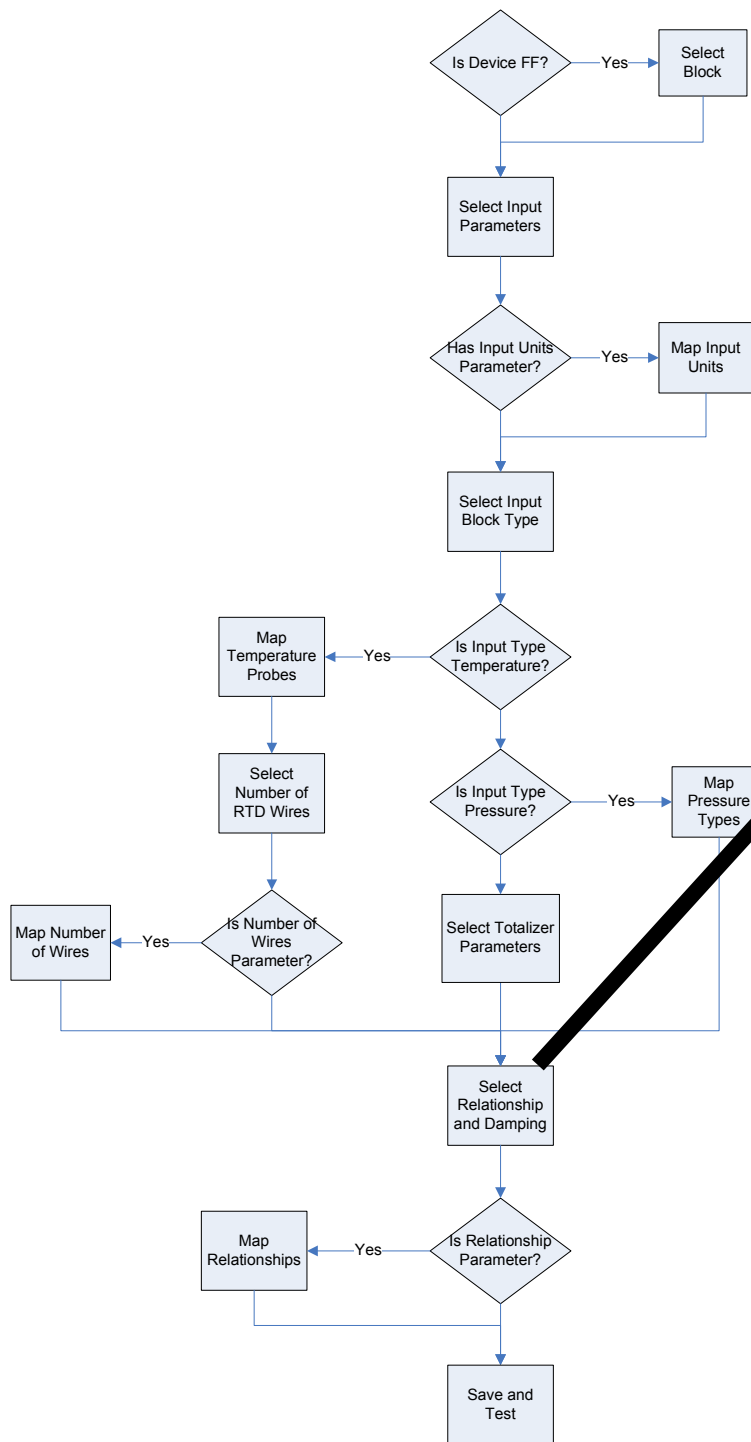
Totalizer Parameters

☐ Check this box if this device supports totaled flow!

Totalizer Units

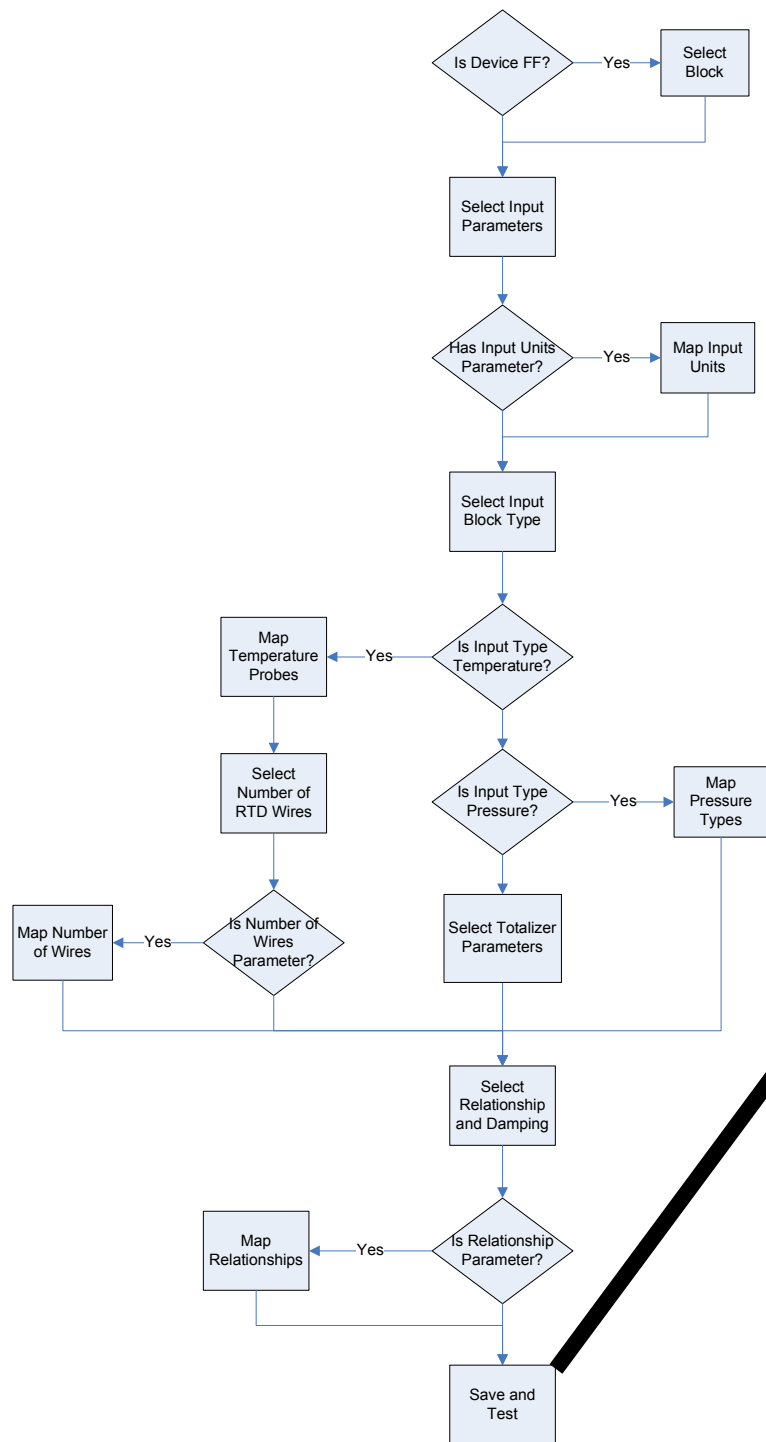
Totalizer Value

Don't bother with the totalizer.



The screenshot shows the 'Input/Output Relationship' dialog box. It has a blue title bar with a close button. The dialog is divided into two main sections: 'Relationship' and 'Damping'. In the 'Relationship' section, there is a text input field, a 'Browse' button, and a checked checkbox labeled 'Default To:' followed by a dropdown menu showing 'Linear'. In the 'Damping' section, there is another text input field, a 'Browse' button, and a checked checkbox labeled 'Default To:' followed by a text input field containing the value '1'. At the bottom right, there are three buttons: '< Back', 'Next >', and 'Cancel'.

Default to linear and 1 second of damping.



The 'Finished' dialog box has a blue title bar with a close button. The main area is light beige. It contains a checked checkbox labeled 'Is This Wireless HART?'. Below this is a 'Map File' section with a white background, containing 'Write' and 'Test' buttons. At the bottom, there are three buttons: '< Back', 'Finish' (highlighted with a dashed border), and 'Cancel'.

This will save a map file where the input is 0 – 100 % with an output of... (HART 4 – 20 mA; wireless HART 0 -100 %; FF 0 – 100%).

The input and output are directly related (i.e. a Linear relationship).

One last (Flow Specific) set of screens

- If the device is “Generic” it could be either a Valve, Analytical, or Flow
- In the case of Flow Transmitters we can run an additional calibration test – Flow Verifications
- A Flow Verification uses the totalizer parameter.

What is a Totalizer?

- Most flow transmitters keep a running count of the flow that it measures.
- This means that there is a number that represents the total volume (or mass) that has passed through the flow sensor since a given point in time:

$$1 \text{ gal/min} * 4 \text{ minutes} = 4 \text{ gal}$$

Flow Transmitters can have totalizer parameters

Totalizer Parameters

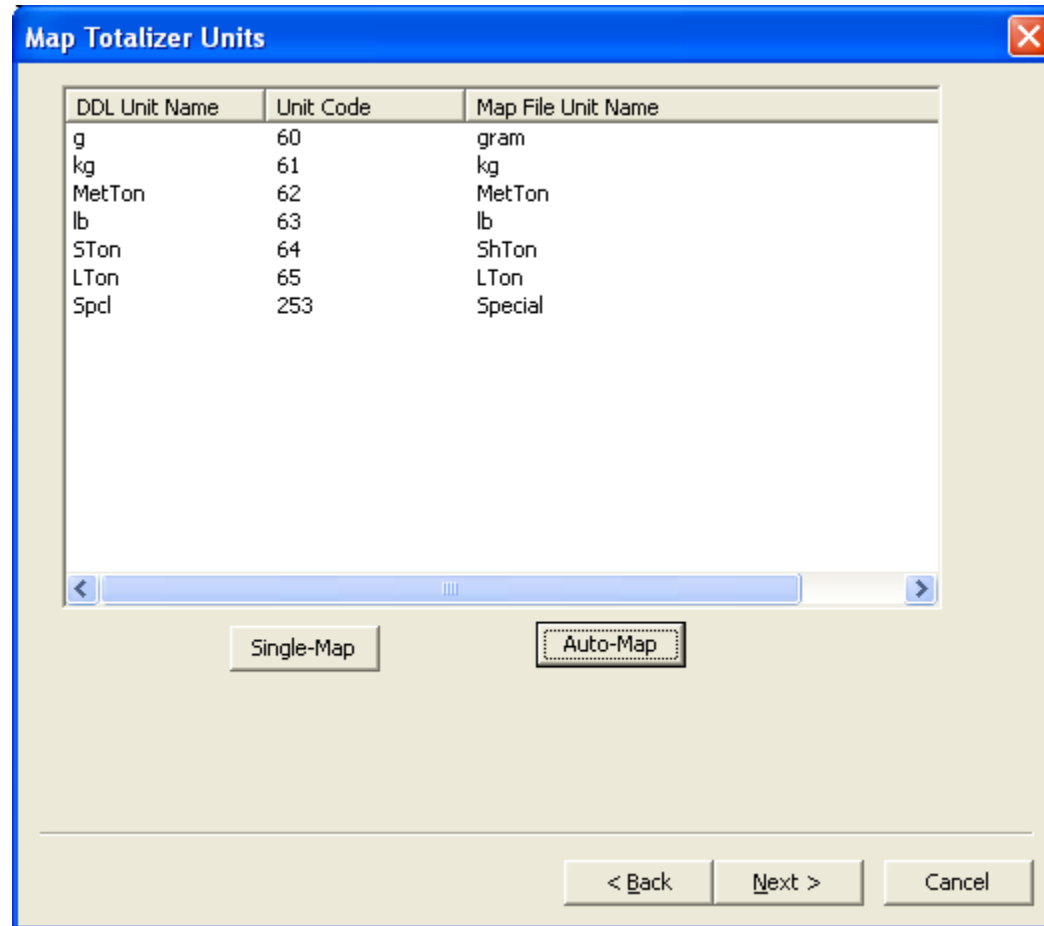
☒ Check this box if this device supports totaled flow

Totalizer Units
Param!mtot_digital_units

Totalizer Value
Param!mtot_digital_value

< Back Next > Cancel

Mass Totals or Volume Totals



The image shows a software dialog box titled "Map Totalizer Units". It contains a table with three columns: "DDL Unit Name", "Unit Code", and "Map File Unit Name". The table lists several units: g (60, gram), kg (61, kg), MetTon (62, MetTon), lb (63, lb), STon (64, ShTon), LTon (65, LTon), and Spcl (253, Special). Below the table is a horizontal scrollbar. At the bottom of the dialog, there are three buttons: "Single-Map", "Auto-Map" (which is highlighted with a dashed border), and "< Back", "Next >", "Cancel".

DDL Unit Name	Unit Code	Map File Unit Name
g	60	gram
kg	61	kg
MetTon	62	MetTon
lb	63	lb
STon	64	ShTon
LTon	65	LTon
Spcl	253	Special

Single-Map Auto-Map

< Back Next > Cancel