LD-232, LD-485 and LC-CL
Serial Input
Large Digit Display
Arithmetic and Wind Speed/Direction Addendum

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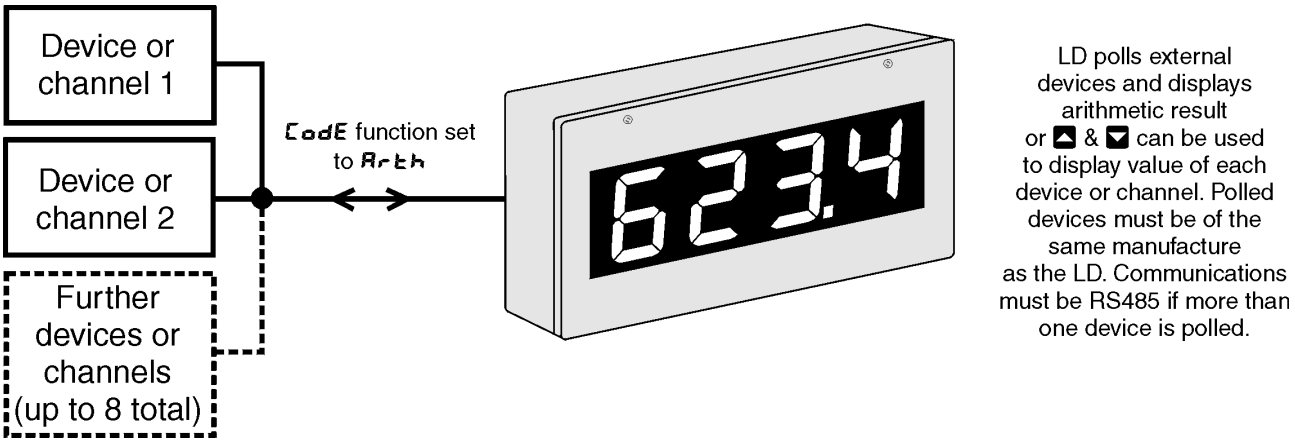
1 Introduction

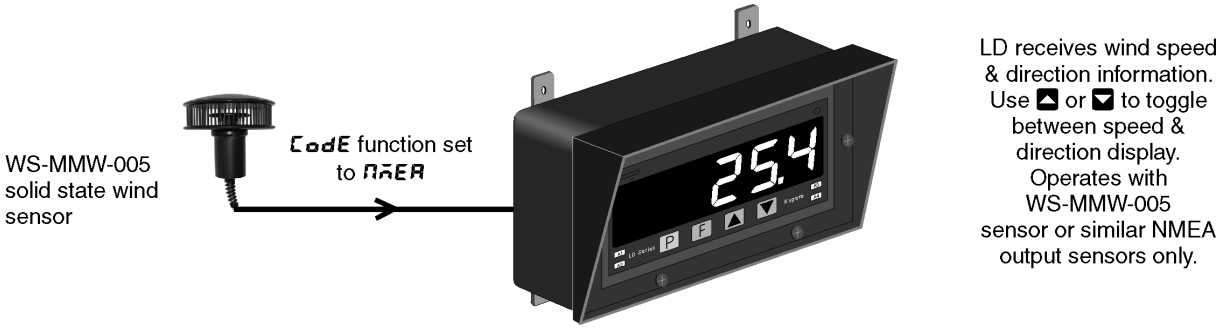
This addendum to the LD-232, LD-485 and LD-CL manual contains information for the installation and operation using the arithmetic mode **ArtH** or the wind monitor mode **nmEA**. The display will accept inputs from RS232, RS485, RS422 or serial current loop inputs (input type is factory configured). The two modes covered by this addendum are detailed below. If the mode is changed it is necessary to remove power from the instrument then reapply power in order to reset the mode:

Arithmetic mode. The instrument can be programmed to accept input from up to eight RS485 or RS422 sources and combine these arithmetically. The time between polling requests is programmable from 0.0 to 20.0 seconds. The instruments polled for arithmetic operation must be of the same manufacture as this instrument. To operate in this mode the **CodE** function must be set to **ArtH**.



Wind speed and direction (NMEA). This mode is used only with instruments using NMEA (National Marine Electronics Association) serial code such as model WS-MMW-005 wind speed and direction sensor. To operate in this mode the **CodE** function must be set to **nmEA**.

The display can be set to display wind speed, wind direction or to toggle (using ▲ or ▼ button) or automatically alternate the display between wind speed and direction. Analog retransmission output options can be selected to transmit wind direction (**Ch 1**) or wind speed (**Ch2**) at the **rEC** function (also at the **rEC2** function if dual analog output is used.) Similarly **Ch 1** or **Ch2** can be selected for the alarm relays at the **A 1**, **A2** etc. functions.

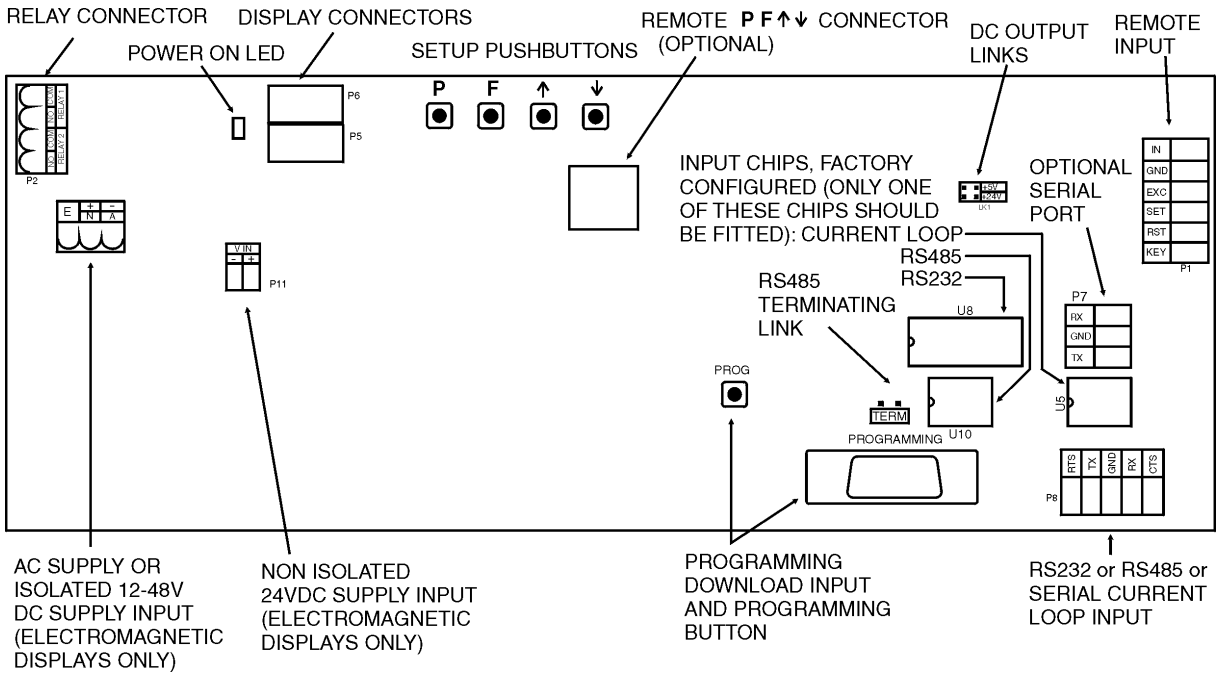


2 Electrical installation

2.1 Electrical installation

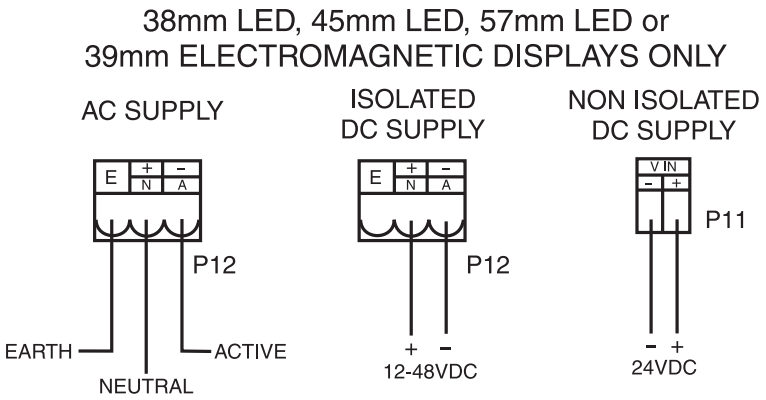
The display is designed for continuous operation and no power switch is fitted to the unit. It is recommended that an external switch and fuse be provided to allow the unit to be removed for servicing. The terminal blocks are plug in screw type for ease of installation and allow for wires of up to 1.5mm^2 (2.5mm^2 for relay, AC or isolated DC supply connections) to be fitted. Connect the wires to the appropriate terminals as indicated below. Refer to other details provided in this manual to confirm proper selection of voltage, polarity and input type before applying power to the instrument. When power is applied the instrument will cycle through a display sequence, indicating the software version and other status information.

2.2 Main circuit board layout



2.3 38, 45, 57mm LED or 39mm electromagnetic display power supplies

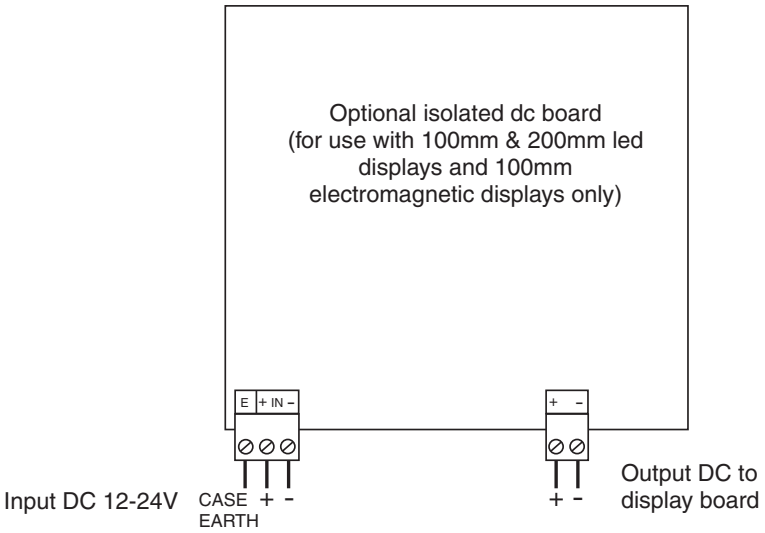
AC power connections use a plug in connector with screw terminals at P12 (2.5mm^2 max. wire). Isolated DC supplies (12-48VDC) use the same terminals. Non isolated DC supplies (24VDC only) may be connected directly to the main circuit board power supply connector via the plug in connector terminals at P11 (1.5mm^2 max. wire diameter). Note supply type is factory configured.



2.4 100mm and 200mm display isolated DC power supplies

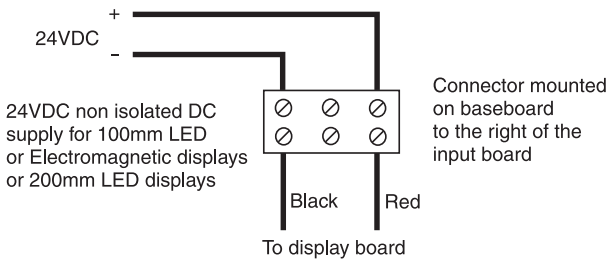
Isolated DC supplies (12 to 24VDC) for 100mm and 200mm LED and 100mm electromagnetic displays connect to the isolated supply pcb on the base board.

Optional isolated DC supply



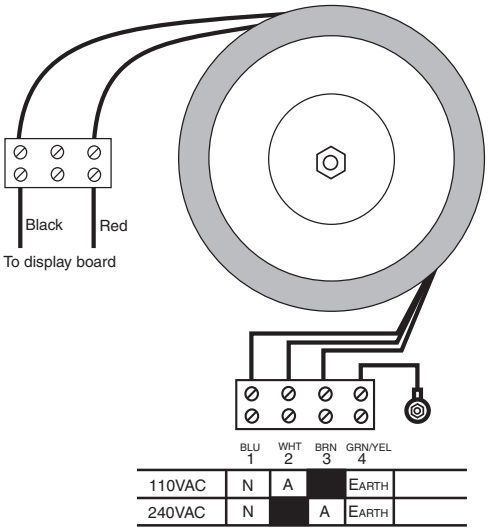
2.5 100mm and 200mm display non isolated DC power supplies

Non isolated DC supplies (24VDC) for 100mm and 200mm LED and 100mm electromagnetic displays are wired to a connector on the baseboard as shown below.

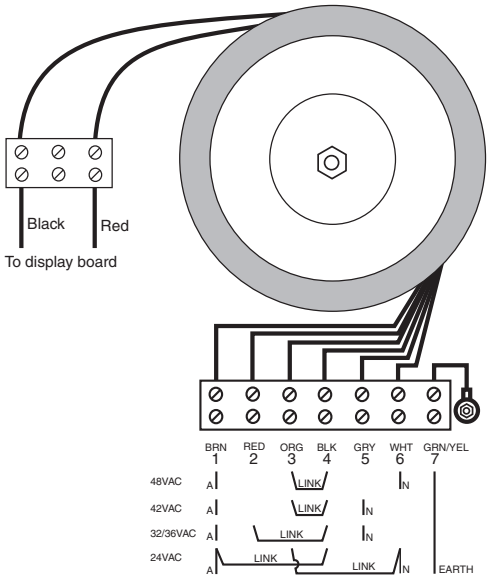


High and low voltage AC supplies

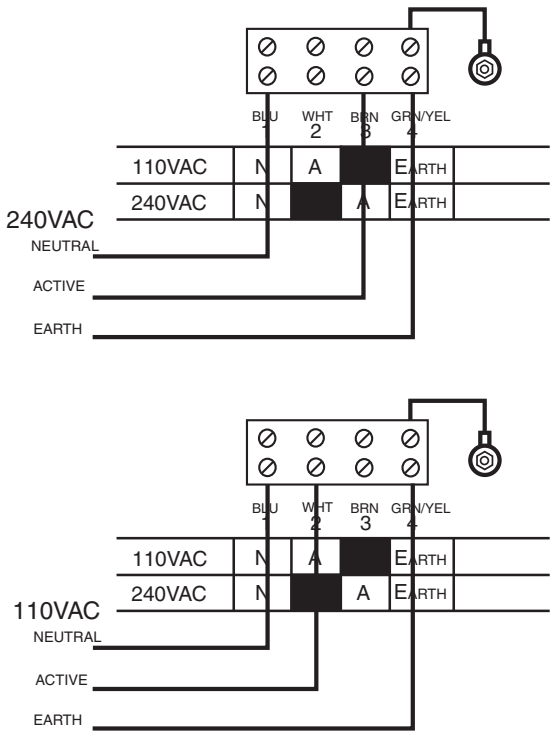
240 & 110VAC supplies.
For 100mm/200mm LED or 100mm electromagnetic display types only.



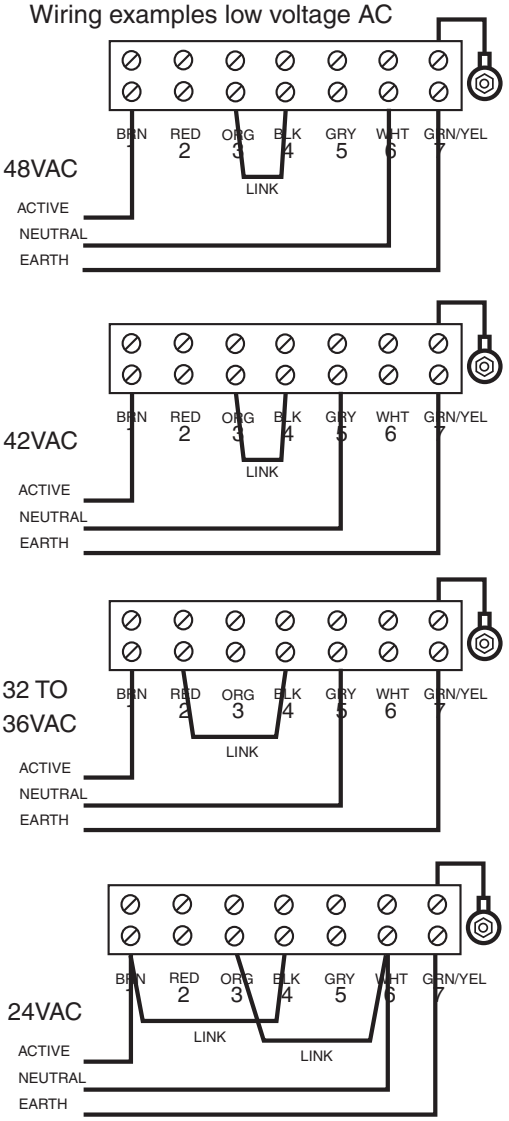
Low voltage AC supplies.
For 100mm/200mm LED or 100mm electromagnetic display types only.



Wiring examples 240VAC & 110VAC



Wiring examples low voltage AC

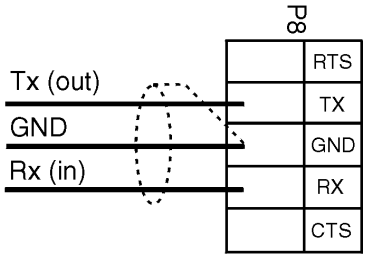


Important note: the 240V & 110V supplies use the same transformer, low voltage instruments use a different transformer. Do not use a low voltage transformer for 240V or 110V or vice versa.

2.6 Serial input connections

If wiring RS232 to a 9 or 25 pin D type connector the standard connections are as follows:
9 pin: Tx pin 3, Rx pin 2, GND pin 5
25 pin: Tx pin 2, Rx pin 3, GND pin 7
See note below regarding Tx and Rx crossing when wiring RS232

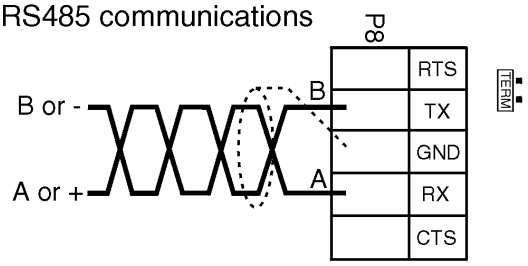
RS232 communications



Use 3 core shielded cable

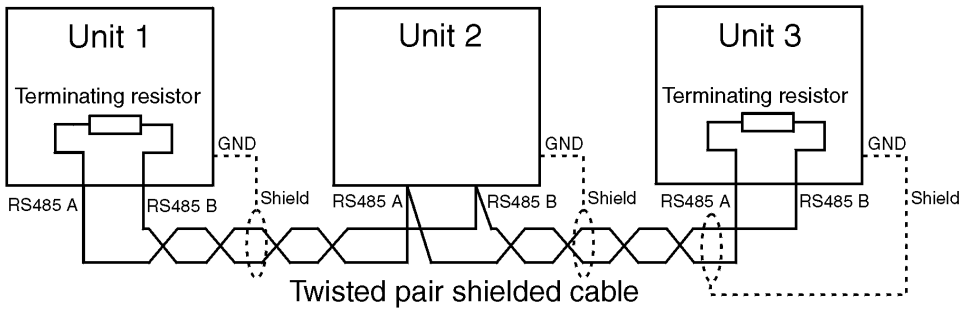
Note: when connecting using RS232 the Tx line at the instrument connects to the Rx line at the device it is communicating with. Likewise the Rx line at the instrument connects to Tx. When using RS485 connections are A to A and B to B

RS485 communications

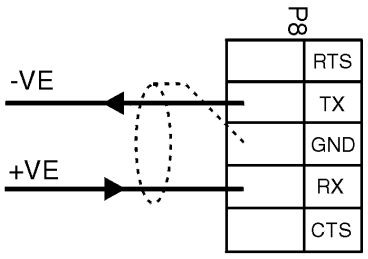


Use twisted pair shielded cable.
Note: shield can be connected at each end, see below for example.

Rs485 terminating link.
The link should be in for long cable runs if communications difficulties are encountered. If multiple instruments are connected insert the link if the instrument is the first and last unit on the line, see drawing below.

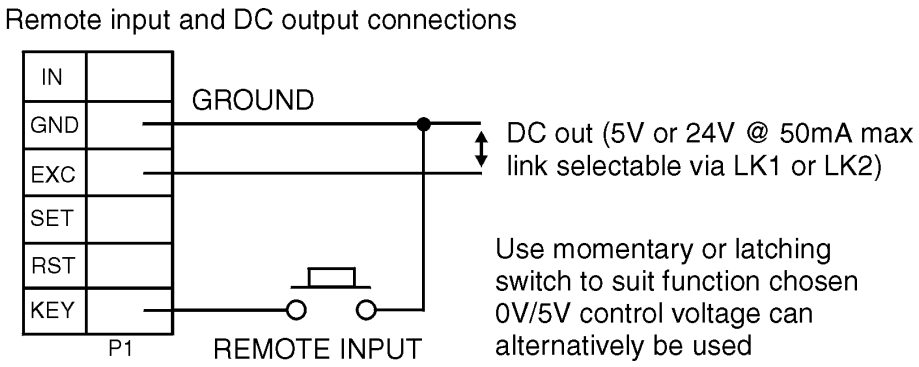


20mA serial current loop communications.



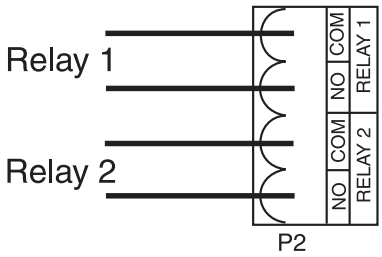
Use 2 core shielded cable

2.7 Remote input and DC out connections



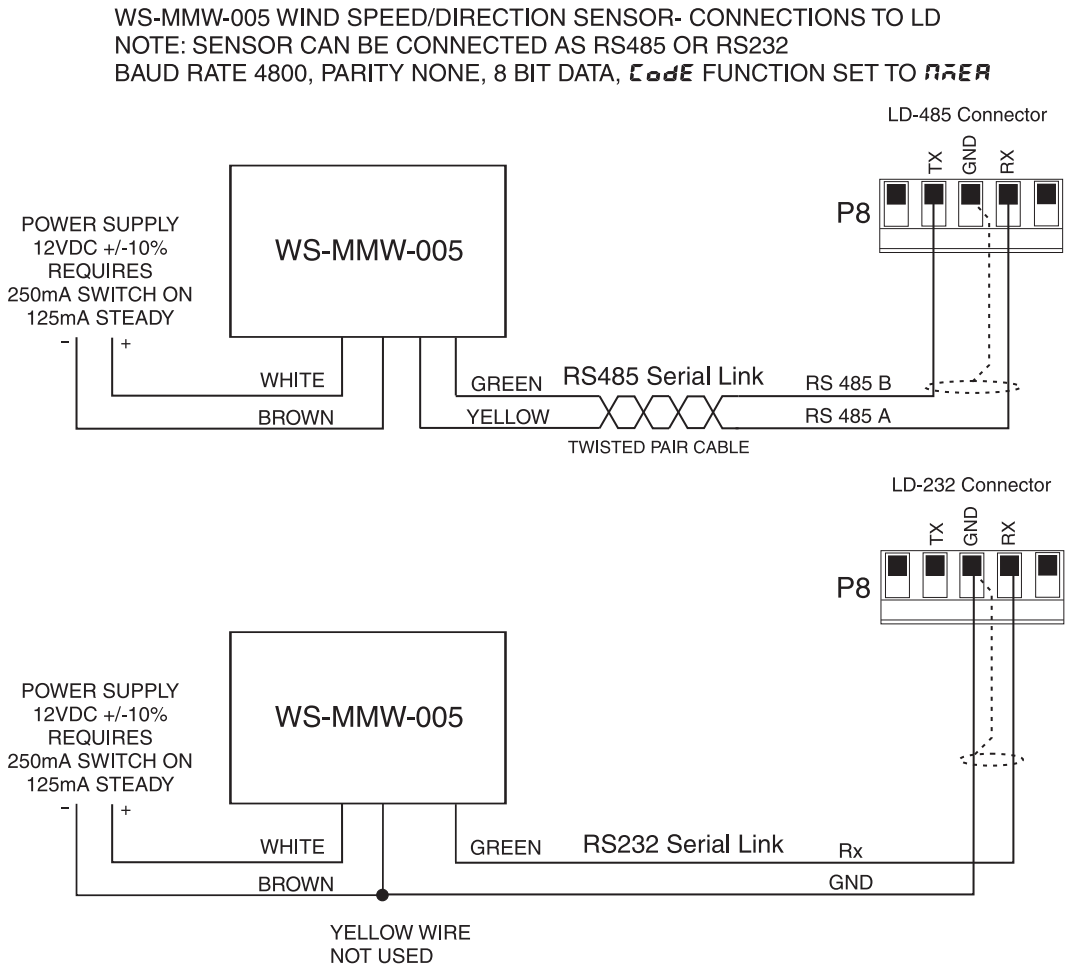
2.8 Relay connections

The display is supplied with two alarm relays as standard with connections on terminal P2. The relays are single pole single throw types and are rated at 5A, 240VAC into a resistive load. The relay contacts are voltage free and may be programmed for normally open or normally closed operation. With power removed the relay contacts will be in closed position.



2.9 Wiring to WS-MMW-005 wind speed and direction sensor

The WS-MMW-005 can be connected as either RS232 or RS485 (not serial current loop) use the connection type which matches the input type of the display.



3 Function tables - Arithmetic mode

Note: the order in which the functions appear on the display may not be exactly as shown below. The availability and order of functions is determined by choice of function settings and options fitted.

Functions in this first table are available in FUNC or CAL mode

Display	Function	Range	Default	Your record	Ref/Page
A1Lo	Low setpoint value for alarm relay 1	Any display value or OFF	OFF		4.1 / 16
A1Hi	High setpoint value for alarm relay 1	Any display value or OFF	OFF		4.2 / 17
A2Lo	Low setpoint value for alarm relay 2	Any display value or OFF	OFF		4.3 / 17
A2Hi	High setpoint value for alarm relay 2	Any display value or OFF	OFF		4.4 / 17
A1HY	Hysteresis value for alarm relay 1	0 to 9999	10		4.5 / 18
A2HY	Hysteresis value for alarm relay 2	0 to 9999	10		4.6 / 18
A1tt	Trip time delay for alarm relay 1	0 to 999.9	0.0		4.7 / 18
A2tt	Trip time delay for alarm relay 2	0 to 999.9	0.0		4.8 / 19
A1rt	Reset time delay for alarm relay 1	0.0 to 999.9	0.0		4.9 / 19
A2rt	Reset time delay for alarm relay 2	0.0 to 999.9	0.0		4.10 / 19
A1n.o or A1n.c	Alarm relay 1 action to normally open or normally closed	A1n.o or A1n.c	A1n.o		4.11 / 19
A2n.o or A2n.c	Alarm relay 2 action to normally open or normally closed	A2n.o or A2n.c	A2n.o		4.12 / 20
A2SP or A2t1	Relay operation independent setpoint or trailing setpoint	A2SP or A2t1	A2SP		4.13 / 20

(*__Optional__)—this function will only be accessible if the relevant option is fitted

Functions in this second table are available only in CAL mode or if ACCS is set to ALL

Display	Function	Range	Default	Your record	Ref/Page
brgt	Display brightness level	1 to 63	63		4.14 / 20
brgt AUto	Automatic display brightness adjustment	on or OFF	OFF		4.16 / 21
brgt HI gH	Automatic display brightness adjustment - high level	1 to 63	63		4.17 / 21
brgt Lo	Automatic display brightness adjustment - low level	1 to 63	1		4.18 / 21
dULL	Display remote brightness switching	0 to 63	15		4.15 / 20
drnd	Display rounding	1 to 5000	1		4.19 / 21

(*__Optional__)—this function will only be accessible if the relevant option is fitted

dCPt	Decimal point	0, 0.1 etc.	0		4.20 / 22
FLtr	Digital filter	0 to 8	2		4.21 / 22
AtHH CH	Number of active channels for ArtH mode	1 to 8	4		4.25 / 23
Ch1 Addr	Channel 1 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.26 / 23
Ch2 Addr	Channel 2 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.27 / 23
Ch3 Addr	Channel 3 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.28 / 23
Ch4 Addr	Channel 4 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.29 / 24
Ch5 Addr	Channel 5 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.30 / 24
Ch6 Addr	Channel 6 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.31 / 24
Ch7 Addr	Channel 7 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.32 / 24
Ch8 Addr	Channel 8 address	P1 to P8 or S1 to S8 or t1 to t8	P1		4.33 / 24
Ch1 dCPt	Channel 1 decimal point	0, 0.1 etc.	0		4.34 / 24
Ch2 dCPt	Channel 2 decimal point	0, 0.1 etc.	0		4.35 / 25
Ch3 dCPt	Channel 3 decimal point	0, 0.1 etc.	0		4.36 / 25
Ch4 dCPt	Channel 4 decimal point	0, 0.1 etc.	0		4.37 / 25
Ch5 dCPt	Channel 5 decimal point	0, 0.1 etc.	0		4.38 / 25
Ch6 dCPt	Channel 6 decimal point	0, 0.1 etc.	0		4.39 / 25
Ch7 dCPt	Channel 7 decimal point	0, 0.1 etc.	0		4.40 / 25
Ch8 dCPt	Channel 8 decimal point	0, 0.1 etc.	0		4.41 / 26
EA1	EA1 value for arithmetic formula	-32767 to 32767	1		4.42 / 26

(*__Optional__)—this function will only be accessible if the relevant option is fitted

Eb1	Eb1 value for arithmetic formula	-32727 to 32767	0		4.43 / 26
EC1	EC1 value for arithmetic formula	-32727 to 32767	1		4.44 / 26
EA2	EA2 value for arithmetic formula	-32727 to 32767	1		4.45 / 26
Eb2	Eb2 value for arithmetic formula	-32727 to 32767	0		4.46 / 27
EC2	EC2 value for arithmetic formula	-32727 to 32767	1		4.47 / 27
EA3	EA3 value for arithmetic formula	-32727 to 32767	1		4.48 / 27
Eb3	Eb3 value for arithmetic formula	-32727 to 32767	0		4.49 / 27
EC3	EC3 value for arithmetic formula	-32727 to 32767	1		4.50 / 27
EA4	EA4 value for arithmetic formula	-32727 to 32767	1		4.51 / 27
Eb4	Eb4 value for arithmetic formula	-32727 to 32767	0		4.52 / 28
EC4	EC4 value for arithmetic formula	-32727 to 32767	1		4.53 / 28
EA5	EA5 value for arithmetic formula	-32727 to 32767	1		4.54 / 28
Eb5	Eb5 value for arithmetic formula	-32727 to 32767	0		4.55 / 28
EC5	EC5 value for arithmetic formula	-32727 to 32767	1		4.56 / 28
EA6	EA6 value for arithmetic formula	-32727 to 32767	1		4.57 / 28
Eb6	Eb6 value for arithmetic formula	-32727 to 32767	0		4.58 / 29
EC6	EC6 value for arithmetic formula	-32727 to 32767	1		4.59 / 29
EA7	EA7 value for arithmetic formula	-32727 to 32767	1		4.60 / 29
Eb7	Eb7 value for arithmetic formula	-32727 to 32767	0		4.61 / 29
EC7	EC7 value for arithmetic formula	-32727 to 32767	1		4.62 / 29
EA8	EA8 value for arithmetic formula	-32727 to 32767	1		4.63 / 29
Eb8	Eb8 value for arithmetic formula	-32727 to 32767	0		4.64 / 30
EC8	EC8 value for arithmetic formula	-32727 to 32767	1		4.65 / 30

(*__Optional__)—this function will only be accessible if the relevant option is fitted

OP 1	Arithmetic operation between channels 1 and 2	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE, COS or C.Sub	Add		4.66 / 30
OP2	Arithmetic operation between channel 3 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.67 / 30
OP3	Arithmetic operation between channel 4 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.68 / 31
OP4	Arithmetic operation between channel 5 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.69 / 31
OP5	Arithmetic operation between channel 6 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.70 / 32
OP6	Arithmetic operation between channel 7 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.71 / 32
OP7	Arithmetic operation between channel 8 and previous operation	Add, Sub, Prod, di U, Hi 9h, Lo, SI nE or COS	Add		4.72 / 33
Ch 1	Channel 1 polarity	both, POS or nEG	both		4.74 / 33
Ch2	Channel 2 polarity	both, POS or nEG	both		4.75 / 34
Ch3	Channel 3 polarity	both, POS or nEG	both		4.76 / 34
Ch4	Channel 4 polarity	both, POS or nEG	both		4.77 / 34
Ch5	Channel 5 polarity	both, POS or nEG	both		4.78 / 34
Ch6	Channel 6 polarity	both, POS or nEG	both		4.79 / 34
Ch7	Channel 7 polarity	both, POS or nEG	both		4.80 / 35
Ch8	Channel 8 polarity	both, POS or nEG	both		4.81 / 35

(*__Optional__)—this function will only be accessible if the relevant option is fitted

CodE	Data type for display	dI SP, ASCI, UAL, ArtH, Ñ.buS, PtA, SCAN, nÑEA or CS	dI SP		4.82 / 35
A1 OPEr	Alarm relay 1 operation mode	I nPt, t.out or both	I nPt		4.83 / 35
A2 OPEr	Alarm relay 2 operation mode	I nPt, t.out or both	I nPt		4.84 / 36
dS.to	Display timeout	0 to 9999	10		4.87 / 36
t.out	Data string timeout	0.0 to 10.0	1.0		4.88 / 37
P.but	P button function	nonE, Hi, Lo, HI Lo, tArE or 2Er0	nonE		4.89 / 37
r.I nP	Remote input (external input) one function	nonE, P.HLd, d.HLd, Hi, Lo, Hi Lo, tArE, 2Er0, SP.Ac, no.Ac or dull	nonE		4.90 / 37
ACCS	Access mode	OFF, EASY, nonE or ALL	OFF		4.85 / 36
SPAC	Setpoint access mode (*Optional)	A1, A1-2 etc.	A1		4.86 / 36
A1	Alarm relay 1 operation channel	ch0 to ch8	ch0		4.91 / 38
A2	Alarm relay 2 operation channel	ch0 to ch8	ch0		4.92 / 38
CLr 2Er0	Clear zero	n/a	n/a		4.93 / 38
bAUd rAtE	Baud rate for serial communications	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	9600		4.94 / 39
PrtY	Parity for serial input	nonE, EUEn or Odd	nonE		4.95 / 39
dAtA	Data type	8.bit or 7.bit	8.bit		4.96 / 39
SEr.1 tYPE	Serial communications type (*Optional)	nonE, r232 or r485	nonE		4.97 / 39
SEr.2 tYPE	Not applicable to this model	nonE, r232 or r485	nonE		4.98 / 39

(*Optional)—this function will only be accessible if the relevant option is fitted

4 Arithmetic and Wind Speed/Direction mode functions

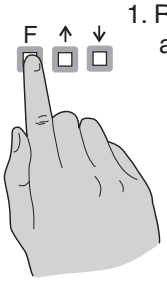
The LD display setup and calibration functions are configured through a push button sequence. The three push buttons located on the input pcb (also at the front on some display options) are used to alter settings. Two basic access modes are available:

FUNC mode (simple push button sequence) allows access to commonly set up functions such as alarm setpoints.

CAL mode (power up sequence plus push button sequence) allows access to all functions including calibration parameters.

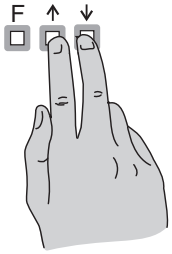
Once **CAL** or **FUNC** mode has been entered you can step through the functions, by pressing and releasing the **F** push button, until the required function is reached. Changes to functions are made by pressing the ▲ or ▼ push button (in some cases both simultaneously) when the required function is reached.

Entering CAL Mode



1. Remove power from the instrument and wait 5 seconds . Hold in the **F** button and reapply power. The display will indicate **CAL** as part of the "wake up messages" when the **CAL** message is seen you can release the button. Move to step 2 below.

2. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the **F** button. Move to step 3 below.

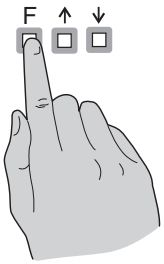


3. Within 2 seconds of releasing the **F** button press, then release the ▲ and ▼ buttons together. The display will now indicate **FUNC** followed by the first function.

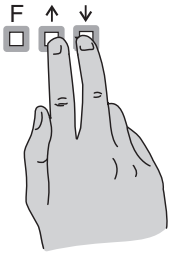
Notes: If step 1 above has been completed then the instrument will remain in this **CAL** mode state until power is removed. i.e. there is no need to repeat step 1 when accessing function unless power has been removed. The instrument should show all 8's on power up e.g. **8.8.8.8.** if the instrument does not reset then these numbers will not be seen. Switch off the instrument and allow a longer time delay before powering up again.

Entering FUNC Mode

No special power up procedure is required to enter **FUNC** mode.



1. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the **F** button. Move to step 2 below.



2. Within 2 seconds of releasing the **F** button press, then release the ▲ and ▼ buttons together. The display will now indicate **FUNC** followed by the first function.

Alternative CAL Mode Entry

This alternative method allows **CAL** mode entry without the need to remove power:
1. Enter **FUNC** mode using the 2 steps above
2. When the first function appears press and hold the **P** button until you see the message **FUNC** followed by **CAL** (the **P** button will have to be held pressed for approximately 2 seconds)
3. You should now return to the function you were in but have full access to **CAL** mode functions
Note: when you exit back to live reading the display will remain in **CAL** mode for approximately 4 minutes, after this time you will need to repeat this process to enter **CAL** mode.

Easy alarm relay adjustment access facility

The display has an easy alarm access facility which allows access to the alarm setpoints simply by pressing the **F** button at the front or rear of the instrument. The first setpoint will then appear and changes to this setpoint may be made to this setpoint via the ▲ or ▼ buttons. Press the **F** button to accept any

changes or to move on to the next setpoint. Note: this easy access also functions in the same manner for the PI control setpoint (relay and/or analog PI output) if PI control is available. The instrument must be set in the manner described below to allow the easy access facility to work:

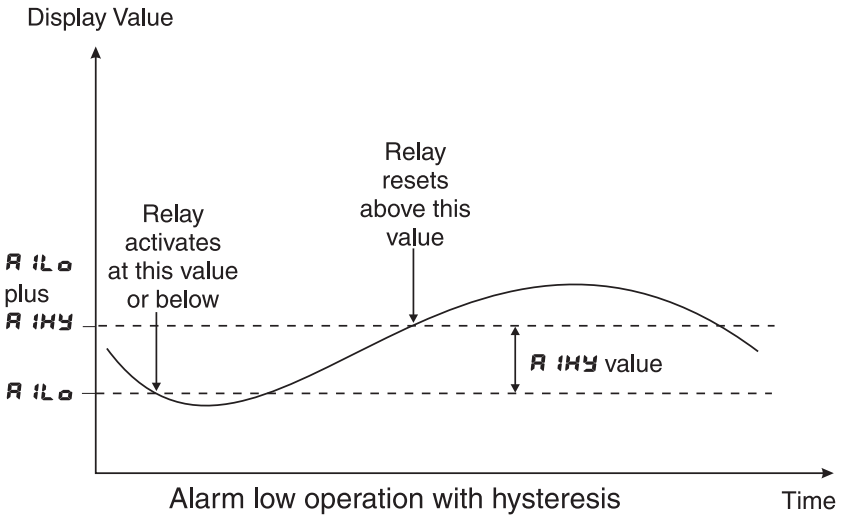
1. The **F.I nP** function must be set to **SPAC** or the **ACCS** function must be set to **EASY**.
2. At least one alarm must have a setpoint, nothing will happen if all the alarm setpoints are set to **OFF**.
3. The **SPAC** function must be set to allow access to the relays required e.g. if set to **A 1-2** then the easy access will work only with alarm relays 1 and 2 even if more relays are fitted.
4. The instrument must be in normal measure mode i.e. if the instrument is powered up so that it is in **CAL** mode then the easy access will not function. If in doubt remove power from the instrument, wait for a few seconds then apply power again.
5. If the easy access facility is used then the only way to view or alter any other function settings is to power up via **CAL** mode i.e. there is no entry to **FUNC** mode functions unless the instrument is powered up in **CAL** mode.

4.1 Alarm relay 1 low setpoint

Display: **A 1Lo**
Range: Any display value or **OFF**
Default Value: **OFF**

Displays and sets the low setpoint value for alarm relay 1. Use this low setpoint function if a relay operation is required when the display value becomes equal to or less than the low setpoint value. To set a low alarm value go to the **A 1Lo** function and use the ▲ or ▼ push buttons to set the value required then press **F** to accept this value. The low alarm setpoint may be disabled by pressing the ▲ and ▼ push buttons simultaneously. When the alarm is disabled the display will indicate **OFF**. If the relay is allocated both a low and high setpoint then the relay will activate when the value displayed moves outside the band set by the low and high setpoints. The value at which the relay will reset is controlled by the **A 1HY** function.

Example:
If **A 1Lo** is set to **10** then relay 1 will activate when the display value is 10 or less.

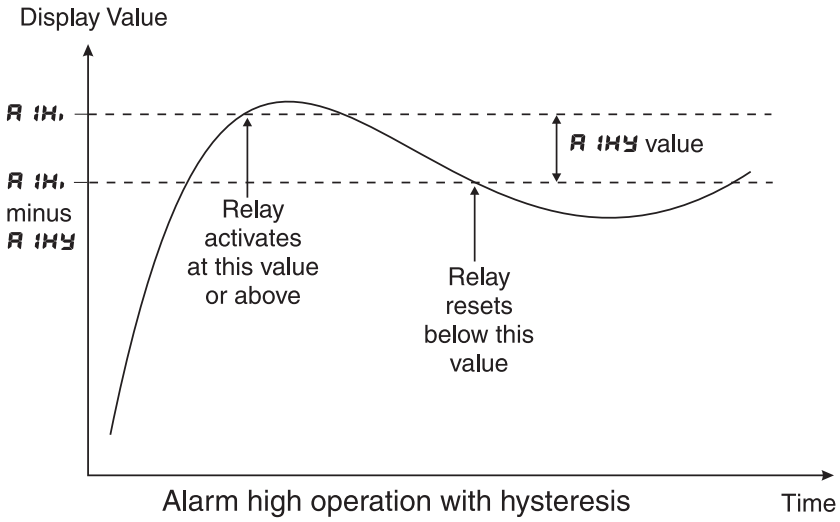


4.2 Alarm relay 1 high setpoint

Display: A 1H,
Range: Any display value or OFF
Default Value: OFF

Displays and sets the high setpoint value for alarm relay 1. Use this high setpoint function if a relay operation is required when the display value becomes equal to or more than the low setpoint value. To set a high alarm value go to the A 1H, function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The high alarm setpoint may be disabled by pressing the ▲ and ▼ push buttons simultaneously. When the alarm is disabled the display will indicate OFF. If the relay is allocated both a low and high setpoint then the relay will activate when the value displayed moves outside the band set by the low and high setpoints. The value at which the relay will reset is controlled by the A 1HY function.

Example:
If A 1H, is set to 100 then relay 1 will activate when the display value is 100 or higher.



4.3 Alarm relay 2 low setpoint

Display: A2Lo
Range: Any display value or OFF
Default Value: OFF

Displays and sets the low setpoint value for alarm relay 2 which operates in the same manner as the A 1Lo function. See A 1Lo function for further description.

4.4 Alarm relay 2 high setpoint

Display: A2H,
Range: Any display value or OFF
Default Value: OFF

Displays and sets the high setpoint value for alarm relay 2 which operates in the same manner as the A 1H, function. See A 1H, function for further description.

4.5 Alarm relay 1 hysteresis (deadband)

Display: A 1HY
Range: 0 to 9999
Default Value: 10

Displays and sets the alarm relay hysteresis limit for relay 1. To set a relay hysteresis value go to the A 1HY function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value. The hysteresis value is common to both high and low setpoint values. The hysteresis value may be used to prevent too frequent operation of the relay when the measured value is rising and falling around setpoint value. e.g. if A 1HY is set to zero the alarm will activate when the display value reaches the alarm setpoint (for high alarm) and will reset when the display value falls below the setpoint, this can result in repeated on/off switching of the relay at around the setpoint value. The hysteresis setting operates as follows: In the high alarm mode, once the alarm is activated the input must fall below the setpoint value minus the hysteresis value to reset the alarm. e.g. if A 1H, is to 50.0 and A 1HY is set to 3.0 then the setpoint output relay will activate once the display value goes to 50.0 or above and will reset when the display value goes below 47.0 i.e. at 46.9 or below. In the low alarm mode, once the alarm is activated the input must rise above the setpoint value plus the hysteresis value to reset the alarm. e.g. if A 1Lo is to 20.0 and A 1HY is set to 10.0 then the alarm output relay will activate when the display value falls to 20.0 or below and will reset when the display value goes above 30.0 i.e at 30.1 or above. The hysteresis units are expressed in displayed engineering units.

Example:
If A 1H, is set to 100 and A 1HY is set to 10 then relay 1 will activate when the display value is 100 or higher and will reset at a display value of 89 or lower.

4.6 Alarm relay 2 hysteresis (deadband)

Display: A2HY
Range: 0 to 9999
Default Value: 10

Displays and sets the alarm relay hysteresis limit for relay 2 which operates in the same manner as the A 1HY function. See A 1HY function for further description.

4.7 Alarm relay 1 trip time

Display: A 1tt
Range: 0 to 999.9
Default Value: 0.0

Displays and sets the alarm trip time in seconds and tenths of seconds. The trip time is common for both alarm high and low setpoint values. The trip time provides a time delay before the alarm relay will activate when an alarm condition is present. The alarm condition must be present continuously for the whole trip time period before the alarm will activate. If the input moves out of alarm condition during this period the timer will reset and the full time delay will be restored. This trip time delay is useful for preventing an alarm trip due to short non critical deviations from setpoint. The trip time is selectable over 0.0 to 999.9 seconds. To set a trip time value go to the A 1tt function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

Example:
If A 1tt is set to 5.0 seconds then the display must indicate an alarm value for a full 5 seconds before relay 1 will activate.

4.8 Alarm relay 2 trip time

Display: A2tt
Range: 0 to 999.9
Default Value: 0.0

Displays and sets the alarm trip time in seconds and tenths of seconds for relay 2 and operates in the same manner as the A 1tt function. See A 1tt for further description.

4.9 Alarm relay 1 reset time

Display: A 1rt
Range: 0.0 to 999.9
Default Value: 0.0

Displays and sets the alarm reset delay time in seconds and tenths of seconds. The reset time is common for both alarm high and low setpoint values. With the alarm condition is removed the alarm relay will stay in its alarm condition for the time selected as the reset time. If the input moves back into alarm condition during this period the timer will reset and the full time delay will be restored. The reset time is selectable over 0.0 to 999.9 seconds. To set a reset time value go to the A$x$rt function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

Example:
If A 1rt is set to 10.0 seconds then the resetting of alarm relay 1 will be delayed by 10 seconds.

4.10 Alarm relay 2 reset time

Display: A2rt
Range: 0.0 to 999.9
Default Value: 0.0

Displays and sets the alarm reset time in seconds and tenths of seconds for relay 2 and operates in the same manner as A 1rt function. See A 1rt for further description.

4.11 Alarm relay 1 normally open/closed

Display: A 1n.o or A 1n.c
Range: A 1n.o or A 1n.c
Default Value: A 1n.o

Displays and sets the setpoint alarm relay 1 action to normally open (de-energised) or normally closed (energised), when no alarm condition is present. Since the relay will always open when power is removed a normally closed alarm is often used to provide a power failure alarm indication. To set the alarm alarm for normally open or closed go to the A 1n.o or A 1n.c function and use the ▲ or ▼ push buttons to set the required operation then press F to accept this selection.

Example:
If set to A 1n.o alarm relay 1 will be open circuit when the display is outside alarm condition and will be closed (short circuit across terminals) when the display is in alarm condition.

4.12 Alarm relay 2 normally open/closed

Display: A2n.o or A2n.c
Range: A2n.o or A2n.c
Default Value: A2n.o

Displays and sets the setpoint alarm relay 2 action to normally open (de-energised) or normally closed (energised) and operates in the same manner as the A 1n.o or A 1n.c function. See A 1n.o or A 1n.c for further description.

4.13 Alarm relay setpoint or trailing operation

Display: A2SP or A2t 1
Range: A2SP or A2t 1
Default Value: A2SP

Relay operation independent setpoint or trailing setpoint, this function will not be seen unless extra optional relays are fitted. Each alarm, except relay 1, may be programmed to operate with an independent setpoint value or may be linked to operate at a fixed difference to another relay setpoint, known as trailing operation. The operation is as follows:

Alarm 1 (A1) is always independent. Alarm 2 (A2) may be independent or may be linked to Alarm 1. For trailing set points the setpoint value is entered as the difference from the setpoint being trailed. If the trailing setpoint is to operate ahead of the prime setpoint then the value is entered as a positive number and if operating behind the prime setpoint then the value is entered as a negative number.

Example:
With Alarm 2 set to trail alarm 1, if A 1H, is set to 1000 and A2H, is set to 50 then Alarm 1 will activate at 1000 and alarm 2 will activate at 1050 (i.e. 1000 + 50). If Alarm 2 had been set at -50 then alarm 2 would activate at 950 (i.e. 1000 – 50).

4.14 Display brightness

Display: br9t
Range: 1 to 63
Default Value: 63

Seen only when br9t AUto is set to OFF. Displays and sets the digital display brightness. The display brightness is selectable from 1 to 63, where 1 = lowest intensity and 63 = highest intensity. This function is useful for improving the display readability in dark areas or to reduce the power consumption of the instrument. See also the duLL function 4.15. To set brightness level go to the br9t function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

4.15 Display remote brightness switching

Display: duLL
Range: 0 to 63
Default Value: 15

Displays and sets the level for remote input brightness switching, see r.1 nP function. When a remote input is set to duLL the remote input can be used to switch between the display brightness level set by the br9t function 4.14 and the display brightness set by the duLL function. The display dull level is selectable from 0 to 63, where 0 = lowest intensity and 63 = highest intensity. This function is useful in reducing glare when the display needs to be viewed in both light and dark ambient light levels. To set dull level go to the duLL function and use the ▲ or ▼ push buttons to set the value required then press F to accept this value.

Example:
With **dULL** set to **15** and **br9t** set to **63** and the **F.1 nP** function set to **dULL** the display brightness will change from the **63** level to **15** when a switch connected to the remote input terminals is activated.

4.16 Automatic display brightness adjustment

Display: **br9t AUto**
Range: **on** or **OFF**
Default Value: **OFF**

Automatic display brightness adjustment. Not applicable unless the optional light sensor is fitted. The automatic brightness adjustment uses the optional light sensor to gauge the required brightness level for the environment. The high and low brightness limits are set at the **br9t HI 9H** and **br9t Lo** functions described below. If the light sensor is not fitted this function should be set to **OFF**.

4.17 Automatic display brightness adjustment - high level

Display: **br9t HI 9H**
Range: **1** to **63**
Default Value: **63**

Automatic brightness high level - seen only when **br9t AUto** is set to **on**. The high brightness level sets the maximum brightness which the automatic brightness control can achieve with 63 being the highest intensity.

4.18 Automatic display brightness adjustment - low level

Display: **br9t Lo**
Range: **1** to **63**
Default Value: **1**

Automatic brightness low level - seen only when **br9t AUto** is set to **on**. The high brightness level sets the minimum brightness which the automatic brightness control can achieve with 63 being the highest intensity.

4.19 Display rounding

Display: **drnd**
Range: **1** to **5000**
Default Value: **1**

Displays and sets the display rounding value. This value may be set to 1 - 5000 displayed units. Display rounding is useful for reducing the instrument resolution without loss of accuracy in applications where it is undesirable to display to a fine tolerance. To set the display rounding value go to the **drnd** function and use the ▲ or ▼ push buttons to set the required value then press **F** to accept this selection.

Example: If set to **10** the display values will change in multiples of 10 only i.e. display moves from **10** to **20** to **30** etc.

4.20 Decimal point

Display: dCPt
Range: 0, 0.1 etc.
Default Value: 0

Displays and sets the decimal point. By pressing the ▲ or ▼ pushbutton at the dCPt function the decimal point position may be set. The display will indicate as follows: 0 (no decimal point), 0.1 (1 decimal place), 0.02 (2 decimal places), 0.003 (3 decimal places) and 0.0004 for display with more than 4 digits. Note if the decimal point is altered the display will need to be recalibrated and alarm etc. settings checked. In arithmetic mode this function sets the decimal point position for channel 0 i.e. the arithmetic result.

4.21 Digital filter

Display: FLtr
Range: 0 to 8
Default Value: 2

Displays and sets the digital filter value. Digital filtering uses a weighted average method of determining the display value and is used for reducing display value variation due to short term interference. The digital filter range is selectable from 0 to 8, where 0 = none and 8 = most filtering. Use ▲ or ▼ at the FLtr function to alter the filter level if required. Note that the higher the filter setting the longer the display may take to reach its final value when the input is changed, similarly the relay operation and any output options will be slowed down when the filter setting is increased. To set the digital filter value go to the FLtr function and use the ▲ or ▼ push buttons to set the required value then press F to accept this selection.

4.22 Units to be used for nnEA mode

Display: SPEd Unit
Range: nS, nPH, hPH or knot
Default Value: nS

Applicable to nnEA mode only. Select from the following choices: nS (metres/sec), nPH (miles/hour), hPH (kilometers/hour) or knot (knots).

4.23 Default display for nnEA mode

Display: dFLt di SP
Range: di r, SPEd or SCAn
Default Value: SCAn

Applicable to nnEA mode only. Select from the following choices: di r (wind direction), SPEd (wind speed) or SCAn (automatically toggles display between direction and speed at the rate set by the SCAn SECS function). For example if this function is set to di r then the operator will need to push the ▲ or ▼ button to display speed, the display will then automatically revert back to direction after approximately 4 minutes.

4.24 Number of seconds between scans

Display: SCAn SECS
Range: 0 to 255
Default Value: 0

Seen only when CodE function is set to SCAn, CS or nnEA. Selects the number of seconds between

channel scans or between wind speed and direction if CodE function is set to MAEA. The scan period can be set from 0 to 255 seconds. If set to 0 the display will not automatically scroll between channels and the ▲ or ▼ button must be used to change the channel displayed. Note the display will not automatically scan if it is in CAL mode.

4.25 Number of active channels for ArtH mode

Display: AtHH CH
Range: 1 to 8
Default Value: 4

Displays and selects the number of active input channels used in the arithmetic operation. The instrument will automatically poll the number of channels selected.

4.26 Channel 1 address

Display: Ch 1 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. The instruments connected to the display for scanning purposes must be of the same manufacture this instrument. These units allow a primary and in some cases secondary values to be sent. Refer to the separate manuals supplied when this option is fitted to see if secondary values are available for that instrument. The primary value is the main display value for that instrument e.g. For a conductivity instrument the conductivity would be the primary value and the temperature the secondary. Addresses available are P 1 to P8 (to poll for primary values), S 1 to S8 (to poll for secondary values) and t 1 to t8 (to poll a channel of model TP488 scanning monitor). The numerical value refers to the channel number of a TP488 scanning monitor, for other instruments the numerical value is the address which is set at the Addr function of the instrument being polled. For example if Ch2 Addr is set to P2 then the value will be returned will be the primary display value from the instrument whose Addr function is set to 2.

4.27 Channel 2 address

Display: Ch2 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 2, see function 4.26 for further information.

4.28 Channel 3 address

Display: Ch3 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 3, see function 4.26 for further information.

4.29 Channel 4 address

Display: Ch4 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 4, see function 4.26 for further information.

4.30 Channel 5 address

Display: Ch5 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 5, see function 4.26 for further information.

4.31 Channel 6 address

Display: Ch6 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 6, see function 4.26 for further information.

4.32 Channel 7 address

Display: Ch7 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 7, see function 4.26 for further information.

4.33 Channel 8 address

Display: Ch8 Addr
Range: P 1 to P8 or S 1 to S8 or t 1 to t8
Default Value: P 1

Seen only when CodE function is set to SCAN or ArtH. Scan address for channel 8, see function 4.26 for further information.

4.34 Channel 1 decimal point

Display: Ch 1 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 1. By pressing the ▲ or ▼ pushbuttons the decimal point position may be set. The display will indicate as follows: 0 (no decimal point), 0.1 (1 decimal place), 0.02 (2 decimal places) etc.

4.35 Channel 2 decimal point

Display: CH2 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 2. See function 4.34 for further details.

4.36 Channel 3 decimal point

Display: CH3 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 3. See function 4.34 for further details.

4.37 Channel 4 decimal point

Display: CH4 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 2. See function 4.34 for further details.

4.38 Channel 5 decimal point

Display: CH5 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 5. See function 4.34 for further details.

4.39 Channel 6 decimal point

Display: CH6 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 6. See function 4.34 for further details.

4.40 Channel 7 decimal point

Display: CH7 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 7. See function 4.34 for further details.

4.41 Channel 8 decimal point

Display: Ch8 dCPt
Range: 0, 0.1 etc.
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the decimal point for input channel 8. See function 4.34 for further details.

4.42 Channel 1 EA1 value for arithmetic formula

Display: EA1
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA1 value to be used in the arithmetic formula. If the number of display digits allows a range from -32767 to 32767 is available for this function. This value is used together with the input value for channel 1, the Eb1 and EC1 to produce the a value to be used in the formula below:

$$\frac{EA1 * (Ch1 + Eb1)}{EC1} \left\{ \begin{array}{c} Add \\ Sub \\ Prod \\ d.U \\ hi\ gh \\ Lo \\ S.nE \\ CoS \\ C.SUb \end{array} \right\} \frac{EA2 * (Ch2 + Eb2)}{EC2} \left\{ \begin{array}{c} Add \\ Sub \\ Prod \\ d.U \\ hi\ gh \\ Lo \\ S.nE \\ CoS \\ C.SUb \end{array} \right\} \frac{EA3 * (Ch3 + Eb3)}{EC3}$$

etc. for the remaining active channels. Note: A and C are whole numbers, b has the same decimal place setting as its associated channel.

4.43 Channel 1 Eb1 value for arithmetic formula

Display: Eb1
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb1 value to be used in the arithmetic formula. See function 4.42 for further details.

4.44 Channel 1 EC1 value for arithmetic formula

Display: EC1
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC1 value to be used in the arithmetic formula. See function 4.42 for further details.

4.45 Channel 2 EA2 value for arithmetic formula

Display: EA2
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA2 value to be used in the arithmetic formula.

See function 4.42 for further details.

4.46 Channel 2 Eb2 value for arithmetic formula

Display: Eb2
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb2 value to be used in the arithmetic formula. See function 4.42 for further details.

4.47 Channel 2 EC2 value for arithmetic formula

Display: EC2
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC2 value to be used in the arithmetic formula. See function 4.42 for further details.

4.48 Channel 3 EA3 value for arithmetic formula

Display: EA3
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA3 value to be used in the arithmetic formula. See function 4.42 for further details.

4.49 Channel 3 Eb3 value for arithmetic formula

Display: Eb3
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb3 value to be used in the arithmetic formula. See function 4.42 for further details.

4.50 Channel 3 EC3 value for arithmetic formula

Display: EC3
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC3 value to be used in the arithmetic formula. See function 4.42 for further details.

4.51 Channel 4 EA4 value for arithmetic formula

Display: EA4
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA4 value to be used in the arithmetic formula. See function 4.42 for further details.

4.52 Channel 4 Eb4 value for arithmetic formula

Display: Eb4
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = Arth mode. Displays and sets the Eb4 value to be used in the arithmetic formula. See function 4.42 for further details.

4.53 Channel 4 EC4 value for arithmetic formula

Display: EC4
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EC4 value to be used in the arithmetic formula. See function 4.42 for further details.

4.54 Channel 5 EA5 value for arithmetic formula

Display: EA5
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EA5 value to be used in the arithmetic formula. See function 4.42 for further details.

4.55 Channel 5 Eb5 value for arithmetic formula

Display: Eb5
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = Arth mode. Displays and sets the Eb5 value to be used in the arithmetic formula. See function 4.42 for further details.

4.56 Channel 5 EC5 value for arithmetic formula

Display: EC5
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EC5 value to be used in the arithmetic formula. See function 4.42 for further details.

4.57 Channel 6 EA6 value for arithmetic formula

Display: EA6
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = Arth mode. Displays and sets the EA6 value to be used in the arithmetic formula. See function 4.42 for further details.

4.58 Channel 6 Eb6 value for arithmetic formula

Display: Eb6
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb6 value to be used in the arithmetic formula. See function 4.42 for further details.

4.59 Channel 6 EC6 value for arithmetic formula

Display: EC6
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC6 value to be used in the arithmetic formula. See function 4.42 for further details.

4.60 Channel 7 EA7 value for arithmetic formula

Display: EA7
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA7 value to be used in the arithmetic formula. See function 4.42 for further details.

4.61 Channel 7 Eb7 value for arithmetic formula

Display: Eb7
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb7 value to be used in the arithmetic formula. See function 4.42 for further details.

4.62 Channel 7 EC7 value for arithmetic formula

Display: EC7
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC7 value to be used in the arithmetic formula. See function 4.42 for further details.

4.63 Channel 8 EA8 value for arithmetic formula

Display: EA8
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EA8 value to be used in the arithmetic formula. See function 4.42 for further details.

4.64 Channel 8 Eb8 value for arithmetic formula

Display: Eb8
Range: -32767 to 32767
Default Value: 0

Seen only in CodE = ArtH mode. Displays and sets the Eb8 value to be used in the arithmetic formula. See function 4.42 for further details.

4.65 Channel 8 EC8 value for arithmetic formula

Display: EC8
Range: -32767 to 32767
Default Value: 1

Seen only in CodE = ArtH mode. Displays and sets the EC8 value to be used in the arithmetic formula. See function 4.42 for further details.

4.66 Arithmetic operation between channels 1 and 2

Display: OP 1
Range: Add, Sub, Prod, di U, Hi 9h, Lo, Si nE, COS or C.SUb
Default Value: Add

Displays the arithmetic operation to be undertaken between the formula for channels 1 and 2. See also function 4.42 which illustrates the formula.
Choices are:

- Add - channel 1 formula plus channel 2 formula
- Sub - channel 1 formula minus channel 2 formula
- Prod - channel 1 formula times channel 2 formula
- di U - channel 1 formula divided by channel 2 formula
- Hi 9h - highest of channel 1 formula or channel 2 formula
- Lo - lowest of channel 1 formula or channel 2 formula
- Si nE - channel 1 formula times the sine of the angle represented by channel 2 formula
- COS - channel 1 formula times the cosine of the angle represented by channel 2 formula
- C.SUb - channel 1 formula clock time input minus channel 2 formula clock time.
  Note: C.SUb is meant to be used when connecting to two clocks with compatible serial outputs.

4.67 Arithmetic operation between channel 3 and previous operation

Display: OP2
Range: Add, Sub, Prod, di U, Hi 9h, Lo, Si nE or COS
Default Value: Add

Displays the arithmetic operation to be undertaken between the channel 3 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- Add - mathematical result of OP 1 plus channel 3 formula

- **Sub** - mathematical result of **OP 1** minus channel 3 formula
- **Prod** - mathematical result of **OP 1** times channel 3 formula
- **di U** - mathematical result of **OP 1** divided by channel 3 formula
- **Hi 9h** - highest of mathematical result of **OP 1** or channel 3 formula
- **Lo** - lowest of mathematical result of **OP 1** or channel 3 formula
- **Si nE** - mathematical result of **OP 1** times the sine of the angle represented by channel 3 formula
- **COS** - mathematical result of **OP 1** times the cosine of the angle represented by channel 3 formula

4.68 Arithmetic operation between channel 4 and previous operation

Display: **OP3**
Range: **Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **Si nE** or **COS**
Default Value: **Add**

Displays the arithmetic operation to be undertaken between the channel 4 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** and **OP2** plus channel 4 formula
- **Sub** - mathematical result of **OP 1** and **OP2** minus channel 4 formula
- **Prod** - mathematical result of **OP 1** and **OP2** times channel 4 formula
- **di U** - mathematical result of **OP 1** and **OP2** divided by channel 4 formula
- **Hi 9h** - highest of mathematical result of **OP 1** and **OP2** or channel 4 formula
- **Lo** - lowest of mathematical result of **OP 1** and **OP2** or channel 4 formula
- **Si nE** - mathematical result of **OP 1** and **OP2** times the sine of the angle represented by channel 4 formula
- **COS** - mathematical result of **OP 1** and **OP2** times the cosine of the angle represented by channel 4 formula

4.69 Arithmetic operation between channel 5 and previous operation

Display: **OP4**
Range: **Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **Si nE** or **COS**
Default Value: **Add**

Displays the arithmetic operation to be undertaken between the channel 5 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** and **OP2** and **OP3** plus channel 5 formula
- **Sub** - mathematical result of **OP 1** and **OP2** and **OP3** minus channel 5 formula
- **Prod** - mathematical result of **OP 1** and **OP2** and **OP3** times channel 5 formula
- **di U** - mathematical result of **OP 1** and **OP2** and **OP3** divided by channel 5 formula
- **Hi 9h** - highest of mathematical result of **OP 1** and **OP2** and **OP3** or channel 5 formula

- **Lo** - lowest of mathematical result of **OP 1** and **OP2** and **OP3** or channel 5 formula
- **SI nE** - mathematical result of **OP 1** and **OP2** and **OP3** times the sine of the angle represented by channel 5 formula
- **COS** - mathematical result of **OP 1** and **OP2** and **OP3** times the cosine of the angle represented by channel 5 formula

4.70 Arithmetic operation between channel 6 and previous operation

Display: **OP5**
Range: **Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **SI nE** or **COS**
Default Value: **Add**

Displays the arithmetic operation to be undertaken between the channel 6 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** plus channel 6 formula
- **Sub** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** minus channel 6 formula
- **Prod** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** times channel 6 formula
- **di U** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** divided by channel 6 formula
- **Hi 9h** - highest of mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** or channel 6 formula
- **Lo** - lowest of mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** or channel 6 formula
- **SI nE** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** times the sine of the angle represented by channel 6 formula
- **COS** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** times the cosine of the angle represented by channel 6 formula

4.71 Arithmetic operation between channel 7 and previous operation

Display: **OP6**
Range: **Add**, **Sub**, **Prod**, **di U**, **Hi 9h**, **Lo**, **SI nE** or **COS**
Default Value: **Add**

Displays the arithmetic operation to be undertaken between the channel 7 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** plus channel 7 formula
- **Sub** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** minus channel 7 formula
- **Prod** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** times channel 7 formula
- **di U** - mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** divided by channel 7 formula
- **Hi 9h** - highest of mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** or channel 7 formula
- **Lo** - lowest of mathematical result of **OP 1** and **OP2** and **OP3** and **OP4** and **OP5** or channel 7 formula

- **SINE** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** times the sine of the angle represented by channel 7 formula
- **COS** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** times the cosine of the angle represented by channel 7 formula

4.72 Arithmetic operation between channel 8 and previous operation

Display: **OP7**
Range: **Add**, **Sub**, **Prod**, **diV**, **Hi9h**, **Lo**, **SINE** or **COS**
Default Value: **Add**

Displays the arithmetic operation to be undertaken between the channel 8 formula and the previous result. See also function 4.42 which illustrates the formula.
Choices are:

- **Add** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** plus channel 8 formula
- **Sub** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** minus channel 8 formula
- **Prod** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** times channel 8 formula
- **diV** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** divided by channel 8 formula
- **Hi9h** - highest of mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** or channel 8 formula
- **Lo** - lowest of mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** or channel 8 formula
- **SINE** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** times the sine of the angle represented by channel 8 formula
- **COS** - mathematical result of **OP1** and **OP2** and **OP3** and **OP4** and **OP5** and **OP6** times the cosine of the angle represented by channel 8 formula

4.73 Channel 0 polarity

Display: **Ch0**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 0. Channel 0 is the channel which displays the result of the arithmetic operations. If set to **bOtH** then the display will be able to indicate both positive and negative values. If set to **POS** the display will allow only positive values with any values below zero being rounded to zero. If set to **NEG** then the display will allow only negative values with any value above zero being rounded to zero. Channel 0 polarity applies to Arithmetic mode **ArtH** only.

4.74 Channel 1 polarity

Display: **Ch1**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 1. If set to

both then the display will be able to indicate both positive and negative values. If set to **POS** the display will allow only positive values with any values below zero being rounded to zero. If set to **NEG** then the display will allow only negative values with any value above zero being rounded to zero.

4.75 Channel 2 polarity

Display: **Ch2**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 2. See function 4.74 for further information.

4.76 Channel 3 polarity

Display: **Ch3**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 3. See function 4.74 for further information.

4.77 Channel 4 polarity

Display: **Ch4**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 4. See function 4.74 for further information.

4.78 Channel 5 polarity

Display: **Ch5**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 5. See function 4.74 for further information.

4.79 Channel 6 polarity

Display: **Ch6**
Range: **both**, **POS** or **NEG**
Default Value: **both**

Displays and sets the polarity selection for the display of the engineering value for channel 6. See function 4.74 for further information.

4.80 Channel 7 polarity

Display: Ch7
Range: both, POS or NEG
Default Value: both

Displays and sets the polarity selection for the display of the engineering value for channel 7. See function 4.74 for further information.

4.81 Channel 8 polarity

Display: Ch8
Range: both, POS or NEG
Default Value: both

Displays and sets the polarity selection for the display of the engineering value for channel 8. See function 4.74 for further information.

4.82 Data type for display

Display: CodE
Range: di SP, ASCI , UAL, ArtH, n.buS, PtA, SCAn, nMEA or CS
Default Value: di SP

One of eight different display modes can be selected in this function, namely di SP, ASCI , UAL, ArtH, n.buS, PtA, SCAn, nMEA or CS. This Addendum booklet deals only with arithmetic mode ArtH and Wind speed/direction nMEA operation. Refer to the main instruction manual for details of other modes.

Note that if the mode is altered it is necessary to switch the instrument off then on again to reset to the new mode.

- **ArtH mode**
  Arithmetic mode. In this mode the display can accept inputs from up to 8 external sources and combine them arithmetically using a flexible formula (see the EA 1 formula for details of the formula). The ArtHCH function sets the number of channels to be used and the channel address functions are then selected to determine what data is returned for inclusion in the arithmetic formula. See "Arithmetic function
- **nMEA mode**
  With nMEA selected the instrument must be connected to a sensor with NMEA serial output typically these may be wind speed and direction sensors . See "Wind Speed and Direction NMEA mode" chapter for communications setup requirements.

4.83 Alarm relay 1 operation mode

Display: A 1 OPEr
Range: 1 nPt, t.out or both
Default Value: 1 nPt

Relay 1 operation mode - relay 1 can be made to operate from the input value (e.g. at the A 1Lo or A 1H, value, applicable when CodE is set to UAL or n.buS only) or when the display blanks due to the timeout value being exceeded (timeout value set at the dS.to function). If set to both the relay will operate from the display value or if communications fails.

4.84 Alarm relay 2 operation mode

Display: A2 OPEr
Range: inPt, t.out or both
Default Value: inPt

Relay 2 operation mode - relay 2 can be made to operate from the input value (e.g. at the A iLo or A iH, value, applicable when CodE is set to UAL or ñ.buS only) or when the display blanks due to the timeout value being exceeded (timeout value set at the dS.to function). If set to both the relay will operate from the display value or if communications fails. Note that this function is only available for the first 2 relays fitted.

4.85 Access mode

Display: ACCS
Range: OFF, EASY, NONE or ALL
Default Value: OFF

Access mode - the access mode function ACCS has four possible settings namely OFF, EASY, NONE and ALL. If set to OFF the mode function has no effect on alarm relay operation. If set to EASY the "easy alarm access" mode will be activated. Refer to "Easy alarm relay adjustment access facility" page 15. If set to NONE there will be no access to any functions via FUNC mode, entry via CAL mode must be made to gain access to alarm and calibration functions. If set to ALL then access to all functions, including calibration functions, can be gained via FUNC mode.

4.86 Setpoint access mode

Display: SPAC
Range: A 1, A 1-2 etc.
Default Value: A 1

Setpoint access - seen only if more than 1 relay fitted. Sets the access via FUNC mode and "easy alarm access" mode to the alarm relay setpoints. The following choices are available:
A 1 - Allows setpoint access to alarm 1 only.
A 1-2 - Allows setpoint access to alarms 1 and 2 only.
A 1-3 - Allows setpoint access to alarms 1, 2 and 3 etc. up to the maximum number of relays fitted.
The remote input function (r.i nP) must be set to SP.AC for this function to operate. Note: Only the setpoints which have been given a value will be accessible e.g. if A iH, is set to OFF then there will be no access to the A iH, function when SPAC is used.

4.87 Display timeout

Display: dS.to
Range: 0 to 9999
Default Value: 10

This function allows the user to set a timeout value for a valid display. Valid times are 0 to 9999 seconds, a setting of 0 disables the timeout. If a new data stream is not received before the timeout value is reached then the display will be blanked.

4.88 Data string timeout

Display: t.out
Range: 0.0 to 10.0
Default Value: 1.0

This function allows the user to set a timeout value for the data stream. Valid times are 0.0 to 10.0 seconds, a setting of 0.0 disables the timeout. The timeout will cause the current data stream to be ignored if the time gap between characters in the stream exceeds the t.out value. This function helps to prevent false displays when the data stream is interrupted.

4.89 P button function

Display: P.but
Range: NONE, HI, LO, HI LO, TARE or ZERO
Default Value: NONE

P button function - The P button function can only be used when the CodE function is set to UAL. The P button may be set to operate some of the remote input functions. With the tare and zero functions, to prevent accidental operation, the P button must be held pressed for 2-3 seconds before the display will tare or zero, momentary operation of the tare function will cause the gross value to be displayed, preceded by the message GROS. If both the remote input and P button function are operated simultaneously the P button will override the remote input. The functions below are as described in the r.i np function below. Functions available are: NONE, HI, LO, HI LO, TARE or ZERO

4.90 Remote input function

Display: r.i np
Range: NONE, P.HLd, d.HLd, HI, LO, HI, LO, TARE, ZERO, SP.Ac, No.Ac or dULL

Default Value: NONE

Remote input functions can only be used when the CodE function is set to UAL.

Remote input function - When these remote input terminals are short circuited, via a switch, relay, keyswitch etc. the instrument will perform the selected remote input function. A message will flash to indicate which function has been selected when the remote input pins are short circuited. The remote input functions are as follows:

NONE - no remote function required i.e. activating the remote input has no effect.

P.HLd - peak hold. The display will show the peak value (highest positive value) only whilst the remote input terminals are short circuited i.e. the display value can rise but not fall whilst the input terminals are short circuited. The message P.HLd will appear briefly every 8 seconds whilst the input terminals are short circuited to indicate that the peak hold function is active.

d.HLd - display hold. The display value will be held whilst the remote input terminals are short circuited. The message d.HLd will appear briefly every 8 seconds whilst the input terminals are short circuited to indicate that the display hold function is active.

HI - peak memory. The peak value stored in memory will be displayed if the remote input terminals are short circuited, if the short circuit is momentary then the display will return to normal measurement after 20 seconds. If the short circuit is held for 2 to 3 seconds or the power is removed from the instrument then the memory will be reset.

LO - valley memory. The minimum value stored in memory will be displayed. Otherwise operates in the same manner as the HI function described above.

Hi Lo - toggle between **Hi** and **Lo** displays. This function allows the remote input to be used to toggle between peak and valley memory displays. The first operation of the remote input will cause the peak memory value to be displayed, the next operation will give a valley memory display. **PHi** or **PLo** will flash before each display to give an indication of display type.

tARE - display tare. Short circuiting the remote input pins momentarily will allow toggling between nett and gross values (shown as **NEtt** and **grOS**). If the remote input is short circuited for approx. 2 seconds the display will be tared and will show zero. The tare will be lost if power is removed.

2Er0 - display zero. Zeroes the display in same manner as the tare function except that the zero is not lost when power is removed and the display will zero as soon as the remote input is shorted. When the **2Er0** operation is used the gross value cannot be recalled and the input at the time of the **2Er0** operation will become the new zero point.

SP.Ac - setpoint access only. This blocks access to any functions except the alarm setpoint functions unless the remote input pins are short circuited or entry is made via **CAL** mode or if the **ACCS** function is set to **ALL**.

No.Ac - no access. This blocks access to all functions unless the remote input pins are short circuited or entry is made via **CAL** mode or if the **ACCS** function is set to **ALL**.

duLL - display brightness control. The remote input can be used to change the display brightness. When this mode is selected the display brightness can be switched, via the remote input terminals, between the brightness level set at the **br9t** function and the brightness level set at the **duLL** function.

4.91 Alarm relay 1 operation channel

Display: **A 1**
Range: **ch0** to **ch8**
Default Value: **ch0**

Alarm relay 1 allocation - applicable only to **ArtH**, **nnEA**, **SCAn** and **CS** modes. Allows relay 1 to be allocated to one channel. Settings available are **ch0**, **ch 1**, **ch2**, **ch3**, **ch4**, **ch5**, **ch6**, **ch7** or **ch8**. In **nnEA** mode **ch 1** represents wind direction and **ch2** represents wind speed. In **ArtH** mode **ch0** represents the arithmetic result. **ch0** should not be selected for any other mode.

4.92 Alarm relay 2 operation channel

Display: **A2**
Range: **ch0** to **ch8**
Default Value: **ch0**

Alarm relay 2 allocation - applicable only to **ArtH**, **nnEA**, **SCAn** and **CS** modes. Allows relay 2 to be allocated to one channel. Settings available are **ch0**, **ch 1**, **ch2**, **ch3**, **ch4**, **ch5**, **ch6**, **ch7** or **ch8**. In **nnEA** mode **ch 1** represents wind direction and **ch2** represents wind speed. In **ArtH** mode **ch0** represents the arithmetic result. **ch0** should not be selected for any other mode.

4.93 Clear zero

Display: **CLr 2Er0**
Range: n/a
Default Value: n/a

Seen only when **CodE** function = **UAL** or **ArtH**. Allows any zero operations performed via the remote input or **P** button to be cleared. Pressing the ▲ and ▼ buttons simultaneously will clear the zero offset, the message **CLrd** will be seen, confirming the zero clearing operation is completed. The instrument will then return to displaying the value of the string sent.

4.94 Baud rate for optional serial communications

Display: bAUd rAtE
Range: 300.600. 1200.2400.4800.9600. 19.2 or 38.4
Default Value: 9600

Select from 300.600. 1200.2400.4800.9600. 19.2 or 38.4 baud. This must be set to match the baud rate selected at the sending device.

4.95 Parity for serial input

Display: PrtY
Range: nonE.EUEn or Odd
Default Value: nonE

Select parity check to either nonE, EUEn or Odd. This must be set to match the parity selected at the sending device.

4.96 Data type

Display: dAtA
Range: 8.b, t or 7.b, t
Default Value: 8.b, t

Displays and selects the input data type. Select either 8.b, t for 8 data bits plus 1 stop bit or 7.b, t for 7 data bits plus 1 stop bit. This must be set to match the number of data bits of the sending device.

4.97 Serial communications type

Display: SEr. 1 tYPE
Range: nonE.r232 or r485
Default Value: nonE

Selects the serial output communications type from: nonE for no serial output, r232 for RS232 output or r485 for RS485 output. Note that the serial output is optional and factory configured with the hardware for one particular type of output i.e. if fitted with RS232 hardware then both the SEr. 1 tYPE and the hardware must be changed to convert to RS485.

4.98 Serial communications type for second comms. port

Display: SEr.2 tYPE
Range: nonE.r232 or r485
Default Value: nonE

Not applicable to this model - leave this function set to nonE.

5 Arithmetic function examples

Example 1: To get an average of channels 1, 2, 3 and 4 each input is added together and divided by 4:

Program:
EA1 = 1, Eb1 = 0, EC1 = 4,
EA2 = 1, Eb2 = 0, EC2 = 4,
EA3 = 1, Eb3 = 0, EC3 = 4,
EA4 = 1, Eb4 = 0, EC4 = 4,
OP1 = Add,
OP2 = Add,
OP3 = Add

$$\frac{1 * (\text{Ch1} + 0)}{4} \ \textbf{Add} \ \frac{1 * (\text{Ch2} + 0)}{4} \ \textbf{Add} \ \frac{1 * (\text{Ch3} + 0)}{4} \ \textbf{Add} \ \frac{1 * (\text{Ch4} + 0)}{4}$$

Example 2: Three inputs are present. The display is to indicate the highest of the 3 inputs. Channel 1 input is to be multiplied 2/3.

Program:
EA1 = 2, Eb1 = 0, EC1 = 3,
EA2 = 1, Eb2 = 0, EC2 = 1,
EA3 = 1, Eb3 = 0, EC3 = 1,
OP1 = Hi, 9H,
OP2 = Hi, 9H

$$\frac{2 * (\text{Ch1} + 0)}{3} \ \textbf{Hi 9H} \ \frac{1 * (\text{Ch2} + 0)}{1} \ \textbf{Hi 9H} \ \frac{1 * (\text{Ch3} + 0)}{1}$$

Example 3: To multiply the figure displayed on channel 1 by the sine of the angle of the figure displayed on channel 2. The second channel would normally be scaled from 0 to 360 when either the sine or cosine is being used, however numbers outside this range are acceptable.

Program:
EA1 = 1, Eb1 = 0, EC1 = 1,
EA2 = 1, Eb2 = 0, EC2 = 1,
OP1 = SinE

$$\frac{1 * (\text{Ch1} + 0)}{1} \ \textbf{SinE} \ \frac{1 * (\text{Ch2} + 0)}{1}$$

6 Function table - Wind Speed and Direction mode

Note: the order in which the functions appear on the display may not be exactly as shown below. The availability and order of functions is determined by choice of function settings and options fitted.

Functions in this first table are available in **FUNC** or **CAL** mode

Display	Function	Range	Default	Your record	Ref/Page
A 1Lo	Low setpoint value for alarm relay 1	Any display value or **OFF**	**OFF**		4.1 / 16
A 1H,	High setpoint value for alarm relay 1	Any display value or **OFF**	**OFF**		4.2 / 17
A2Lo	Low setpoint value for alarm relay 2	Any display value or **OFF**	**OFF**		4.3 / 17
A2H,	High setpoint value for alarm relay 2	Any display value or **OFF**	**OFF**		4.4 / 17
A 1HY	Hysteresis value for alarm relay 1	**0** to **9999**	**10**		4.5 / 18
A2HY	Hysteresis value for alarm relay 2	**0** to **9999**	**10**		4.6 / 18
A 1tt	Trip time delay for alarm relay 1	**0** to **999.9**	**0.0**		4.7 / 18
A2tt	Trip time delay for alarm relay 2	**0** to **999.9**	**0.0**		4.8 / 19
A 1rt	Reset time delay for alarm relay 1	**0.0** to **999.9**	**0.0**		4.9 / 19
A2rt	Reset time delay for alarm relay 2	**0.0** to **999.9**	**0.0**		4.10 / 19
A 1n.o or **A 1n.c**	Alarm relay 1 action to normally open or normally closed	**A 1n.o** or **A 1n.c**	**A 1n.o**		4.11 / 19
A2n.o or **A2n.c**	Alarm relay 2 action to normally open or normally closed	**A2n.o** or **A2n.c**	**A2n.o**		4.12 / 20
A2SP or **A2t 1**	Relay operation independent setpoint or trailing setpoint	**A2SP** or **A2t 1**	**A2SP**		4.13 / 20

(*__Optional__)—this function will only be accessible if the relevant option is fitted

Functions in this second table are available only in **CAL** mode or if **ACCS** is set to **ALL**

Display	Function	Range	Default	Your record	Ref/Page
br9t	Display brightness level	**1** to **63**	**63**		4.14 / 20
br9t AUto	Automatic display brightness adjustment	**on** or **OFF**	**OFF**		4.16 / 21
br9t HI 9H	Automatic display brightness adjustment - high level	**1** to **63**	**63**		4.17 / 21
br9t Lo	Automatic display brightness adjustment - low level	**1** to **63**	**1**		4.18 / 21
dULL	Display remote brightness switching	**0** to **63**	**15**		4.15 / 20

(*__Optional__)—this function will only be accessible if the relevant option is fitted

SPEd Un, t	Units to be used for MAEA mode	AS, APH, HPH or Hnot	AS		4.22 / 22
dFLt di SP	Default display for MAEA mode	d, r, SPEd or SCAn	SCAn		4.23 / 22
SCAn SECS	Number of seconds between scans	0 to 255	0		4.24 / 22
CodE	Data type for display	di SP, ASCI, UAL, ArtH, A.buS, PtA, SCAn, MAEA or CS	di SP		?? / ??
A1 OPEr	Alarm relay 1 operation mode	1 nPt, t.out or both	1 nPt		4.83 / 35
A2 OPEr	Alarm relay 2 operation mode	1 nPt, t.out or both	1 nPt		4.84 / 36
dS.to	Display timeout	0 to 9999	10		4.87 / 36
t.out	Data string timeout	0.0 to 10.0	1.0		4.88 / 37
P.but	P button function	nonE, Hi, Lo, HiLo, tArE or 2Er0	nonE		4.89 / 37
r.1 nP	Remote input (external input) one function	nonE, P.HLd, d.HLd, Hi, Lo, Hi Lo, tArE, 2Er0, SP.Ac, no.Ac or dull	nonE		4.90 / 37
ACCS	Access mode	OFF, EASY, nonE or ALL	OFF		4.85 / 36
SPAC	Setpoint access mode (*Optional)	A1, A1-2 etc.	A1		4.86 / 36
A1	Alarm relay 1 operation channel	ch0 to ch8	ch0		4.91 / 38
A2	Alarm relay 2 operation channel	ch0 to ch8	ch0		4.92 / 38
bAUd rAtE	Baud rate for serial communications	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	9600		4.94 / 39
PrtY	Parity for serial input	nonE, EUEn or Odd	nonE		4.95 / 39
dAtA	Data type	8.bit or 7.bit	8.bit		4.96 / 39
SEr.1 tYPE	Serial communications type (*Optional)	nonE, r232 or r485	nonE		4.97 / 39
SEr.2 tYPE	Not applicable to this model	nonE, r232 or r485	nonE		4.98 / 39

(*Optional)—this function will only be accessible if the relevant option is fitted

7 Wind speed and direction NMEA mode

This chapter deals specifically with the NMEA (National Marine Elecronics Association) mode of operation. When used in this mode the display must be connected to a wind sensor with NMEA output such as model WS-MMW-005 solid state wind speed and direction sensor and the RM4 **CodE** function must be set to **nMEA**.

Communication settings require the baud rate (**bAUd rAtE** function) to be set to **4800** with no parity (**PrtY** function) and 8 data bits (**dAtA** function).

The display can be set to show wind speed, wind direction or to toggle (using ▲ or ▼ button) or automatically alternate the display between wind speed and direction. Wind direction (**ch 1**) or wind speed (**ch2**) can be chosen to activate the internal relays via the **A 1** and **A2** functions.

Other settings allow the wind speed units and default display to be selected. See Chapter 6, page 41 for details of setup functions for the NMEA wind speed and direction mode.

See section 2.9, page 9 for wiring details of the WS-MMW-005 NMEA wind sensor.

7.1 ASCII Code Conversion Listing

ASCII for control characters is shown in brackets. e.g. STX may in some cases be entered as ∧B.

ASCII char.	Decimal	Hex	ASCII char.	Decimal	Hex	ASCII char.	Decimal	Hex
NUL (∧@)	00	00	+	43	2B	V	86	56
SOH (∧A)	01	01	,	44	2C	W	87	57
STX (∧B)	02	02	-	45	2D	X	88	58
ETX (∧C)	03	03	.	46	2E	Y	89	59
EOT (∧D)	04	04	/	47	2F	Z	90	5A
ENQ (∧E)	05	05	0	48	30	[	91	5B
ACK (∧F)	06	06	1	49	31	\	92	5C
BEL (∧G)	07	07	2	50	32	]	93	5D
BS (∧H)	08	08	3	51	33	∧	94	5E
HT (∧I)	09	09	4	52	34	_	95	5F
LF (∧J)	10	0A	5	53	35	‘	96	60
VT (∧K)	11	0B	6	54	36	a	97	61
FF (∧L)	12	0C	7	55	37	b	98	62
CR (∧M)	13	0D	8	56	38	c	99	63
SO (∧N)	14	0E	9	57	39	d	100	64
SI (∧O)	15	0F	:	58	3A	e	101	65
DLE (∧P)	16	10	;	59	3B	f	102	66
DC1 (∧Q)	17	11	<	60	3C	g	103	67
DC2 (∧R)	18	12	=	61	3D	h	104	68
DC3 (∧S)	19	13	>	62	3E	i	105	69
DC4 (∧T)	20	14	?	63	3F	j	106	6A
NAK (∧U)	21	15	@	64	40	k	107	6B
SYN (∧V)	22	16	A	65	41	l	108	6C
ETB (∧W)	23	17	B	66	42	m	109	6D
CAN (∧X)	24	18	C	67	43	n	110	6E
EM (∧Y)	25	19	D	68	44	o	111	6F
SUB (∧Z)	26	1A	E	69	45	p	112	70
ESC (∧[)	27	1B	F	70	46	q	113	71
FS (∧\)	28	1C	G	71	47	r	114	72
GS (∧∧)	29	1D	H	72	48	s	115	73
RS (∧)	30	1E	I	73	49	t	116	74
US (∧_)	31	1F	J	74	4A	u	117	75
SP ( )	32	20	K	75	4B	v	118	76
!	33	21	L	76	4C	w	119	77
”	34	22	M	77	4D	x	120	78
#	35	23	N	78	4E	y	121	79
$	36	24	O	79	4F	z	122	7A
%	37	25	P	80	50	{	123	7B
&	38	26	Q	81	51	|	124	7C
’	39	27	R	82	52	}	125	7D
(	40	28	S	83	53	~	126	7E
)	41	29	T	84	54	DEL	127	7F
*	42	2A	U	85	55			