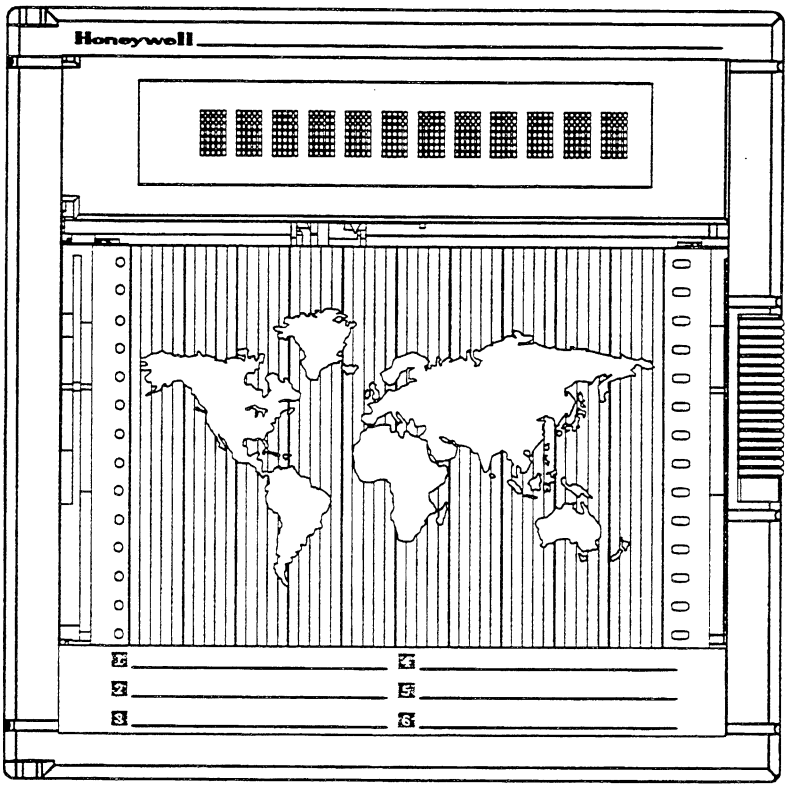
Honeywell

DPR100 C - DPR100 D

STRIP CHART RECORDER

MATH OPTION MANUAL



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Ref : US1I-6138

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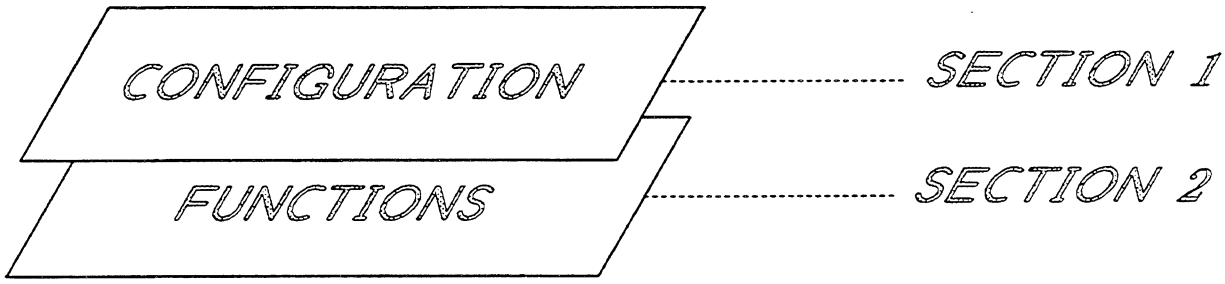
MATH OPTION MANUAL

Ref. : US1I-6138

Issue : 5

March, 1997

The multichannel recorder math option manual consists of 2 sections numbered as shown below.



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1. CONFIGURATION

1.1 INTRODUCTION

This manual explains how to install and configure the math option and describes the mathematical functions provided.

1.2 AVAILABLE FUNCTIONS

Package 1	Package 2	Package 3	Package 4
	Package 1	*Package 2*	*Package 3*
No function	Sterilization	Sum	Relative humidity
Addition	Totalization	Steam flow totalization	Vacuum 10X
Basic math 1	Gas mass flow	Energy consumption	Envelope
Basic math 2	Liquid mass flow	Group min.	Elapsed time
Square root	Group average	Group max.	Lap time
		Group min. max.	Cumulative time
		Periodic max.	Count down
		Periodic min.	Synchronize on time
		Periodic average	Carbon potential
		Periodic pulse	Periodic report
			Special 1 to 2

This math option allows the use of any function on any recorder channel.

Note : Special functions 1 and 2 are reserved for use with special software.

1.3 ACCESSING THE MATH PACKAGE

In the MISCELLANEOUS MATRIX overwrite the current value of MATH PAK with your personal MATH ACCESS CODE.
If you do not have it, please contact your nearest sales office and provide the serial number of your unit.

1.4 DESCRIPTION OF A MATH FUNCTION

A math function is characterized by :
A set of processing conditions
A set of constant coefficients
A set of variables
Y = function (conditions, coefficients, variables)

PROCESSING CONDITIONS

3 conditions (**START, RESET, BACKUP**) have to be configured for each computed chart channel.

- The **START** condition defines when the math computation must start. When the start conditions becomes true the math function continuously computes. When the start condition becomes false the math function keeps the latest computed result.
- The **RESET** condition defines when the math computation must reset. As long as the reset condition is true the computed result stay at the default value.
  These 2 conditions allow the operator to play sequences of **START/STOP** without returning to default value, or to make continuous computation with periodic reset.
- The **BACKUP** condition defines if the computed result has to be memorized in case of power off.

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	**FUNCTION**	♦

DEFINITION : Selection of a formula

HOW TO MODIFY IT : Select a new value.

POSSIBLE VALUES : See available functions (refer to 1.2)

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	COEF A	◆

DEFINITION : First coefficient of a formula

HOW TO MODIFY IT : Enter a numeric value.

POSSIBLE VALUES : Up to 5 digits including negative sign and decimal point

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	COEF B	♦

DEFINITION : Second coefficient of a formula

HOW TO MODIFY IT : Enter a numeric value.

POSSIBLE VALUES : Up to 5 digits including negative sign and decimal point

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	COEF C	♦

DEFINITION : Third coefficient of a formula

HOW TO MODIFY IT : Enter a numeric value.

POSSIBLE VALUES : Up to 5 digits including negative sign and decimal point

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	V A R I A B A	♦

DEFINITION : First variable of a formula

ANALOG 1
ANALOG 2
ANALOG 3
ANALOG 4
ANALOG 5
ANALOG 6

COMM 1
COMM 2
COMM 3
COMM 4
COMM 5
COMM 6

MATH 1
MATH 2
MATH 3
MATH 4
MATH 5
MATH 6

HOW TO MODIFY IT : Select a new variable.

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	VARIAB B	♦

DEFINITION : Second variable of a formula

ANALOG 1
ANALOG 2
ANALOG 3
ANALOG 4
ANALOG 5
ANALOG 6

COMM 1
COMM 2
COMM 3
COMM 4
COMM 5
COMM 6

MATH 1
MATH 2
MATH 3
MATH 4
MATH 5
MATH 6

HOW TO MODIFY IT : Select a new variable.

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	V A R I A B C	◆

DEFINITION : Third variable of a formula

ANALOG 1
ANALOG 2
ANALOG 3
ANALOG 4
ANALOG 5
ANALOG 6

COMM 1
COMM 2
COMM 3
COMM 4
COMM 5
COMM 6

MATH 1
MATH 2
MATH 3
MATH 4
MATH 5
MATH 6

HOW TO MODIFY IT : Select a new variable.

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	START	◆

DEFINITION : Start condition of math computation.

HOW TO MODIFY IT : Select a new value.

POSSIBLE VALUES :

DECISION i ON
LOG 1 CLOSED
LOG 2 CLOSED
LOG 3 CLOSED
LOG 4 CLOSED
CONTINUOUSLY

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	**RESET**	♦

DEFINITION : Reset condition of math computation.

HOW TO MODIFY IT : Select a new value.

POSSIBLE VALUES :

DECISION i OFF
LOG 1 OPEN
LOG 2 OPEN
LOG 3 OPEN
LOG 4 OPEN
NO RESET

SUB- MATRIX	PARAMETER	CLASSIFICATION
MATH	**BACKUP**	♦

DEFINITION : To have math result storage in case of power off.

HOW TO MODIFY IT : Select a new status.

POSSIBLE VALUES :
ENABLE
DISABLE

NOTE : The backup function is not possible with functions : "periodic max, periodic min, periodic/running average and periodic report".

1.5 DETERMINING CONFIGURATION DATA

The combination of conditions will give the following results :

START	RESET	RESULT
Open contact	Close contact	Reset value
Close contact	Close contact	Reset value
Close contact	Open contact	Continuously computed result
Open contact	Open contact	Latest result

The configuration of conditions can be one of following conditions.

START on :
Digital input 1 closed
Computes as longs as the contact of digital input 1 is closed.
Digital input 2 closed
Computes as longs as the contact of digital input 2 is closed.
Digital input 3 closed
Computes as longs as the contact of digital input 3 is closed.
Digital input 4 closed
Computes as longs as the contact of digital input 4 is closed.
Continuously
Always computes, never stops.

RESET on :
Digital input 1 opened
Keeps reset value as long as digital input 1 is opened.
Digital input 2 opened
Keeps reset value as long as digital input 2 is opened.
Digital input 3 opened
Keeps reset value as long as digital input 3 is opened.
Digital input 4 opened
Keeps reset value as long as digital input 4 is opened.
No reset
Never resets by digital input.

CONSTANT COEFFICIENTS

Constant coefficients are fixed values entered during the configuration of the math function by the operator.
These coefficients are represented in formulas by "$COEFF_i$ ".

VARIABLES

Variables are values, generally analog input values or communication input values, or others Math inputs that will vary between two computations.
These variables are represented in formulas by "VAR_i ".

The math results are displayed with a 9 digit format, this defines the default interval [-99 999 999...999 999 999] for possible computed results. The floating point representation is the IEEE standard.

1.6 CONFIGURATION DATA CHECK

When you press the SETUP key to exit the configuration mode, the multichannel recorder checks all the mathematical data configured. If the selected functions are not compatible with the coefficients or channels configured, the recorder takes the following actions :

CONDITION	ACTION
It is not possible to compute the Math function. (Example : The value under the square root is negative).	No calculated Math result. Output = - 9999
Selected channel is configured as "NO ENTRY" in the analog sub-matrix, or it doesn't exist.	No calculated Math result. Output = 9999
Error in the Math configuration. (Example : $COEF_B$ = 0 for sterilization function)	No calculated Math result. Output = 8888

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2.1 No function (included in package # 1)

No Function	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This "no function" provides an output value with the variable value (analog input value or communication input value) without any transformation. This output value is not printed in case of a math result printout.

Formula :

$Y = VAR_A$

Limits :

[-99999999...999999999]

2.2 Addition (included in package # 1)

Addition	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Unused*

Definition :

This function adds two input channels, which may be weighted by $COEF_A$, $COEF_B$.

Formula :

$$Y = (COEF_A * VAR_A + COEF_B * VAR_B + COEF_C)$$

Limits :

[-99999999...999999999]

Example :

Sum of 2 analog inputs without correction factor.

$PV_{CH1} + PV_{CH4}$

$Y = 1 * VAR_{CH1} + 1 * VAR_{CH4} + 0$

Configuration :

$COEF_A = 1$

$COEF_B = 1$

$COEF_C = 0$

VAR_A = Analog 1

VAR_B = Analog 4

2.3 Basic Math 1 (included in package # 1)

Basic Math 1	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function uses general arithmetic calculation (addition and multiplication) of three input channels which may be weighted by $COEF_A$, $COEF_B$, $COEF_C$.

Formula :

$$Y = (COEF_A * VAR_A + COEF_B * VAR_B) * (COEF_C * VAR_C)$$

Limits :

[-99999999...999999999]

2.4 Basic Math 2 (included in package # 1)

Basic Math 2	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function uses general arithmetic calculation (addition and division) of three analog input (or communication input) channels which may be weighted by $COEF_A$, $COEF_B$, $COEF_C$.

Formula :

$$Y = \frac{COEF_A * VAR_A + COEF_B * VAR_B}{COEF_C * VAR_C}$$

Limits :

[-99999999...999999999]

Remark :

☞ $COEF_C$ and VAR_C must not be zero.

2.5 Square Root (included in package # 1)

Square root	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the square root of the value from a specified channel VAR_A.

Formula :

$$Y = COEF_A * \sqrt{VAR_A} + COEF_B$$

Limits :

[-99999999...999999999]

Remarks :

- The input value (VAR_A) must be ≥ 0.
- If it is negative, the output value is -9999.

2.6 Sterilization (included in package # 2)

Sterilization	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the time to sterilize foods for example.

Formula :

$$Y[t] = Y[t-1] + dt * 10^{\frac{(VAR_A - COEF_A)}{COEF_B}}$$

Limits :

[-99999999...999999999]

Remarks :

- dt = time interval in minutes (calculated by the recorder).
- Y = Sterilization time in minutes.
- VAR_A = Product temperature (in °F or °C).
- $COEF_A$ = Standard reference temperature, usually 250° F or 121° C.
- $COEF_B$ = Thermal resistance, usually 18° F or 10° C.
- Y [t-1] = Previous Y calculation.

2.7 Sum (included in package # 3)

Sum	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function totalizes periodically the value from a specified channel during a time configured in hours as $COEF_A$.
At the end of the period the sum result is printed.

Formula :

$$Y[t] = COEF_B * \sum_{t=0}^{t=COEF_A} VAR_A[t]$$

Limits :

[-99999999...999999999]

Remarks :

- A decimal point is accepted during $COEF_A$ configuration. For example :
  1.25 represents 1 hour 15 minutes.
- If $COEF_A = 0$ the duration is infinite.
- To have the print out based on real time clock, configure the "synchronize on time" function
  (See section 2.28).

2.8 Totalization (included in package # 2)

Totalization	
COEF A	***Used***
COEF B	***Used***
COEF C	***Used***
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function integrates periodically the volume from an input flow sensor through the use of totalization. If a flow sensor is recorded in liter/hour, for example the total volume over a period of time can be also recorded.
At the end of the period the result is printed.

Formula :

$$Y[t] = COEF_B * \sum_{t=0}^{t=COEF_A} VAR_A[t] * dt$$

Limits :

[-99999999...999999999]

Remarks :

- $COEF_C$ is the engineering unit of flow sensor :
  0 = sec., 1 = minute, 2 = hour, 3 = day, 4 = 10^6 . day.
  examples : for flow in m^3 / minute $COEF_C = 1$, for flow in 10^6 l / day $COEF_C = 4$.
- A decimal point is accepted during $COEF_A$ configuration.
  For example : 1.25 represents 1 hour 15 minutes.
- If $COEF_A = 0$ the duration is infinite.
- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28) .

2.9 Gas or Steam Mass Flow (included in package # 2)

Gas Mass Flow	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function calculates the mass flow rate of a compressible gas which may be weighted by $COEF_A$ or of steam.

Formula :

$$Y = COEF_A * \sqrt{\frac{VAR_A * (VAR_B + COEF_B)}{VAR_C + COEF_C}}$$

Limits :

- The contents of the formula under the square root must be greater than zero.
- $VAR_C + COEF_C$ must not be zero.

Remarks :

		IS (metric)	USA
$COEF_B$	= pressure reference	1	14.5
$COEF_C$	= temperature reference	273.2	459.7
VAR_A	= differential pressure	BAR	P.S.I
VAR_B	= gauge pressure	BAR	P.S.I
VAR_C	= temperature	°C	°F

$COEF_A$ = K_0, constant depending on the process.
For steam flow calculation **$COEF_A$** = $K_o\ (T_r/(V_r \times P_r))^{1/2}$ where T_r, V_r and P_r are Temperature, Volume and Pressure at the reference conditions.

Example :

V_r = 2.76 cuFt/lb	P_r = 164.7 psia	T_r = 825.8 R
Vr = 172.3 cm^3/g	Pr = 11.4 bar	Tr = 366 K

2.10 Liquid Mass Flow (included in package # 2)

Liquid Mass Flow	
COEF A	***Used***
COEF B	***Used***
COEF C	***Used***
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the mass flow rate of a liquid which may be weighted by $COEF_A$, $COEF_B$.

Formula :

$$Y = COEF_A * \sqrt{VAR_A * COEF_B} + COEF_C$$

Limits :

☞ $COEF_B * VAR_A$ must be greater than zero.

Remarks :

☞

$COEF_A$ = proportionality constant

$COEF_B$ = liquid density

$COEF_C$ = constant

VAR_A = differential pressure

2.11 Gas or Steam Flow Totalization (included package # 3). With I.S. Metric

Steam Flow Totalization	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function integrates periodically a gas or a steam flow.
At the end of the period the result is printed.

Formula :

$$Y[t] = COEF_B * \sum_{t=0}^{t=COEF_A} \sqrt{\frac{VAR_A[t] * (VAR_B[t]+1)}{(273.2 + VAR_C[t])}} * dt$$

Limits :

[-99999999...999999999]

Remarks :

- $COEF_C$ is the engineering unit of flow sensor :
  0 = sec., 1 = minute, 2 = hour
  example : for flow in m^3 / minute $COEF_C = 1$
- A decimal point is accepted during $COEF_A$ configuration.
  For example : 1.25 represents 1 hour 15 minutes.
- If $COEF_A = 0$ the duration is infinite.

VAR_A	= differential pressure	BAR
VAR_B	= gauge pressure	BAR
VAR_C	= temperature	°C

- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28).

2.12 Energy Consumption (included in package # 3)

Energy Consumption	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function calculates periodically the energy from a flow.
At the end of the period the result is printed.

Formula :

$$Y[t] = COEF_B * \sum_{t=0}^{t=COEF_A} (VAR_A[t] - VAR_B[t]) * VAR_C[t] * dt$$

Limits :

[-99999999...999999999]

Remarks :

- $COEF_C$ is the engineering unit of flow sensor, and the unit of time:
  0 = sec., 1 = minute, 2 = hour
  example : for flow in m^3 / minute $COEF_C = 1$
- A decimal point is accepted during $COEF_A$ configuration.
  For example : 1.25 represents 1 hour 15 minutes.
- If $COEF_A = 0$ the duration is infinite.
- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28).

2.13 Relative humidity (wet and dry bulb) (included in package # 4)

Relative humidity	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates the relative humidity from the temperature difference between wet and dry bulb input sensors.

Formula :

$Y = W * X$
$W = 100 / P_{dry}$
$K_a = VAR_A$ converted in °F
$K_b = VAR_B$ converted in °F
$X = P_{wet} - (K_b * 0.001258 + 0.993)(K_a - K_b) * A_w * 0.000701$

Limits :

[0...100]

Remarks :

- $COEF_A$ = 0, degree Fahrenheit.
- $COEF_A$ = 1 degree Celsius.
- $COEF_B = A_w$ = atmospheric pressure in mmHg (generally 760mmHg, bat configurable).
- VAR_A = Dry bulb temperature in $COEF_A$ unit, included in [0...100° C] / [32...212° F].
- VAR_B = Wet bulb temperature in $COEF_A$ unit, included in [0...100° C] / [32...212° F].
- P_{wet} and P_{dry} are automatically calculated by the recorder.

2.14 Vacuum 10X (included in package # 4)

Vacuum 10^x	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the 10^x value.

Formula :

$Y = 10^{VAR_A}$

Limits :

[0...999999999]

2.15 Group Average (included in package # 2)

Group Average	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates the average value of a specified group of consecutive channels between $CHANNEL_A$ and $CHANNEL_B$.

Formula :

$$Y = \frac{SUM\ (\ VAR_A ... VAR_B\ )}{CHANNEL_B - CHANNEL_A + 1}$$

Limits :

[-99999999...999999999]

Remark :

- All consecutive channels between $CHANNEL_A$ and $CHANNEL_B$ must be configured. Channel number are configured through VAR_A and VAR_B.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).

2.16 Group Min. (included in package # 3)

Group Min.	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates the lowest value of a specified group of consecutive channels between $CHANNEL_A$ and $CHANNEL_B$.

Formula :

$Y = (Min. (VAR_A ... VAR_B))$

Limits :

[-99999999...999999999]

Remark :

- All consecutive channels between $CHANNEL_A$ and $CHANNEL_B$ must be configured. Channel number are configured through VAR_A and VAR_B.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).

2.17 Group MAX. (included in package # 3)

Group Max.	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates the highest value of a specified group of consecutive channels between $CHANNEL_A$ and $CHANNEL_B$.

Formula :

$Y = (MAX. (VAR_A ... VAR_B))$

Limits :

[-99999999...999999999]

Remark :

- All consecutive channels between $CHANNEL_A$ and $CHANNEL_B$ must be configured. Channel number are configured through VAR_A and VAR_B.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).

2.18 Group MAX. - Min. (included in package # 3)

Group Max. - Min.	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates the difference between the highest value and the lowest value of a specified group of consecutive channels between $CHANNEL_A$ and $CHANNEL_B$.

Formula :

$Y = (MAX. (VAR_A ... VAR_B) - Min. (VAR_A ... VAR_B))$

Limits :

[-99999999...999999999]

Remark :

- All consecutive channels between $CHANNEL_A$ and $CHANNEL_B$ must be configured. Channel number are configured through VAR_A and VAR_B.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).

2.19 Periodic MAX. (included in package # 3)

Periodic Max.	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates periodically the highest values of a specified group of consecutive ANALOG inputs between VAR_A and VAR_B. At the end of the period the maximal are printed.

At every moment this function display the maximal of the highest values detected from the start of period.

Remarks :

- $COEF_A$ gives the engineering unit :
  1 = minute, 2 = hour, 3 = day
- $COEF_B$ is the configured time interval.
  This time interval is limited by the printing time of the recorder.
- All consecutive ANALOG inputs between VAR_A and VAR_B must be configured.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).
- VAR_A and VAR_B must be of the same type. (ANALOG INPUTS, MATH RESULTS and COMM PVS can not be mixed together).
- No backup function.
- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28).

2.20 Periodic Min. (included in package # 3)

Periodic Min.	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

Remarks :

This function calculates periodically the lowest values of a specified group of consecutive ANALOG inputs between VAR_A and VAR_B. At the end of the period the minimal are printed.

At every moment this function display the minimum of the lowest values detected from the start of period.

Remarks :

- $COEF_A$ gives the engineering unit :
  1 = minute, 2 = hour, 3 = day
- $COEF_B$ is the configured time interval.
  This time interval is limited by the printing time of the recorder.
- All consecutive ANALOG inputs between VAR_A and VAR_B must be configured.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).
- VAR_A and VAR_B must be of the same type. (ANALOG INPUTS, MATH RESULTS and COMM PVS can not be mixed together).
- No backup function.
- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28).

2.21 Running or Periodic Average (included in package # 3)

Running/Periodic Average	
COEF A	***Used***
COEF B	***Used***
COEF C	***Used***
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

PERIODIC AVERAGE ($COEF_C \neq -1$)

This function calculates periodically the average values of a specified group of consecutive inputs of the same type between VAR_A and VAR_B. At the end of the period the average are printed.

At every moment this function display the average of the average values calculated from the start of period.

RUNNING AVERAGE ($COEF_C = -1$)

This function calculates continuously the running average value of a specified group of consecutive inputs of the same type between VAR_A and VAR_B.

Remarks : At every moment this function display the average of the average values calculated on the time interval.

- $COEF_A$ gives the engineering unit :
  1 = minute, 2 = hour, 3 = day
- $COEF_B$ is the configured time interval.
  This time interval is limited by the printing time of the recorder for the periodic average.
- $COEF_C$ Permit to choose witch average would be computed.
  $COEF_C = -1$ function is running average.
  $COEF_C \neq -1$ function is periodic average.
- All consecutive inputs between VAR_A and VAR_B must be configured.
- This may be applied to a single $CHANNEL_A$ ($VAR_A = VAR_B$).
- VAR_A and VAR_B must be of the same type. (ANALOG INPUTS, MATH RESULTS and COMM PVS can not be mixed together).
- No backup function.
- To have the print out based on real time clock, configure the "synchronize on time" function (see section 2.28) .

2.22 Envelope (included in package # 4)

Envelope	
COEF A	*Unused*
COEF B	*Unused*
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function checks that all the consecutive analog input channels between channel A and channel B have values that are superior to $CHANNEL_A$ and inferior to $CHANNEL_B$. If true the math result is 1 else the math result is 0.

Formula :

$Y = (ENVELOPE (CHANNEL_A ... CHANNEL_B))$

Limits :

[0, 1]

Remark :

- All consecutive channels between $CHANNEL_A$ and $CHANNEL_B$ must be configured. Channel number are configured through VAR_A and VAR_B.

2.23 Elapsed Time (included in package # 4)

Elapsed Time	
COEF A	***Used***
COEF B	*Unused*
COEF C	*Unused*
VAR A	*Unused*
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the elapsed time.
If the START condition is OFF, the Elapsed Time is NULL.
If the RESET condition is ON, the Elapsed Time is NULL.
If the START condition is ON and the RESET condition is OFF, the timer counts

Formula :

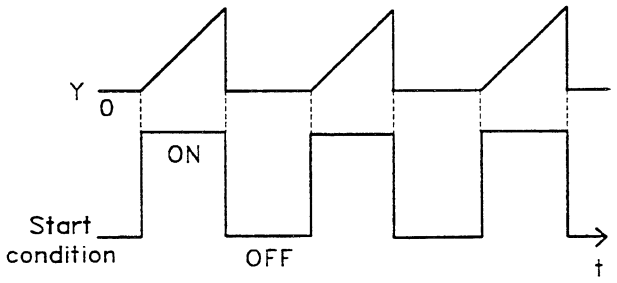
Y = Elapsed Time ($COEF_A$)

Limits :

[-99999999...999999999]

Remark :

☞ $COEF_A$ gives the engineering unit :
0 = sec., 1 = minute, 2 = hour, 3 = day



2.24 Lap Time (included in package # 4)

Lap Time	
COEF A	***Used***
COEF B	*Unused*
COEF C	*Unused*
VAR A	*Unused*
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the lap time.
If the START condition is OFF, the Elapsed Time is CONSTANT but the timer still continues to count.
If the RESET condition is ON, the Elapsed Time is NULL.
If the START condition is ON and the RESET condition is OFF, the timer counts

Formula :

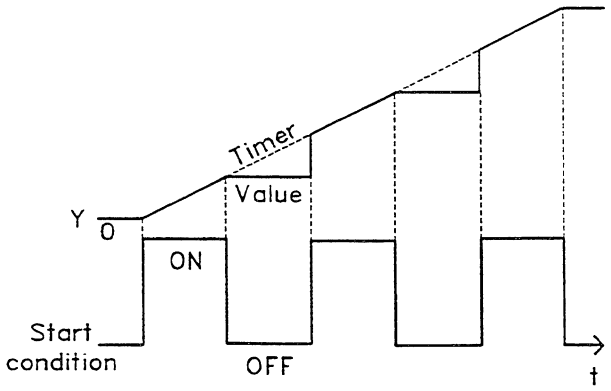
Y = Lap Time ($COEF_A$)

Limits :

[-99999999...999999999]

Remark :

☞ $COEF_A$ gives the engineering unit :
0 = sec., 1 = minute, 2 = hour, 3 = day



2.25 Cumulative Time (included in package # 4)

Cumulative Time	
COEF A	***Used***
COEF B	*Unused*
COEF C	*Unused*
VAR A	*Unused*
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function calculates the cumulative time.
If the START condition is OFF, the Elapsed Time is CONSTANT and the timer stops to count.
If the RESET condition is ON, the Elapsed Time is NULL.
If the START condition is ON and the RESET condition is OFF, the timer counts

Formula :

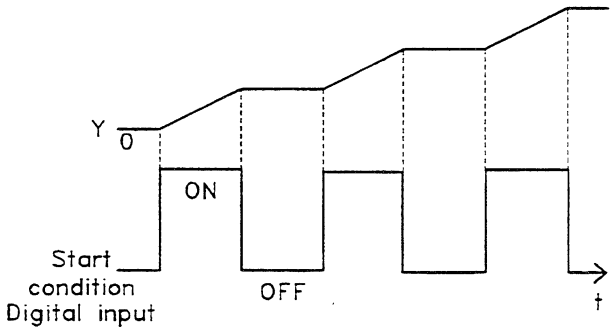
Y = Cumulative Time ($COEF_A$)

Limits :

[-99999999...999999999]

Remark :

☞ $COEF_A$ gives the engineering unit :
0 = sec., 1 = minute, 2 = hour, 3 = day



2.26 Count Down (included in package # 4)

Count Down	
COEF A	*Used*
COEF B	*Used*
COEF C	*Unused*
VAR A	*Unused*
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function decrements a timer.
If the START condition is OFF, the Time is CONSTANT and the timer stops to decrement.
If the START condition is ON and the RESET condition is OFF, the timer decrements.
When the timer reaches 0 it stops to decrement.
The math result is generally 1, this result becomes 0 when the timer counter reaches 0.
When the reset condition is ON the value becomes "1".

Formula :

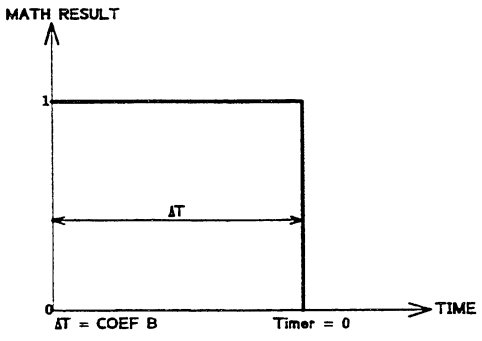
$Y = \text{Count Down} (COEF_A, COEF_B)$

Limits :

[0, 1]

Remarks :

- $COEF_A$ gives the engineering unit :
  0 = sec., 1 = minute, 2 = hour, 3 = day
- $COEF_B$ is the configured time interval to decrement.



2.27 Periodic Pulse (included in package # 3)

Periodic Pulse	
COEF A	***Used***
COEF B	***Used***
COEF C	***Used***
VAR A	*Unused*
VAR B	*Unused*
VAR C	*Unused*

Definition :

This function decrements a timer.
If the START condition is OFF, the Time is CONSTANT and the timer stops to decrement.
If the RESET condition is ON the timer is contents the configured time value.
If the START condition is ON and the RESET condition is OFF, the timer decrements.
When the timer reaches 0 it switch back to the other configured time value and begin to decrement again.
The math result is 1 after a reset and $COEF_B$ is the first time value that is decremented.
When the timer counter reaches 0 it switch its result from 1 to 0, or from 0 to 1.

Formula :

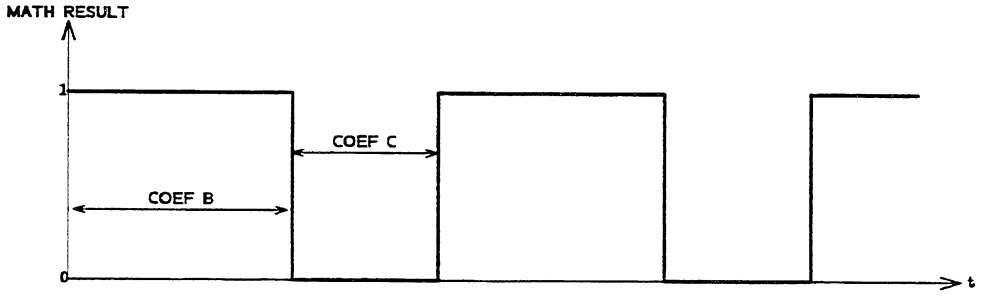
$Y = \text{Count Down} (COEF_A, COEF_B, COEF_C)$

Limits :

[0, 1]

Remarks :

- $COEF_A$ gives the engineering unit :
  0 = sec., 1 = minute, 2 = hour, 3 = day
- $COEF_B$ is the configured periodic time interval corresponding to the 1 result.
- $COEF_C$ is the configured periodic time interval corresponding to the 0 result.
- To have the periodic pulses based on the real time clock, configure the "synchronize on time" function (see section 2.28)



2.28 Synchronize on Time (included in package # 4)

Synchronize on Time	
COEF A	***Used***
COEF B	***Used***
COEF C	***Used***
VAR A	***Used ****
VAR B	***Used ****
VAR C	*Unused*

Definition :

1. **Real time clock setting**
   $COEF_C$: From 0 to 59
   To set the time of the recorder on a predetermined time by logic input action.
   If the START condition is OFF or if the RESET condition is ON, the result is 0.
   When the START condition is switched from OFF to ON with RESET OFF, the TIME of the recorder is forced with the $COEF_A$, $COEF_B$, $COEF_C$ values and the result becomes 1. After that the result stay 1.
2. Synchronization of math functions on real time clock
   a) $COEF_C = -1$
   To synchronize periodic math functions a predicted time.
   If the START condition is OFF or if the RESET condition is ON, the result is 0.
   When the START condition is switched from ON with RESET OFF, if the TIME is equal to $COEF_A$ (hour), $COEF_B$ (min.), the result becomes 1 and the math results VAR_A to VAR_B are reseted. After that, the result stays 1.

Formula :

Y = Synchronize on Time ($COEF_A$, $COEF_B$, $COEF_C$)

Limits :

[0, 1]

Remarks :

- No decimal for $COEF_A$, $COEF_B$ and $COEF_C$
- $COEF_A$ represents the hours.
- $COEF_B$ represents the minutes.

REAL TIME CLOCK SETTING

- $COEF_C$ represents the seconds (0 to 59).

MATH SYNCHRONIZATION

- $Coef_C$: -1
- VAR_A : First math result to be synchronized.
- VAR_B : Last math result (MA1 to MA6) to be synchronized
- Backup : Disable
- Start : Continuous
- Reset : No.

Example : synchronize MA1 and MA2 at 8 a.m.

$Coef_A = 8.0$; $Coef_B = 0.0$; $Coef_C = -1$

Var_A = MA1 ; Var_B = MA2

2.29 Carbon Potential (included in package #4)

% Carbon	
COEF A	*Used*
COEF B	*Used*
COEF C	*Used*
VAR A	*Used*
VAR B	*Used*
VAR C	*Used*

Definition :

This function calculates the carbon potential from a carbon sensor, a temperature in degree Fahrenheit (or degree Celsius) and a fractional carbon monoxide coefficient or a fractional carbon monoxide input sensor.
Five types of carbon probes are supported, you may chose the carbon with $COEF_B$.

Formula :

a) For Marathon, Corning, AACC and Barber types

$$\%\,C = \frac{191.5 * (10^K)}{(1 + 50.5 * 10^K)}$$

b) For FCC type

$$\%\,C = 10^K$$

Where :

If $COEF_B = 1$ (Marathon, Cambridge type)

$$K = \frac{(Ec - 820.7)}{(0.05511 * Tr)} + LOG\,(Pco) - 4.2143$$

If $COEF_B = 2$ (Corning type)

$$K = \left[\frac{(Ec - 800.8)}{(0.05511 * Tr)} - 5.0113 + 0.86 * LOG (Pco) \right] / 1.21$$

result is modified by the following formula if % C > 0.85

$$\% C = \% C + (\% C - 0.85) * 0.24$$

If $COEF_B = 3$ (AACC type)

$$K = \frac{(Ec - 799.38)}{(0.05511 * Tr)} - 4.39673 + LOG (Pco)$$

result is modified by the following formula if % C > 0.85

$$\% C = \% C + (\% C - 0.85) * 0.26$$

If $COEF_B = 4$ (Barber type)

$$K = \frac{(Ec - 849.5)}{(0.05511 * Tr)} + LOG (Pco) - 3.99332$$

If $COEF_B = 5$ (FCC type)

$$K = \frac{(802.904 + 0.1601 * Tr - Ec - 0.05512 * Tr * LOG (5 * Pco))}{(113.165 - 0.1249 * Tr)}$$

Remarks :

- $COEF_A$ temperature unit 0 = Fahrenheit; 1 = Celsius
- $COEF_B$ = Carbon type
  1 : Marathon, Cambridge
  2 : Corning
  3 : AACC
  4 : Barber
  5 : FCC .

- $COEF_C$ = Pco : Fractional Carbon monoxide coefficient from 0.02 to 0.35.
  If $COEF_C$ is configured to 0.0 Pco become the result of VAR_C input.
  VAR_B = Ec : Carbon sensor output in mV (0 - 1250)
  VAR_A = Temperature in degree Fahrenheit or degree Celsius used to calculate Tr (1400 - 2000 degree R).
  VAR_C = Pco : Fractional carbon monoxide value when $COEF_C$ = 0.0
  % C = Carbon potential (0.1 - 1.4 %) - performance specified or 0.0 - 0.1 %, 1.4 - 2.0 % performance not specified.

Example :

Marathon sensor with thermocouple in °F
$COEF_A$ = 0 (°F)
$COEF_B$ = 1 (Marathon type)
$COEF_C$ = 0.2 (PCo)
VAR_A = 1500 °F
VAR_B = 1098 mV
VAR_C = unused in this example because $COEF_C$ different from 0.

Result : % C = 0.7 % (Carbon Potential)

2.30 Periodic Report (included in package # 4)

Periodic Report	
COEF A	***Used***
COEF B	***Used***
COEF C	*Unused*
VAR A	***Used***
VAR B	***Used***
VAR C	*Unused*

Definition :

This function calculates periodically the minimum, maximum and the average value of consecutive channels of the same type between CHANNEL A and CHANNEL B. (for 1 CH. Conf. CH_A to CH_B)

At every moment this function displays the average value calculated from the start of the period.

Remarks :

- $COEF_A$ gives the engineering unit :
  1 = minute, 2 = hour, 3 = day.
- $COEF_B$ is the configured time interval between 2 consecutive reports:
  This time interval is limited by the printing speed of the recorder, for each channel configured minimum, average and maximum values are printed.
- All consecutive inputs between VAR_A and VAR_B must be configured.
- VAR_A and VAR_B are limits of the group of consecutive channels and must be of the same type. (Analog inputs, math results and communication PVS cannot be mixed together)
- No backup function
- The periodic report may be cutted by alarm message or periodic printings
- Printing of periodic report is always over the traces
- To have the printout base on real time clock, configure the "synchronize on time" function (see section 2.28) .

Example : Report.