ABB MEASUREMENT & ANALYTICS | USER GUIDE

C1300

Advanced circular chart recorder

User Guide supplement

Advanced software options

Measurement made easy

—

C1300 advanced circular chart recorder

For more information

Further publications are available for free download from:

www.abb.com/measurement

or by scanning this code:

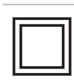
	Search for or click on
C1300 Advanced circular chart recorder Datasheet	DS/C1300-EN
C1300 Advanced circular chart recorder User Guide	IM/C1300
C1300 Advanced circular chart recorder User Guide supplement Modbus communications option	IM/C1300-MOD

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

One or more of the following symbols may appear on the equipment labelling:

	**Warning** – refer to the manual for instructions
	**Caution** – risk of electric shock
	Protective earth (ground) terminal
	Earth (ground) terminal
	Direct current supply only
	Alternating current supply only
	Both direct and alternating current supply
	The equipment is protected through double insulation

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

- The relevant sections of these instructions must be read carefully before proceeding.
- Warning labels on containers and packages must be observed.
- Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
- Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
- Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
- When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

Contents

1 Introduction **2**

2 Math Configuration **3**
2.1 Introduction 3
2.1.1 Standard Math Block 3
2.1.2 Relative Humidity (RH) 4
2.1.3 Mass Flow 1 and 2 4
2.1.4 Maximum and Minimum Value 7
2.1.5 Real Time Average 7
2.2 Configure Math Block 8
2.2.1 Configure Standard Math Block 9
2.2.2 Configure Relative Humidity Math Block 10
2.2.3 Configure Mass Flow Math Block 11
2.2.4 Configure High and Low Value Math Block 13
2.2.5 Configure Average Math Block 13
2.2.6 Configure Constant 14

3 Timers Configuration **15**
3.1 Configure Timer 15

Appendix A – Signal Sources **19**

Notes **20**

1 Introduction

This supplement provides additional information for the advanced software options:

- Math Functions
- Timer Functions

2 Math Configuration

2.1 Introduction

Overview.

- **Four user-configurable math blocks** – can be used independently or cascaded together.
- **Each math block can be configured to perform one of seven functions**:
  - **Standard math block (arithmetic operations)** – add, subtract, divide, multiply, high select, low select and median
  - **Relative humidity (RH)** – from wet and dry bulb sensor temperature
  - **Mass flow 1** – calculation of mass flow from volume
  - **Mass flow 2** – calculation of mass flow from differential pressure
  - **High value** – holds the maximum value measured on an input variable
  - **Low value** – holds the minimum value measured on an input variable
  - **Real time average** – averages a continually varying input over a set period of time.
- **Inputs can be either variables or constants**.

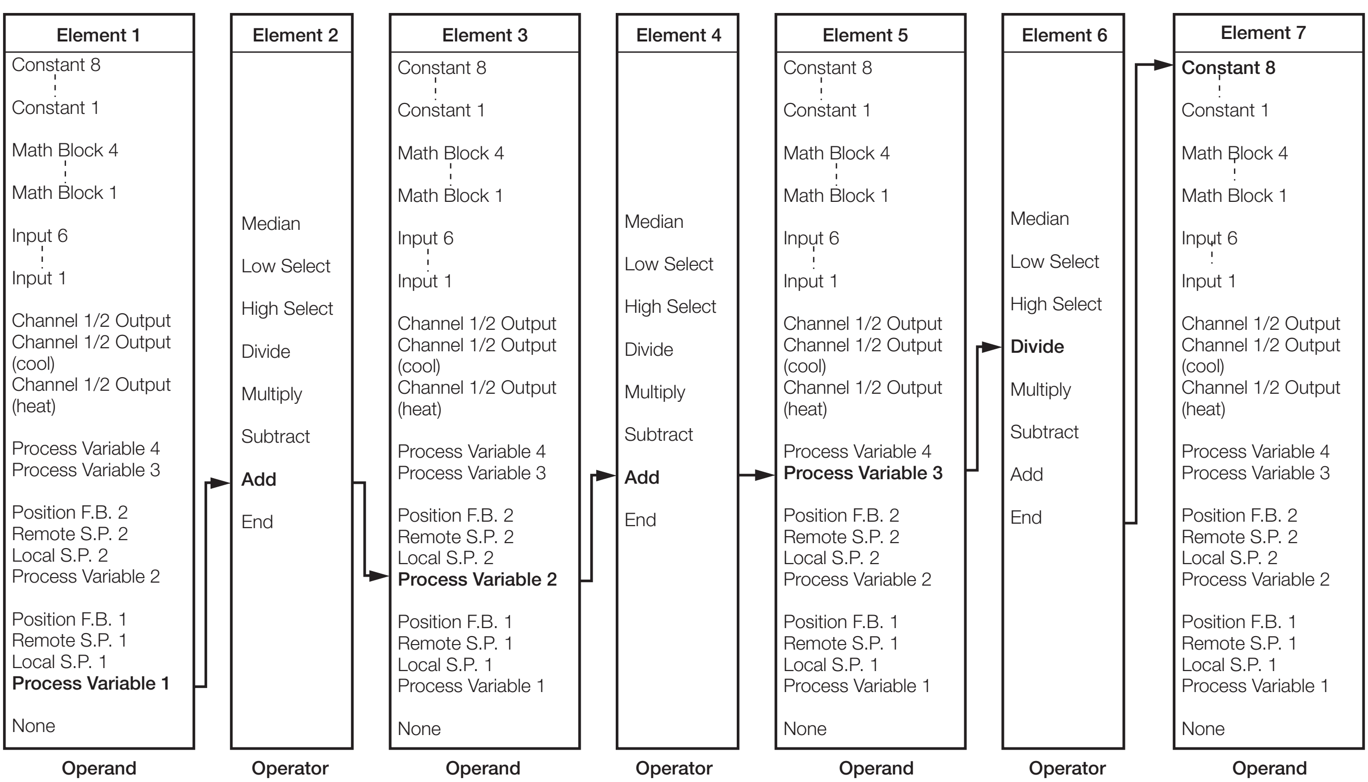
2.1.1 Standard Math Block

There are four programmable math blocks. Each math block is constructed using up to four operands and three operators. The four operands can be configured as process variable inputs, set points, constants or other math results. The three operators can be configured for addition, subtraction, multiplication, division, high value selection, low value selection, median (mid-value selection) or end math block.

> **Note.** The elements in each equation are calculated sequentially. It is therefore important to enter the elements in the correct order to obtain the result required e.g. 2 + 3 x 4 = 20 (Not14). If median is selected as element 2, element 4 automatically becomes median and element 6 automatically becomes end.

The example below shows the construction of a math block for the following equation:

$$\frac{(PV1 + PV2 + PV3)}{\text{Constant 8}}$$



2.1.2 Relative Humidity (RH)

The relative humidity calculation requires two inputs, one from a wet-bulb sensor and one from a dry-bulb sensor. Both of these inputs are configured as variables. RH tables are based on the use of an aspirated psychrometer having an air velocity of at least 11.5 feet per second or 3.5 meters per second across the bulb sensors.

Note. Inputs used for wet- and dry-bulb measurement must be in the range 0 to 100°C (32 to 212°F).

2.1.3 Mass Flow 1 and 2

The two types of mass flow calculations available are as follows:

Mass Flow 1 – applications where a volumetric flow meter is used to measure flow.

Mass Flow 2 – applications where a differential pressure transmitter is used to measure flow.

The standard formula for mass flow 1 is as follows:

$$M = k\ V\frac{P}{T}\ \frac{T_r}{P_r}$$

where:

k = Scaling constant
V = Input a (input from volume flow source)
P = Pressure (pressure input source)
T = Temperature (temperature input source)
T_r = Reference temperature (for the scaling constant used)
P_r = Reference pressure (for the scaling constant used)

The temperature units used by the input source must be specified, since all calculations use absolute temperatures and conversion is made if the input uses °C (or °F).

The standard formula for mass flow 2 is as follows:

$$M = k\sqrt{\frac{h\,P\,T_r}{T\,P_r}}$$

where:

h = differential pressure head

Some differential pressure transmitters incorporate a square root linearizer and therefore produce an output linear to flow. In this instance, no additional linearization within the C1300 is required and the relevant **Linearizer Type** must be set to **None** – see Section 3.5 of the C1300 User Guide (*IM/C1300*).

Therefore the formula used internally within the C1300 is:

$$M = k\ a\sqrt{\frac{P}{T}\ \frac{T_r}{P_r}}$$

where:

a = linearized flow signal

The linearized flow signal is produced by the transmitter or derived from the signal linearized within the C1300.

Example A – calculating the mass flow of water from the volume flow.

At a temperature of 60°F (520°R) and an absolute pressure of 14.696 psia, 1 gallon (US) of water has a mass of 8.334 lbs.

To calculate the mass flow of water from the volume flow the following settings are used:

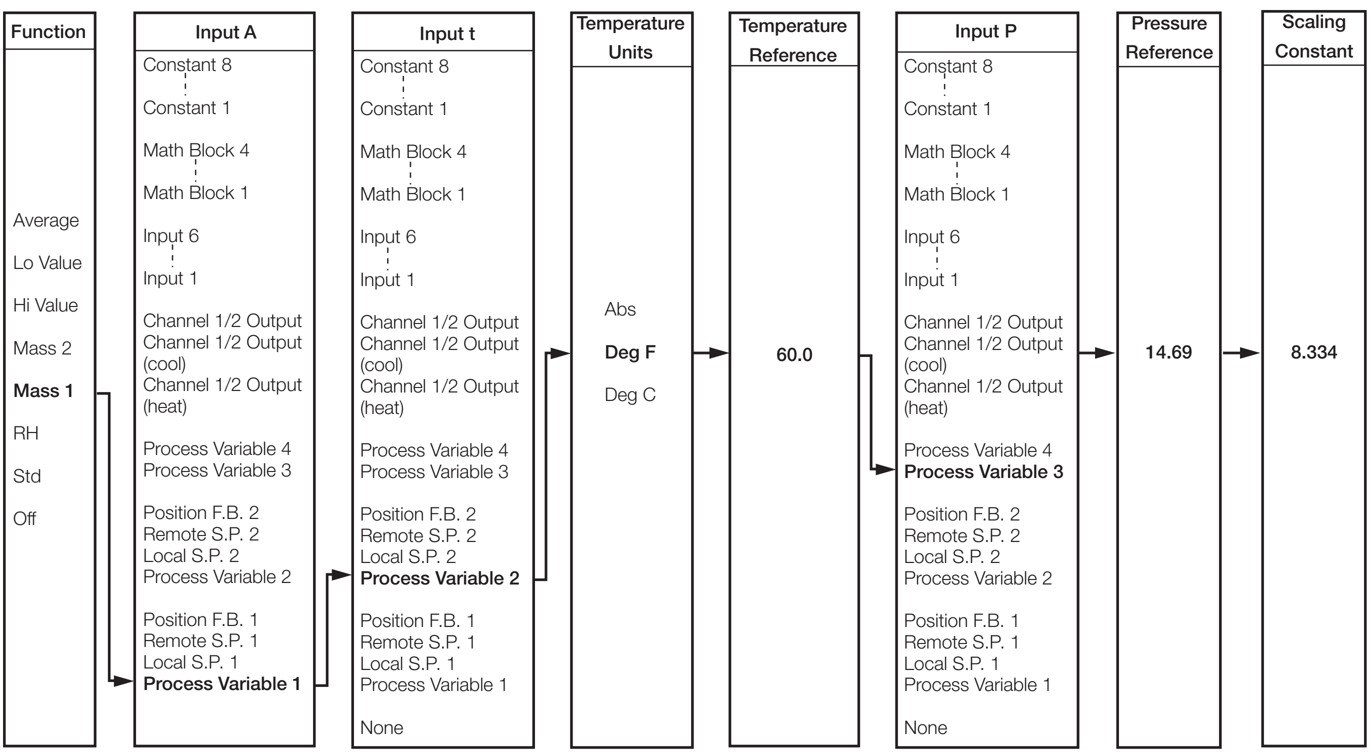
PV1 – volume flow of water (gal/min)
PV2 – temperature of water (°F)
PV3 – pressure of water (psia.)
PV4 – result of math block 1 (lb/min)

therefore the equation is:

$$\text{M (lb/min)} = 8.334 \times \text{Volume (gal/min)} \times \frac{\text{measured pressure (psia)}}{\text{14.69 (psia)}} \times \frac{(460 + 60)°\text{R}}{\text{measured temperature °R}}$$

The example below shows the construction of Math block 1 with the following selected:

- math block function – **Mass 1**
- input A source – **Process Variable 1**
- input t source – **Process Variable 2**
- temperature units – **Deg F**
- temperature reference (process conditions using maximum flow rate) – **60.0**
- input P source – **Process Variable 3**
- pressure reference (process conditions using maximum flow rate) – **14.69**
- scaling constant – **8.334**



Note.

- Ensure that the temperature input/temperature reference have the same units and the pressure input/pressure reference have the same absolute units.
- The basic mass flow equation must use absolute temperatures (K or °R). The C1300 converts automatically from °C or °F to absolute.
- If temperature or pressure correction is not required, set the temperature or pressure inputs to **None** – see Section 2.2.3, page 11.

Example B – calculating the mass flow of water from the volume flow.

At a temperature of 15.6°C (288.6K) and an absolute pressure of 1013.25 mbar, 1 liter of water has a mass of 1kg.

To calculate the mass flow of water from the volume flow the following settings are used:

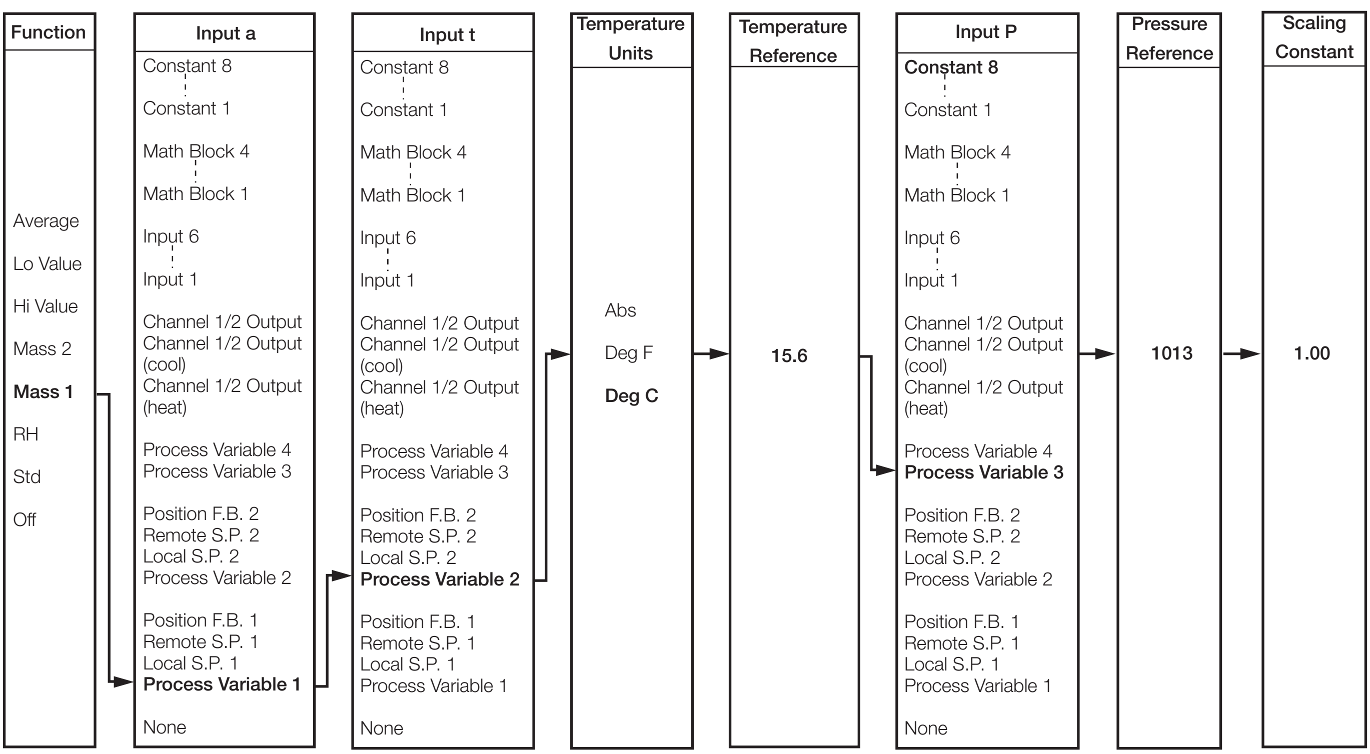
PV1 – volume flow of water (liters/min)
PV2 – temperature of water (°C)
PV3 – pressure of water (mbar (abs))
PV4 – result of math block 1 (kg/min)

therefore the equation is:

$$\text{M (kg/min)} = 1 \times \text{Volume (liters/min)} \times \frac{\text{measured pressure (mbar)}}{\text{1013.25 mbar}} \times \frac{\text{288.6K}}{\text{measured temperature K}}$$

The example below shows the construction of Math block 1 with the following selected:

- math block function – **Mass 1**
- input A source – **Process Variable 1**
- input t source – **Process Variable 2**
- temperature units – **Deg C**
- temperature reference (process conditions using maximum flow rate) – **15.6**
- input P source – **Process Variable 3**
- pressure reference (process conditions using maximum flow rate) – **1013**
- scaling constant – **1.000**



Note.

- Ensure that the temperature input/temperature reference have the same units and the pressure input/pressure reference have the same absolute units.
- The basic mass flow equation must use absolute temperatures (K or °R). The C1300 converts automatically from °C or °F to absolute.
- If temperature or pressure correction is not required, set the temperature or pressure inputs to **None** – see Section 2.2.3, page 11.

2.1.4 Maximum and Minimum Value

If the High Value function is selected the math result holds the **maximum** value measured on an input variable. If the Low Value function is selected the math result holds the **minimum** value measured on an input variable. The math result can be reset to its current value by an internal or external digital signal.

Fig. 2.1 shows the process variable from a flow meter that is varying continually with time. The maximum and minimum values are the highest and the lowest samples taken since an external reset last occurred. The external reset can be independent of the average reset signal.

2.1.5 Real Time Average

The real time average function averages a continually varying input over a set time scale, between 1 and 1440 minutes (24 hours). Any process variable, remote set point or other math block result can be averaged. The math result can be reset to its current value by an internal or external signal.

Fig. 2.1 shows the process variable from a flow meter that is varying continually with time. At 0 minutes an external digital input signal resets the average to the current value measured. The process variable is then sampled for 10 minutes. The average function result is the average value of the process variable over the 10 minutes sampled.

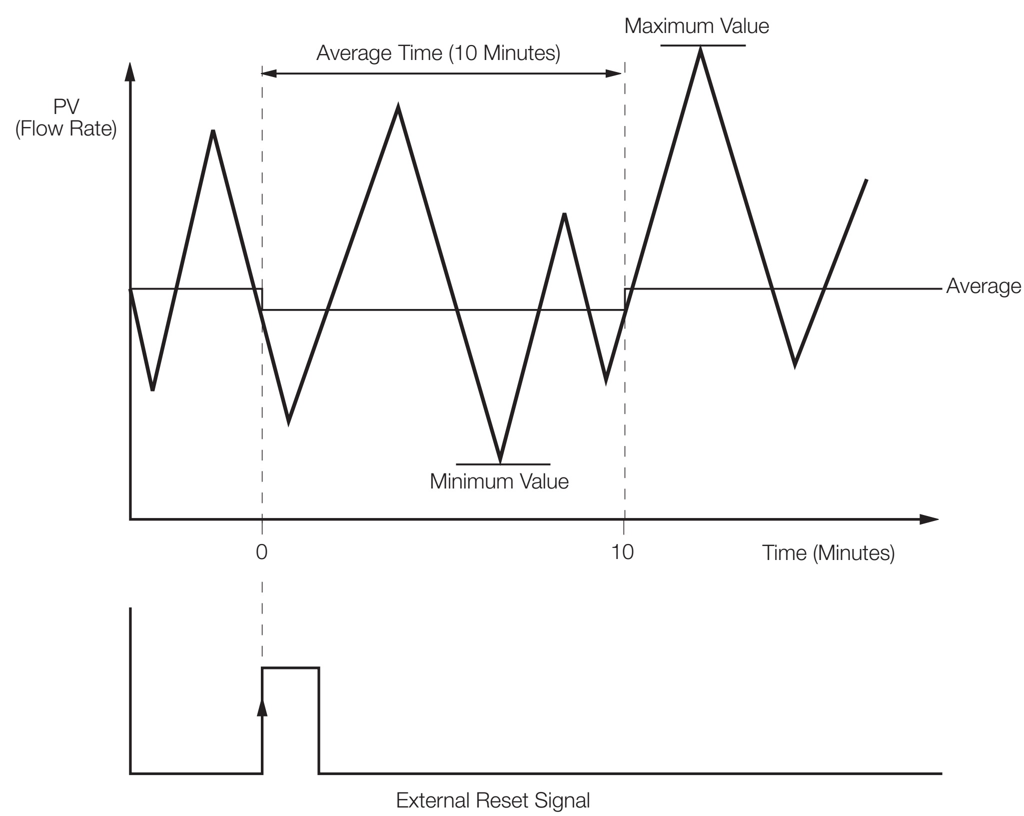
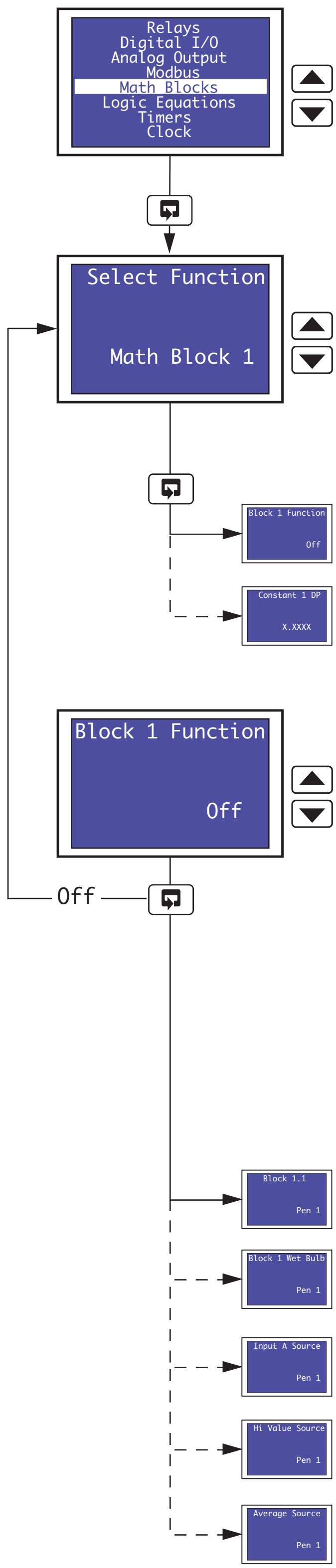


Fig. 2.1 Example of Average, Maximum and Minimum Functions

2.2 Configure Math Block



Channels Configuration

Press the key to open the **Main Menu**.

Highlight **Math Blocks**.

Select Function

Select the math block or constant to be configured:

- `Math Block 1 to 4` – Math block 1 to 4
- `Constant 1 to 8` – Constant 1 to 8, arithmetic value used as multiplier/divisor or for addition/subtraction

Math Block (1 to 4) selected – continued below.

Constant (1 to 8) selected – see Section 2.2.6, page 14.

Math Block Function

Select the math block function required:

- `Off` – Math function not selected
- `Standard` – Standard math block
- `RH` – Relative humidity calculation
- `Mass Flow 1` – Calculates mass flow from volume flow
- `Mass Flow 2` – Calculates mass flow from differential pressure
- `High Value` – Holds maximum value measured on input variable
- `Low Value` – Holds minimum value measured on input variable
- `Average` – Averages a continually varying input over a set period of time

Standard selected – see Section 2.2.1, page 9.

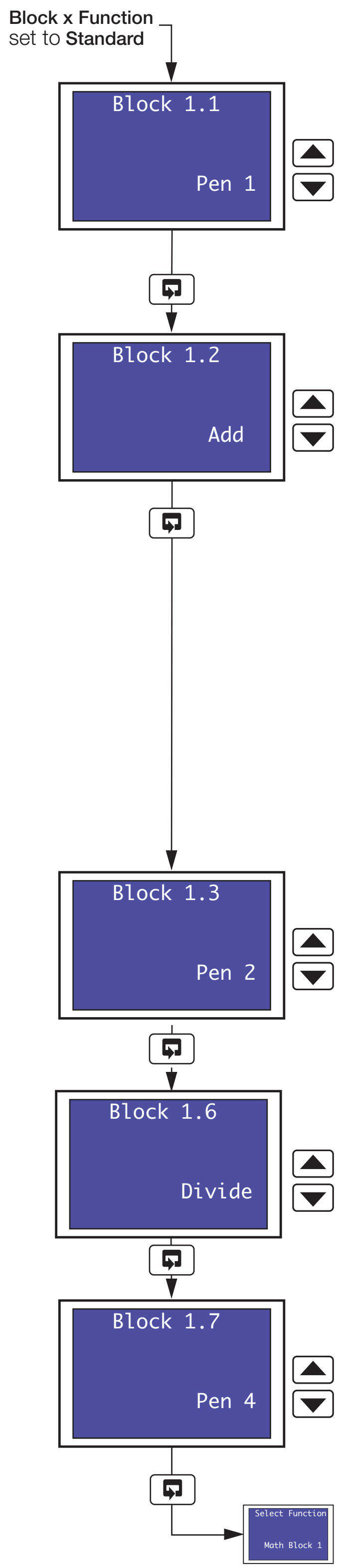
RH selected – see Section 2.2.2, page 10.

Mass Flow 1 or **Mass Flow 2** selected – see Section 2.2.3, page 11.

High Value or **Low Value** selected – see Section 2.2.4, page 13.

Average selected – see Section 2.2.5, page 13.

2.2.1 Configure Standard Math Block



Math Block x.Element 1 (Operand 1)

Select the source required for element 1.

For description of sources, refer to APPENDIX A.

Math Block x.Element 2 (Operator 1)

Select the operator required for element 2:

- `End` – select to end math block if seven elements are not required
- `Add` – add
- `Subtract` – subtract
- `Multiply` – multiply
- `Divide` – divide
- `High Select` – high select
- `Low Select` – low select
- `Median Sel` – median select

Note. If **Median Sel** is selected for element 2, elements 4 and 6 are set automatically to **Median Sel** and **End** respectively.

Math Block x.Element 3 (Operand 2)

Select the source required for element 3.

Math Block x.Element 6 (Operator 3)

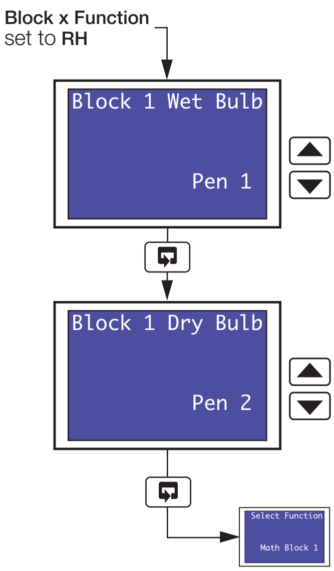
Select the operator required for element 6.

Math Block x.Element 7 (Operand 4)

Select the source required for element 7.

see Section 2.2, page 8.

2.2.2 Configure Relative Humidity Math Block



Wet-bulb Input

Select the source required for wet-bulb input.

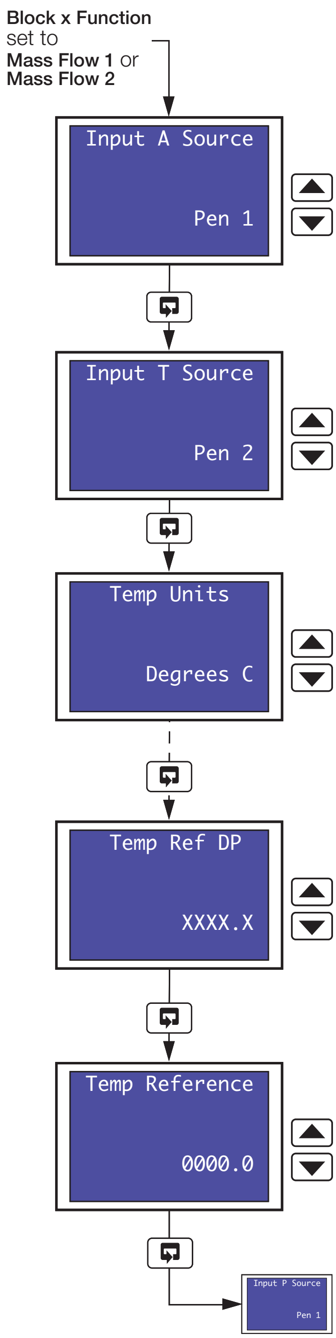
For description of sources, refer to APPENDIX A.

Dry-bulb Input

Select the source required for dry-bulb input.

see Section 2.2, page 8.

2.2.3 Configure Mass Flow Math Block



Mass Flow 1 or 2 Input

Select the source required for input A (input A is the input from volume flow or differential pressure).

For description of sources, refer to APPENDIX A.

Temperature Input

Select the source required for the temperature input.

Temperature Units

Select the input source temperature units:

- `Degrees C` – temperature input source measured in °C
- `Degrees F` – temperature input source measured in °F
- `Absolute` – temperature input source measured in degrees absolute (°K or °R)

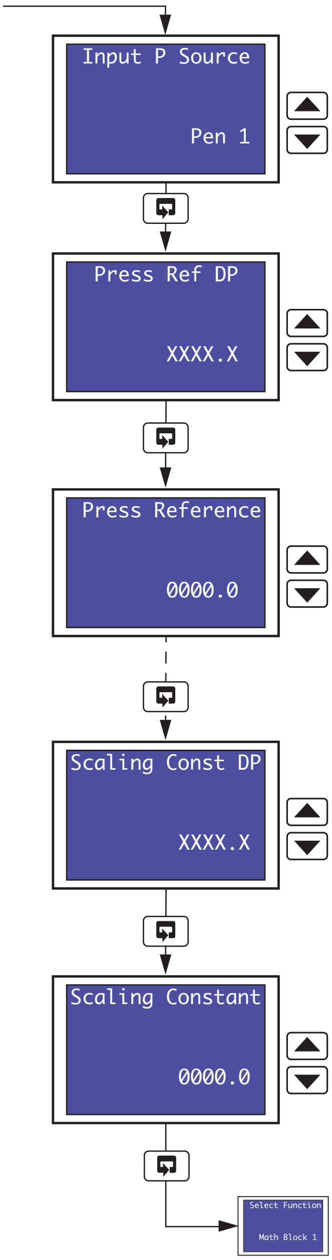
Reference Temperature Decimal Point

Set the number of decimal places required for the reference temperature below, between 0 and 3 places.

Reference Temperature

Set the value that represents the reference temperature, between 0 and +9999.

Continued on next page.



Pressure Input

Select the source required for the pressure input.

For description of sources, refer to APPENDIX A.

Reference Pressure Decimal Point

Set the number of decimal places required for the reference pressure below, between 0 and 3 places.

Reference Pressure

Set the value that represents the reference pressure, between 0 and +9999.

Scaling Constant Decimal Point

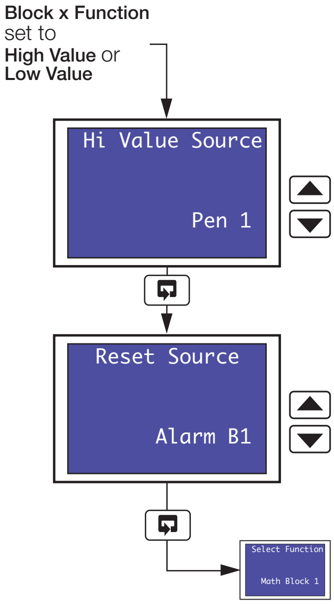
Set the number of decimal places required for the scaling constant (k) below, between 0 and 3 places.

Scaling Constant

Set the value that represents the scaling constant (k), between 0.00 and +99.99.

see Section 2.2, page 8.

2.2.4 Configure High and Low Value Math Block



High (or Low) Value Source

Select the source whose minimum or maximum value is to be detected.

For description of sources, refer to APPENDIX A.

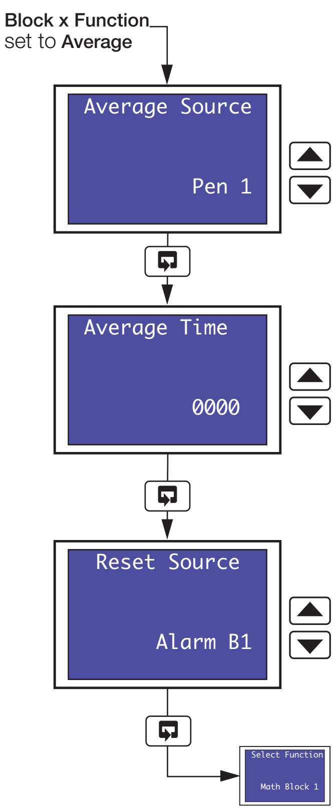
Reset High/Low Input

Select the digital source required to reset the minimum or maximum value.

For description of sources, refer to APPENDIX A.

see Section 2.2, page 8.

2.2.5 Configure Average Math Block



Averaging Input

Select the input which is to be averaged.

For description of sources, refer to APPENDIX A.

Time Scale

Set the time scale interval over which the input is to be averaged, between 1 and 1440 minutes (24 hours).

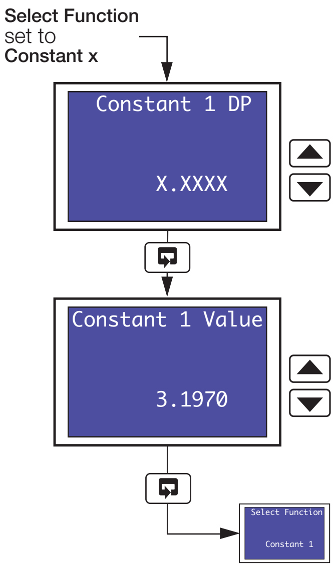
Reset Average Source

Select the digital source required to reset the average value to the present input value.

The reset is leading edge triggered.

see Section 2.2, page 8.

2.2.6 Configure Constant



Constant Decimal Point

Set the number of decimal places required for the constant value, between 0 and 4 places.

Constant Value

Set a value for the constant, between –99999 and 99999.

see Section 2.2, page 8.

3 Timers Configuration

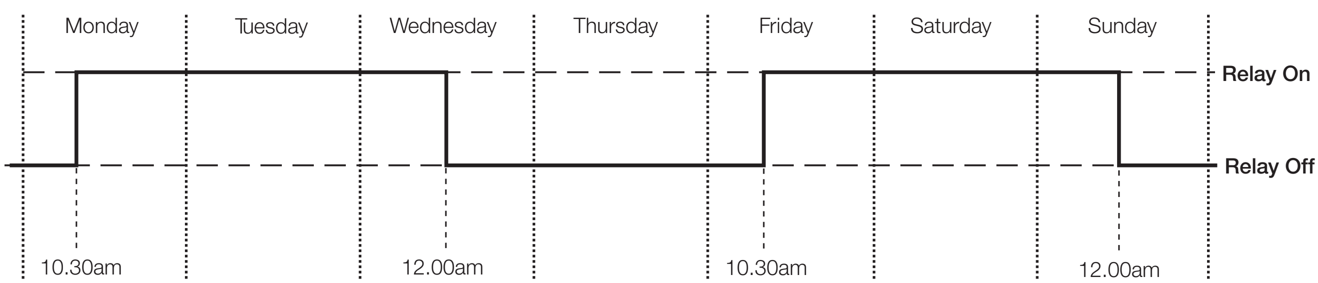
3.1 Configure Timer

Overview.

- **Two timers available**.
- **'ON' duration of 1 minute to 167 hours 59 minutes (1 week)**.
- **Programmable Timers** – can operate on specific days, hours or minutes for an exact period of time.
- **Timer 'ON/OFF' states** – can be used to energize relay outputs, acknowledge alarms, stop the chart, select auto/manual control modes and local/remote set points, in logic calculations, start/stop/reset totalizers, reset math results or run/hold/reset profile programs/segments.

Example A – setting up timer:

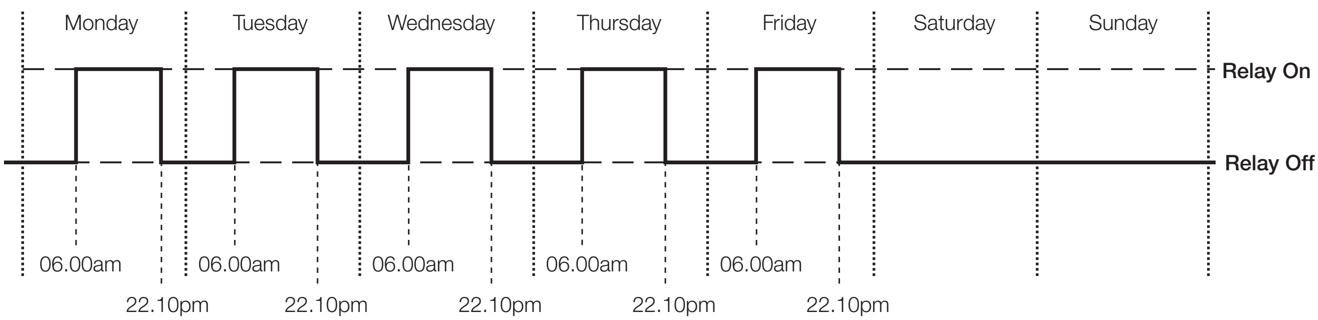
- Monday enabled
- Tuesday disabled
- Wednesday disabled
- Thursday disabled
- Friday enabled
- Saturday disabled
- Sunday disabled
- on hour set to 10.00am
- on minute set to 30 minutes
- duration in hours set to 49 hours
- duration in minutes set to 30 minutes



Example A – shows timer option programmed to energize relay output for 49 hours 30 minutes over a two day period

Example B – setting up timer:

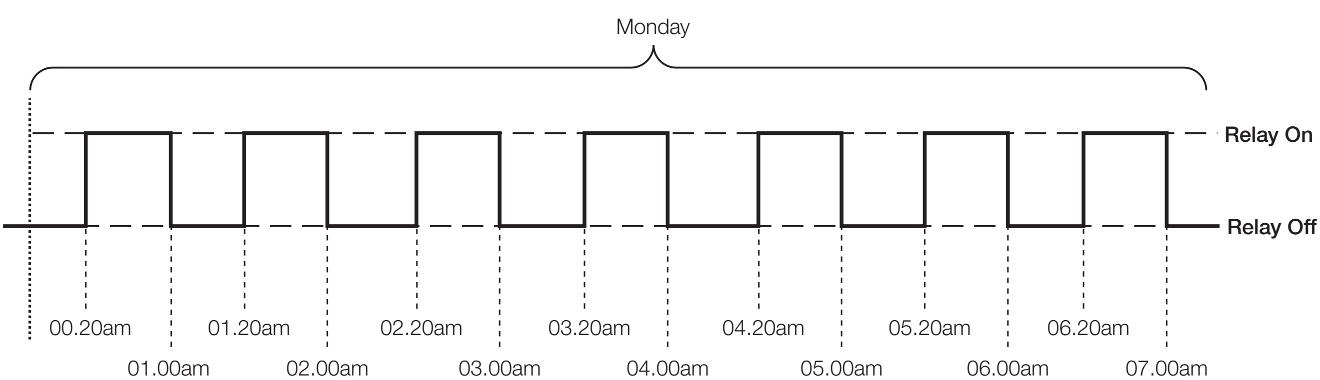
- Monday enabled
- Tuesday enabled
- Wednesday enabled
- Thursday enabled
- Friday enabled
- Saturday disabled
- Sunday disabled
- on hour set to 06.00am
- on minute set to 0 minutes
- duration in hours set to 16 hours
- duration in minutes set to 10 minutes



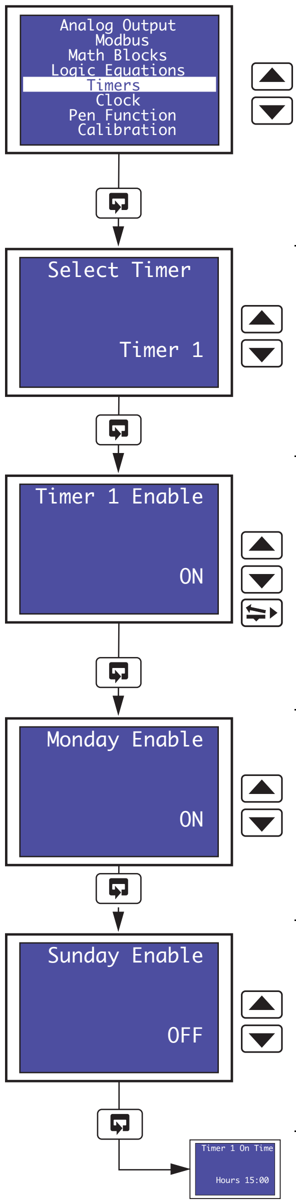
Example B – shows timer option programmed to energize relay output for 16 hours 10 minutes from Monday to Friday

Example C – setting up timer:

- Monday enabled
- Tuesday disabled
- Wednesday disabled
- Thursday disabled
- Friday disabled
- Saturday disabled
- Sunday disabled
- on hour set to All
- on minute set to 20 minutes
- duration in hours set to 0 hours
- duration in minutes set to 40 minutes



Example C – shows timer option programmed to energize relay output for 40 minutes every 20 minutes past the hour on a Monday only



Channels Configuration

Press the key to open the **Main Menu**.

Highlight **Timers**.

Select Timer

Select timer 1 or 2.

Timer On/Off Enable

Select **ON** to enable or **OFF** to disable.

Monday Enable

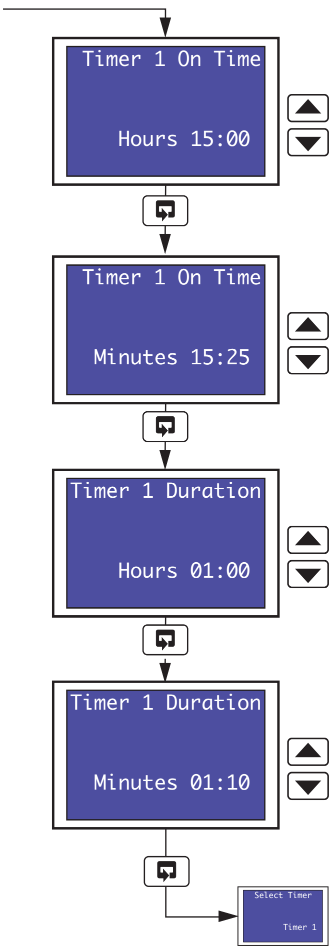
Select **ON** to enable the timer on Monday.

Select **OFF** to disable the timer on Monday.

Tuesday to Sunday Enable

Repeat as above for Tuesday to Sunday.

Continued on next page.



On Hour

Set the hour at which the timer becomes active.

On Minute

Set the minute at which the timer becomes active.

Duration Hour

Set the duration of the timer in hours.

Duration Minute

Set the duration of the timer in minutes.

Return to top of page.

Appendix A – Signal Sources

Source	Description
None	No source required
Pen 1 to Pen 4	Process variable assigned to Pen 1 Process variable assigned to Pen 2 Process variable assigned to Pen 3 Process variable assigned to Pen 4
Math Block 1 to Math Block 4	Result of Math Block 1 Result of Math Block 2 Result of Math Block 3 Result of Math Block 4 Available only if Math software option enabled by installation of appropriate software key
Constant 1 to Constant 8	Available only if Math software option enabled by installation of appropriate software key
Input 1 to Input 6	Analog inputs 1 to 6
Alarm A1 to Alarm D1	Alarm A Alarm B Alarm C Alarm D Channel 1 Alarms (if applicable)
Alarm A2 to Alarm D2	Alarm A Alarm B Alarm C Alarm D Channel 2 Alarms (if applicable)
Alarm A3 to Alarm D3	Alarm A Alarm B Alarm C Alarm D Channel 3 Alarms (if applicable)
Alarm A4 to Alarm D4	Alarm A Alarm B Alarm C Alarm D Channel 4 Alarms (if applicable)
Dig Input Main 1 to Dig Input Mod6 8	Digital input module 1 input 1 Digital input module 6 input 8 Available only if digital input module fitted
Tot 1 Count Tot 1 Wrap to Tot 4 Count Tot 4 Wrap	Totalizer 1 external counter drive Wrap around on totalizer 1 Totalizer 4 external counter drive Wrap around on totalizer 4 Available only if Totalizer software option enabled by installation of appropriate software key
Equation 1 to Equation 8	Programmable logic equation 1 Programmable logic equation 8
Timer 1 Timer 2	Real time event 1 Real time event 2 Available only if Timers software option enabled by installation of appropriate software key

Table A.1 Signal Sources

Notes

Acknowledgements

Modbus is a registered trademark of the Modbus-IDA organization.

Sales

Service

Software

—

ABB Limited
Measurement & Analytics
Howard Road, St. Neots
Cambridgeshire, PE19 8EU
UK
Tel: +44 (0) 870 600 6122
Fax: +44 (0)1480 217948
Email: enquiries.mp.uk@gb.abb.com

ABB Inc.
Measurement & Analytics
125 E County Line Road
Warminster, PA 18974
USA
Tel: +1 215 6746000
Fax: +1 215 6747183

abb.com/measurement

—

IM/C1300-ADV Rev. D 06.2018