OPTIONS MANUAL

LIST OF CONTENTS

INSTALLATION CATEGORY AND POLLUTION DEGREE

This product has been designed to conform to BS EN61010 installation category II and pollution degree 2. These are defined as follows:

INSTALLATION CATEGORY II
The rated impulse voltage for equipment on voltages up to 230V ac supply voltage is 2500V. I.E. The equipment is supplied from the fixed installation (IEC664)

POLLUTION DEGREE 2
Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

NOTE

Questions concerning installation, performance or service should be directed to the company from which the instrument was purchased.

1 RELAY OUTPUTS

1.1 INTRODUCTION

The relay output option can have various numbers of relays. A relay board can have two, four or six relays. There can be one, two or three relay boards mounted within the recorder. Each relay has change-over contacts (i.e. common, normally closed and normally open). **In alarm or power off conditions, the common and normally closed contacts are closed.**

1.1.1 Configuration

Alarm types, thresholds etc. are set up as described in the Channel Configuration section of the Installation and Operation manual. Each relevant Process Variable can operate one or more relays using jobs.

JOBS

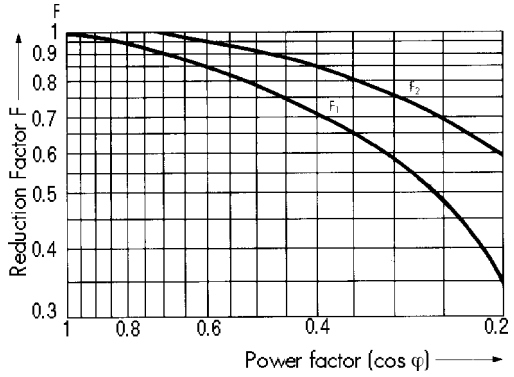
A single job 'Drive relay N of card N' (while active/inactive) is added to the job list shown in Section 4.1 of the installation and operation manual.

1.1.2 Relay specification

The relay specification for resistive loads is given below. Derate with reactive or inductive loads in accordance with figure 1.1.2, in which:

F1 = Actually measured on representative samples
F2 = Typical values (according to experience)
Contact life = Resistive contact life x Reduction factor.

Number of relays per board	two, four or six
Estimated life	30,000,000 operations
Maximum contact voltage	250V ac
Maximum contact current	2 Amps
Maximum switching power	500VA or 60W



Safety isolation (dc to 65Hz; BS EN61010) Installation category II, Pollution degree 2 (see page 2 for definitions).

Relay to relay:	300v RMS or dc (double insulation)
Relay to ground:	300V RMS or dc (basic insulation)

Figure 1.1.2 Derating curves

1.2 RELAY WIRING

The following diagrams show user terminations for the relay output board. Where other options are present, they are always mounted 'after' relay boards (i.e. relay boards always have the lowest option board numbers).

1.2.1 Six change-over (also called Form C or SPDT) relays board

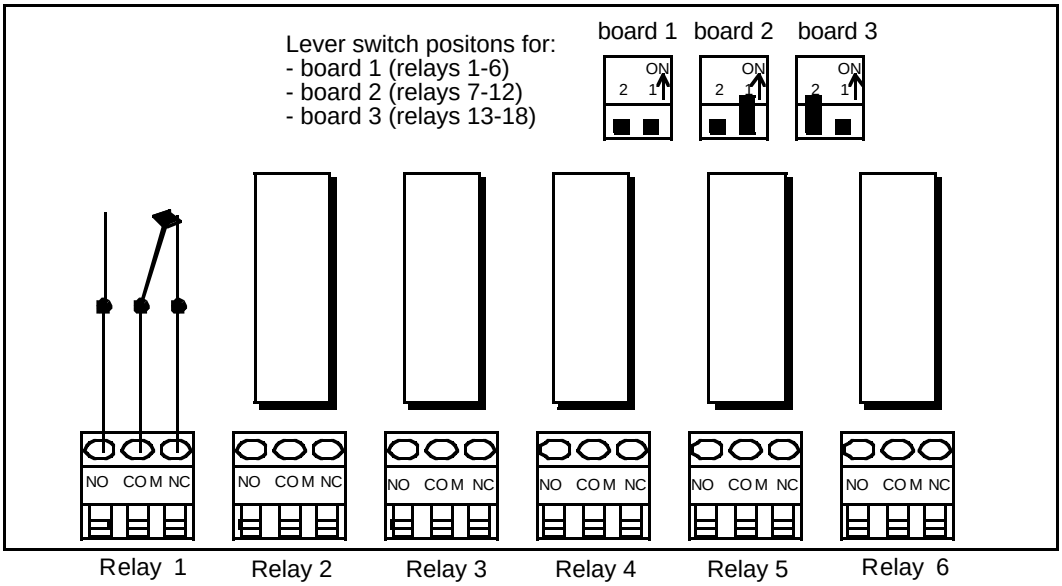


Figure 1.2.1 Change-over relay option wiring

2 ANALOG OUTPUT (RETRANSMISSION)

2.1 INTRODUCTION

The analog output option provides one card fitted with either 2 or 4 retransmissions of input or math channels, where a configurable proportion of a selected source channel's span is linearly mapped onto a configurable output range. The type of output (Volts or mA) and the output scaled, can be set up using the configuration pages described in 2.4, following. The recorder will accommodate one analog output (retransmission) board only.

2.2 SPECIFICATION

Analog (retransmission) outputs (Output ranges (user configurable))

VOLTAGE OUTPUT	Voltage range:	0 to 10 V calibrated (will drive up to 11.5V)
	Current limit is between:	6.0 mA and 12.3 mA.
	Min. current limit output at 11.5 V:	6.0 mA
	Max. linearity error:	2.0 mV
	Min. resolution:	1.6 mV
	Max. output resistance:	+/- 2Ω
	Temp. coeff. at zero output:	300 microvolts per deg. C max.
	Temp. coeff. of gain:	70 ppm per deg. C of output max.
	Max.output voltage for minimum setting:	-0.3V at load resistance: 2kΩ
	Max. series mode high frequency ripple:	150 mV peak to peak
	Max. common mode high frequency ripple:	300 mV peak to peak
	Nominal output voltage,O/P type set to OFF:	- 1.1 V into open circuit

2.2 SPECIFICATION (cont.) Analog (retransmission) outputs (Output ranges (user configurable))

CURRENT OUTPUT Current range:	0 to 20 mA (will drive up to 23 mA)
Voltage limit is between:	18 V and 30 V, decreasing towards 18 V as current output rises.
Max. voltage limit output at 23 mA:	18 V
Max. linearity error:	4.0 µA
Min. resolution:	3.2 µA
Min. output resistance:	10 M Ω
Temp. coeff. at zero output:	1.0 µA per deg. C max.
Temp. coeff. of gain:	80 ppm per deg. C of output max.
Max. output current for minimum setting:	-0.2 mA at load resistance: 1kΩ
Max. voltage limit:	30V into a open circuit
Max. series mode high frequency ripple:	150 µA peak to peak
Max. common mode high frequency ripple:	300 mV peak to peak
Nominal output current, O/P set to OFF:	-250 µA into a short circuit

GENERAL

Update rate:	1 Hz.
Step response (10% to 90%):	250 msec maximum
Safety isolation (dc to 65Hz; BS EN61010):	Installation category II; Pollution degree 2 (see page 2 for definitions)
Channel to channel:	300V RMS or dc (double insulation)
Channel to ground:	300V RMS or dc (basic insulation)
Performance:	

Performance in instrument at 20 deg. C +/- 10 deg. C	
Output	Maximum Error
Voltage	11.7 mV + 0.18% of Output
Current	30.5 µA + 0.21% of Output
These figures do not include errors from the customer's measuring equipment	

2.3 WIRING

Either two or four outputs are present, depending on the installed option.

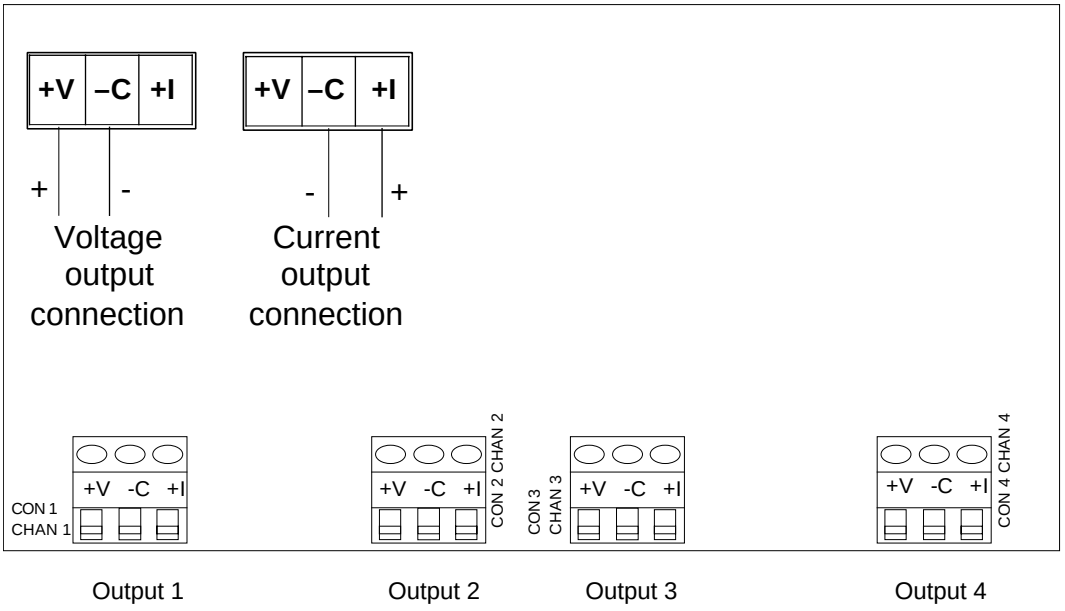


Figure 2.3 Retransmission option wiring

2.4 CONFIGURATION PAGES

The configuration below is an example of how to setup a retransmission output channel. Configurations will vary based on the needs of the specific application.

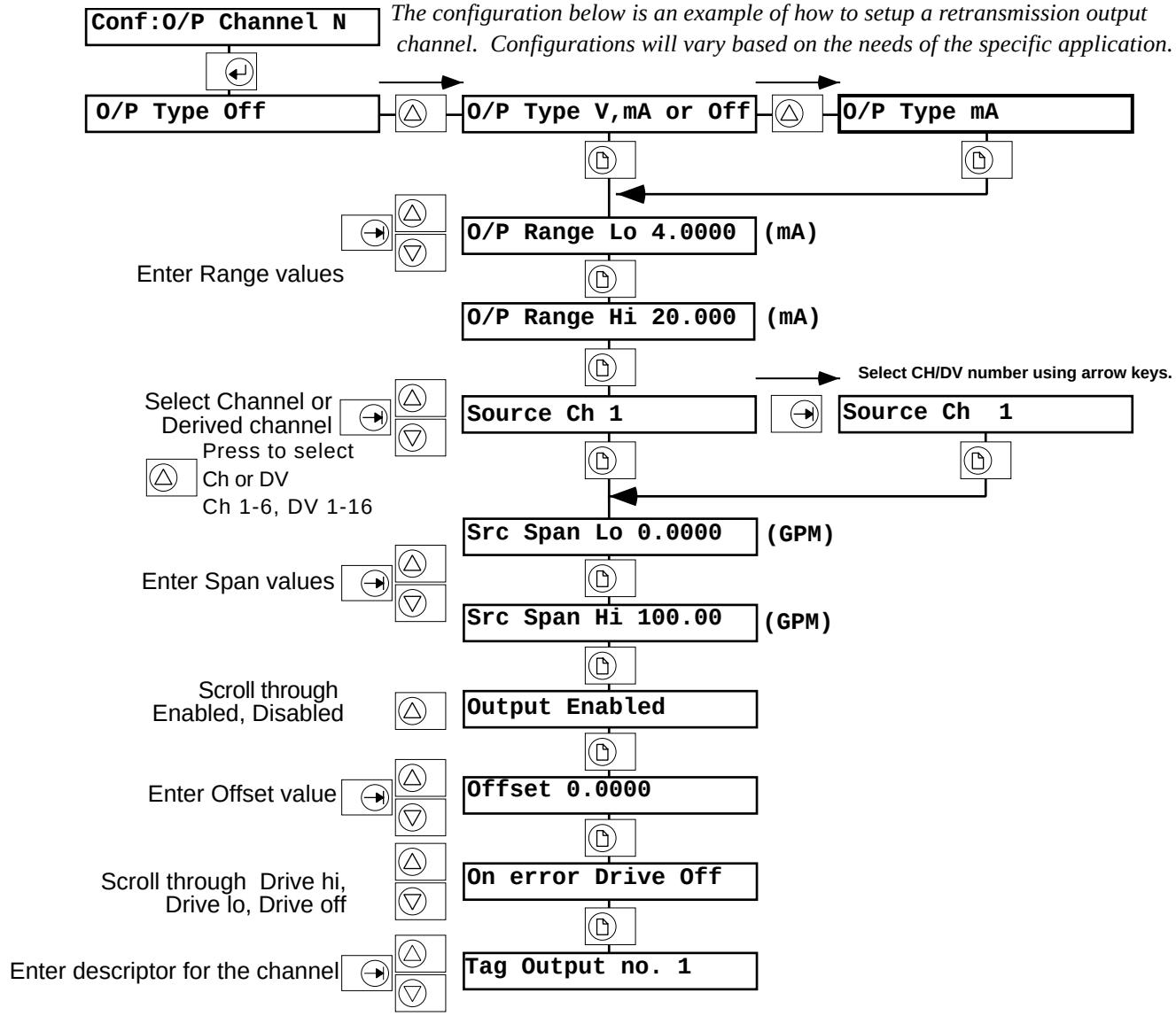


Figure 2.4 Retransmission configuration pages

Figure 2.4 shows the configuration pages for the analog output option.

O/P Type	Allows V, mA or off to be selected as the output type. When 'off', the channel output goes to -250µA at +I and –C terminals and to approximately -1.1 V across the +V and –C terminals
O/P Range Lo/Hi	Allows the setting of the voltage or current that is to appear at the output terminals when the source signal is at Src Span Lo/Hi (See below).
Source Ch	Allows 'Ch' (measuring channel) or 'DV' (derived channel) to be selected as input source type. When source type is as required, use the cursor key to move to the numeric field and use the arrow keys to scroll through the available channels or DVs.
Src Span Lo/Hi	Allows the setting of the high and low values of the source Ch/DV (engineering scale Lo and Hi values) which cause the high and low values (O/P Range Lo/Hi) of the retransmission output signal..
Output Enabled	Allows the output channel to be switched off, (Disabled) without its configuration being lost.
Offset	Allows a fixed value to be added to the value of the source Ch/DV input to the retransmitter.
On error Drive	Allows Drive off, Drive hi or Drive lo to be selected as an error output (e.g. if the input source is missing). 'off' causes the output to be set to its off state as defined in O/P type above. 'Drive hi' or 'Drive lo' cause the output to drive to approximately 15% above span or below 'zero' respectively.
Tag	Allows a 14-character descriptor to be applied to the selected channel.

2.5 OUTPUT ADJUST

This feature allows the retransmitted output signal to be adjusted to compensate for differences between the readings on the recorder and readings on the device connected to the retransmission output.
The adjustment can be applied or removed as required.

The technique used is:

1. The recorder outputs a known value (10%* of output span) at the analog output terminals.
2. The user takes the resulting value as indicated by the connected equipment and enters it into the recorder.
3. The recorder outputs a second value (90%* of output span).
4. The user takes the resulting value as indicated by the connected equipment and enters it into the recorder.

The recorder then calculates a linear gain and offset correction to be applied to the output.

*These are default values and can be adjusted by the user.

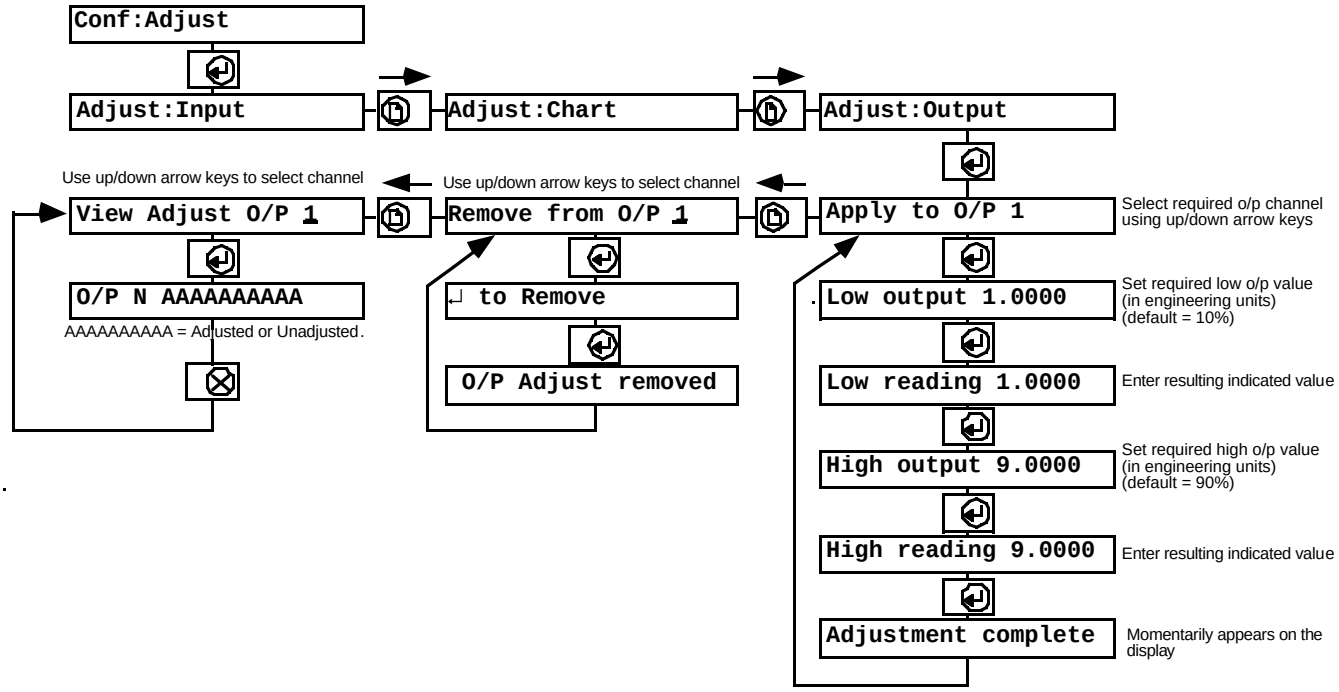


Figure 2.5 Output Adjust menu pages

'Remove' allows the adjustment to be removed from a selected channel.

'View' allows the user to determine whether any particular retransmission output is currently adjusted or not.

Examples of +/- 15% above span or below zero output levels:

1V to 5V range:

+15% will give +15% * (5V - 1V) + 5V = 5.6V (above span)

- 15% will give - 15% * (5V - 1V) + 1V = 0.4V (below zero)

The maximums are 11.5V, 23 mA, 0V and 0 mA. Nominal below "zero" outputs are -1.1V and -250µA.

3 MATH PACK
(DERIVED CHANNELS)

3.1 INTRODUCTION

The math pack option provides 16 'derived' channels (DV1 to DV16), in addition to the measuring channels.

The option comes in three levels: level 1 which provides basic arithmetic functions, level 2 which provides advanced functions such as averaging, relative humidity calculations, mass flow etc. and level 3 which is a display format only . Scientific notation displays calculated values using a mantissa and an exponent of 10 (e.g. 1000 = **1.00** $^{+3}$). The functions for levels 1 & 2 are listed in table 3.1 below.

Table 3.1 Math functions

Level 1 functions	Level 2 functions (additional to level 1 functions)	
Off Constant Copy Add Subtract Multiply Divide Modulus	Square root Channel average DV Group average Rolling average e^x $\log_n$ 10^x $\log_{10}$ Rate of change Sample and hold Channel minimum DV group latching minimum DV group continuous MinimumChannel maximum DV group latching maximum	DV group continuous maximum Third order polynomial Relative humidity F value Linear mass flow Square root mass flow Zirconia probe Switch High select Low select Stopwatch Time stamp O_2 Correction Percentile

3.1.1 Groups

Derived channels can be added to the log and display groups described in the Group configuration section of the Installation and Operation manual. The operator can edit these groups to contain only those items which are to be logged or which are to appear at the display.

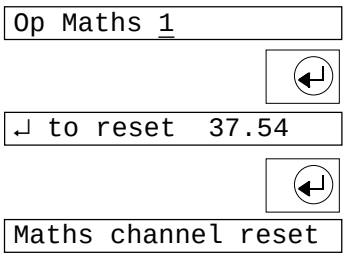
The Level 2 math pack option adds a further group, called the DV group, which can contain only derived and measuring channels (i.e. not totalizers or counters). The group can be used to assemble channels which are to be part of group averaging, group max/min, or group reset of averages, sample-and-hold, etc.

3.1.2 Jobs

The following jobs are added to the list given in the Installation and Operation Manual:
Reset channel NN
Reset all DVs
Switch to B on NN
Disable channel NN
Disable all DVs
Trigger Ch NN

3.1.3 Operator pages

If allowed by operator access (section 4.13 in the Installation and Operation manual), the operator can reset any of the resettable functions in level 2 from this menu. The reset page displays the current value of the channel to be reset.



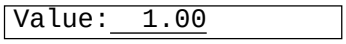
3.2 EQUATIONS

Note - Unless otherwise stated, a "channel" can be either an input channel or another derived calculation channel.

3.2.1 Level 1 equations

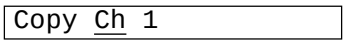
CONSTANT

Allows the entry of a constant to be used in other equations, values between -99999 and 999999.



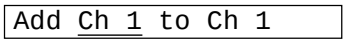
COPY

Can be used to duplicate input or derived channels when more than four alarms are required. Also useful to import totalizer or counter values so they can be traced on the chart and/or, so that they can be used in math calculations.



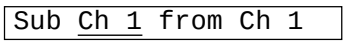
ADD

Allows one channel to be added to another.



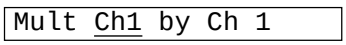
SUBTRACT

Allows one channel to be subtracted from another.



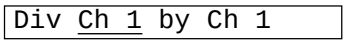
MULTIPLY

Allows one channel to be multiplied by another.



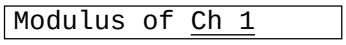
DIVIDE

Allows one channel to be divided by another.



MODULUS

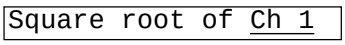
Takes the value of a channel, ignoring sign (i.e. always positive).



3.2.2 Level 2 equations

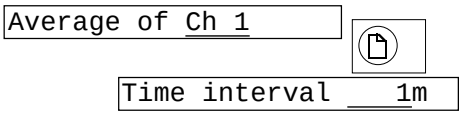
SQUARE ROOT

Takes the square root of the value of a channel. Produces a system error if signal value goes negative.



CHANNEL AVERAGE

Provides the average value of a channel over a configurable time interval, then repeats.



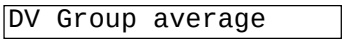
GROUP AVERAGE

Provides the current average value of all the channels in the DV group i.e.

(DVa + DVb + -------+ DVc)/R

where R is the total number of DVs in the group.

The function may be globally reset.

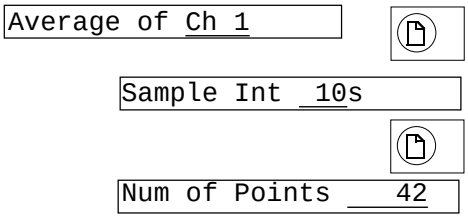


ROLLING AVERAGE

Takes the average value of a channel sampled a specified number of times (up to 9999) each at a specified time period in seconds.

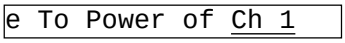
Example - a seven minute average can be 42 readings, taken every 10 seconds (42X10 = 420sec = 7min). The first reading is discarded when the 43rd one is taken and so on.

The function may be globally reset.



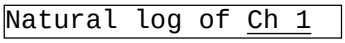
E TO THE POWER

Raises e to the power of the value of the specified channel. e ≈ 2.71828



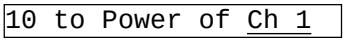
NATURAL LOG

Takes the Naperian log of the value of the specified input or derived channel.



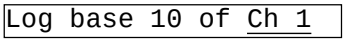
10 TO THE POWER

Raises 10 to the power of the value of the specified input or derived channel.



LOG BASE 10

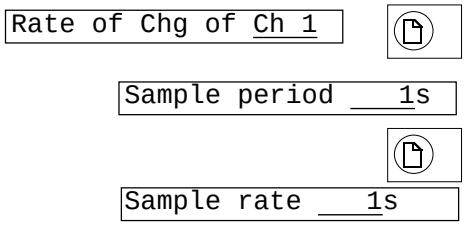
Takes base 10 log of the specified input or derived channel's value.



3.2.2 LEVEL 2 EQUATIONS (Cont.)

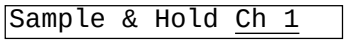
RATE OF CHANGE

Calculates the rate at which the selected channel's value changes over a specified time period, with a specified sample rate which will determine the number of measurements being taken during that time period.



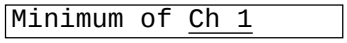
SAMPLE AND HOLD

When triggered, retains the current value of the specified channel's value, until reset.



CHANNEL MINIMUM

Saves the lowest value that the specified channel has reached since initiation or last reset.

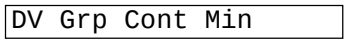


DV GROUP LATCH MIN

Outputs the lowest value reached by any channel in the DV group since initiation or last reset.

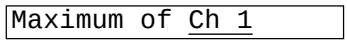
DV GROUP CONT MIN

Outputs the current value of whichever channel in the DV group has the lowest value.



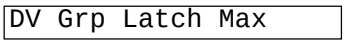
CHANNEL MAXIMUM

Outputs the highest value that the specified channel has reached since initiation or last reset.



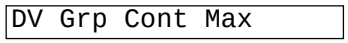
DV GROUP LATCH MAX

Outputs the highest value reached by any channel in the DV group since initiation or last reset.



DV GROUP CONT MAX

Outputs the current value of whichever channel in the DV group has the highest value.



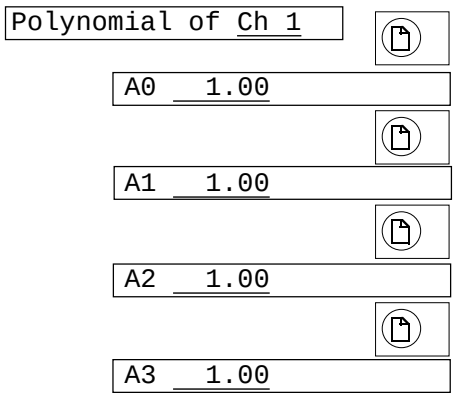
THIRD ORDER POLYNOMIAL

Provides a third order polynomial curve fit:

$$A0 + A1x + A2x^2 + A3x^3$$

where A0 to A3 are constants and x is the specified channel's value.

Constants less than 0.0001 or greater than 99999 require further configuration to execute, consult factory.

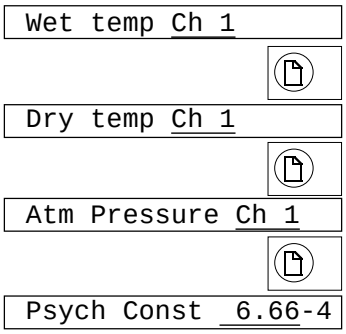


3.2.2 LEVEL 2 EQUATIONS (Cont.)

RELATIVE HUMIDITY

To determine the relative humidity percentage using wet and dry temperature readings in ˚F and atmospheric pressure inputs in bars. 1 bar = 14.7 psia.

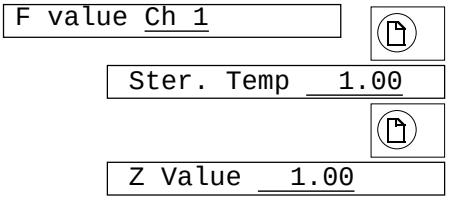
The mantissa of the psychrometric constant times the pressure should equal 6.66 - e.g. a 0.9 bar times a 7.40 constant equals 6.66; (the exponent "-4" is fixed).



FVALUE

To calculate the equivalent time at Sterilizing Temperature (for temperatures below, at and above Sterilizing Temperature) both in dry (FH) and steam (FO) sterilizing environments, using the following equation:

$$Fval_t = Fval_{t-1} + T \times 10^{\frac{ma_t\text{-target temp}}{Z}}$$



Where $Fval_t$ = F value at time t (minutes)
$Fval_{t-1}$ = F value last iteration
T = Internal recorder iteration rate (minutes)
ma_t = Value of temperature measuring channel
Target temp = 121.1˚C for FO; 170˚C for FH
Z = Temperature interval representing a factor-of-10 reduction in killing efficiency
= 10˚C for FO; = 20˚C for FH

MASS FLOW LINEAR (see also Mass Flow Square Root)

Note: the overall accuracy of a flow measurement installation depends on a number of factors outside the control of the recorder manufacturer. For this reason, the manufacturer takes no responsibility for the accuracy of results obtained by using the mass flow equations implemented in the maths pack. **Independent verification is recommended before this recorder is used for custody transfer.**

The equation solved is: $$Qmt = \frac{K}{Rg \times Z} \times \frac{Flow_t \times AbsP_t}{Temp}$$

where: Qm_t = mass flow at time t, in the same flow units as '$Flow_t$'.
$Flow_t$ = measured value from the flow meter at time t
$AbsP_t$ = absolute pressure of the fluid at time t
Temp = absolute temperature of the fluid in Kelvins
K = scaling factor (see below)
Rg = specific gas constant in J/(kg-K) (see below)
Z = compressibility factor (see below)

For the recorder user, this becomes: $$Mass\ flow = \frac{md \times ma_t \times mb_t}{mc_t}$$

where: mat = the value, at time t, of the channel measuring the flow meter output
mbt = the value, at time t, of the channel measuring the absolute pressure of the fluid
mct = the value, at time t, of the channel measuring the fluid temperature in Kelvins

md = a constant, derived from the equation: $$Const = \frac{K}{Rg \times Z}.$$

where: K = a scaling factor (see below)
Rg = specific gas constant in J/(kg-K) (see below)
Z = compressibility factor (see below)

3.2.2 LEVEL 2 EQUATIONS (Cont.)

SCALING FACTOR K

This is derived from the equation: $K = \frac{S}{ma_{max}}$.

where: S = The full scale output from the flow meter

ma_{max} = the full scale input of the channel which is reading the flow meter output

SPECIFIC GAS CONSTANT (Rg)

The specific gas constant values are available from published tables.

For convenience, the Rg values for a number of common gases are given in table 3.2

Gas	RG (J/kg-K)
Air	287.1
Ammonia	488.2
Carbon dioxide	188.9
Carbon monoxide	296.8
Ethylene	296.4
Hydrogen	4116.0
Methane	518.4
Nitrogen	296.8
Oxygen	259.8
Propane	188.5
Steam	461.4

Table 3.2 Common gas constants

COMPRESSIBILITY FACTOR (Z-FACTOR)

The compressibility factor is a density-related measure of how far a particular gas deviates from a 'perfect' gas under any set of temperature and pressure conditions, and is given by the equation:

$$Z = \frac{S}{T} \times \frac{1}{P}$$

Where: Z = Compressibility factor

P = Absolute pressure of the gas

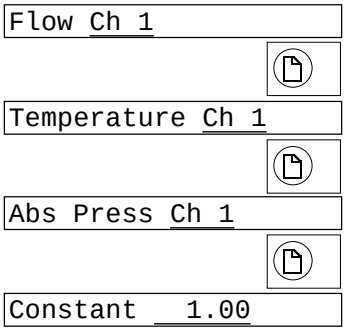
T = Absolute temperature of the gas

ρ = Gas density at pressure P and temperature T (from published tables)

Alternatively, the Z-factor can be established experimentally.

CONFIGURATION PAGES

Enter the flow rate, absolute temperature and the absolute pressure channels and the constant



3.2.2 LEVEL 2 EQUATIONS (Cont.)

MASS FLOW SQUARE ROOT (normally used for AGA 3 gas flow equation)

Note: the overall accuracy of a flow measurement installation depends on a number of factors outside the control of the recorder manufacturer. For this reason, the manufacturer takes no responsibility for the accuracy of results obtained by using the mass flow equations implemented in the maths pack.
Independent verification is recommended before this recorder is used for custody transfer.

The equation solved is: $Qmt = \sqrt{\frac{K}{Rg \times Z}} \times \sqrt{\frac{Flow_t \times AbsP_t}{Temp}}$

where: Qm_t = mass flow at time t, in the same flow units as '$Flow_t$'.
$DeltaP_t$ = measured value of the differential pressure across the orifice plate at time t, in kPa.
$AbsP_t$ = absolute pressure of the fluid at time t
Temp = absolute temperature of the fluid in Kelvins
K = scaling factor (see below)
Rg = specific gas constant in J/(kg-K) (see below)
Z = compressibility factor (see below)

For the recorder user, this becomes: $Mass\ flow = \sqrt{\frac{md \times ma_t \times mb_t}{mc_t}}$

where: mat = the value, at time t, of the channel measuring the flow meter output
mbt = the value, at time t, of the channel measuring the absolute pressure of the fluid
mct = the value, at time t, of the channel measuring the fluid temperature in Kelvins

md = a constant, derived from the equation: $Const = \frac{K}{Rg \times Z}$.

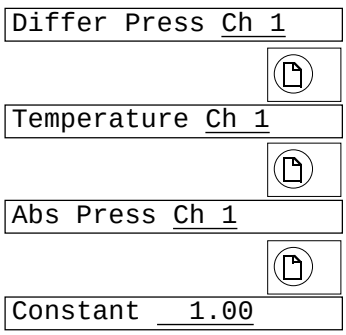
where: K = a scaling factor (see below)
Rg = specific gas constant in J/(kg-K) (see linear mass flow above)
Z = compressibility factor (see linear mass flow above)

SCALING FACTOR K
This is derived from the equation: $K = \frac{S}{\sqrt{ma_{max}}}$.

where: S = The full scale output from the flow meter
ma_{max} = the full scale input of the channel which is reading the flow meter output

CONFIGURATION PAGES

Enter the differential pressure, absolute temperature and the absolute pressure channels and the constant



3.2.2 LEVEL 2 EQUATIONS (Cont.)

ZIRCONIA PROBES

A zirconia (oxygen) probe consists of two platinum electrodes bonded to a pellet or cylinder of zirconia. At elevated temperatures, such a probe develops an emf across it which is proportional to probe temperature and to the log of partial pressure of oxygen difference between its two ends.

OXYGEN CONCENTRATION MEASUREMENT

In order to measure oxygen concentrations, one end of the probe is inserted into the atmosphere to be measured, while the other is subjected to a reference atmosphere. For most applications, air provides a suitable reference (reference input = 20.95% for air).

The temperature of the probe is usually measured using a type K or a type R thermocouple. The temperature effect on the thermocouple is such that for successful operation with the recorder, the probe temperature must be greater than 973K (700˚C).

The probe output obeys a law, described by the Nernst oxygen equation:

$$E_{(Volts)} = \frac{RT}{4F} \times \ln \frac{P_1}{P_2}, \quad \text{or, rewritten: } P_2 = \frac{P_1}{e^{\left(\frac{46.42\,E}{T}\right)}}$$

where, R = Universal Gas Constant, 8.3143×10^{3} J/K/kMOL

F = Faraday Constant, 9.64867×10^{4}

P_2 = Partial pressure of oxygen in the sampled gas (%)

P_1 = Partial pressure of oxygen in the reference atmosphere (%) (20.95% for air)

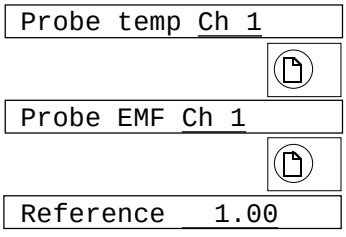
E = Electromotive force across the probe (the *"E"* in the rewritten equation is in **mV** from the sensor).

T = Probe temperature in Kelvins

In order to obtain a useful result, it is necessary to scale the inputs and outputs correctly. The channel measuring the probe voltage will normally need a scale of 0 to 100 mV. The temperature measuring channel will probably be scaled at 273 to 1800K, while the output scaling would typically be 0 to 5 % for boiler flues, and 0 to 20% in kilns.

CONFIGURATION PAGES

Enter channel numbers for Probe temperature, Probe emf and reference % measurements.



3.2.2 LEVEL 2 EQUATIONS (Cont.)

ZIRCONIA PROBES (Cont.)

OXYGEN POTENTIAL MEASUREMENT

The oxygen potential of an atmosphere is a measure of its ability to oxidise or reduce. For any element, a value of oxygen potential (free energy of formation) is known. Above this value, the material will oxidise, below it, no oxidation will occur.

Oxygen potential is given by the equation:

$$Op = 0.00457 \; X \; T \; X \; logOp'$$

where, Op = Required oxygen potential (kilocalories)
T = Probe temperature (Kelvin)
Op′ = Partial pressure of oxygen in the reference atmosphere in atmospheres

It can be shown that, because oxygen potential of air is essentially constant over the range 870 to 1450 Kelvins, the probe output is proportional to the oxygen potential of an atmosphere according to:

between 870 to 1450 K.

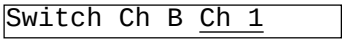
$$E = (10.84 \; X \; T) \; + \; 40mV$$

Thus it is possible to measure oxygen potential directly from a zirconia probe, using a standard input channel of the recorder, scaled in units of oxygen potential.

A typical input range would be 40 to 1124 mV, with a scale of 0 to -100 kilocalories. Such scaling would be appropriate over the temperature range 873 to 1473 K (600 to 1200 ˚C).

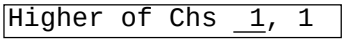
SWITCH

This function copies one of two channel values according to the state of its 'Select channel B for NN' job. I.E. if the relevant switch is active, copy the value of source channel B, else copy the value of source channel A.



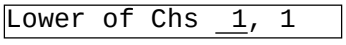
HIGH SELECT

This function has two channel inputs, and copies whichever has the higher value.



LOW SELECT

This function has two channel inputs, and copies whichever has the lower value.



STOPWATCH

The stopwatch starts counting as soon as the function is configured. The stopwatch can be held (disabled) by a maths pack 'job, (disable channel NN) and can also be reset to zero (Reset channel NN). The value is normally displayed as a number of 1/4 seconds, but if one of the date/time formats described in section 3.3 is selected, the value can be displayed in hours/minutes/seconds. When logged to the chart, it will appear in the specified format .

3.2.2 LEVEL 2 EQUATIONS (Cont.)

TIME STAMP

When triggered by a maths pack job (Trigger channel NN) becoming active, the time stamp reads the current time and date from the system clock and holds it. The time or the date can be displayed according to the configured value format.

Note: The display format selected affects only the value displayed, not the internal value of the channel. This internal value is a number of 1/4 seconds elapsed either since enabled (stopwatch) or since the 1st January 1988 (Time stamp). This allows time stamp functions to be processed in the maths pack. For example, two channels, each with a time stamp as its value can be subtracted from one another to give the time between the stamps, and this can be displayed as elapsed time if so configured in the Value Format page.

OXYGEN (O_2) CORRECTION

This function carries out O_2 correction of gas measurements for use in Continuous Emissions Monitoring (CEM) applications.

The equation calculated is:

$$Qmt = \frac{20.9\% - Spec\ O_2}{20.9\% - Meas\ O_2} \times Meas.\ gas$$

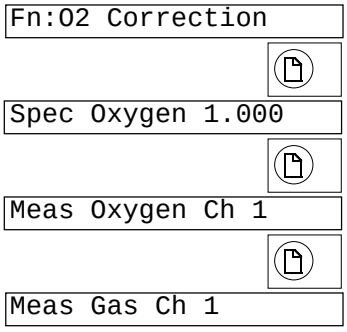
where,

Spec. O_2 = specified oxygen entered as a constant 5-digit value (prescribed for the particular process).
Meas. O_2 = measured oxygen, entered as a channel number (gas analyzer input)
Meas. gas = the measured gas, entered as a channel number (gas analyzer input)

NOTE - If the measured O_2% were to go below the specified O_2%, the above calculation will result in a compensated gas measurement that is **less than the actual measured gas value**. **This may not be allowed by some regulatory agencies.**

To prevent the calculated value from going lower than the measured value, add a "High Select" DV channel with inputs from the measured gas channel and the O_2 calculation above (*Qmt*). Since this DV selects the highest of its two input values, the actual measured gas channel value will be chosen when the *Qmt* calculation is lower. This High Select is now the compensated gas DV channel to be displayed, recorded, etc. rather than the above *Qmt* calculation.

CONFIGURATION PAGES

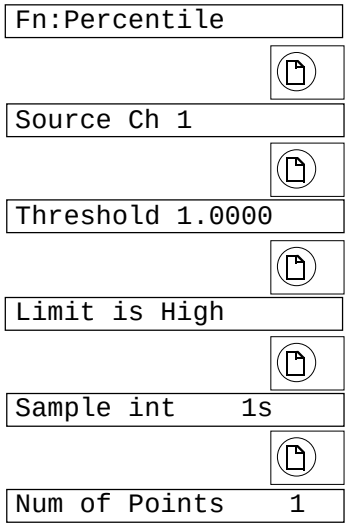


3.2.2 LEVEL 2 EQUATIONS (Cont.)

PERCENTILE

This function looks at a specifiable number of the most recent samples of a specified channel. It continuously calculates the percentage of these samples which are equal to or which lie within a specifiable limit. The limit can be a high limit or a low limit. (e.g. - the percentage of the last 20 samples that are equal to or less than 100˚F).

Once the specified number of samples has been reached, the oldest sample is discarded and the percentage re-calculated with each new sample. The sample rate can also be specified.



Scroll through 'high' and 'low'

Use minimum number of points you can, to save memory space.

3.3 CONFIGURATION

Figure 3.3 is an overview of the maths pack configuration pages

The configuration technique for derived channels is similar to that described for measuring channels in the Installation and Operation manual. Input and derived channels share the following parameters:

Channel units	Five character user definable string	
Trace	On, off	
Line thickening*	On, off	
Color	Selectable from those available	
Span	A and B	
Tag	14-character tag	
Alarms	Type, threshold, jobs	
Value format	Level 1 & 2 Functions:	Five digits with configurable decimal point position.
	Level 3 Functions	Two digits (positive) or one digit (negative) plus the exponent (-9 to 9).

* Not graphics units

MATHS PACK UNIQUE PARAMETERS

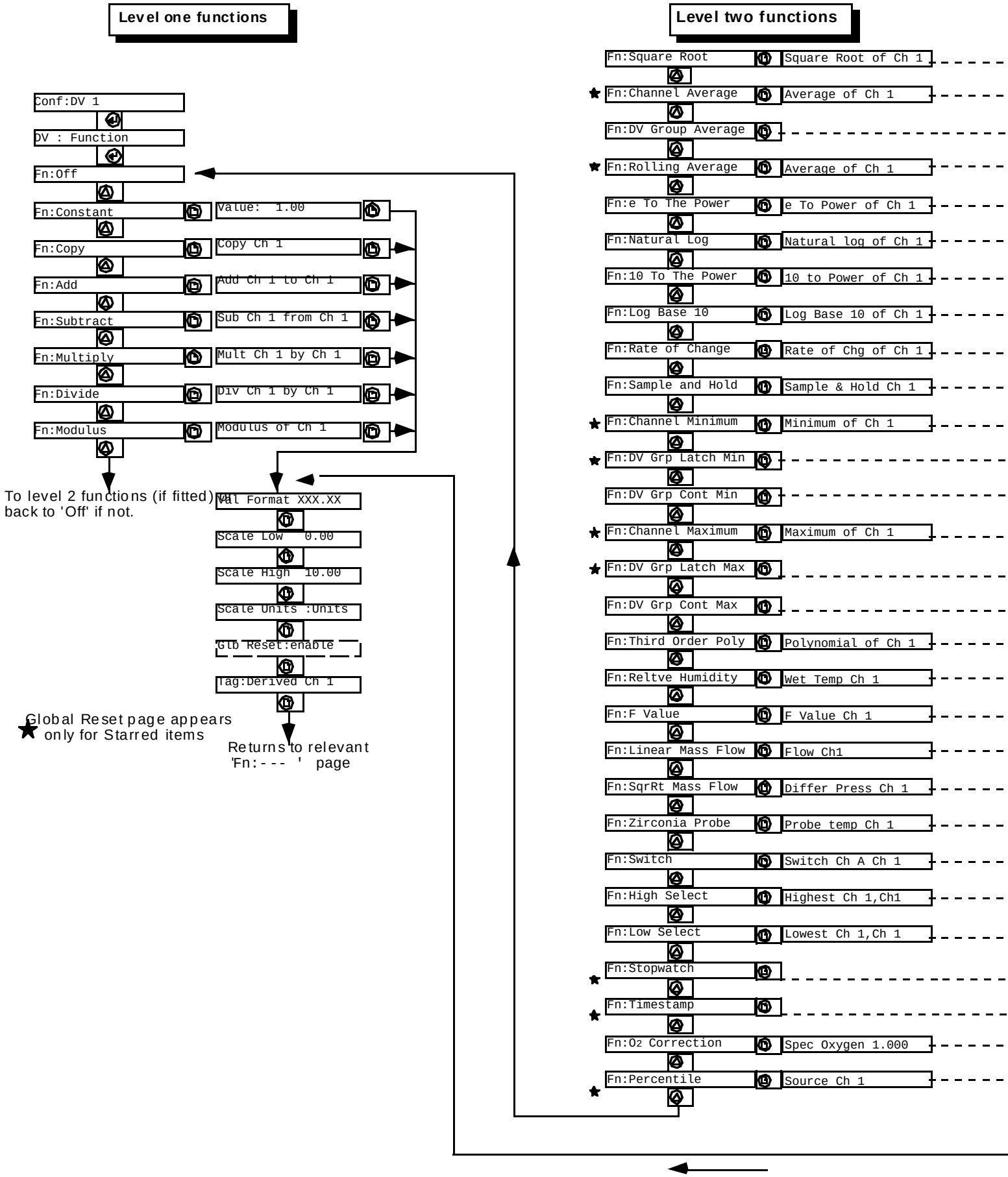
GROUP RESET ENABLE

Allows resettable functions to be made susceptible to group reset.

LEVEL 2 VALUE FORMATS

Value format — Five digits with configurable decimal point position.
Time as HH:MM:SS (Time part of time stamp function, or elapsed time for the stopwatch).
Date as DD/MM/YY or MM/DD/YY (Date part of Time Stamp function). Date format is defined as a part of instrument configuration.
Elapsed time as HH:MM:SS. If the period is 100 hours or more, the format changes to HHHHH:MM.

Note: If a DV is configured with one of the above Date, Time or Elapsed formats, it will be displayed as -----, but will be logged on a separate line in the chosen format.


Level one functions
Level two functions
Conf:DV 1
DV : Function
Fn:Off
Fn:Constant
Value: 1.00
Fn:Copy
Copy Ch 1
Fn:Add
Add Ch 1 to Ch 1
Fn:Subtract
Sub Ch 1 from Ch 1
Fn:Multiply
Mult Ch 1 by Ch 1
Fn:Divide
Div Ch 1 by Ch 1
Fn:Modulus
Modulus of Ch 1
To level 2 functions (if fitted) or back to 'Off' if not.
Val Format XXX.XX
Scale Low 0.00
Scale High 10.00
Scale Units :Units
Glb Reset:enable
Tag:Derived Ch 1
Global Reset page appears only for Starred items
Returns to relevant 'Fn:--- ' page
Fn:Square Root
Square Root of Ch 1
Fn:Channel Average
Average of Ch 1
Fn:DV Group Average
Fn:Rolling Average
Average of Ch 1
Fn:e To The Power
e To Power of Ch 1
Fn:Natural Log
Natural log of Ch 1
Fn:10 To The Power
10 to Power of Ch 1
Fn:Log Base 10
Log Base 10 of Ch 1
Fn:Rate of Change
Rate of Chg of Ch 1
Fn:Sample and Hold
Sample & Hold Ch 1
Fn:Channel Minimum
Minimum of Ch 1
Fn:DV Grp Latch Min
Fn:DV Grp Cont Min
Fn:Channel Maximum
Maximum of Ch 1
Fn:DV Grp Latch Max
Fn:DV Grp Cont Max
Fn:Third Order Poly
Polynomial of Ch 1
Fn:Reltve Humidity
Wet Temp Ch 1
Fn:F Value
F Value Ch 1
Fn:Linear Mass Flow
Flow Ch1
Fn:SqrRt Mass Flow
Differ Press Ch 1
Fn:Zirconia Probe
Probe temp Ch 1
Fn:Switch
Switch Ch A Ch 1
Fn:High Select
Highest Ch 1,Ch1
Fn:Low Select
Lowest Ch 1,Ch 1
Fn:Stopwatch
Fn:Timestamp
Fn:O2 Correction
Spec Oxygen 1.000
Fn:Percentile
Source Ch 1

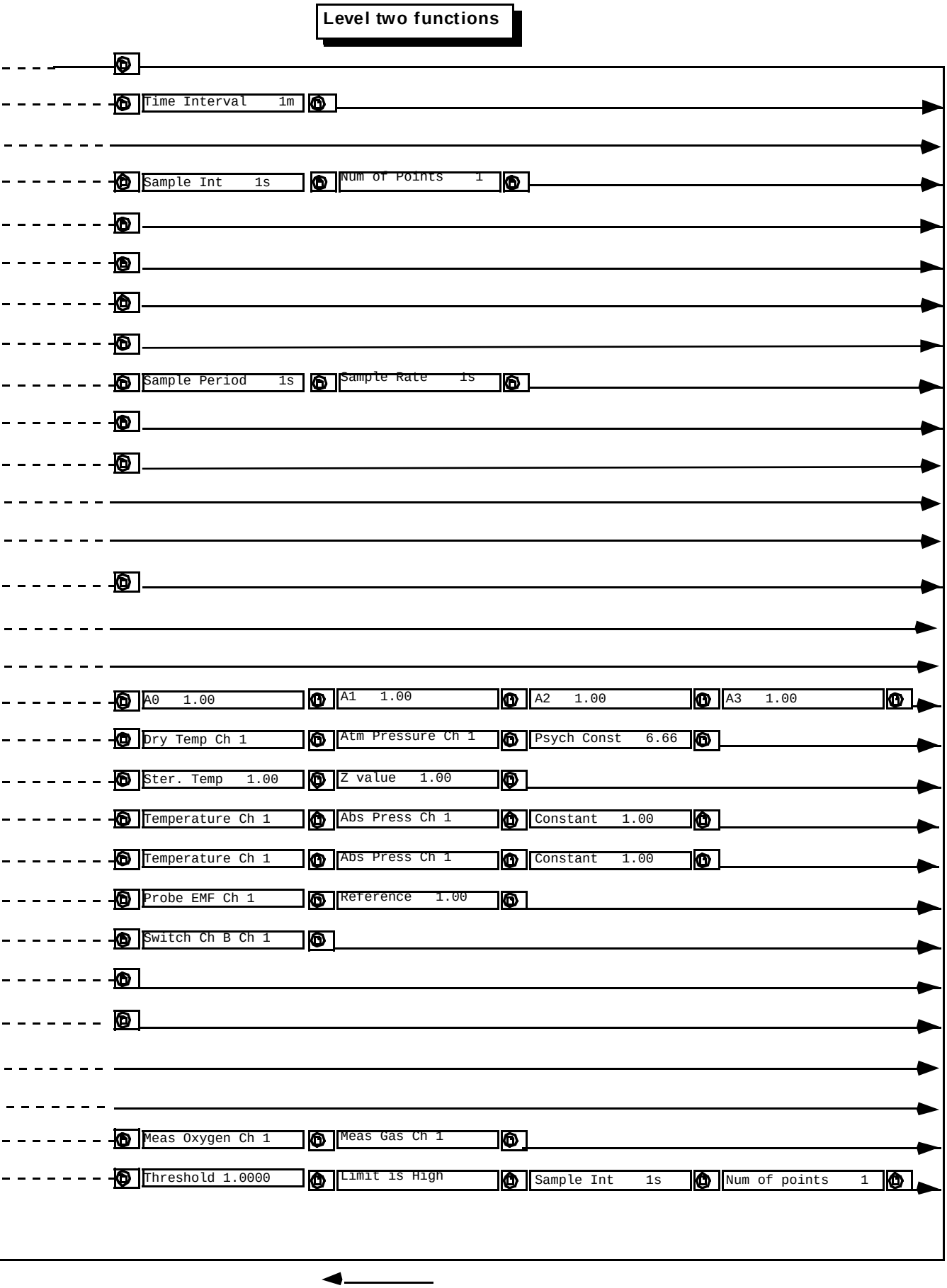


Figure 3.3 Maths pack configuration menu structure

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4 TOTALIZERS, COUNTERS AND TIMERS

4.1 INTRODUCTION

The Totalizer, Timer/Counter and Totalizer/Timer/Counter options supply up to six each of 9-digit (8-digit when decimal point used) totalizers, 8-digit counters and clock timers.

4.2 TOTALIZERS

4.2.1 Source types

Each totalizer can integrate a given input or derived channel's value providing this value is between the totalizer's configured low cut-off point and high cut-off point and within the channel's configured range.

4.2.2 Alarms

An alarm threshold can be set up for each totalizer, and each threshold can have up to two jobs associated with it. A 'limit' setting defines whether the job list is to be initiated when the totalizer value lies above (high) or below (low) the threshold value. Up to two jobs can be initiated by the alarm.

4.2.3 Display

The Display Group (described in the Installation and Operation Manual) is initially empty. With the TCT option, totalizers can be included in the display group with identifiers t1 to t6. It is up to the user to include totalizers in each group as required.

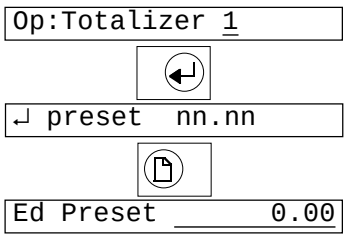
The value and units of each totalizer in the Display Group are displayed, in turn, in the 20-character text area. (The decimal point position is set up in the 'Value Format' configuration page.) Operation of the page key displays the totalizer tag and units instead.

4.2.4 Tracing on the chart (maths pack level 1 required)

To trace the value of a totalizer on the chart, it must be imported into a derived channel (using the 'Copy' function), and the derived channel then traced.

4.2.5 Operator pages

If operator access is allowed, the operator can preset individual totalizers, and can edit the preset value.



4.2.6 Totalizer configuration

Configuration is carried out using the normal techniques described in the Installation and Operation manual. Figure 4.2.6 below, shows the configuration pages.

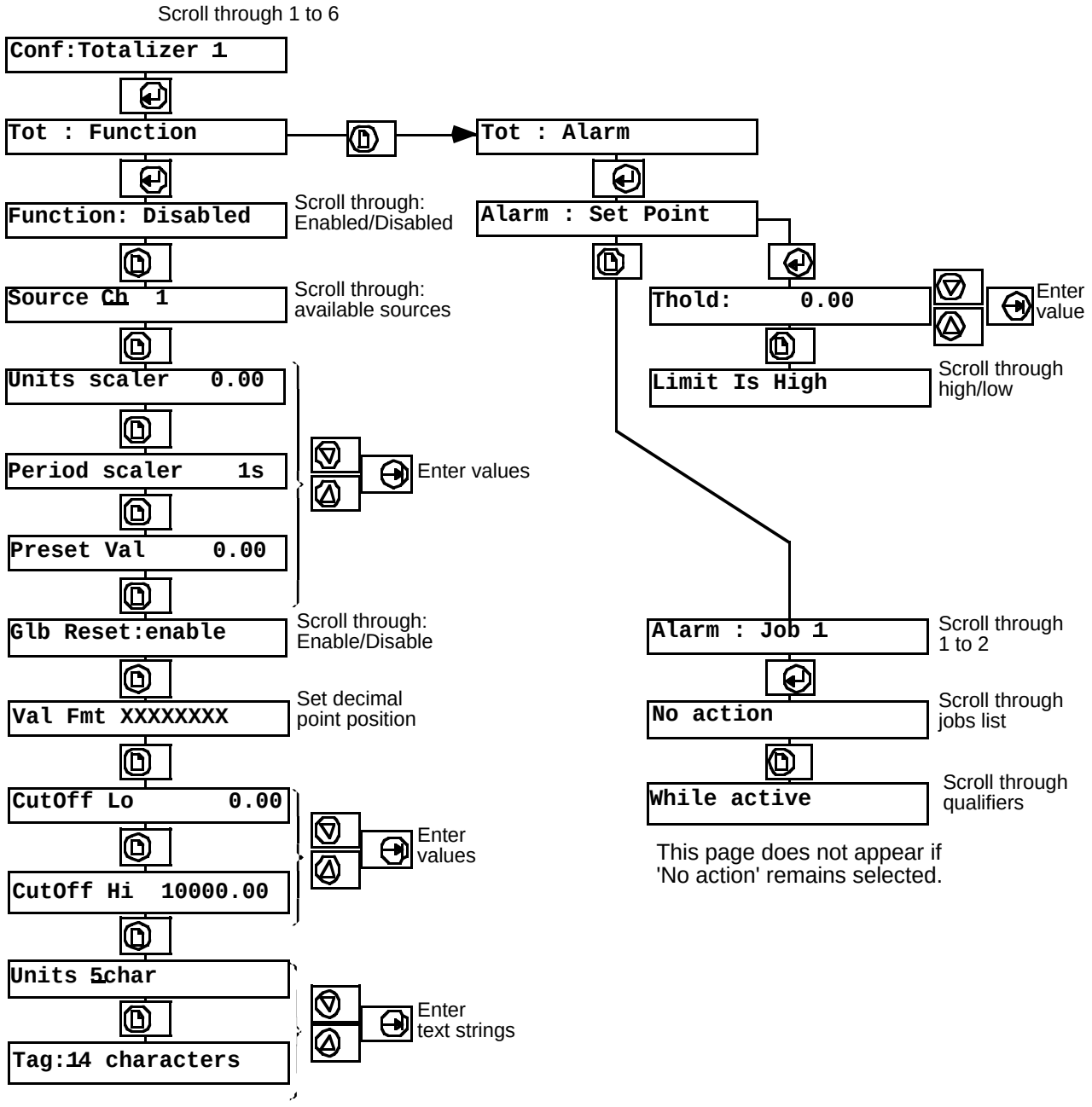


Figure 4.2.6 Totalizer configuration

4.2.6 TOTALIZER CONFIGURATION (Cont.)

Source — Allows input channels or derived channels to be selected as totalizer sources

Units scaler — Allows the counting to be scaled. For example, if the input to a storage tank is gallons/min and the totalizer value is to be gallons x 10^3 (i.e. one count for each thousand gallons), then the units scaler would be set to 1000. A units scaler greater than 1.0 causes the totalizer to run slower by the size of the scaler (counts divided by scaler). A units scaler less than 1.0 causes the totalizer to run faster.

Period scaler — The totalizer reads the source channel value every second. The period scaler defines the time value of the input units (/sec, /min, /hr, etc). **Except as (*) below, the period scaler is ALWAYS the number of seconds**. For example, if the input is in gallons/minute, then the period scaler would have to be the number of seconds in a minute (60). The larger the period scaler, the slower the totalizer counts.

Examples

Measured Value	Units Scaler	Period Scaler	Each Count Is
Pounds per Second	1.0000	1	1 Pound
Pounds per Second	1000.0	1	1000 Pounds
Standard Cubic Feet per Minute	1.0000	60	1 Cubic Foot
Gallons per Hour	1.0000	3600	1 Gallon
Gallons per Hour	100.00	3600	100 Gallons
Millions of Gallons per Day	10.000*	8640*	1 Million Gallons*
Millions of Gallons per Day	0.0100**	8640**	1000 Gallons**

* The period scaler would normally be 86,400 (the number of seconds in a day), but the entry for the period scaler only allows a maximum of 4 digits. This means that 86,400 cannot be entered directly. A 4-digit period scaler of 8640 is 10 times too small and makes the totalizer count 10 times too fast. However, also changing the units scaler to 10 makes the totalizer count 10 times slower and makes the millions in the totalizer correct (10 X 8640 = 86,400).

** Since it is unlikely that anyone would want each count on a totalizer to represent a million gallons, the units scaler can be reduced by a factor of 1000 resulting in a totalizer that counts in 1,000's of gallons (0.01 X 8640 = 86.400).

Preset value — Allows the entry of a nine-digit (eight digit when decimal point is used) number from which the totalizer will count. Totalizers can be set to their preset values, either individually or as a group, by job action or individually by the operator, if access permission is granted. See also 'Glb Preset Disable' immediately below. Preset to 0.000000 "resets" the totalizer.

Glb Reset — Allows each totalizer to be configured to be susceptible to global reset (Enable) or not (Disable).

Val format — Allows the decimal point position to be specified using the up and/or down arrow keys.

Cut Off Lo(Hi) — Allows cut-off values to be entered, below (above) which the totalizing function will be disabled.

Units — Allows a 5-character text string to be entered to describe the totalizer units.

Tag — Allows a 14-character descriptive text string to be entered.

ALARM PAGES

Threshold — Allows a value to be entered to act as an alarm trigger.

Limit — Defines whether the alarm triggers when the totalizer value is ≥ the threshold (absolute high alarm) (limit = high) or ≤ the threshold (absolute low alarm) (limit = low)

Jobs — The following jobs are added to the scroll list given in Section 4.1.5 of the Installation and Operation manual:
Preset Tot N
Preset all Tots
Disable all Tots

4.3 TOTALIZER COUNTER OUTPUT

The totalizer counter output option provides a pulse output to an assigned relay which is scaled to the count on the associated totalizer. There are two entries for this feature (see figure 4.2.6).

O/P (output)factor: divide the totalizer value, e.g. a factor of 100 outputs a pulse every 100 totalizer counts. A factor of 0.00 disables the output.

Pulse Relay "n" of card "n":

4.4 COUNTERS

4.4.1 Introduction

The counter options supply six, eight-digit counters which are controlled from other recorder functions through job lists. The following jobs are added to the list given in section 4.1.5 of the Installation and Operation Manual. They can all be triggered when the source goes active, goes inactive or on alarm acknowledgment, as configured:

1. Increment Counter N
2. Decrement Counter N
3. Preset counter N
4. Preset all counters
5. Disable all counters

Each counter can be configured with a threshold value to enable it to trigger up to two jobs itself. A 'limit' input allows a job list to be initiated either when the counter value ≥ the threshold (limit high) or when it is ≤ the threshold (limit low).

4.4.2 Tracing on the chart (maths pack level 1 required)

To trace the value of a counter on the chart, it must be imported into a derived channel (using the 'Copy' function), and the derived channel then traced.

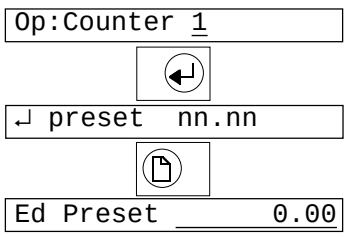
4.4.3 Display

The Display Group (described in the Installation and Operation Manual) is initially empty. With the TC or TCT option, counters can be included in the display group with identifiers Co1 to Co6. It is up to the user to include counters in the group as required.

The value and units of each counter in the Display Group are displayed, in turn, in the 20-character text area. (The decimal point position is set up in the 'Value Format' configuration page). Operation of the page key displays the counter tag and units instead.

4.4.3 Operator pages

If operator access is allowed, the operator can preset individual counters, and can edit the preset value. Initiation of preset can also be carried out by job action on individual channels or on all channels simultaneously.



4.4.4 Configuration

Configuration is carried out using the normal techniques described in the Installation and Operation manual. Figure 4.3.4, shows the configuration pages.

Preset	Eight digit value of preset, entered using the up and down arrows. The preset value is loaded into the counter by job or by operator action.
Units	Allows a 5-character units string to be entered using the up/down arrows and cursor key.
Glb preset	Allows each counter to be defined as being susceptible to global reset (enable) or not (disable).
Tag	Allows a 14-character descriptive tag to be entered for each counter.

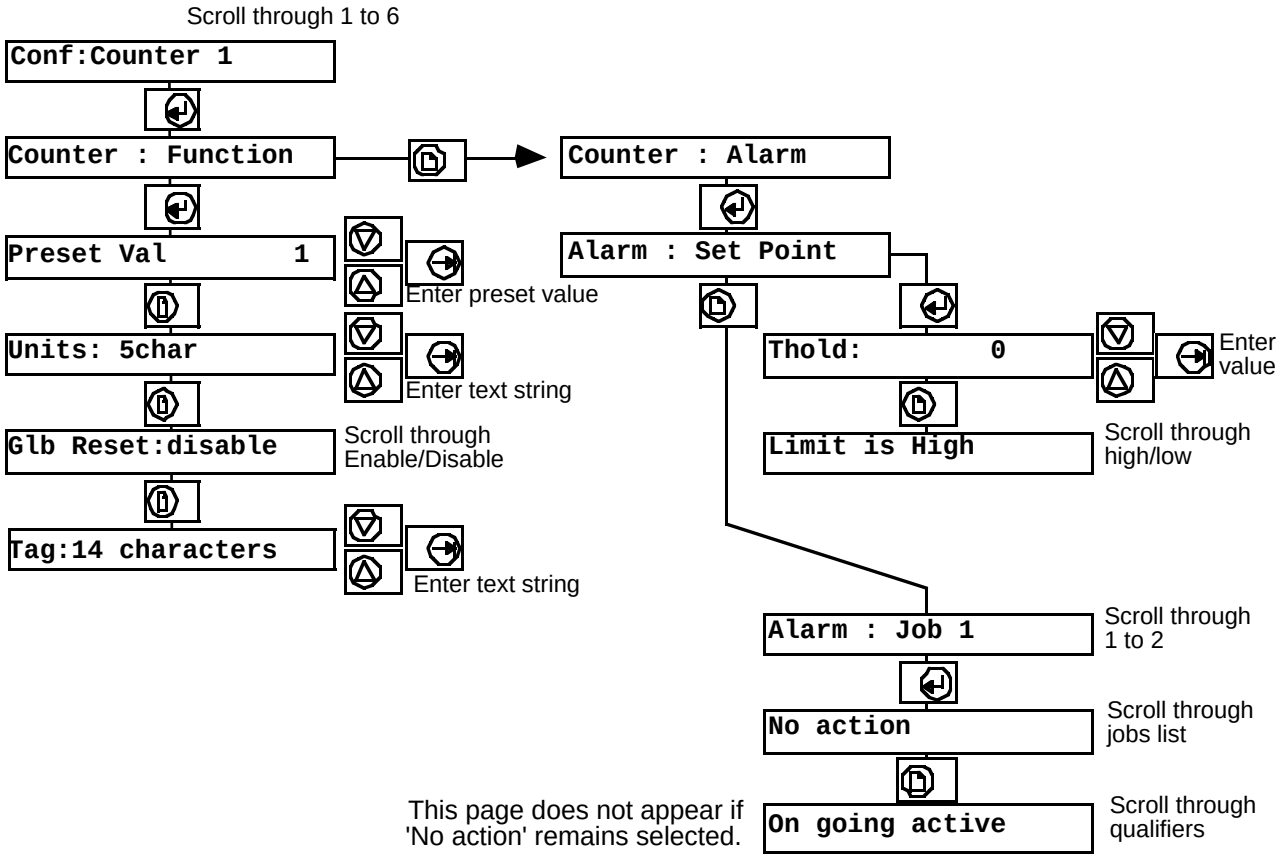


Figure 4.3.4 Counter configuration

ALARM PAGES

Threshold	Allows a value to be entered to act as an alarm trigger.
Limit	Defines whether the alarm triggers when the counter value is ≥ the threshold (absolute high alarm) (limit = high) or ≤ the threshold (absolute low alarm) (limit = low)

4.5 TIMERS

4.5.1 Introduction

The timer options supply six timers, each of which can be configured to start at a specific time and date relative to the real-time clock in the recorder. Once initiated, the timer will run for a configurable time period (duration) and repeat at a configurable rate. Alternatively, the timer can be initiated by a job, and it will then repeat at the configured repetition rate. Once initiated, the timer will re-start every repeat period until it is disabled.

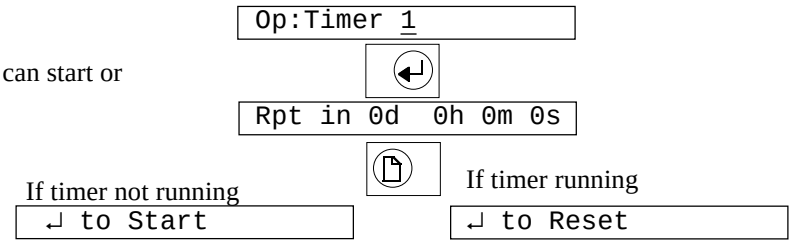
Each timer can have up to two jobs associated with it, and continuous jobs (e.g. chart speed change) remain active for the full time of the timer duration period. "One shot" jobs (e.g. resetting a totalizer) can be defined to occur as the timer is "going active" or "going inactive".

The timer options add the following jobs to the list given in the Installation and Operation Manual:

Start specified timer - resets and starts timer
Reset specified timer - resets but does not start timer

4.5.2 Operator pages

If access permission is granted, the operator can start or reset a timer



4.5.3 Configuration

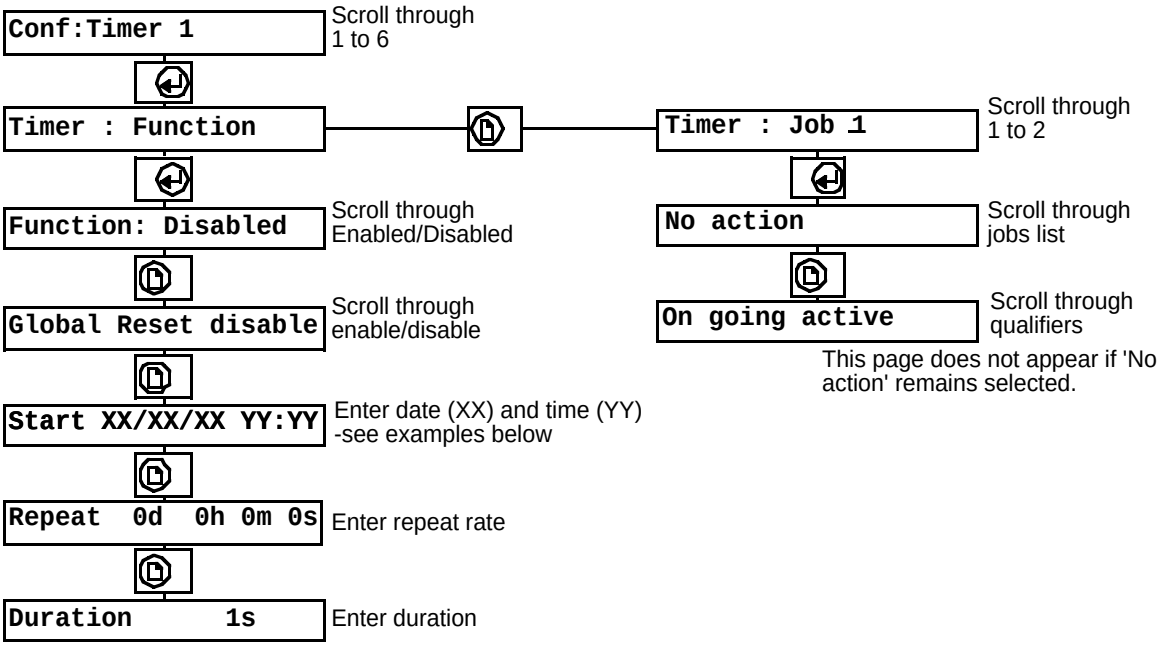


Figure 4.4.3 Timer configuration pages

4.5.3 TIMER CONFIGURATION (Cont.)

Function	Allows the timer to be switched on or off
Global reset	Allows each timer to be configured to be susceptible to global reset (enable) or not (disable)
Start	Allows a date and time to be entered for the timer to start. If an entry is left as XX, the timer will operate at the next smallest time unit. If all entries are left as XX, the timer can be started only by job or by operator action
Repeat	Allows a repeat period to be entered. If entries are left as zeros, the timer does not repeat.
Duration	Allows a duration period to be entered for the timer

JOBS PAGES

Allows up to two jobs to be entered for the timer to trigger.

4.5.4 Timer examples

1. To start a timer at mid-day on the 1st of each month:

```
Start XX/01/XX 12:00
```

2. To start a timer every hour, on the 1/2 hour, starting at 12:30 on 31st December:

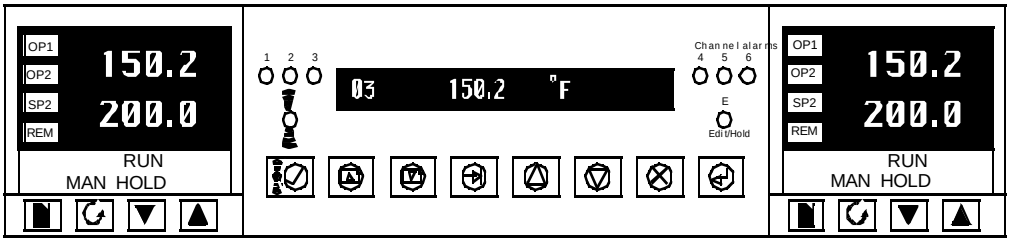
```
Start 31/12/XX 12:30
```

```
Repeat  0d  1h 0m 0s
```

5 CONTROLLERS

5.1 INTRODUCTION

One or two precision PID temperature controllers with self-tuning in a 1/16 DIN size can be mounted within the recorder (see figure 5.1). These controllers are fitted with a single-contact alarm relay and may be specified with one or two outputs. Outputs can be either relay, triac or dc current (refer to the temperature controller manual for specifications). Controllers are fully user configurable. Controller measurements **<u>can be</u>** used as recorder inputs. Recorder channels **<u>can not</u>** be used as controller inputs. **<u>Controllers can not be fitted on D.C. powered recorders.</u>**



Controller 1 Figure 5.1 Controller 2

5.2 VIEWING ON RECORDER CHANNEL

In the Channel Menu under Range / Input Type "Cont1" or "Cont2" can be selected. This selection couples the controller measured value (PV) into the recorder channel. This value can then be traced, alarmed, used in calclulations like a direct input to a channel. Any recorder channel (1 to 6) can display a controller value even if no direct input was ordered for that channel, (e.g. a recorder ordered as a 4-input recorder can display controllers on channels 5 and 6).

5.3 WIRING - OUTPUT AND PV DATA

Controller power input, PV data and other outputs are pre-wired during manufacture. Controller output connections are made by the user to the option controller interface pcb located in the bottom right hand area of the case interior. (see Figure 5.3). These terminals are identified with the same designations as are shown in the temperature controller manual.

5.4 WIRING - USER INPUT - T/C, RTD, MA, VOLTS OR MV

Controller signal inputs are connected directly to the temperature controller terminals VI, V+ and V- (see figure 5.2). Refer to the temperature controller manual - sensor input connections. The signal input connections will accept wire sizes from 16 to 22 awg (0.5 to 1.5 square mm). Figure 5.4 details the recommended routing of the signal input connections to the temperature controllers. Plastic fasteners are provided to secure signal input cable routing.

Controller communications setup parameters are:

Protocol: Modbus
Slave address: 1- for controller 1
2- for controller 2
Baud rate: 19200
Data bits: 8
Stop bits: 1
Parity: none

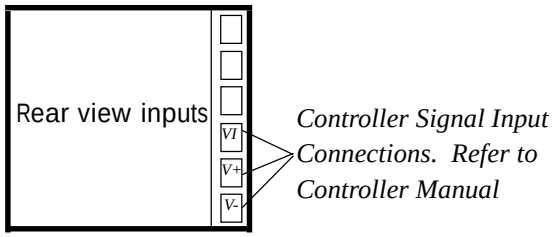


Figure 5.2

5.4 WIRING
(continued)

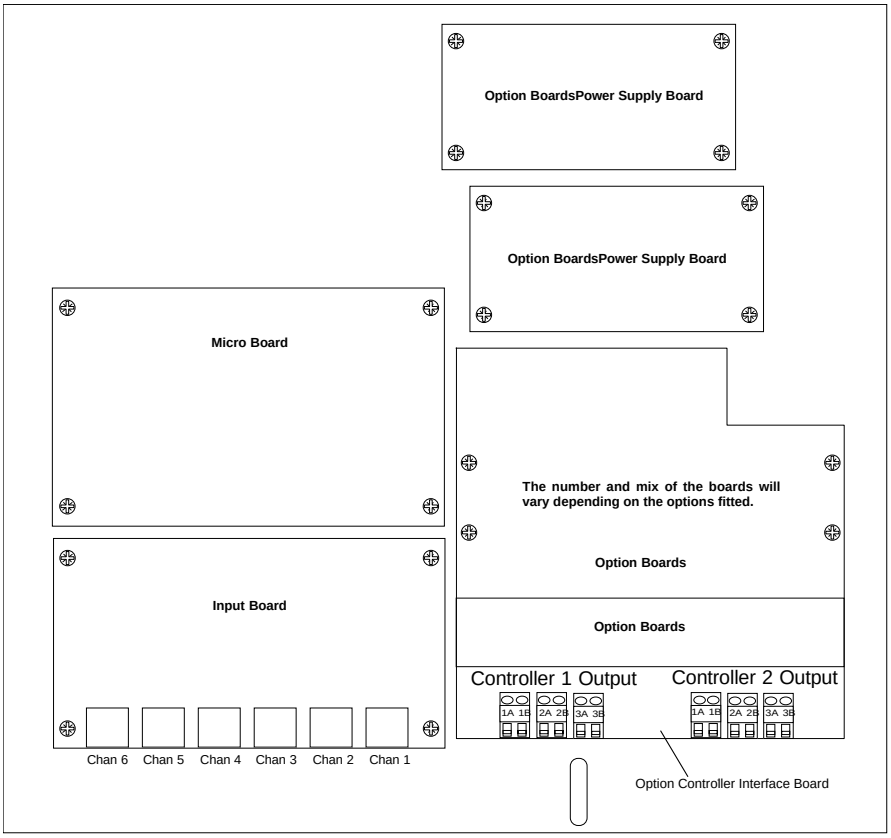


Figure 5.3

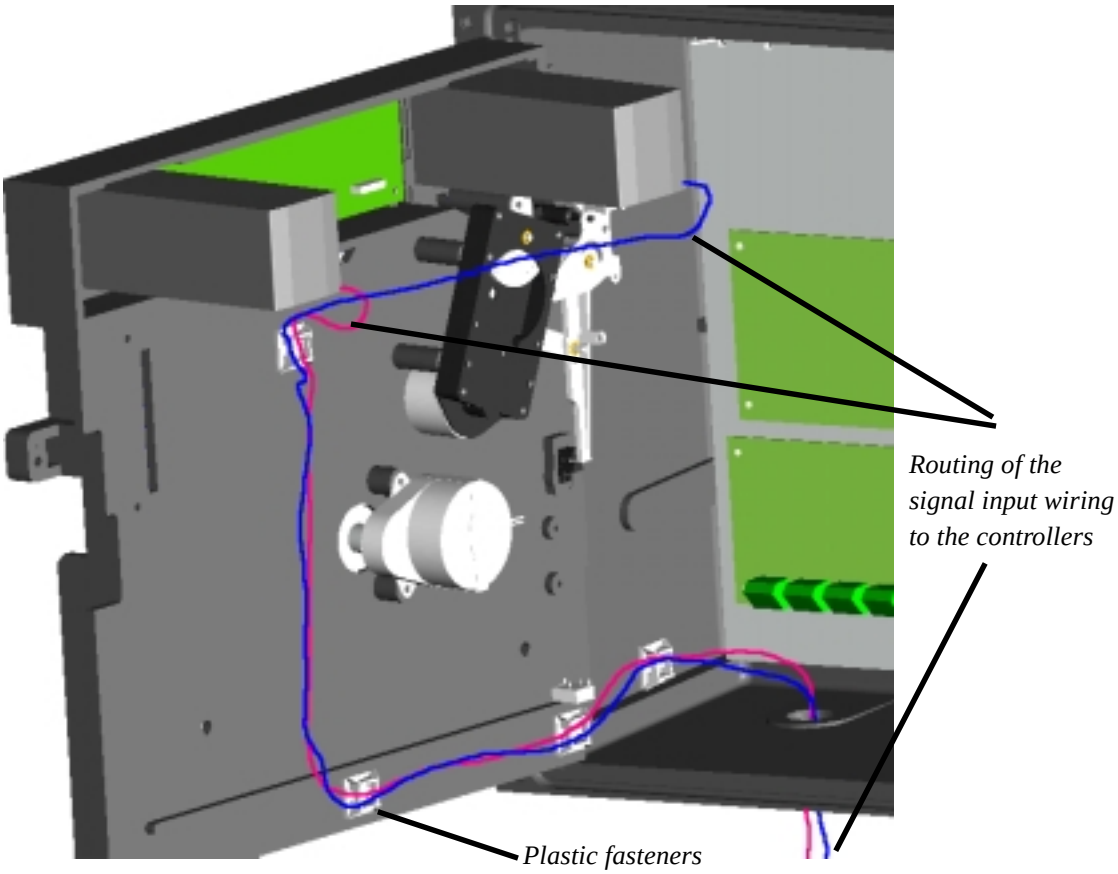


Figure 5.4

5.5 SPECIFICATIONS

Input

General	Range	±100mV and 0 - 10Vdc (auto ranging)
	Sample rate	9Hz (110ms)
	Calibration accuracy	0.25% of reading, ±1 LSD, ±1˚C/F
	Resolution	<1µV for ±100mV range, <0.2mV for 10Vdc range
	Linearization accuracy	<0.1% of reading
	Input filter	1.0 to 999.9 seconds
	Zero offset	User adjustable over the full display range
Thermocouple	Types	J, K, T, L, N, C, R, S, B & Platinell II
	Cold junction comp.	Automatic: typically >30 to 1 rejection from 20˚C
RTD	Type	Platinum 100, DIN std. 0.00385 Ω/Ω/˚C
	Excitation current	0.2mA
	Lead compensation	Up to 22Ω in each of 3 equal resistance leads
V/mV	Range	±100mV and 0 - 10Vdc (user configurable with these limits)

Outputs

Relay	Rating	Min: 12V @ 100mA, Max: 2A @ 264 Vac resistive
Triac	Rating	1A resistive @ 264 Vac
Analog	Range	Isolated, 0 to 20 mA configurable (load 600Ω max.), 12Vdc limit

Control Functions

Control	Modes	PID or PI with overshoot inhibition, PD, PI, P only or On/Off
	Auto/manual	Bumpless transfer
	Setpoint rate limit	0.01 to 99.99 degrees (or display units per minute)
	Cooling algorithms	Linear, Water (non-linear), Fan (minimum on time), Oil, proportional only
Tuning	One-shot tune	Automatic calculation of PID and overshoot inhibition parameters
	Automatic droop comp.	Automatic calculation of manual reset value when using PD control
Alarms	Types	Full scale high or low, Deviation high, low or band
	Modes	Latching or non-latching, Normal or blocking action
		up to 4 process alarms can be combined onto a single output

General

	Display	Dual, 4-digit x 7-segment high intensity LED
	Dimensions & weight	48mmW x 48mmH x 103mmD (1.89" x 1.89" x 4.06"); 250g (8.82oz)
	Supply	100 to 240Vac (-15%,+10%), 48 to 62Hz, 10 Watts max.
	Environmental	Operating: 0 to 40˚C (32 to 104˚F) (ambient with controller)
		5 to 90%RH (non condensing), storage -10 to 70˚C
	Panel sealing	IP65, NEMA 4X
	Electromagnetic compat.	EN50081 general emissions for industrial environments
		EN50082-2(95) standards for industrial environments
	Safety standards	EN61010, installation category 2 (voltage transients not to exceed 2.5kV)
	Atmospheres	Electrically conductive pollution must be excluded from the controller cabinet
		Not suitable for use above 2000m (6,562ft) or in corrosive or explosive areas

6 CUSTOM LINEARIZATION TABLE

6.1 INTRODUCTION

This option allows the user to enter a linearization function of up to 32 points, which can then be used instead of the standard linearizations supplied with the recorder ('User' added to Lin Type list in Channel Range configuration).

The curve must be monotonic (i.e it may have only one y value for each x value entered) and the x inputs must increase in value as they are entered. The points do not have to be equally spaced, so if the curve varies in gradient, more points can be entered round any 'knees', leaving the recorder to interpolate in areas where the gradient is more constant.

The curve is entered as pairs of points, one representing the input value which will be applied to the recorder (X), the other the output value (Y) which is to appear on the chart.

6.2 CONFIGURATION PAGES

The following set up shows how to enter a $y = x^3$ output function using inputs of -5 to +5.

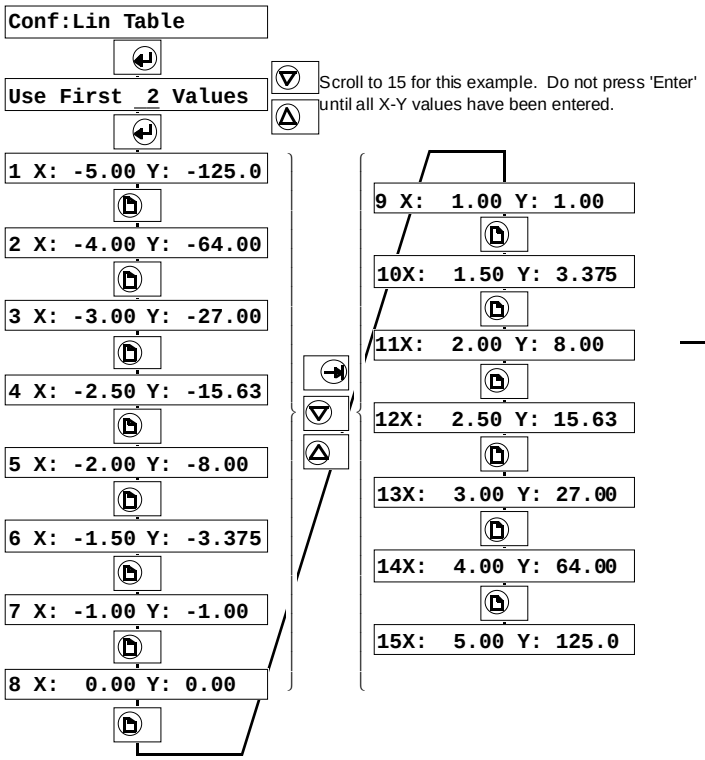


Figure 6.2a
Linearisation table configuration pages

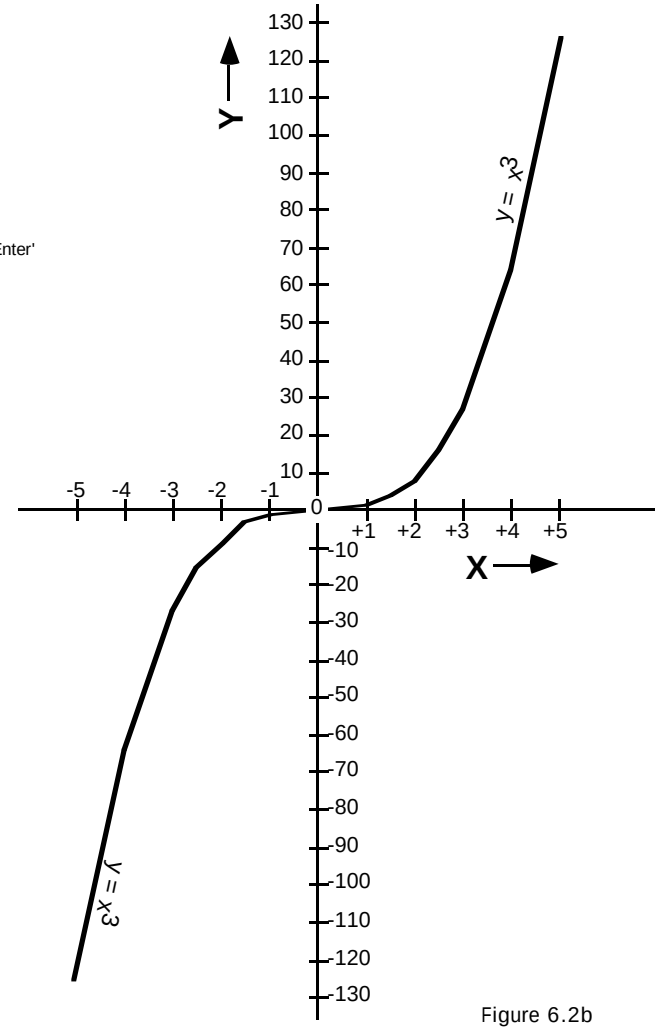


Figure 6.2b
$y = x^3$ function

7 SERIAL COMMUNICATIONS

7.1 INTRODUCTION

This option provides the means for establishing an RS244/RS485 serial communications link with a host computer, using the Gould Modicon MODBUS protocol. The option comes on a single board (one of three option boards). For communication parameter (e.g. Baud rate) setting, see Section 7.3 below.

7.1.1 Safety isolation specification

Safety isolation	(dc to 65Hz; BS EN61010)
Installation category II;	Pollution category 2 (see page 2 for definitions)
Terminals to ground:	100 V RMS or dc (basic insulation)

7.2 WIRING

7.2.1 Pinout

Only one communications board may be mounted in any one of the three option positions. Figure 7.2.1 gives termination details for both connectors.

Note: The PU (pull up) output is 5V with a series 1000Ω resistor.

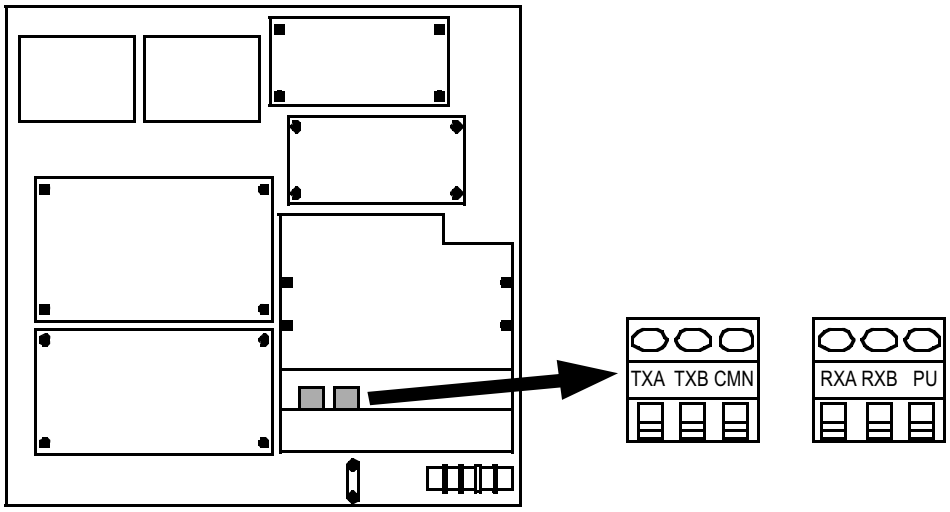


Figure 7.2.1 Communications option pinout

Communications terminal identifications vary, the following identifications are also used: TXA = (TX or TX+) and TXB = ($\overline{TX}$ or TX-); RXA = (RX or RX+) and RXB = ($\overline{RX}$ or RX-). Terminal "PU" is supplied by the "5 Volt" shown in Figure 7.2.2a and "CMN" is the "0 Volt" connection as well as the common connec3 tion for the transmit and receive lines. It should be connected to all instruments and to ground at a **single** point.

7.2.2 Termination and Biasing

If the communications line is left without a terminating resistor, reflected signals may interfear with communications.

In order to avoid this, a termination resistor is fitted across the line at the final instrument. If the value of this resistor is equal to the characteristic impedance of the cable (120 Ohms in this case), then the line appears to be of infinite length and no reflections occur. Such a value however, does not give the best signal-to-noise ratio, so a compromise value (220 Ohms) is chosen to give the optimum performance in reducing unwanted reflections and in improving the signal-to-noise ratio.

The recorder communications port is terminated as shown in figure 7.2.2a, below. In a single point-to-point application, it may be necessary to terminate the instrument with a 220Ω resistor. In multi-drop systems, only the final unit should be terminated in this way, otherwise the transmitted signal levels may be reduced to an unacceptable level.

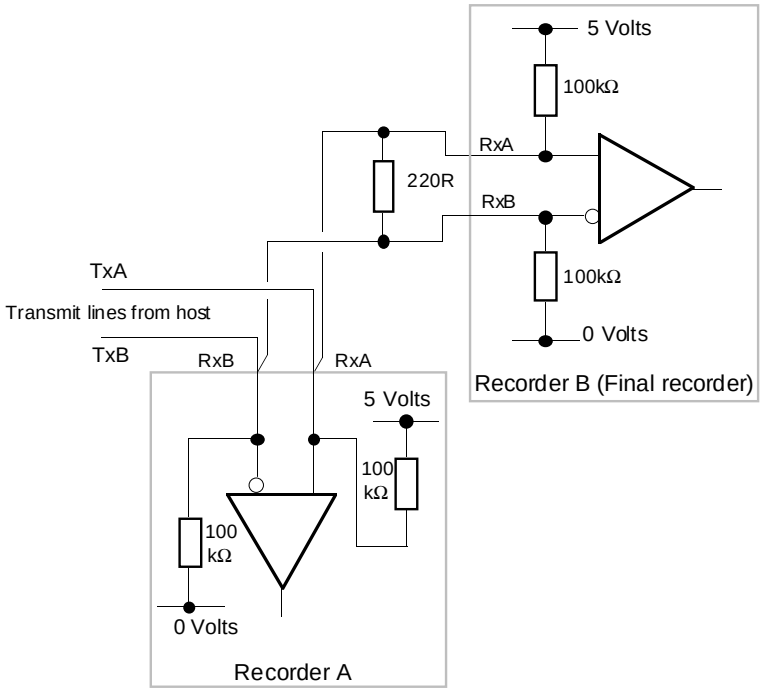


Figure 7.2.2a System termination and biasing
(for clarity, only transmit lines are shown,
the 100K resistors are built into the circuit board)

HOST COMPUTER

When not communicating, the instrument outputs go to a high-impedance state to allow multi-drop connection. This will cause a problem if the host computer is not fitted with biasing resistors to pull these essentially open circuit lines to their idle states as defined for the RS422/RS485 standards. To overcome such problems, external biasing resistors can be fitted as shown in figure 7.2.2b (a) below.

With long cable runs it may also be necessary to terminate the transmission line. Figure 7.2.2b (b) shows how this may be done using external biasing resistors. Such a circuit is for use where the host receiver does not have its own internal biasing arrangements. Where the host does have its own internal biasing, the fitting of a 220Ω resistor across the receive inputs (figure 7.2.2b (c)) will terminate the line correctly.

7.2.2 TERMINATION AND BIASING (Cont.)

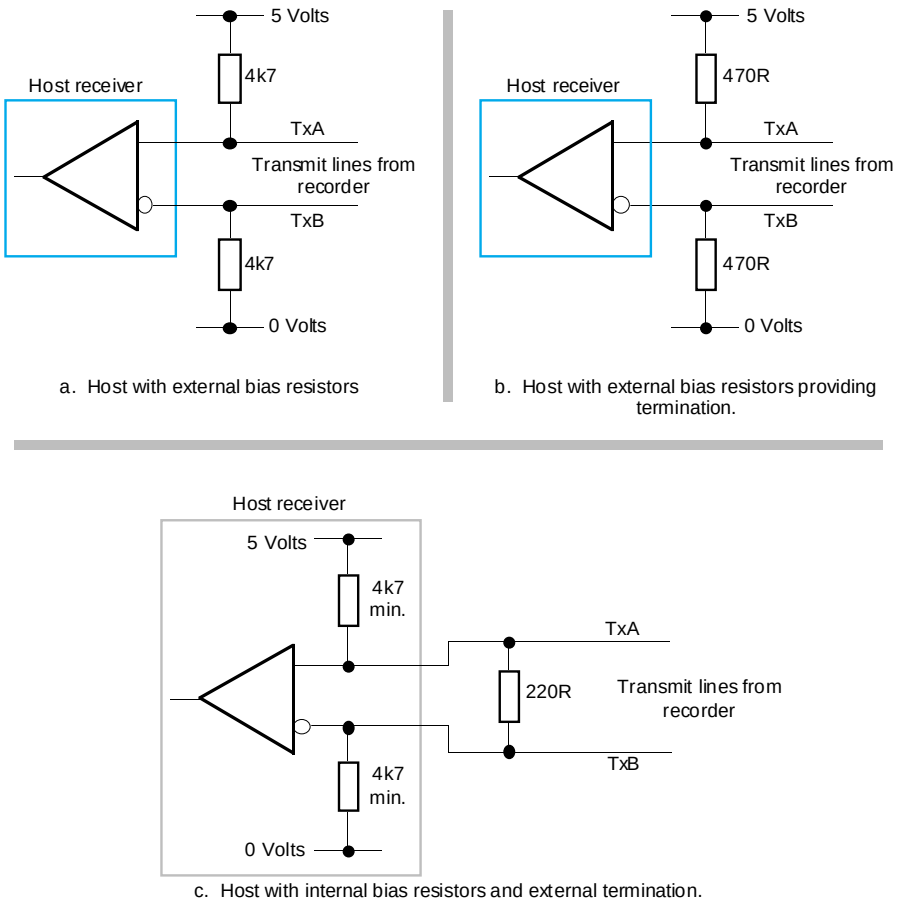


Figure 7.2.2b Host computer termination and biasing

7.3 CONFIGURATION PAGES

The configuration pages (figure 7.3) allow the Baud Rate, Parity, Nº of stop bits and the instrument address to be set up:

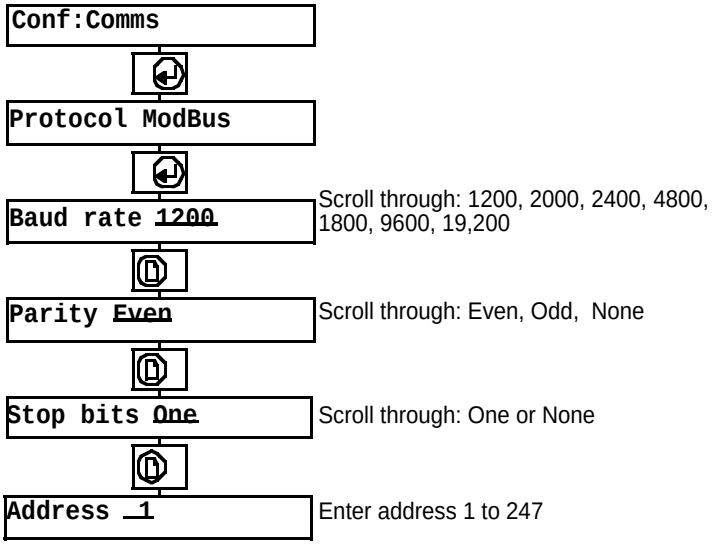


Figure 7.3 Configuration pages

7.4 GOULD MODICON MODBUS PROTOCOL

7.4.1 Introduction

When connected to a host computer the recorder acts as a slave Modbus device. The unit address (1 to 247) being set up as a part of the recorder's communications configuration. Only a limited number of function codes have been implemented (ref. Modbus protocol manual) and these are listed in section 7.4.4

7.4.2 Channel addressing

The channel 1 address listed in table 7.4.4 is the base address at which channel 1 may be accessed.

Note: Addressing starts at zero, whilst channel numbers start at 1

Example: to read a digital input at channel 23, the required address passed with the code 01 would be 22

If an alarm is set for an input or derived channel, the associated alarm parameters can be read using code 03

Example: To read the set point of absolute alarm 1 on channel 8, the required address passed with code 03 should be 1257 (1250 = channel 1; 1251 = channel 2 etc.).

The interpretation of alarm parameters (A1 to A4 and SP1 to SP4 in table 7.4.4) depends on alarm type as follow

ALARM TYPE	PARAMETER	DEFINITION
Absolute	A1 to A4	Not used
Absolute	SP1 to SP4	Setpoint values
Deviation	A1 to A4	Deviation Values
Deviation	SP1 to SP4	Setpoint values
Rate	A1 to A4	Rate value
Rate	SP1 to SP4	Period value (secs)
Digital	A1 to A4	Not used
Digital	SP1 to SP4	0000 = Open; FFFF = Closed

Table 7.4.2 Alarm parameter definition

Note: Any request to read a nonexistent setpoint value will result in the value 0000 being returned. This should not be taken to mean that the setpoint is at 0.000

7.4.3 Reading analog inputs

The values read are in the range 0000 to FFFF. To obtain the scaled relative value, the following calculation must be carried out where the analog input is in hex:

In the event of a hardware error or under-range value, the value is forced to scale zero. Should the analog value be over range, the scaled value is forced to scale high.

7.4.4 Function codes

CODE	FUNCTION	RECORDER ACTION	CHANNEL 1 ADDRESS (DECIMAL)
01	Read coil status	Digital input state (true = >0.5)	0
02	Digital read input status	Digital input state (true = < 0.5)	0
		Input alarm 1 status	250
		Input alarm 2 status	500
		Input alarm 3 status	750
		Input alarm 4 status	1000
		Derived alarm 1 status	1250
		Derived alarm 2 status	1500
		Derived alarm 3 status	1750
		Derived alarm 4 status	2000
03	Read holding register	Analog input value	0
		Analog input A1 (Table 7.4.2)	250
		Analog input A2 (Table 7.4.2)	500
		Analog input A3 (Table 7.4.2)	750
		Analog input A4 (Table 7.4.2)	1000
		Analog input SP1 (Table 7.4.2)	1250
		Analog input SP2 (Table 7.4.2)	1500
		Analog input SP3 (Table 7.4.2)	1750
		Analog input SP4 (Table 7.4.2)	2000
		Derived channel A1 (Table 7.4.2)	2250
		Reserved (always returns 0000)	2500
		Derived channel A2 (Table 7.4.2)	2750
		Reserved (always returns 0000)	3000
		Derived channel A3 (Table 7.4.2)	3250
		Reserved (always returns 0000)	3500
		Derived channel A4 (Table 7.4.2)	3750
		Reserved (always returns 0000)	4000
		Derived channel SP1 (Table 7.4.2)	4250
		Reserved (always returns 0000)	4500
		Derived channel SP2 (Table 7.4.2)	4750
		Reserved (always returns 0000)	5000
		Derived channel SP3 (Table 7.4.2)	5250
		Reserved (always returns 0000)	5500
		Derived channel SP4 (Table 7.4.2)	5750
		Reserved (always returns 0000)	6000
		Input channel status (read only) (flags - see code 04)	6250
		Derived channel status (read only) (flags - see code 04)	6500
		Instrument status (read only) (flags - see code 07)	6750
		Print mode	7000
		0 = Trace priority	
		1 = Text priority	
		2 = Text only	

Table 7.4.4 Modbus implementation channel addresses (Sheet 1: codes 01 to 03)

7.4.4 FUNCTION CODES (Cont.)

CODE	FUNCTION	RECORDER ACTION	CHANNEL 1 ADDRESS (DECIMAL)
04	Read input register	Analog input value	0
		Input channel status	250
		No bits set: Channel OK Bit 0 set: Channel off Bit 1 set: Over range Bit 2 set: Under range Bit 3 set: Hardware error / bad PV Bit 4 set: Ranging error / no data Bit 5 set: Overflow Bits 6 to 15: Always 0.	
		Derived channel value	500
		Reserved (returns 0000)	750
		Derived channel status	1000
		(Bits 0 to 15 as for Input channel status above)	
		Instrument status (flags - code 7)	1250
05	Force single coil	Sets digital input state for comms channel	0
		0 = 0.000; 1 = 1.000	
06	Preset single register	Preset holding register	As code 03
		(Presets values for comms channels only)	
07	Read exception status	Read instrument status Bit 0: System error Bit 1: Writing system failure Bits 2 to 7 Always 0	
08	Loopback test	Diagnostic code 0 (Echoes message as sent)	
15	Force multiple coil	Sets digital input code for comms channels in	0
		address range. 0 = 0.000; 1 = 1.000	
16	Preset multiple registers	Preset holding register for each channel in	As code 03
		address range. (Presets values for comms channels only)	
16	Print text string	In addition to the above code 16.	7250
		Data quantity is the total number of characters in the text string (including color commands) divided by two (must have an even number of characters. The text string must consist of no more than 39 characters and may contain no more than 10 colour commands of the form !n, where n is a numeric character from 1 to 6 as shown in the table below. Text is printed in black unless otherwise commanded The '!' character may not be used as a text character. MSB is printed first.	

n	Color
1	Red
2	Green
3	Green
4	Blue
5	Blue
6	Black

Table 7.4.4 Modbus implementation channel addresses (Sheet 2)

7.4.4 FUNCTION CODES (Cont.)

65	Enter XMODEM mode	Holds 1 byte of data specifying which mode to enter 0 = standby; 1 = Receiver; 2 = Sender
66	Report XMODEM error	Returns 1 byte of data as follows: 0: Transfer OK - no errors 1: Restore failed completely File was incompatible or comms failed to transfer the file, Original configuration unchanged. 2: Restore failed on data. Some records ignored, but transfer mostly successful. 3: Restore failed on transfer Some config. transferred before failure. New configuration undefined 16: Save had no reply from comms and timed out 32: Save failed before transfer completed
		EXCEPTION RESPONSES
01	Illegal function	Unsupported or illegal Modbus function 0
02	Illegal data address	Data address out of range for instrument config ..... 0 Attempt to preset input value of non comms channel Invalid configuration data
03	Illegal data	Data value out of range for function
06	Illegal busy	Configuration transfer in progress via another port so unable to action function

Table 7.4.4 Modbus implementation channel addresses (Sheet 3)

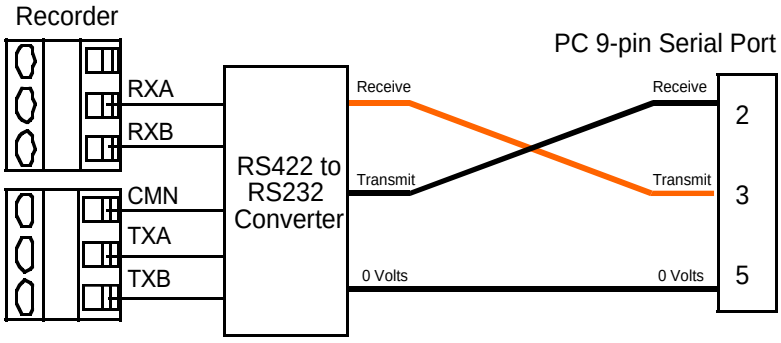
7.5 XMODEM TRANSFER

XMODEM transfers take place between a host computer and a single instrument to save or restore configuration.

The transfer procedure is as follows

1. Place any other instruments on the communications link into standby mode.
2. Set the required recorder to sender or receiver mode as appropriate.
3. Send or receive file at host.
4. 10 seconds after completion, host communications is restored to normal use.

Note: 10 seconds of inactivity on the communications link, at any point in the procedure, will cause the host communications to return to normal use for instruments in standby mode.



recorder - to - PC wiring for transfer using configuration program

Figure 7.5.1

8 MEMORY CARD

8.1 INTRODUCTION

Note: Most of the memory card functions are not accessible to the operator until they have been enabled in the Memory Card Operator Access' configuration as described in section 8.5 of this manual.

The memory card is a static RAM (Random Access Memory) with battery back-up. The battery, located within the card, maintains the data for a period which is dependent on card type. The instructions supplied with the card give details of storage periods and battery changing.

Files are stored in DOS format, and the SRAM card is PCMCIA type 1, revision 2 compatible. Configuration software, available from the manufacturer, to run on a PC, can be used in conjunction with the card (and a suitable reader) to create or modify configurations for subsequent down loading to the recorder.

Memory card functions are all available both from the configuration menu and from the operator menu (unless access permission has been denied - see section 8.5). The major functions of the Memory Card options are:

Save and restore option:	Configuration save and restore.
ASCII log option:	As above Save and Restore option but with ASCII Data logging.
Compressed log option:	As ASCII log but with PACKED data format.

E-Review software is included with PACKED format data to convert logs to ASCII format thus allowing manipulation of the data in PCs.

8.2 MEMORY CARD INSERTION

As shown in figure 8.2a, the memory card is inserted into a slot located at the top right corner of the chart platen. To insert the card, open the recorder door. Note that the instructions on the card "insert this edge" and "this side up" should be on the **right** side of the card as it is inserted. Push the card fully into the slot until the ejector button below the card slot moves out.
To remove the card, operate the card ejector button (shown below).

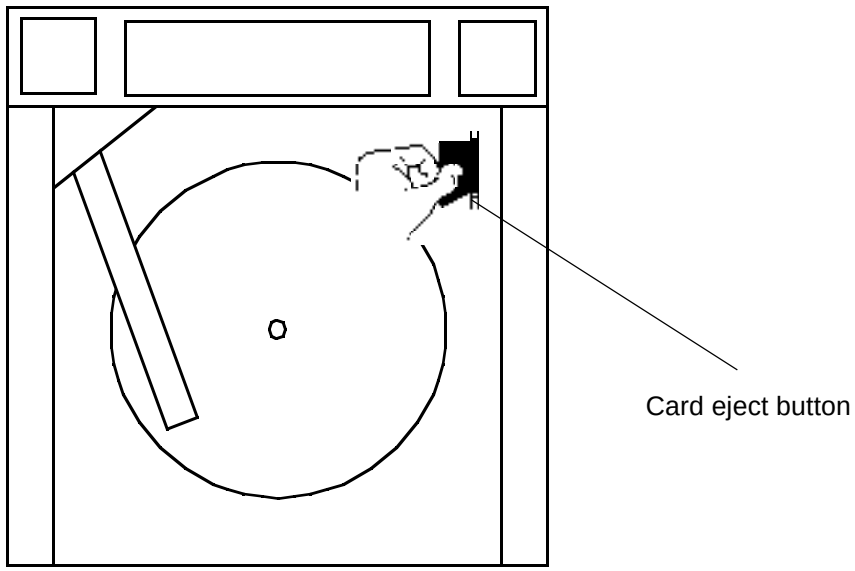


Figure 8.2a Memory card insertion

8 MEMORY CARD (Cont.)

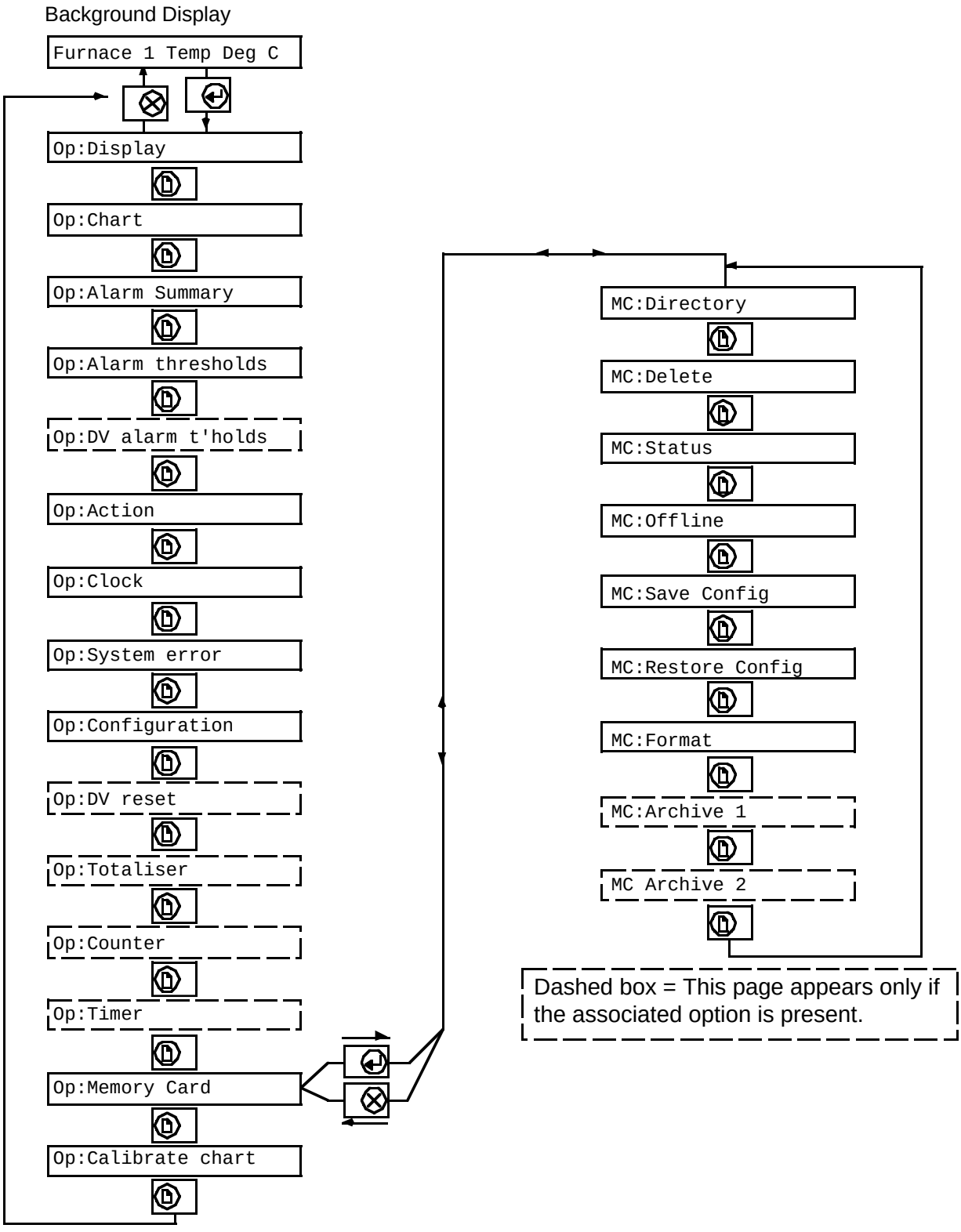


Figure 8.2b Memory card operator menu structure

8.2.1 Card formatting

Memory cards are tested prior to shipment and the battery removed to preserve its useful life. Before a memory card can be put into service, the battery must be installed following the instructions with the card. It then must be formatted by operating the 'Enter' key in the ' ↵ to FORMAT' display page as shown in figure 8.2.1 below.

Note: Any existing data on a card with a battery will be lost during format..

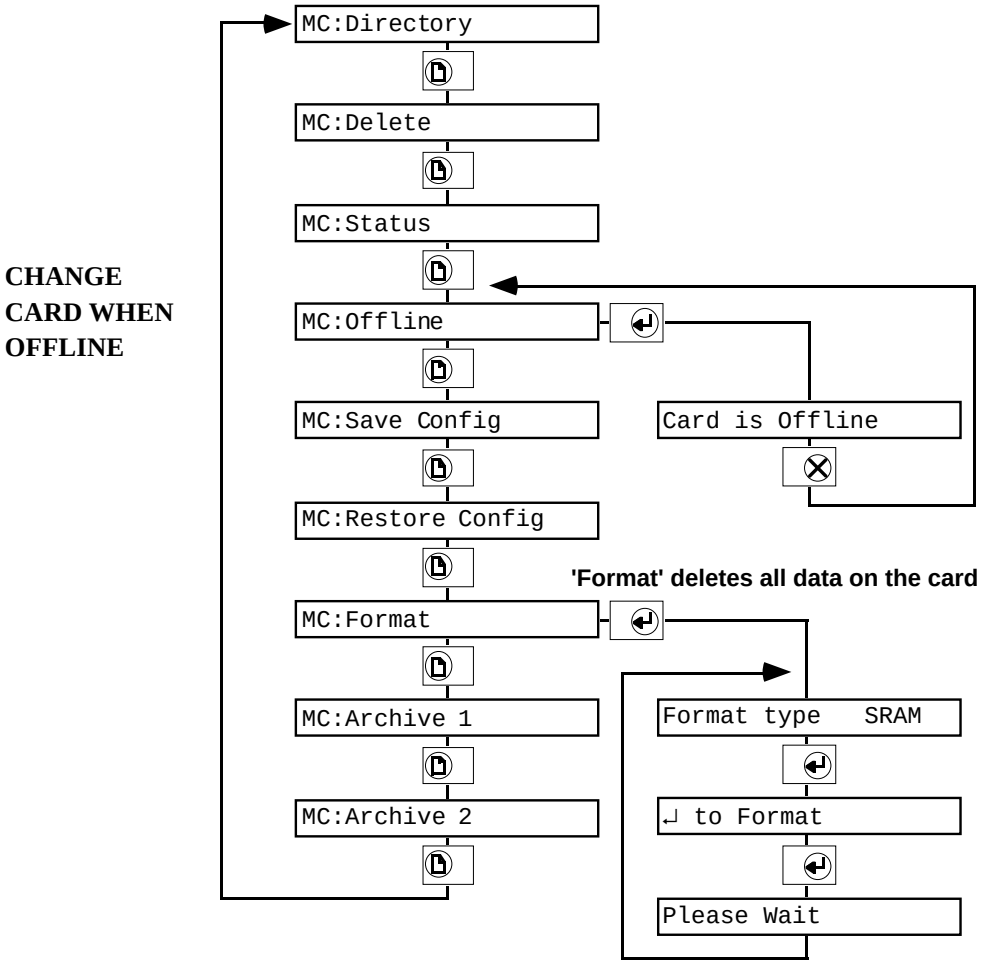


Figure 8.2.1 Card format and off-line menus

8.2.2 Changing cards

CAUTION: In order to ensure that no corruption of card data takes place while changing cards, it is recommended that access to the memory card be inhibited while card removal / insertion is carried out. This is done by setting the card off-line by operating the 'Enter key' in the MC: Offline page. See figure 8.2.1 above

The card comes back on line as soon as the operator quits the "Card is Offline" display.

8.3 CONFIGURATION SAVE AND RESTORE

8.3.1 Save

Operation of the 'Enter' key from the Save Config page, calls a Filename page which allows the entry of an 8-character (max) string as the Configuration's file name. The file extension ".CFG" cannot be changed.

Once the file name has been entered, a further operation of the 'Enter' key causes the configuration to be written to the memory card.

Should the filename already exist, an overwrite confirmation is requested. 'Enter' confirms overwrite, or Cancel returns to the filename page.

See section 8.7.1 for details of permitted file name characters (Only DOS format file names allowed).

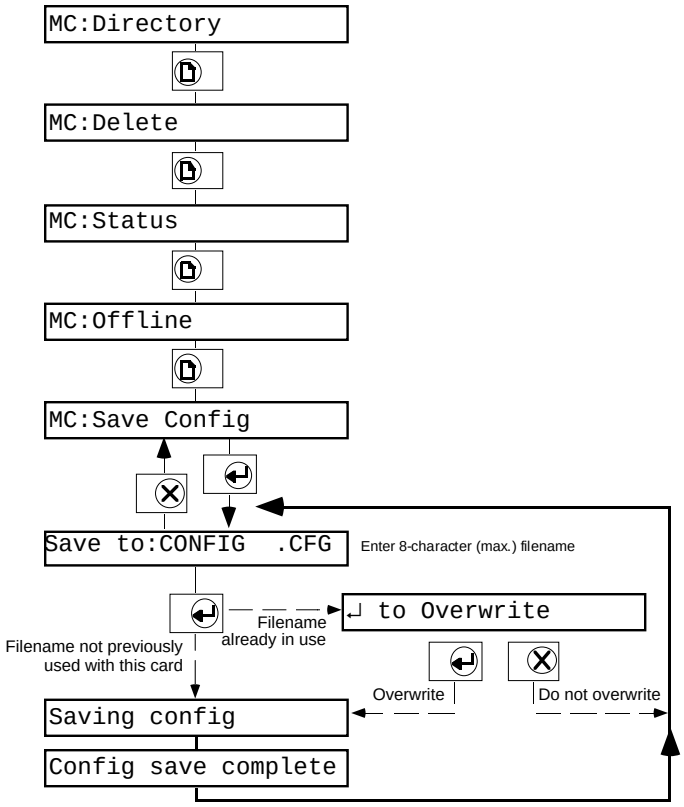


Figure 8.3.1

8.3.2 Restore

NOTE: All configuration information will be overwritten by the new configuration.

Operation of the 'Enter key from the Restore Config page, calls the filename page. This allows the names of all the files held on the card to be scrolled through using the down arrow key. Configuration files can be identified as they have .CFG as their extension

Once the required file name is displayed, a further operation of the 'Enter' key causes the configuration to be read from the memory card.

While the configuration is being read from the memory card, the message 'Restoring config.' is displayed.

Once the configuration read is complete, operation of the Clear (X) key causes the recorder to re-initialize and return to background display.

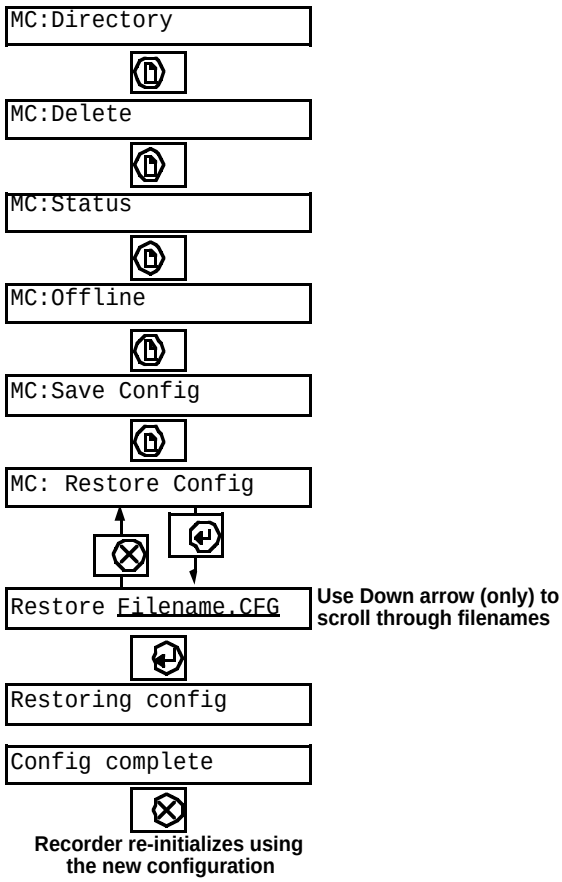


Figure 8.3.2

8.4 DATA LOGGING (ARCHIVE)

To set up a log of channel, derived variable (DV), totalizer or counter values, it is necessary to enter configuration and select group. Within the group menu choices are log 1 and log 2 in which these values can be specified. Refer to the 'Group Configuration' section in the Installation and Operation Manual for this recorder. A log is a "snapshot" of the values within the log group at one point in time. Log files may contain one or a large number of single logs (snapshots). Log files are written to the data card via archive 1 or archive 2. Log 1 is associated with archive 1 and log 2 with archive 2. Archive 1 is intiated by a job action only. Archive 2 is initiated by either a job action or by interval A or B. When a log is required to occur at a certain time every day, the timer option is a recommended solution in conjunction with log 1 and archive 1.

8.4.1 Archive Configuration

Logging to a data card file can be initiated by job, through operator action or, for log group 2, automatically at one of two configurable periods (archive intervals A and B). Under normal circumstances, interval A is used, interval B being selected by job action. More details can be found in section 4.1 of the Installation and Operation Manual supplied with the recorder.

When archiving automatically, log group 2 is sent to the file defined in Archive 2 configuration (see section 8.4.1). The log interval and starting point can be set (i.e. if an interval is entered as "01:00:00" at 8:27, logging will start on the next full hour and log each hour thereafter (e.g. 9:00, 10:00, 11:00, etc).

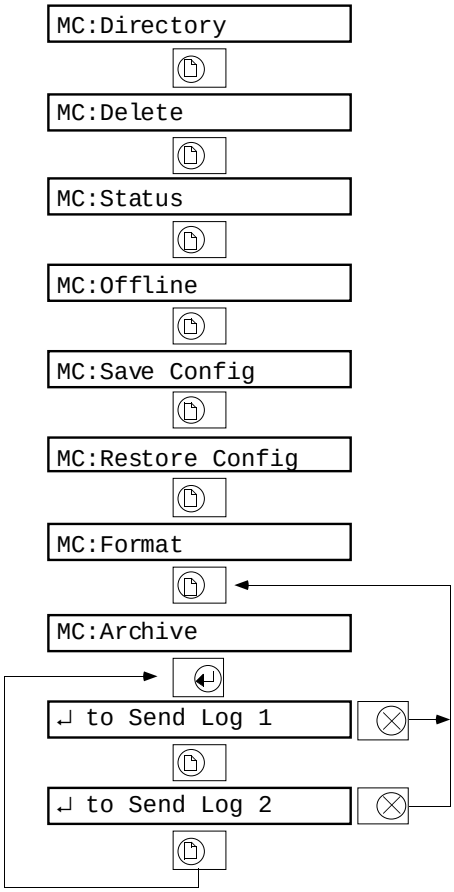


Figure 8.4.1 Operator Log initiation

According to which of the archiving options is chosen, data can be logged in ASCII format or in PACKED format which is a compressed format for high density data archiving. E-Review Software for running on a PC, is included with the packed data option to allow conversion of the compressed data into ASCII comma-delimited format, suitable for direct use with PC spreadsheet or word processing packages.

Note: See section 8.7 for details of permissible file names / types.

The Archiving operator pages (figure 8.4) allow only the initiation of the log. Entry of file names, archive interval, data type etc., is carried out using the configuration menus (figure 8.4.1).

File containing two input channels (2 and 3) including tags (TempVes1 and PressVes1) and units (˚C and bar respectively), with DD/MM/YY,HH:MM:SS date format. Column headers (Channel tags) included: "XXXXA", ,"2","3" "DD/MM/YY","HH:MM:SS","˚C","Bar" "Log",,"TempVes1","PresVes1" 29/02/96,12:15:06,28.93,0.989 29/02/96,12:16:04,28.71,0.963 (Where XXXXA is the recorder model number)	File containing two input channels (1 and 3) NOT including tags or units, with DD/MM/YY,HH:MM:SS date format. Column headers (Channel tags) included: "XXXXA", ,"1","3" ,, "Log",, 29/02/96,12:15:06,28.93,0.989 29/02/96,12:15:06,28.71,0.963 (Where XXXXA is the recorder model number)

Table 8.4.1 Examples of ASCII format files

8.4.1 ARCHIVE CONFIGURATION (Cont.)

With reference to menus in figure 8.4.1 following, and table 8.4.2, below, these configuration steps are possible:

File type	ASCII	Produces comma delimited columns of data. File name extension is .ASC (See table 8.4.1 above for examples)
	PACKED	Proprietary format. Data is stored in a compressed manner which requires reformatting software to extract data from it. File name extension is .PKD
File name type	Text	Fixed file name - see section 8.7.1.
	Hourly	New file opened hourly - see section 8.7.2.
	Daily	New file opened daily - see section 8.7.3.
	Counter	File name takes counter value - see section 8.7.4.
Include column titles	Yes/No	For ASCII files only. If YES, comma delimited column titles are sent depending on the 'Channel tag' and 'Instrument tag' fields in the Log Format Configuration described in the Installation and Operation Manual supplied with the recorder.
Date format (ASCII)	DD/MM/YY,HH:MM:SS	First two columns used to specify time and date of archive. (DD/MM/YY might be MM/DD/YY according to the date format selected in Clock configuration.
	Spreadsheet	Single, floating-point number. The integer part is the number of days since 31st Dec 1899, the decimal part is the proportion of the day since mid-night. For example, Noon on the 1st Jan 1900 would be represented by a value of 1.5, while a value of 34121.25 would represent the 6 am on the 1st June 1993.
	Integer	Compresses time and date as YYMMDDHHMMSS, so that 6 am on the 1st June 1993 would be represented as 930601060000.
Compression ratio	Normal	For PACKED data only, compresses the data, but provides an exact copy.
	High	For PACKED data only, compresses the data more than NORMAL. Input channel values are saved to 0.02% accuracy, Totalizers, counters and derived channels are saved to 0.000004% of display accuracy (4 parts in 10^8)

Table 8.4.2

JOBS

If an archiving option is present, the following jobs are added to the list given in secion 4.1.5 of the Installation and Operation manual:

Log 1 to archive 1
Log 2 to archive 2
Archive interval B
Message (Msg) N to archive 1
Message (Msg) N to archive 2

All the above can be initiated 'On going active', 'On going inactive' or 'On acknowledge'

8.4.1 ARCHIVE CONFIGURATION (Cont.)

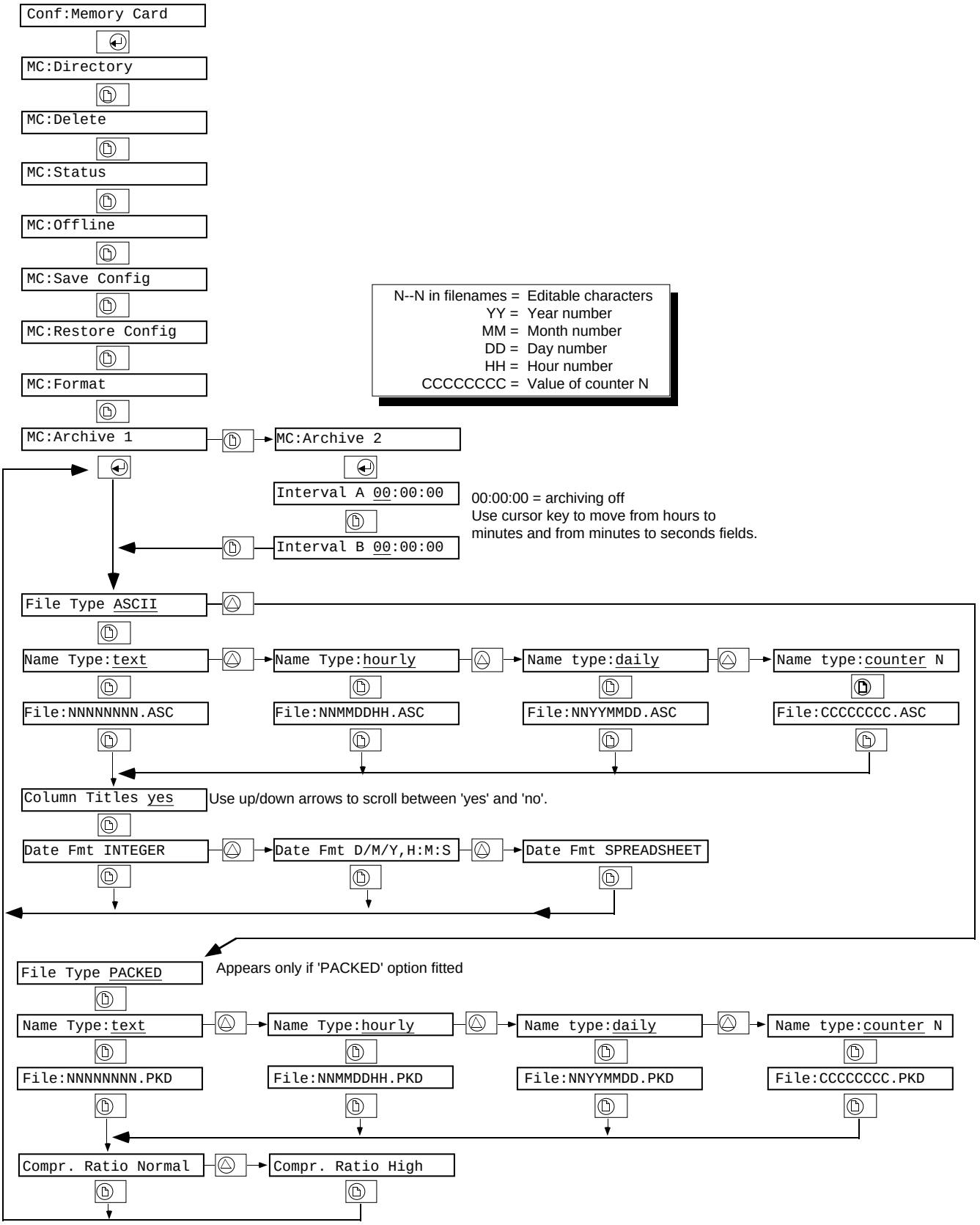


Figure 8.4.2 Archiving configuration menus

8.4.2 Archive interval

In 'Archive 2' configuration page, use the cursor and numeric entry keys to enter the required archive intervals A and B for automatic logging of log 2 group . An entry of 00:00:00 causes the automatic triggering to be inhibited. Automatic archiving is carried out at interval A except when interval B is selected by job action.

If a ‘round figure’ value (e.g. 00:10:00 for 10 mins, 01:00:00 for 1 hr.) is entered at 9:03AM, the recorder will start its automatic archiving at the next whole 10-minutes or the next whole hour (e.g. 9:10AM, or 10:00AM).

8.5 OPERATOR ACCESS

For the sake of security, each of the memory card functions can be added to or removed from the operator pages using the OPERATOR ACCESS part of the recorder configuration. Refer to the Operator Access description in the Configuration section of the Installation and Operation manual for further details. If all functions are removed, M CARD does not appear in the Operator Menu.

The up/down arrow keys are used to toggle the permissions between ‘yes’ and ‘no’.

Figure 8.5 Operator permissions

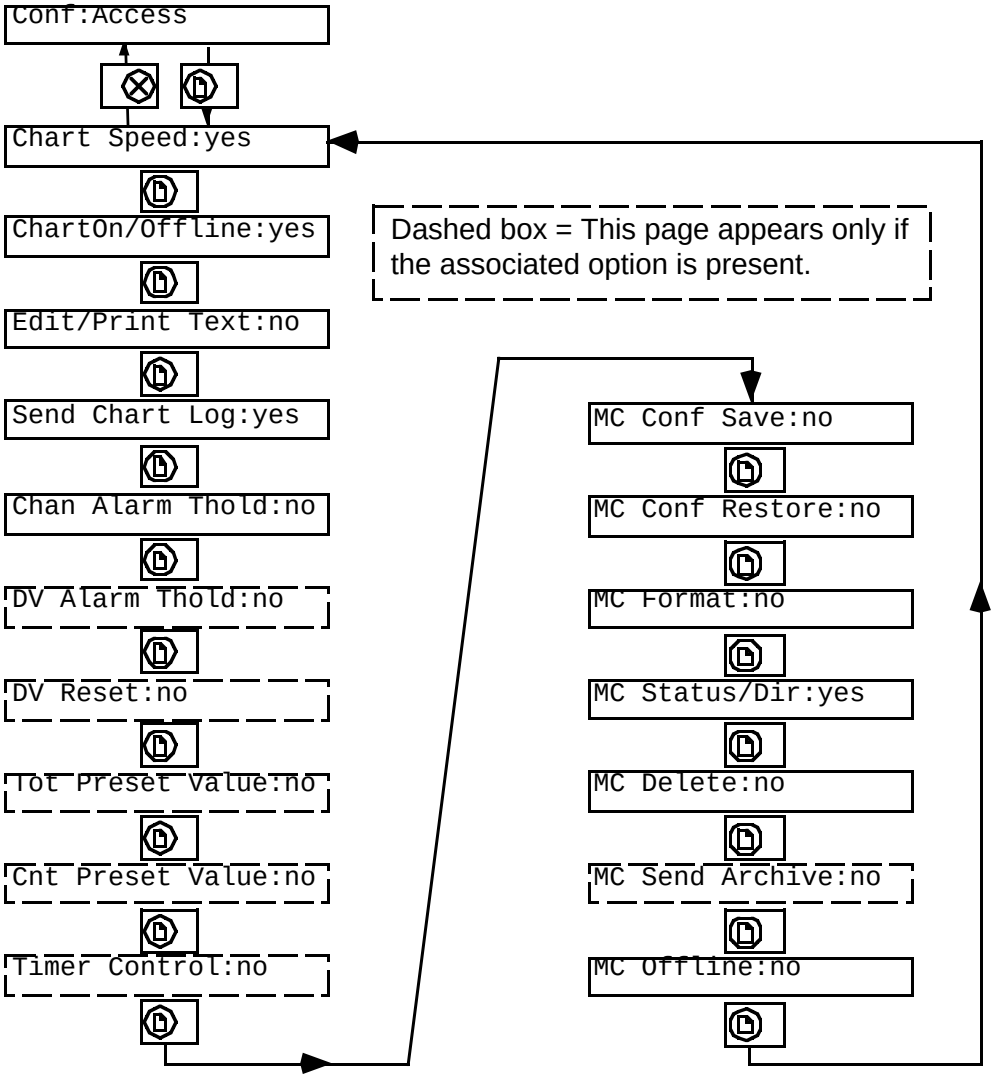


Figure 8.5 Operator permissions

8.6 MEMORY CARD GENERAL FUNCTIONS

8.6.1 Directory

The display shows the name of the oldest file on the card, together with its size in Bytes. As shown in figure 8.6.1, the down arrow key allows the user to scroll through the file names held in the card memory. For each filename on display, operation of the page key calls a further display page which shows the time and date of the file's last activity.

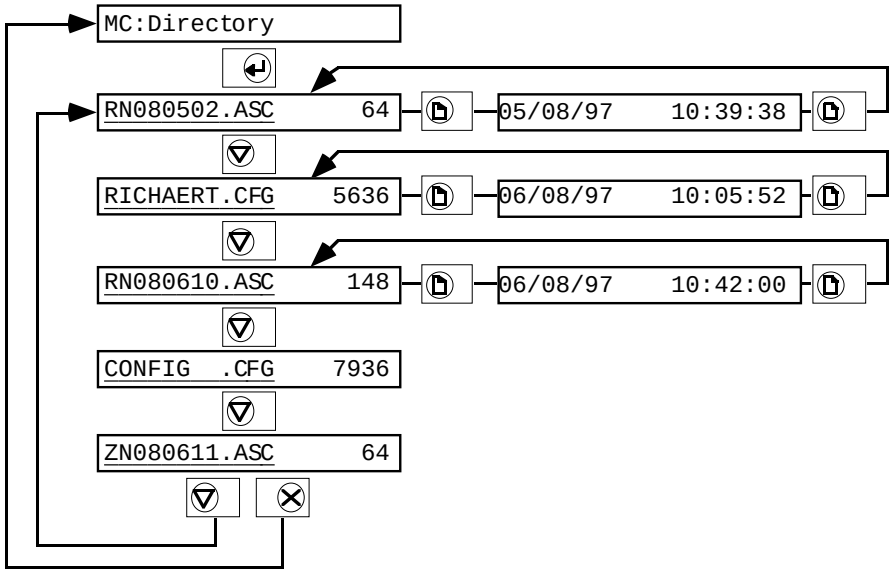


Figure 8.6.1 Directory function display pages

8.6.2 Delete

As shown in figure 8.6.2, the display shows the name of the oldest file on the card, together with a '↵ to erase' statement. The down arrow key allows the user to scroll through the file names held in the card memory. For each filename on display, operation of the 'Enter' key calls a further display page which asks for confirmation of erasure. A further operation of the 'Enter' key removes the file from the directory.

Operation of the Page key from any of the filename pages, allows the file size, and data and time of last activity to be viewed as shown in the figure.

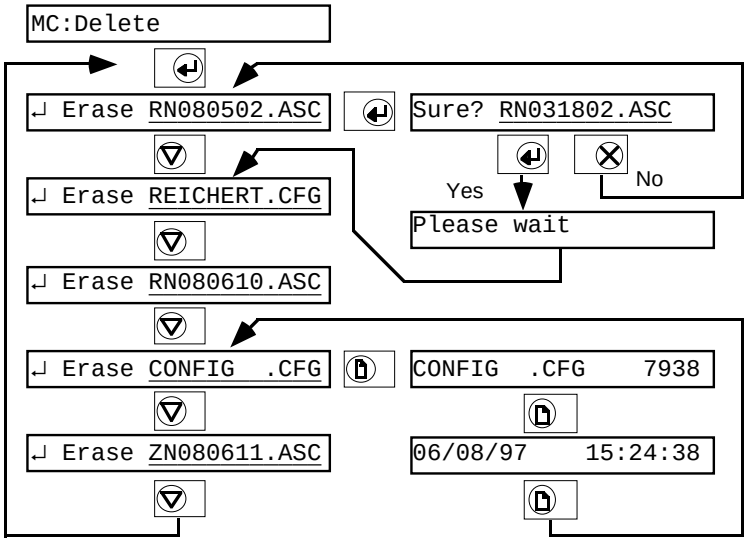


Figure 8.6.2 Delete function display pages

8.6.3 Card status

This display tells the user how much memory is currently used (11kB in the example) out of the card's total memory (128kB in the example).

Operation of the page key calls a display which shows whether the card is write protected or not.

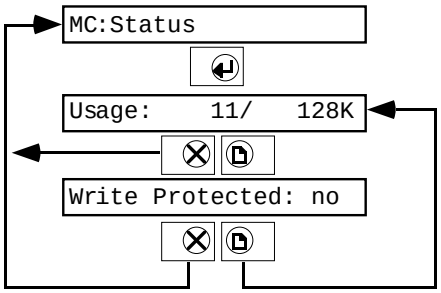


Figure 8.6.3 Status display pages

Note: A newly formatted card uses some space for format data,

8.6.4 Automatic file deletion

Should the card become full while chart copy or data logging / archiving activities are being carried out, the oldest data logging / archiving file on the card is deleted. (The oldest file will be deleted whether or not it is of the same type as the one being written.) **Existing configuration files (.CFG) are not deleted.**

Should the card become full while a Configuration Save is being attempted the Save will be aborted and the message 'Err:Card full' will be displayed until cleared by the 'Clear' (X) key.

8.7 ARCHIVE FILES

As shown in figure 8.7 for 'Archive 1', the following types of file name may be used when archiving data.

1. Text
2. Daily (Uses the recorder's real-time clock)
3. Hourly (Uses the recorder's real-time clock)
4. Counter value.

The file names consist of up to eight characters, followed by a three-character non-editable extension.

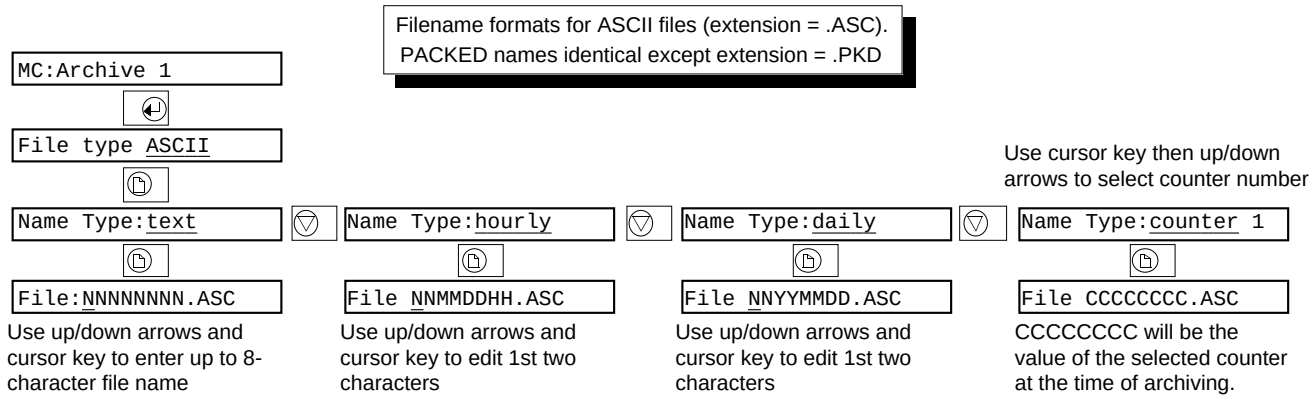


Figure 8.7 Filename selection

8.7.1 Text file names

With ‘Filename type’ selected as ‘Text’, the NN—NN field can be freely edited with alphanumeric characters as follows:

A to Z, a to z, 0 to 9 à ê è ô ù # $ % & ( ) - _ ! ^ ‘ { } ~ â ë ï î ì ò û ÿ á í ó ú

The use of any other character will result in a fleeting 'Invalid config' message.

8.7.2 Hourly file names

With ‘Name Type’ scrolled to ‘Hourly’, only the first two characters (NN) can be edited. The remainder of the file name will be the time and date on which the copy was initiated. Thus if an ASCII log were started some time between nine and ten a.m. on the 3rd of August, then the file name would be NN080309.ASC.

8.7.3 Daily file names

Daily filenames are similar to hourly filenames except that they contain the date rather than the time at which the file is opened Only the first two characters (NN) can be edited; the remainder of the file name will be the date on which the file was initiated. Thus if an ASCII log were initiated some time on the 3rd of August 1998, then the file name would be NN980803.ASC.

8.7.4 Counter file names

With ‘Filename type’ scrolled to ‘Counter’, none of the filename characters can be edited; the file name being the value of counter N. This allows, for example, a separate chart copy to be made for individual batches, if counter N is set up to hold the batch number. Should the counter be incremented during data transfer, the file will be closed at an appropriate point, and a new file opened with the counter’s new value for a file name.

8.7.5 File name extensions

All logging file names have automatic extensions of "ASC*" or "PKD*" depending on whether they are in ASCII or PACKED format (See section 8.4).

* If a new ASCII file is created on a disk that already has a XXXXXXXX.ASC file, then the extension is ‘incremented’ from ASC to AS1. If AS1 also exists, the extension will be incremented to AS2, AS3 — A10 — 100, and so on (up to 999), until an unused file name is found. PKD extensions are treated in exactly the same way.

Configuration file names (.CFG extensions) are different in that if an attempt is made to create a configuration file which already exists, a warning message appears asking for overwrite permission, and if this is given, the existing file will be overwritten and lost.

8.7.6 Rules for creation of files

1. The first log generated after the disc is placed online will force a new file to be created.
2. If an Hourly or Daily file name is chosen, the first log generated during that clock hour or calendar day will create a new file.
3. The first log generated after any change has been made to the Archive Menu will create a new file.
4. If a Counter name is chosen, the incrimenting of the chosen counter will create a new file.
5. The first log generated after any change has been made to the configuration of any channel will create a new file.

If none of the above events occur, an automatic interval or timer job will add a new set of data to the open file.

8.8 OTHER INFORMATION

8.8.1 Event sources

The following event sources (depending on which option is fitted) are added to the recorder:

1. Mem Card Bat Low
2. Mem Card Full
3. M Card Near Full (80% full)
4. MCC Overdrive (Archiving buffer full and no card or available card space)

These can be used to initiate recorder jobs as described in the Installation and Operation Manual.

8.8.3 System errors

The following possible system errors are added to the recorder:

1. Memory card battery low
2. Memory card battery flat
3. MCC Overdrive error (Archiving buffer full) (Archiving options only)

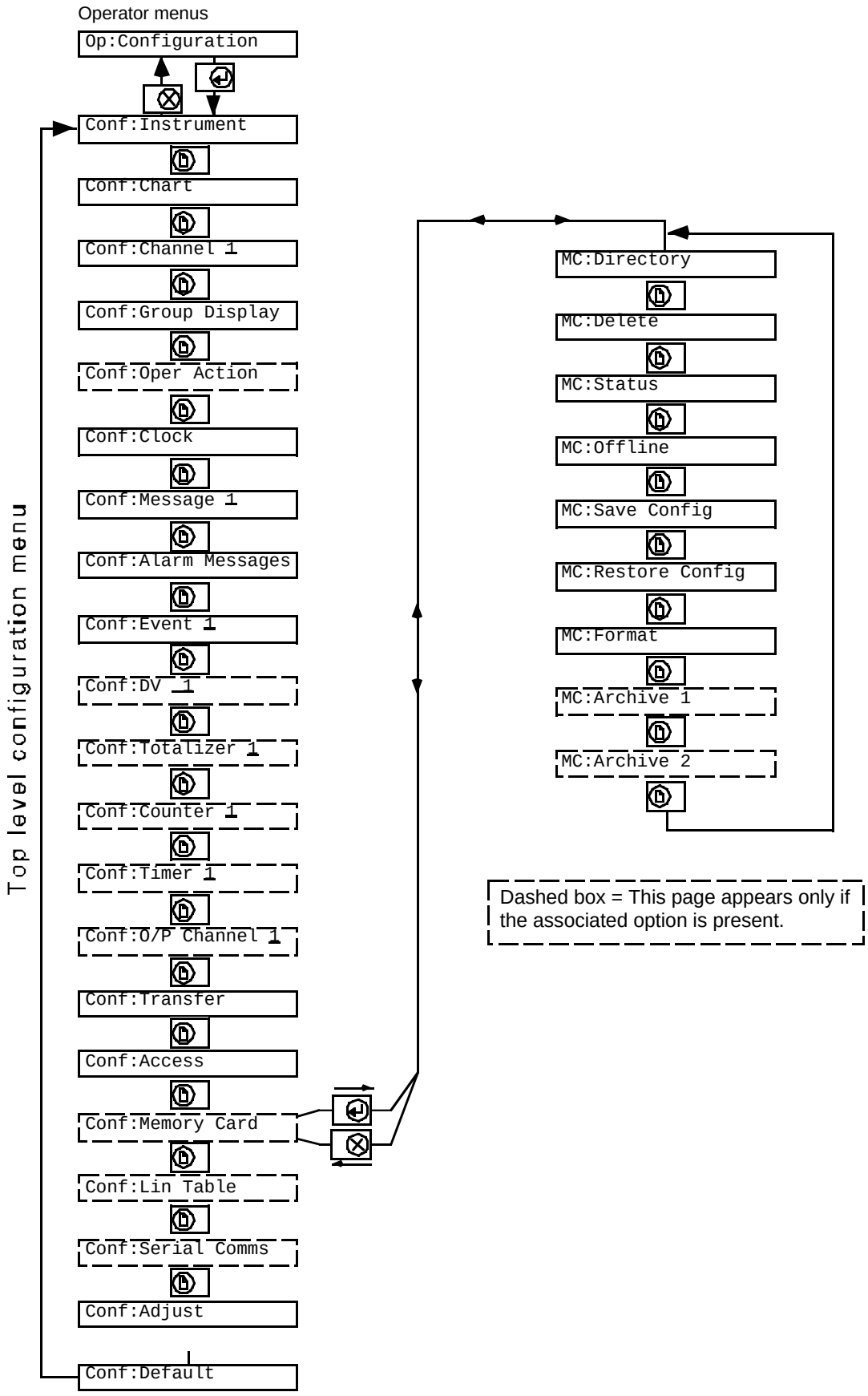
Any of these will cause a message to be sent to the display and an entry to be placed in the system error list (see the Installation and Operation Manual).

8.8.4 Error messages

In the event of an error occurring during card use, a message will appear for a few seconds. The following error messages are possible, if all memory card options are present:

Directory empty	Card reader fault
Card write protected	Card read failure
Card changed	Card write failure
Card not formatted	Bad filename
Card not fitted	Card data corrupted
File write protected	Card full
File read protected	MCC overdrive

8.9 MEMORY CARD CONFIGURATION MENU OVERVIEW



9 TRANSMITTER POWER SUPPLY OPTION

9.1 INTRODUCTION

This option supplies one or two sets of three isolated 25 Volt outputs. Each output is intended to supply power to a remote transmitter in order to run a 0 to 20 mA or a 4 to 20 mA current loop.

Physically, each unit consists of a circuit board and associated channel input shunt assemblies located on the inside back wall of the case (see Installation and Operation manual Fig 1.2.2). Electrically, the circuit boards contain a transformer with multiple isolated secondary windings used to drive three simple regulators via individual rectifing/ filtering circuits. Outputs from the regulators are wired to terminal blocks for user connection.

Note: that although the recorder can operate on a line voltage of 90 to 264 Vac, the transmitter power supply must be set for the level of voltage connected. See the link identifications shown in Figure 9.1.

Figure 9.1 shows an overall view of a transmitter power supply option with inputs for three channels.

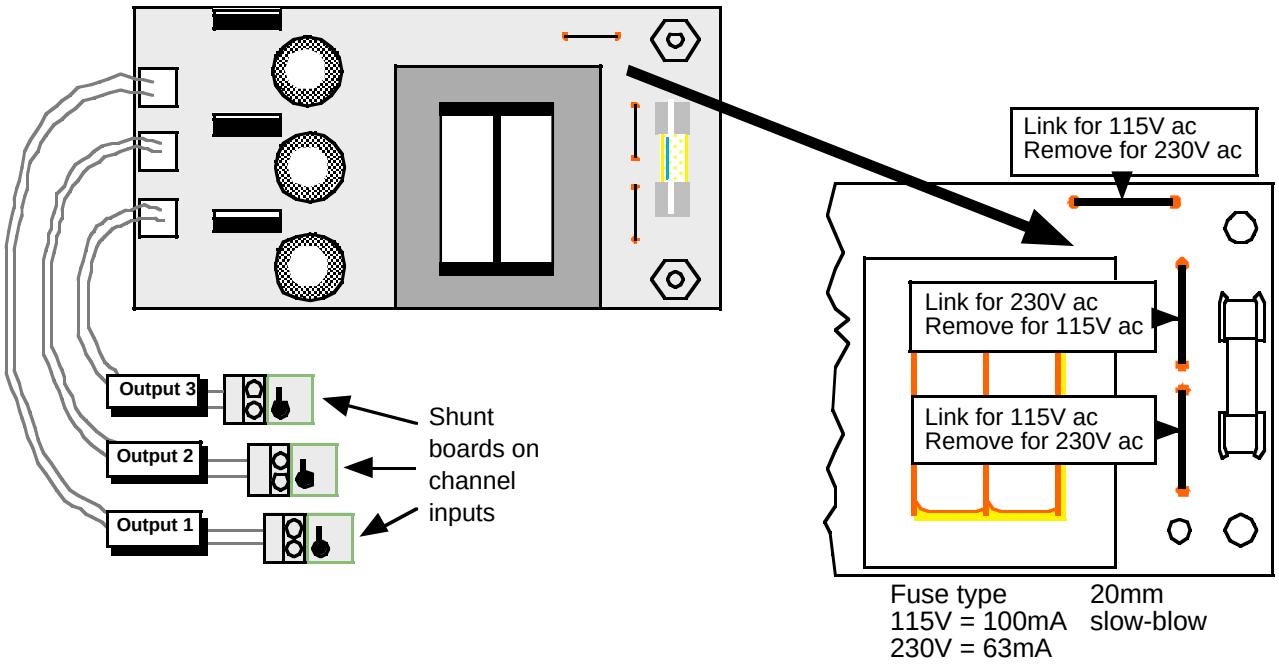


Figure 9.1 Transmitter power supply

9.1.1 Fuses

The required fuse value depends on the supply voltage, as shown in table 9.1.1 below. The fuse type is 20mm slow-blow, and one is located under a insulating cover on each circuit board as shown in figure 9.1 above.

9.1.2 Safety isolation specification

Safety isolation (dc to 65Hz; BS EN61010)	Installation category II; Pollution degree 2 (see page 2 for definitions)
Channel to channel:	100V RMS or dc (double insulation)
Channel to ground:	300V RMS or dc (basic insulation)

9.2 SIGNAL WIRING

The transmitter outputs are connected at a terminal block as shown below. Connection between the shunt board and the power supply are made at manufacture.

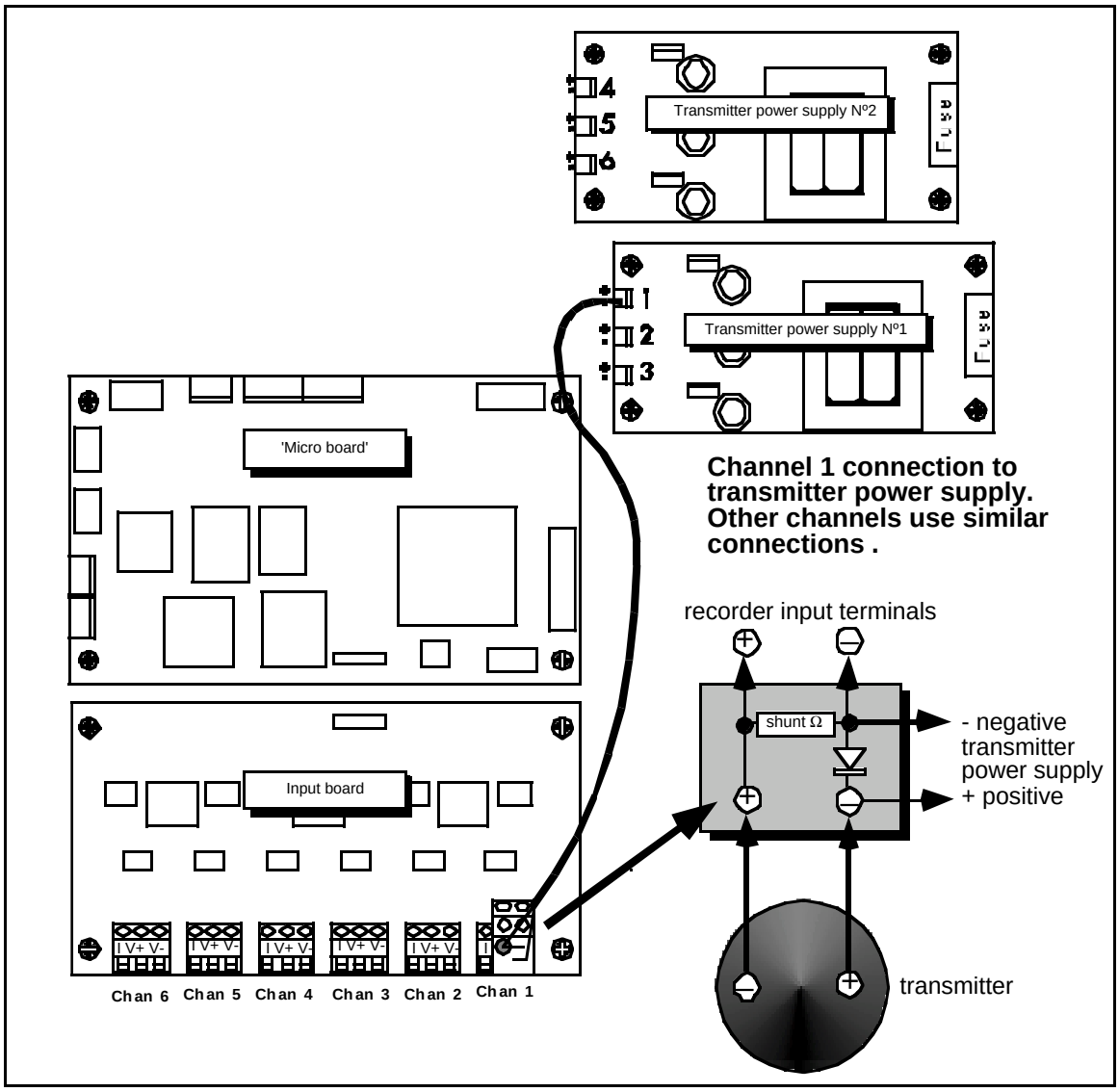


Figure 9.2 Transmitter power supply signal wiring

10 LIST OF EFFECTIVE PAGES

This manual consists of the following pages at their stated revision levels.