Intech INSTRUMENTS LTD

IN-HWD

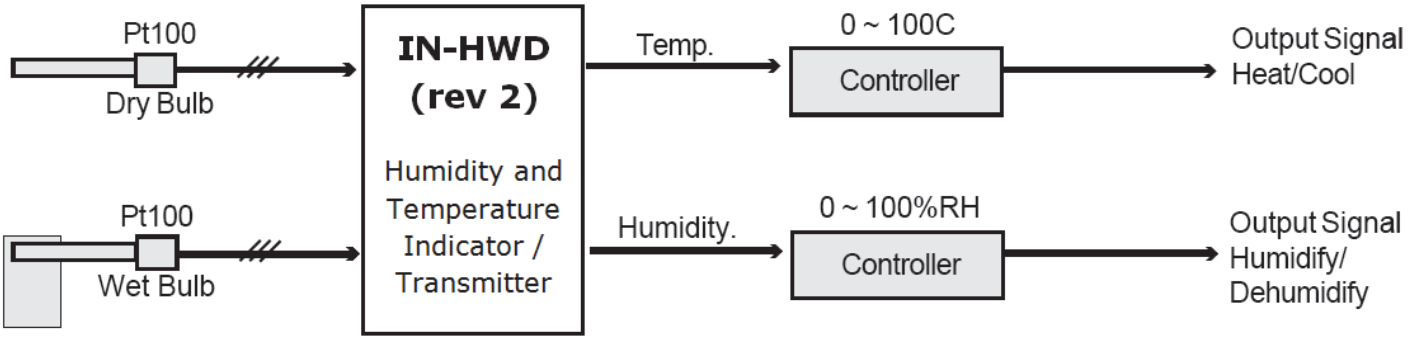
Wet & Dry Bulb Humidity Transmitter / Indicator.

E2180

Installation Guide.

IN-HWD Installation Guide Index.

Connection Example.



IN-HWD (rev 2)

Wet & Dry Bulb Humidity Transmitter / Indicator.

SECTION 1 — *Description.*

The IN-HWD (rev 2) wet & dry bulb humidity transmitter / Indicator is the ideal solution for a variety of humidity and temperature applications. It features two Pt100 inputs for the wet and dry bulb, two 4~20mA outputs for RH and dry bulb temperature, with no software required. Options are available for adding relay alarm outputs and/or serial port with Modbus RTU to allow easy interface with your PC, or with your existing PLC or monitoring system. The IN-HWD has been designed for ease of use, and has intuitive, scrolling text prompts that guide you step-by-step through the setup process. The front panel includes a dual, 6-digit LED display and five buttons, for simple operator interface.
The IN-HWD comes factory pre-calibrated for a Pt100 RTD 0~100°C input, and is simple to recalibrate (if required) using a two-point calibration method.

Ordering Information.

ITEMS	*CODE*				*DESCRIPTION*
SERIES	**IN-HWD-**				Wet & Dry Bulb Humidity Transmitter / Indicator
RELAY OUTPUTS		N-			None
		R4-			4x 5A relay outputs
SERIAL PORT			N-		None
			WS232-		1x serial port isolated RS232 (RJ11 terminal), Modbus RTU
			WS485-		1x serial port isolated RS485 (screw terminal)), Modbus RTU
POWER SUPPLY				HV	85~265Vac / 95~370Vdc
				LV	15~48Vac / 10~72Vdc

Ordering Example: **IN-HWD-R4-N-HV** Wet & dry bulb humidity transmitter / Indicator; 4x 5A relay outputs, no serial port; 85~265Vac / 95~370Vdc Power Supply.

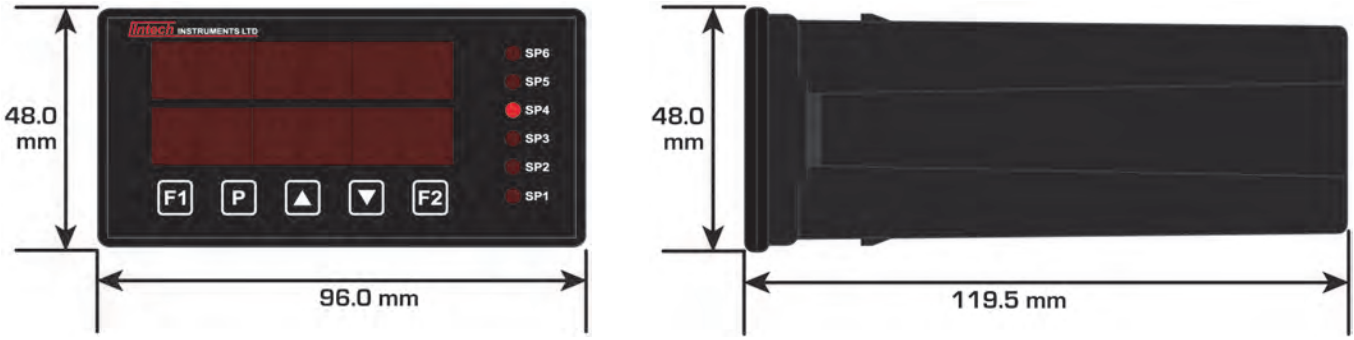
SECTION 2 — *Specifications.*

Input	1 x wet bulb, 1 x dry bulb. Dual 3-wire RTD Pt100 DIN (JIS option).
Power supply	HV: 85~265Vac / 95~370Vdc. LV: 15~48Vac / 10~72Vdc.
Analogue Output	Temperature and humidity output. Dual 16-bit 4~20mA (fully scalable). Window programmable over any range within the full-scale range of the controller.
Sampling rate	2.5Hz.
Resolution	0.025% full scale 16-bit.
Accuracy	0.05% of reading.
Temperature drift	Typically 50ppm/°C.
Temperature units	°C or °F.
Easy Setup	Intuitive text prompts for easy setup.
Calibration	Pre-calibrated for RTD Pt100. Simple recalibration (if required) using high and low display values.
Security	Calibration and setpoint functions have independent PIN security code access. Setpoint functions are independently configurable, and accessible through the F2 key.
OPTIONAL	
Relay Output	4x 5A Form A relays.
Serial Port	Isolated RS232 or RS485. Modes: ASCII, Modbus RTU slave, Ranger A output. Data rates: 300-38400. Parity: Odd, even or none.

SECTION 3 — *Case Schematics.*

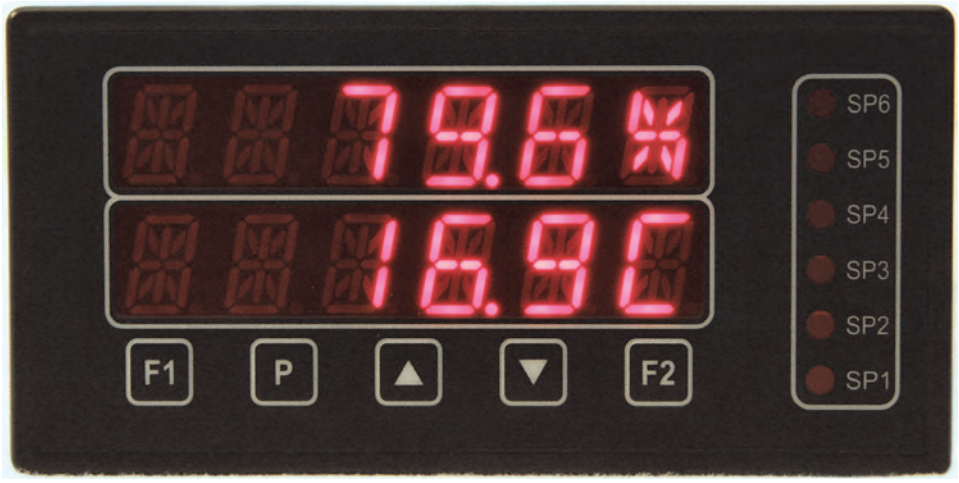
3.1 – Case dimensions:

Dimensions	48 x 96 x 119.5mm (H x W x D)
Panel cutout	45.5 x 92.5mm (H x W)



3.2 – Front panel:

The IN-HWD has a 2 x 6-digit, 14-segment alphanumeric LED display, five front-panel buttons and four setpoint annunciator LED's.



SP(X) The setpoint LED's are used to indicate active setpoints.

F1 This button is used to access the **Input Setup & Calibration** menu. See section 5.

P This button is typically used to save your settings and advance to the next step in the setup process.

▲ This button is typically used to scroll through options or increase values in the setup menu.
Pressing this button from the main display will allow you to view/reset the peak value (see 3.3).

▼ This button is typically used to scroll through options or decrease values in the setup menu.
Pressing this button from the main display will allow you to view/reset the valley value (see 3.3).

F2 This button is used to access the **Setpoint Setup** menu (see section 6) and the **Setpoint Open Access** menu (see section 7).

3.3 – Display shortcuts:

▲ Used to view/reset the **PEAK** value. Press [P] to return to the main display.
- Press the [▲] button once from the main display. **PEAK** appears in the bottom row, and the maximum measured humidity value (since the instrument was turned on or reset) appears in the top row.
- To reset **PEAK**, press both the [▲] and [▼] buttons together now.

▼ Used to view/reset the **VALLEY** value. Press [P] to return to the main display.
- Press the [▼] button once from the main display. **VALLEY** appears in the bottom row, and the minimum measured humidity value (since the instrument was turned on or reset) appears in the top row.
- To reset VALLEY, press both the [▲] and [▼] buttons together now.

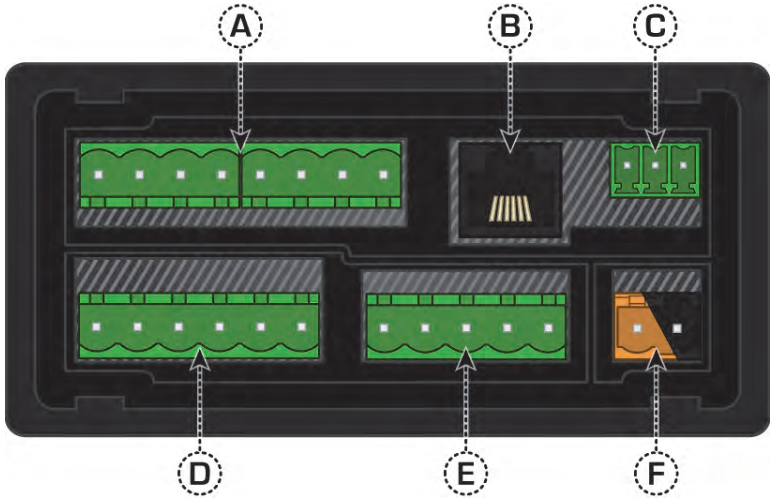
3.4 – Display brightness:

A Press the [P] and [▲] buttons together from the operational display. **BRI** appears on the bottom row and the current brightness setting appears on the top row.

B Use the [▲] and [▼] buttons to adjust the brightness of the LED backlight as required, and then press [P]. The display returns to normal operating mode.

SECTION 4 — *Wiring.*

4.1 – Pinouts:



A – Relay outputs (Refer to 4.5)
B – Serial port (Refer to 4.6)
C – Analogue output (Refer to 4.4)
D – Analogue input (Refer to 4.3)
E – Function pins (Refer to 4.7)
F – Power supply (Refer to 4.2)

4.2 – Connect your controller to the power supply:

Refer to 4.1F

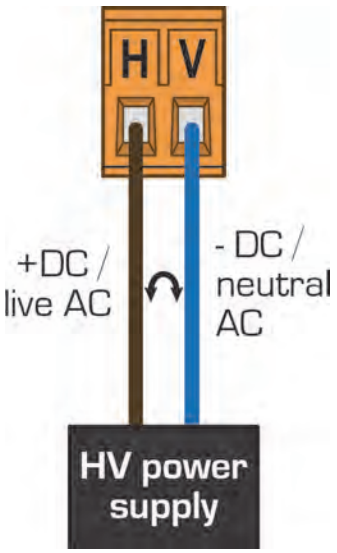
***Before you Begin*:**

Determine whether your controller is configured for low or high voltage power supply. Make sure to check the label on the unit against the colour of the power connector: **Orange** = high voltage, **Black** = low voltage.

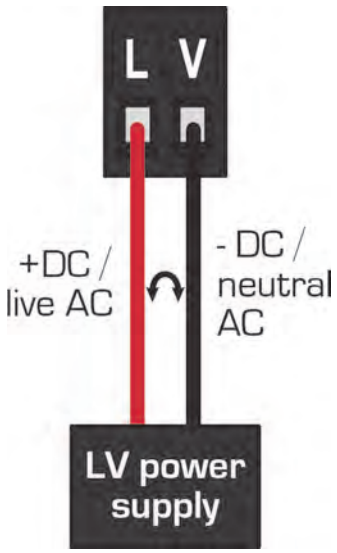
Wire your controller to your power supply as per the appropriate diagram.

Remember to switch your power supply off before you begin wiring, and NEVER connect your low voltage indicator to mains power.

High Voltage (HV)
85~265Vac / 95~370Vdc

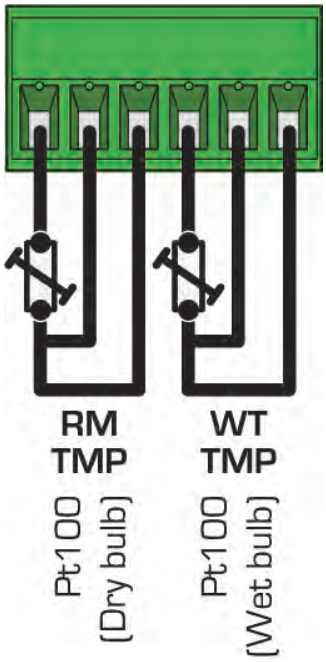


Low Voltage (LV)
15~48Vac / 10~72Vdc



4.3 – Analogue input:
Refer to 4.1D

Wire your humidity input module as shown in the diagram. This input module is precalibrated for RTD Pt100.

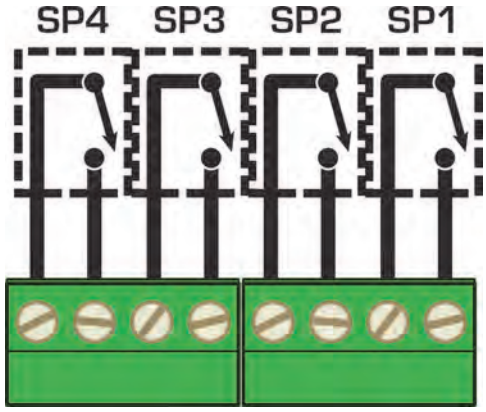


4.4 – Analogue output:
Refer to 4.1C

Wire your 4~20mA analogue outputs as shown in the diagram.

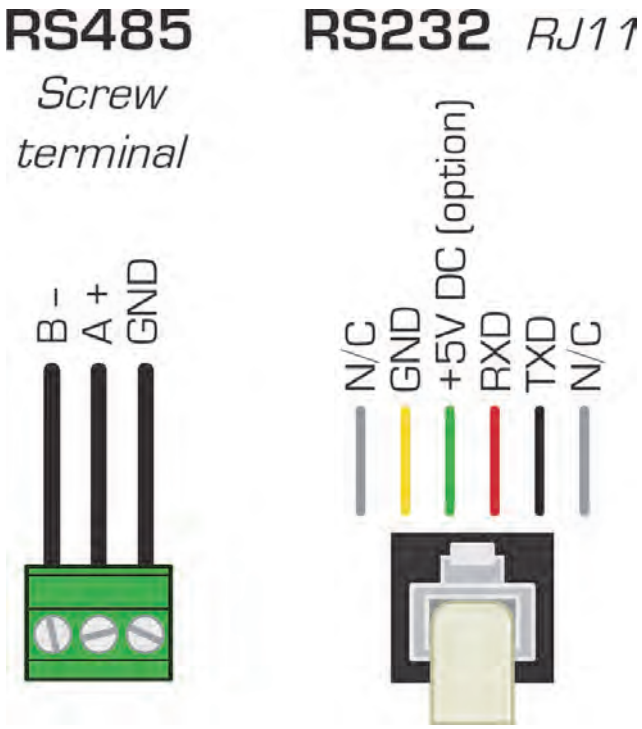
4.5 – Relay outputs (if installed):
Refer to 4.1A

Wire your relay outputs as shown. Relays can be programmed to operate within the total span range of the controller.



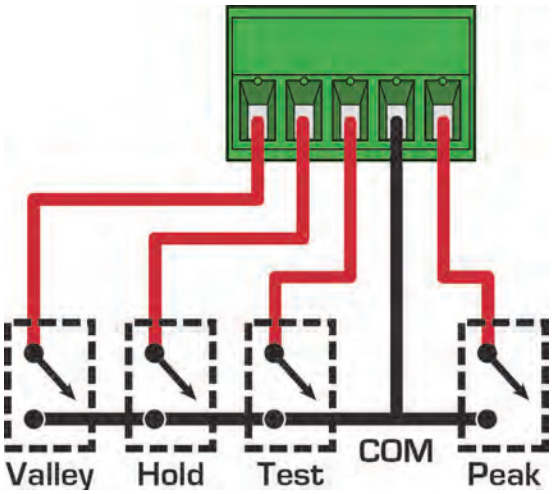
4.6 – Serial port (if installed):
Refer to 4.1B

If your controller has a serial port fitted, wire it as per the appropriate diagram. If you do not have a serial port fitted then skip this step.



4.7 – Function pins:
Refer to 4.1E

Connect external switches as required to enable a function to be executed when its switch is activated.



Valley Clears the valley reading
Hold Hold the current display value
Test Reset the meter
Peak Clears the peak reading

4.8 – Power up:
Once you have completed the wiring process it is safe to switch on your power supply. Ensure that your display is functioning before you proceed.

SECTION 5 – *Setup & Calibration.*

Enter the setup and calibration mode by pressing F1.

You will be given the opportunity to change your PIN number at the end of this section (5.7).
If you have forgotten your PIN number, see section 8.

Note:
To SKIP or ENTER values - Push **P**

To SELECT a menu input - Push ▲

5.1 – Enter calibration PIN:

A _ _ _ **ENTER CAL PIN NUMBER** scrolls across the bottom row, and **0** appears in the top row.
Use the ▲ and ▼ buttons to enter your security code (factory default = 1). Then press P.
If the correct PIN is entered, setup is started at 5.2.
If an incorrect PIN number is entered, _ _ _ _ **INCORRECT PIN NUMBER – ACCESS DENIED** scrolls across the display and it returns to the normal operating mode.

5.2 – Input setup:

A _ _ _ **INPUT SETUP** scrolls across the bottom row, and **SKIP** appears in the top row.
Press P to skip to 5.3, or the ▲ button and then P to ENTER input setup.

B _ _ _ **MAINS FREQUENCY** scrolls across the bottom row, and the current selection appears in the top row.
Use the ▲ and ▼ buttons to select: **50HZ** (default) or **60HZ**. Then press P.

C _ _ _ **SENSOR TYPE** scrolls across the bottom row, and the currently selected sensor type appears in the top row. Use the ▲ and ▼ buttons to select: **RTD385** (DIN Pt100 default) or **RTD392** (JIS). Then press P.

D _ _ _ **SELECT TEMPERATURE SCALE** scrolls across the bottom row, and the current temperature scale appears in the top row. Use the ▲ and ▼ buttons to select: **DEG C** (default) or **DEG F**. Then press P.

E _ _ _ **DISPLAY TEMPERATURE UNITS** scrolls across the bottom row, and the current selection appears in the top row. Use the ▲ and ▼ buttons to select: **YES** (default) or **NO**. Then press P.

F _ _ _ **DISPLAY HUMIDITY UNITS** scrolls across the bottom row, and the current selection appears in the top row. Use the ▲ and ▼ buttons to select: **YES** (default) or **NO**. Then press P.

5.3 – Calibration:

IMPORTANT: The temperature channels have been pre-calibrated for 0~100°C. MOST USERS WILL NOT NEED TO CALIBRATE.
When calibration is complete, you will be automatically directed back to the operational display.
To enter step 5.4, you must select SKIP at 5.3A.

A _ _ _ **CALIBRATE** scrolls across the bottom row, and **SKIP** appears in the top row.
Press P to skip to 5.4, or use the ▲ and ▼ buttons to select a channel to calibrate: **RH** (relative humidity), **RM TMP** (room temperature) or **WT TMP** (wet bulb temperature). Then press P.

B **If you selected RH in 5.3A:** Skip steps 5.3C-G and continue to 5.3H now.

C _ _ _ **APPLY LOW INPUT AND WAIT FOR STABLE READING** scrolls across the bottom row, and the current input signal appears in the top row. Wait for the input signal to stabilise, and then press P.
If averaging has been applied to the selected channel (see 5.4), it may take 20~30 seconds or more for the reading to stabilise.

D _ _ _ **ENTER LOW DISPLAY VALUE** scrolls across the bottom row, and the current low display value appears in the top row. Use the ▲ and ▼ buttons to adjust the low display value, and then press P to accept.

E _ _ _ **APPLY HIGH INPUT AND WAIT FOR STABLE READING** scrolls across the bottom row, and the current input signal appears in the top row. Wait for the input signal to stabilise, and then press P.
If averaging has been applied to the selected channel (see 5.4), it may take 20~30 seconds or more for the reading to stabilise.

F _ _ _ **ENTER HIGH DISPLAY VALUE** scrolls across the bottom row, and the current high display value appears in the top row. Use the ▲ and ▼ buttons to adjust the high display value, and then press P to accept.

G **If you selected RM TMP or WT TMP in 5.3A:** Skip step 5.3H and continue to 5.3I now.

H _ _ _ **ENTER HUMIDITY OFFSET CORRECTION** scrolls across the bottom row, and the current offset value appears in the top row. Use the ▲ and ▼ buttons to adjust the humidity offset value, and then press P to accept. *This allows the user to add an offset of $^{-}20{\sim}^{+}20\%$ to the RH value.*

I If calibration was successful, you will be directed out of the calibration menu to the operational display without viewing any further scrolling messages.
*To enter step 5.4, you must select SKIP at 5.3A. If calibration fails, _ _ _ **CALIBRATION FAILED** will scroll across the display and you will be directed out of the calibration menu to the operational display.*
Check your signal and connections, and then repeat the calibration procedure.

5.4 – Averaging:

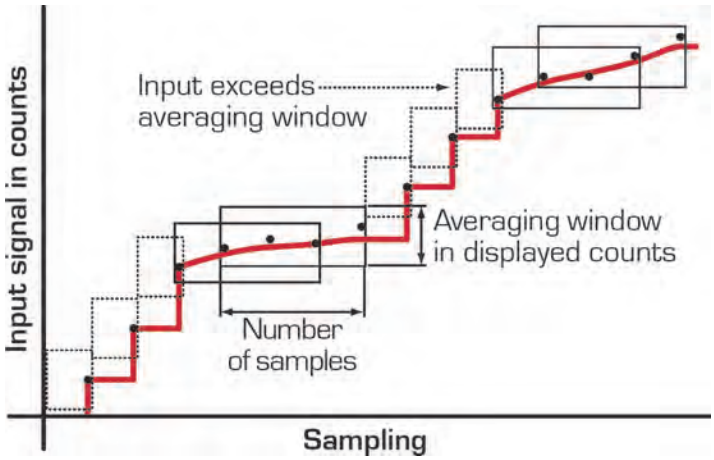
When averaging setup is complete, you will be automatically directed back to the beginning of the averaging setup menu (5.4A). To enter step 5.5, you must select SKIP at 5.4A.

A _ _ _ **AVERAGING SETUP** scrolls across the bottom row, and **SKIP** appears in the top row. Press [P] to skip to 5.5, or use the [▲] and [▼] buttons to select a channel to set up: **RH** (relative humidity), **RM TMP** (room temperature) or **WT TMP** (wet bulb temperature). Then press [P]. *Your controller has input signal averaging, optimising stable measurement. If the change in input exceeds the averaging window value it will not average, ensuring fast response when there are large differences between readings.*

B _ _ _ **AVE SAMPLES** scrolls across the bottom row, and the currently selected averaging appears in the top row. Using the [▲] and [▼] buttons, alter the number of input samples that the controller will average, and then press [P]. *Increasing the number of samples will stabilise measurement, but it will also slow down response rates. Typical value is 4.*

C _ _ _ **AVE WINDOW** scrolls across the bottom row, and the currently selected averaging window value appears in the top row. Using the [▲] and [▼] buttons, alter the signal averaging window. Then press [P]. *If your input signal contains large noise spikes, then you can increase the size of the averaging window to ensure that these pulses are still averaged. However, increasing the averaging window too far will reduce the ability of the controller to respond quickly to real changes in input signal. A setting of 0 averages all reading. A typical value is 10% of your system capacity.*

D You will be directed back to the beginning of the averaging setup menu (5.4A). If you are ready to proceed to 5.5, press [P] now to **SKIP**. If you would like to set up averaging for a different channel, repeat the steps from 5.4A.



5.5 – Analogue output setup:

When analogue output setup is complete, you will be automatically directed back to the beginning of the analogue output setup menu (5.5A). To enter step 5.6, you must select SKIP at 5.5A.

A _ _ _ **ANALOGUE O/P SETUP** scrolls across the bottom row, and **SKIP** appears in the top row. Press [P] now to skip to 5.6, or use the [▲] and [▼] buttons to select an analogue output channel to calibrate: either **RH** (relative humidity) or **RM TMP** (Ambient temperature). Then press [P].

B _ _ _ **LOW SCALE VALUE FOR ANALOGUE O/P** scrolls across the bottom row, and the currently selected low scale value appears in the top row. Use the [▲] and [▼] buttons to set the low scale value. Then press [P].

C _ _ _ **HIGH SCALE VALUE FOR ANALOGUE O/P** scrolls across the bottom row, and the currently selected high scale value appears in the top row. Use the [▲] and [▼] buttons to set the high scale value. Then press [P].

D _ _ _ **CALIBRATE ANALOGUE O/P?** scrolls across the bottom row, and **SKIP** appears in the top row. Use the [▲] and [▼] buttons to select either **SKIP** (to skip analogue output calibration) or **ENTER** (to continue with analogue output calibration). Then press [P].

F | **If you selected SKIP in 5.5D:** Skip steps 5.5F-G and continue to 5.5H now. |

E _ _ _ **CAL LOW ANALOGUE O/P** scrolls across the bottom row, and a calibration number (shown in mA) appears in the top row. Use the [▲] and [▼] buttons to calibrate your low analogue output as required, and then press [P] to accept.

G _ _ _ **CAL HIGH ANALOGUE O/P** scrolls across the bottom row, and a calibration number (shown in mA) appears in the top row. Use the [▲] and [▼] buttons to calibrate your high analogue output as required, and then press [P] to accept.

H You will be directed back to the beginning of the calibration menu (5.5A). If you are ready to proceed to 5.6, press [P] now to **SKIP**. If you would like to recalibrate your analogue output (or calibrate an alternative analogue output channel), please repeat the steps from 5.5A.

5.6 – Serial setup:

See Appendix A for serial register tables. Configuring the serial port will allow you to connect your controller to a PC or another device. Skip this step if your unit does not have this option installed.

A _ _ _ **SERIAL SETUP** scrolls across the bottom row, and **SKIP** appears in the top row.
Press [P] to skip to 5.7, or the [▲] button and then [P] to ENTER serial setup.

B _ _ _ **SERIAL MODE** scrolls across the bottom row, and the currently selected serial mode appears in the top row. Using the [▲] and [▼] buttons, select either: **ASCII, MODBUS** (RTU) or **RNGR A** (Ranger A).
Then press [P].
ASCII *is a simple protocol that allows connection to various PC configuration tools.* ***MODBUS*** *is an industry standard RTU slave mode that allows connection to a wide range of devices, such as PC's or PLC's.* ***RNGR A*** *is a continuous output, used to drive remote displays and other instruments in the Rinstrum™ range. (Ranger is a trade name belonging to Rinstrum Pty Ltd.)*

C _ _ _ **BAUD RATE** scrolls across the bottom row, and the current selection appears in the top row.
Using the [▲] and [▼] buttons, select one of: **300, 600, 1200, 2400, 4800, 9600, 19200** or **38400**.
Then press [P].

D _ _ _ **PARITY** scrolls across the bottom row, and the currently selected parity appears in the top row.
Using the [▲] and [▼] buttons, select: **NONE**, **ODD** or **EVEN**, and then press [P].

E _ _ _ **SERIAL ADDRESS** scrolls across the bottom row, and the currently selected serial address appears in the top row. Use the [▲] and [▼] buttons to alter the serial address. Then press [P].
The serial address parameter is used to identify a particular device when it is used with other devices in a system. (It applies particularly to Modbus mode when used on an RS485 serial network.) The serial address of the controller must be set to match the serial address defined in the master device.
For serial register tables, see Appendix A.

5.7 – Edit calibration PIN:

A _ _ _ **EDIT CAL PIN NUMBER** scrolls across the bottom row, and **SKIP** appears in the top row. Press [P] to skip and return to the operational display, or the [▲] button and then [P] to ENTER and change your **PIN** number.

B _ _ _ **ENTER NEW CAL PIN NUMBER** scrolls across the bottom row, and the current **PIN** (default = 1) appears in the top row. Using the [▲] and [▼] buttons, enter your new calibration PIN number.
Then press [P] to exit and return to the operational display.

SECTION 6 – *Setpoint Setup.*

Note:
To SKIP or ENTER values - Push **P**

To SELECT a menu input - Push ▲

Enter the setpoint setup mode by pressing the [F2] button for 3 seconds.

You will have the opportunity to change your PIN number at the end of this section (6.3).
If you have forgotten your PIN number, see section 8.

6.1 – Enter setpoint PIN:

A _ _ _ **ENTER SP PIN NUMBER** scrolls across the bottom row, and **0** appears in the top row.
Use the [▲] and [▼] buttons to enter your security code (factory default = 1), then press [P].
If the correct PIN is entered, setup is started at 6.2.
If an incorrect PIN number is entered, _ _ _ _ **INCORRECT PIN NUMBER – ACCESS DENIED** scrolls across the display and it returns to the normal operating mode.

6.2 – Edit setpoints:

A _ _ _ **EDIT SETPOINT** scrolls across the bottom row, and **SKIP** appears in the top row. Press **P** to skip to 6.3, or use the [▲] and [▼] buttons to select a setpoint to edit: **SP 1, SP 2, SP 3** or **SP 4**. Then press [P].

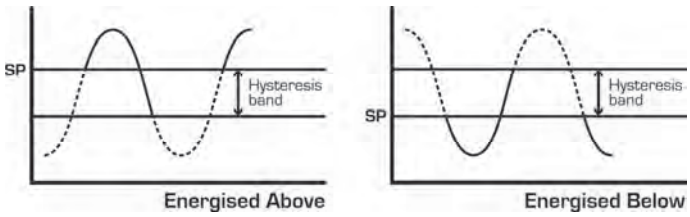
B _ _ _ **SP VALUE** scrolls across the bottom row, and the display value at which the setpoint will activate appears in the top row. Adjust this value using the [▲] and [▼] buttons, and then press [P].
The units for the ***SP VALUE*** *will always correspond with your chosen* ***SP SOURCE****. I.e. If you select 50.0% as your* ***SP VALUE*** *in this step, and then you choose* ***RM TEMP*** *as your* ***SP SOURCE*** *in 6.2C, your* ***SP VALUE*** *will be changed to 50.0°C/F.*

C _ _ _ **SP SOURCE** scrolls across the bottom row, and the current setpoint source appears in the top row.
Use the [▲] and [▼] buttons to select **RH** (relative humidity) or **RM TMP** (Ambient temperature). Then press [P].

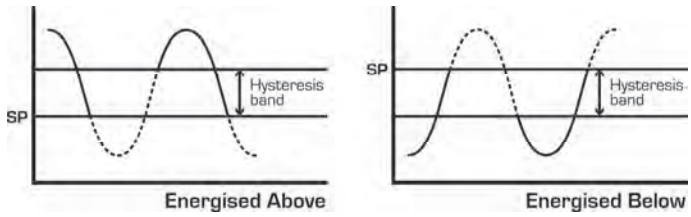
D _ _ _ **SP ACTIVATION** scrolls across the bottom row, and the current selection appears in the top row.
Using the [▲] and [▼] buttons, select the relay activation to operate **ABOVE** or **BELOW** the setpoint value, and then press [P]. Select **ABOVE** for the relay to turn on above the setpoint value and off below it. Select **BELOW** for the relay to turn on below the setpoint value and off above it.

E _ _ _ **SP TYPE** scrolls across the bottom row, and the current selection appears in the top row.
Use the ▲ and ▼ buttons to select **ALARM** or **CNTRL**, and then press **P**.

ALARM
The setpoint value determines setpoint activation, and the hysteresis value determines setpoint deactivation.



CNTRL (Control)
The setpoint value determines setpoint deactivation, and the hysteresis value determines setpoint reactivation.



F _ _ _ **HYSTERESIS VALUE** scrolls across the bottom row, and the current selection appears in the top row.
Adjust this value using the ▲ and ▼ buttons, and then press **P**.
This defines the separation band between setpoint activation and deactivation, and will operate as per the type setting (see 6.2E.)

G _ _ _ **MAKE DELAY** scrolls across the bottom row, and the current selection appears in the top row.
Use the ▲ and ▼ buttons to adjust the make delay value (in tenths of a second) as required, and then press **P**.
The make delay value defines the delay between setpoint activation and when the relay turns on.

H _ _ _ **OPEN ACCESS TO SP VALUE** scrolls across the bottom row, and the current access setting appears in the top row. Use the ▲ and ▼ buttons to select **NO** or **YES**, and then press **P**.
*Choosing **YES** will allow the selected setpoint to be quick-edited via the ▲ button without entering a PIN (see section 7). User access can be independently configured for each setpoint.*

I _ _ _ **EDIT SETPOINT** scrolls across the bottom row, and **SKIP** appears in the top row.
You are now back at 6.2A. To edit another setpoint, follow the instructions from 6.2A-I again.
If you do not wish to edit another setpoint, press **P** now to skip to 6.3.

6.3 – Edit setpoint PIN:

A _ _ _ **EDIT SP PIN NUMBER** scrolls across the bottom row, and **SKIP** appears in the top row.
Press **P** to skip and return to the operational display, or the ▲ button and then **P** to ENTER.

B _ _ _ **ENTER NEW SP PIN NUMBER** scrolls across the bottom row, and the current PIN (default = 1) appears in the top row. Using the ▲ and ▼ buttons, enter your new setpoint entry PIN number. Then press **P** to save and exit to the operational display.

SECTION 7 – *Setpoint Open Access.*

Open access is configured individually for each setpoint (see 6.2H). If none of the setpoints have open access turned on, this feature will be disabled and the F2 button will not respond to a short button press.

A Begin by pressing the **F2** button for less than 3 seconds. The setpoint name (**SP 1, SP 2, SP 3 or SP 4**) will appear on the bottom row and the current value for that setpoint will appear in the top row.
Using the ▲ and ▼ buttons, adjust the selected value. Then press **P** to accept the new setpoint value.

B If any other setpoints have the direct access option enabled then the same process is repeated for the next setpoint. Pressing **P** for the last enabled setpoint will exit and return to the operational display.

SECTION 8 – *Reset PIN Numbers.*

If you have forgotten either of your PIN numbers, follow the procedure below to reset both the calibration and setpoint setup PIN numbers to their factory default of 1.

A Press ▲, ▼ and **P** at the same time.
(This key combination can be difficult to execute and you may need several attempts to get it right.)

B When successful, a factory identification text will scroll across the display, followed by:
_ _ _ **ALL PIN NUMBERS RESET TO 1.**

C Reset the PIN numbers individually as required by following the instructions in 5.7 (for setup and calibration) and 6.3 (for setpoint setup), entering '1' whenever you are prompted for your current PIN.

APPENDIX – *Serial Register Tables.*

Modbus/ASCII:

	16-BIT UNSIGNED			32-Bit SIGNED (2x16-BIT)	
MODBUS*	**ASCII**	**FUNCTION**	**MODBUS***	**ASCII**	**FUNCTION**
40001	**1**	Alarm status (Bit 0=SP1,	**40515**	**254**	Humidity Display
		Bit 1=SP2, Bit 2=SP3,	**40523**	**250**	Web bulb temperature
		Bit 3=SP4)	**40529**	**16**	Ambient temperature
40065	**65**	Hysteresis SP1	**50525**	**12**	Peak
40071	**71**	Make Delay SP1	**40527**	**13**	Valley
40066	**66**	Hysteresis SP2	**40535**	**6**	Setpoint 1
40072	**72**	Make Delay SP2	**40537**	**7**	Setpoint 2
40067	**67**	Hysteresis SP3	**40539**	**8**	Setpoint 3
40073	**73**	Make Delay SP3	**40541**	**9**	Setpoint 4
40068	**68**	Hysteresis SP4	**40587**	**34**	D/A 1 scale low value (humidity)
40074	**74**	Make Delay SP4	**40589**	**35**	D/A 2 scale low value (Ambient temp)
			40591	**36**	D/A 1 scale high value (humidity)
			40593	**37**	D/A 2 scale high value (Ambient temp)

** Modbus addresses are all holding registers and should be accessed via function codes 3 and 6. Register addresses are displayed in the Modicon™ addressing format. i.e. Register 65=40065 (subtract 1 for direct addressing).*

Ranger A:

This allows the controller to drive a remote display from the Rinstrum range. The following shows the output string format when Ranger A output is selected: **<Start> <Sign> <Output Value> <Status> <End>**

STRING CHARACTER(S)

<Start>	STX character (ASCII 02)
<Sign>	Output value sign (space for + and dash for -)
<Output Value>	Seven character ASCII string containing the current output value and decimal point. (If there is no decimal point, then the first character is a space. Leading zero blanking applies.)
<Status>	Single character output value status: U=Under, 0=Over, E=Error
<End>	ETX character (ASCII 03)

Formulae Information.

The IN-HWD (rev 2) formulae and look-up table is based on the ASTM Standards and takes the psychometric constant:

$$A = 6.60 \times 10^{-4} (1 + 0.00115\ tw)$$

tw = Wet bulb temperature and the atmospheric pressure P = 101325 Pa.

Note: 'A' is still under dispute by different organisations.
Most relative humidity tables are within 1% of the ASTM relative humidity tables.

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