Room/Zone Wall-Mount Controller
Specification and Installation Instructions

Models

Model	Temp	RH	CO_2	PIR	VOC
TRUB00-201	•	•			

TRUB00 Series

Description

The TRUB is a room/zone wall-mount controller for adiabatic systems with a built-in temperature and humidity sensor and scheduler. This device is designed for simple integration with the SKH4 system, for custom needs, or for other adiabatic equipment. Its field configurable algorithms enable versatile implementation of required control sequences.

Equipped with an on-board humidity sensor, for accurate humidity control.

Features

- Relative humidity, dew point and temperature control or general unit controller
- Binary and analog fan control
- Optional internal/external humidity sensor input for simple and accurate humidity control
- Selectable internal or external temperature sensor
- Real time clock (RTC) with 24-hour backup
- Precise temperature and humidity control with configurable PID (Proportional-Integral-Derivative) function
- Occupancy and non-Occupancy modes
- External occupancy input
- 7-day programmable occupancy schedule
- Select controller's default display
- Multi-level lockable access menu and setpoint
- Selectable Fahrenheit or Celsius scale
- Option of pulse/on-off output on binary outputs
- Optional external demand signal

Onboard Sensors

- Temperature sensor (°C/°F)
- Humidity sensor (%RH)

Network Communication

- BACnet® MS/TP or Modbus communication port (selectable via configuration menu)
- Select MAC address via menu or via network
- MS/TP and Modbus @ 9600, 19200, 38400, 57600, 76800 or 115200 bps
- Automatic baud rate detection

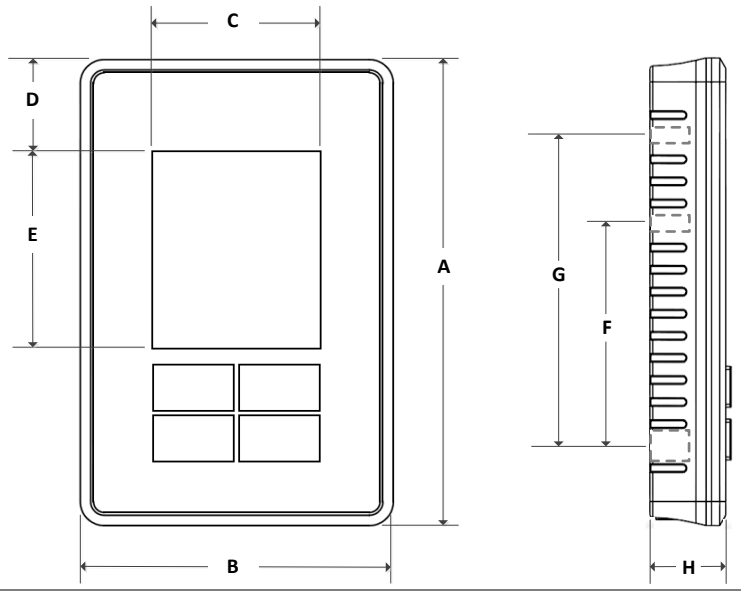
BACnet MS/TP®

- Automatic device instance configuration
- Backup or restore device configuration
- BACnet scheduler (up to 6 events per day)
- Firmware upgradeable via BACnet
- Supports COV (change of value)

Modbus

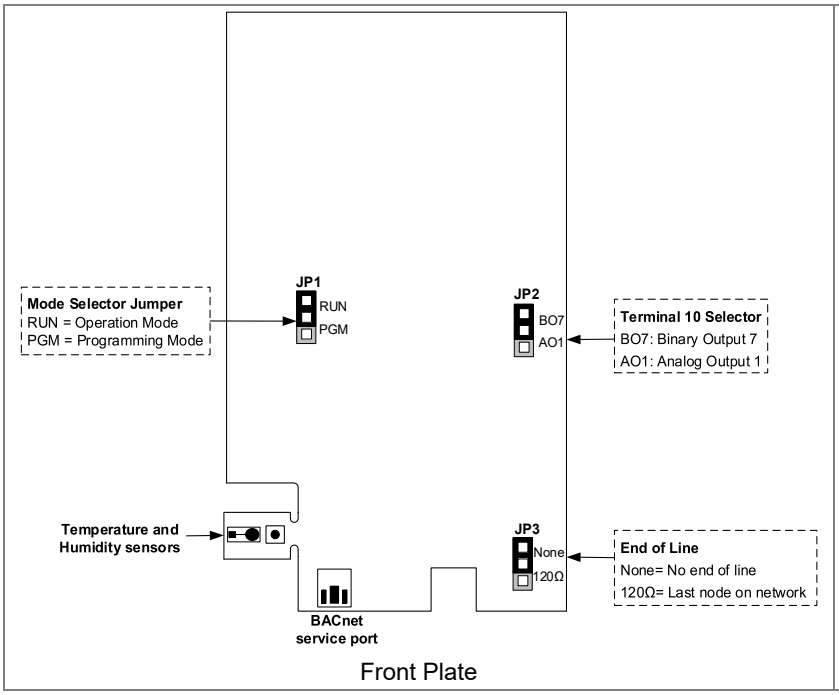
- RTU Slave, 8 bits (configurable parity and stop bits)
- Connects to any Modbus master

Technical Specifications

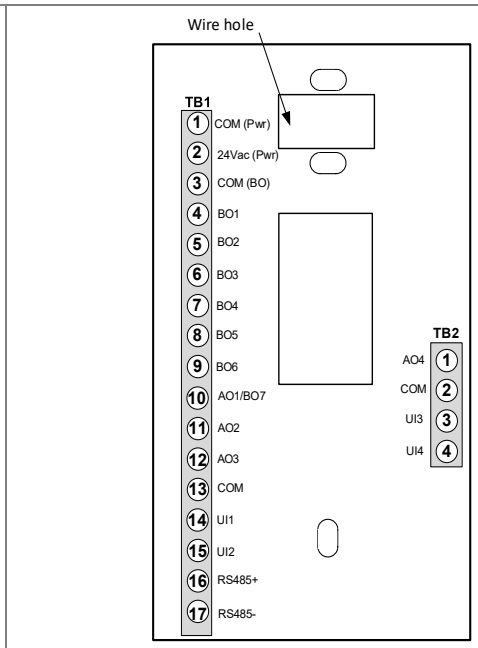
Description	TRUB Series
Temperature Sensor	
Setpoint Range	10ºC to 40ºC [50ºF to 104ºF]
Control Accuracy	Temperature: ±0.4ºC [0.8ºF]
Display Resolution	±0.1ºC [0.2ºF]
Humidity Sensor	
Setpoint Range	10% to 90% RH
Control Accuracy	±3.5% RH
Display Resolution	0.1%
Other	
Inputs	4 Universal Inputs (0.000-10.000Vdc, dry contact, 10K Type 2 and 10K Type 3)
Outputs	6 or 7 Binary Outputs (OptoFET, 250mA max), if using 7 BO, put jumper JP2 on position 1 and 2 4 or 3 Analog Outputs (0.000-10.000Vdc, adjustable, 5mA max), if using 4 AO, put jumper JP2 on position 2 and 3
Binary output modes	On/Off, Time Pulse Modulation (TPM) and Fixed Pulse Width (FPW)
Analog output modes	0-10Vdc or 2-10Vdc
Power supply	22 to 26 Vac or Vdc 50/60Hz
Power consumption	1 VA max
Cooling control mode	Binary or modulating
Heating control mode	Binary or modulating
Humidify control mode	External, binary, modulating or cascade with optional anti-condensation
Dehumidify control mode	Binary or modulating
Electrical connection	0.8 mm^2 [18 AWG] minimum
Operating temperature	0ºC to 50ºC [32ºF to 122ºF]
Storage temperature	-30ºC to 50ºC [-22ºF to 122ºF]
Relative Humidity	5 to 95% noncondensing
Degree of protection of housing	IP 30 (EN 60529)
Weight	135 g. [0.30 lb]
Dimensions: A = 4.88” | 124mm B = 3.25” | 83mm C = 1.75” | 44mm D = 0.96” | 24mm E = 2.07” | 53mm F = 2.36” | 60mm G = 3.28” | 83mm H = 0.95” | 24mm	

TRUB Faceplate and Backplate

The TRUB controller is composed of two separate parts, the faceplate and the backplate. The faceplate refers to the cover of the controller where the jumpers, BACnet port and sensors are located. The backplate, the portion that will be attached to the wall, is what will be used for wiring.



Front Plate



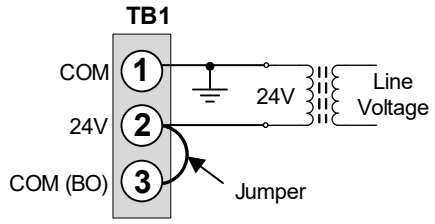
Back Plate

Terminal Description

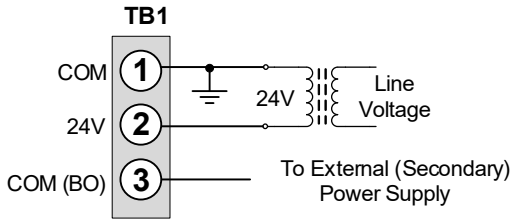
Terminals			Description
TB1	1	COM	Common
	2	24V	24V (power supply)
	3	EXT SRC	Common (Binary output)
	4	BO1	Binary output 1
	5	BO2	Binary output 2
	6	BO3	Binary output 3
	7	BO4	Binary output 4
	8	BO5	Binary output 5
	9	BO6	Binary output 6
	10	AO1/BO7	Analog output 1 or Binary output 7
	11	AO2	Analog output 2
	12	AO3	Analog output 3
	13	COM	Common
	14	UI1	Universal input 1
	15	UI2	Universal input 2
	16	A+	BACnet communication port (A+)
	17	B-	BACnet communication port (B-)
TB2	1	AO4	Analog output 4
	2	COM	Common
	3	UI3	Universal input 3
	4	UI4	Universal input 4

Power Supply

Using Internal Power Supply for BOs



Using External Power Supply for BOs *

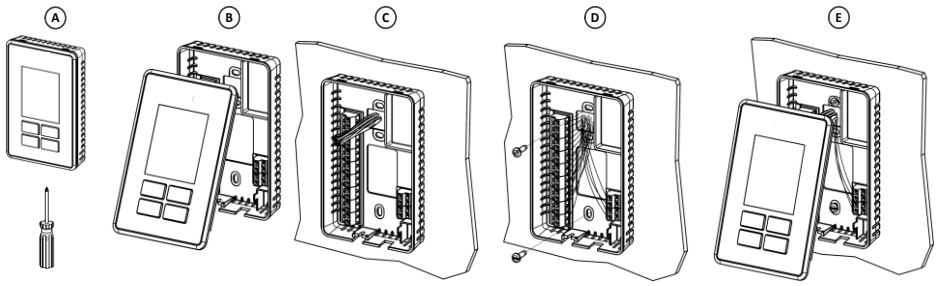


** Note: The combined binary output can pull up to 2A from the source. A secondary power supply can be used to give additional power required to the transformer.*

Mounting Instructions

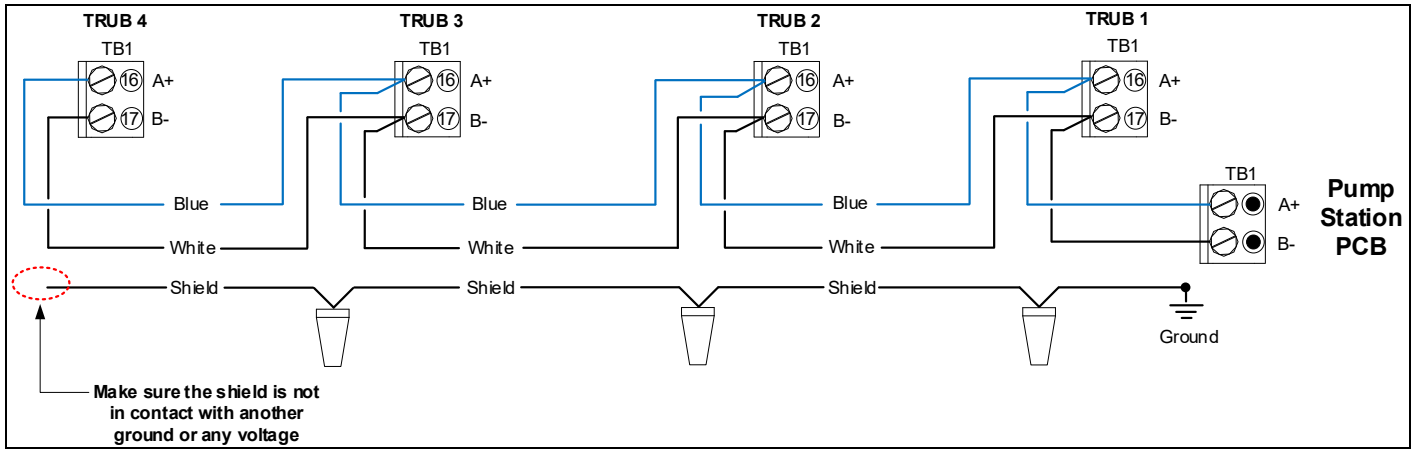
CAUTION: Remove power to avoid a risk of malfunction.

A. Remove the captive screw that's holding the base and the front cover of the unit together.
B. Lift the front cover of the unit to separate it from the base.
C. Pull all wires through the holes in the base.
D. Secure the base to the wall using wall anchors and screws (supplied). Make the appropriate connections.
E. Mount the control module on the base and secure using the screw.



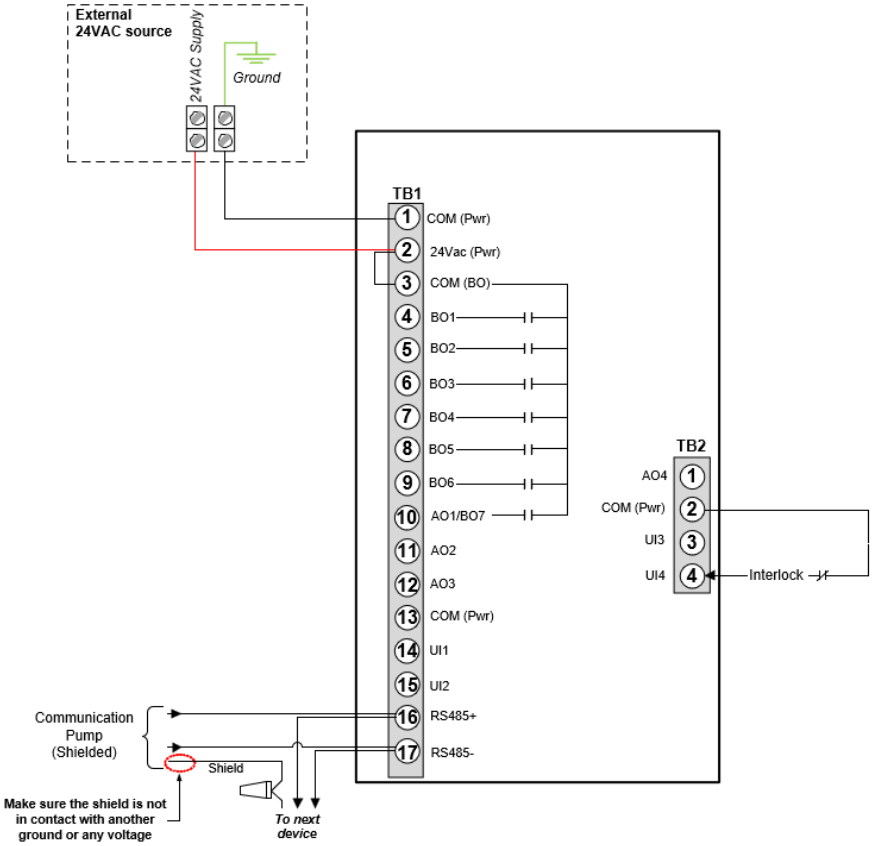
Do not use the supplied screws to mount the unit to an electric box or an equivalent device. The supplied screws are only suitable for mounting the unit to the wall. Ensure to use the appropriate screws for any other application. Tighten by hand only and ensure not to overtighten the screws.

Pump Communication Shield Wiring



Refer to the BACnet Guide for more information: https://www.neptronic.com/controls/NeptronicDocumentation.aspx

SKH4 In-Space Wiring and Terminal Description



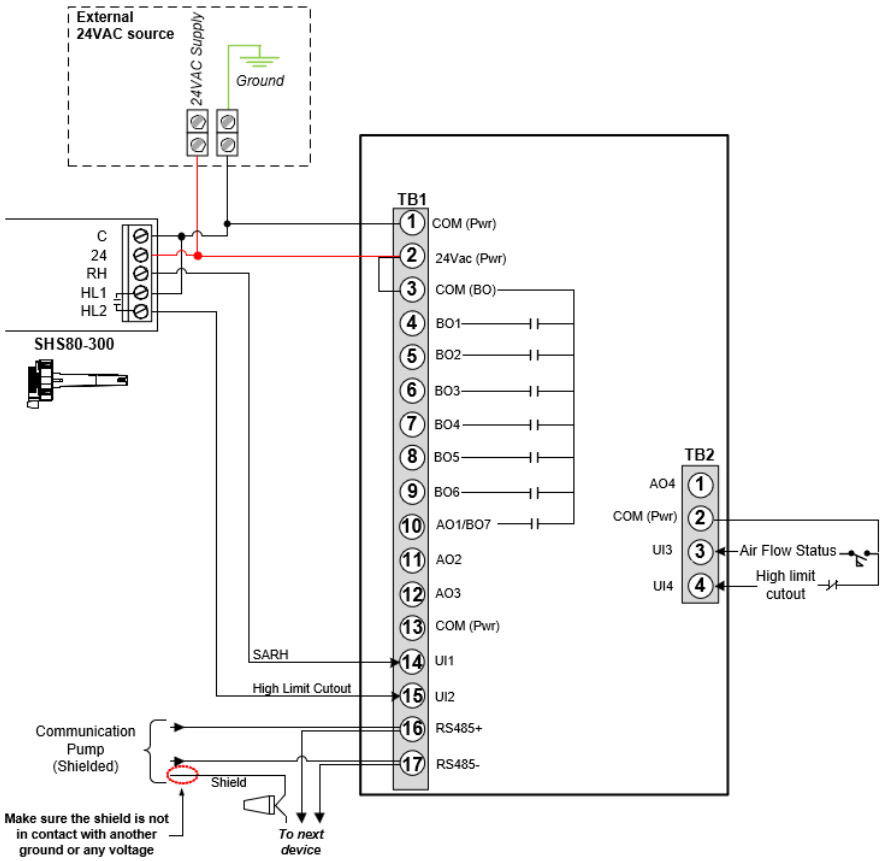
1. **Entering Programming Mode**: To enter programming mode, ensure that jumper (JP1) is set to programming (PGM) mode as per faceplate illustration on page 3.

2. **In Space Settings**: When **SPAC** is selected in the **Settings** > **Control Profile**, the following *Control Profile* settings will be changed (see pages 14 to 19 for more information):

Parameter	Menu Path	BACnet Ref.	Modbus Ref.	Value
UI1 Mode	*SETTING → UI → UI1 ModE*	MSV.1 - Present Value	40**201**	OFF (Unused)
UI2 Mode	*SETTING → UI → UI2 ModE*	MSV.2 - Present Value	40**203**	OFF (Unused)
UI3 Mode	*SETTING → UI → UI3 ModE*	MSV.3 - Present Value	40**205**	OFF (Unused)
UI4 Mode	*SETTING → UI → UI4 ModE*	MSV.4 - Present Value	40**207**	ILOC (Interlock)
BO1 Mode	*SETTING → BO → BO1 → BO1 ModE*	MSV.14 - Present Value	40**223**	OFF (Unused)
BO1 Drive Mode	*SETTING → BO → BO1 → BO1 DRV*	MSV.21 - Present Value	40**224**	OnOf (On / Off)
Humidify Control Variable Type	*SETTING → HUMIDIF CONTROL → HUMIDIF VAR TYPE*	MSV.44 - Present Value	40**324**	rH (Relative Humidity)
Humidify Control Mode	*SETTING → HUMIDIF CONTROL → CONTROL ModE*	MSV.32 - Present Value	40**325**	Mod (Modulating)
Humidify Reading Selection	*SETTING → HUMIDIF CONTROL → READ SELECT*	MSV.34 - Present Value	40**327**	rArH (Return Air Relative Humidity)
Humidify Control Band	*SETTING → HUMIDIF CONTROL → CONTROL BAND*	AV.43 - Present Value	40**328**	5%
Humidify Control Integral Time	*SETTING → HUMIDIF CONTROL → INTEGRAL*	AV.44 - Present Value	40**329**	0
Humidifying Control Derivative Time	*SETTING → HUMIDIF CONTROL → DERIV*	AV.45 - Present Value	40**330**	0
Cooling / Humidifying Dependency	*SETTING → HUMIDIF CONTROL → COOL HUMIDIF DEPEND*	MSV.43 - Present Value	40**323**	Ind (Independent)
Primary display	*DISPLAY* → PRIMARY READ	MSV.51 - Present Value	40**354**	rArH (Return Air Relative Humidity)
Top Line display	*DISPLAY* → TOP LINE DISPLAY SELECT	MSV.52 - Present Value	40**355**	rAt (Return Air Temperature)

Note: Refer to Annex G - Supplementary Wiring Options for other possible in space wiring configurations.

SKH4 In-Duct Wiring and Terminal Description



1. **Entering Programming Mode**: To enter programming mode, ensure that jumper (JP1) is set to programming (PGM) mode as per faceplate illustration on page 3.

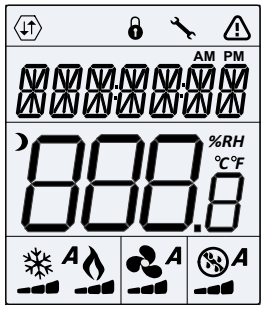
2. **In Duct Settings**: When **dUCt** is selected in the **Settings** > **Control Profile**, the following *Control Profile* settings will be changed (see pages 14 to 19 for more information):

Parameter	Menu Path	BACnet Ref.	Modbus Ref.	Value
UI1 Mode	*SETTING → UI → UI1 ModE*	MSV.1 - Present Value	40**201**	SArH (Supply Air Relative Humidity)
UI2 Mode	*SETTING → UI → UI2 ModE*	MSV.2 - Present Value	40**203**	HLrH (High-Limit Relative Humidity)
UI3 Mode	*SETTING → UI → UI3 ModE*	MSV.3 - Present Value	40**205**	FLS (Airflow)
UI4 Mode	*SETTING → UI → UI4 ModE*	MSV.4 - Present Value	40**207**	ILOC (Interlock)
BO1 Mode	*SETTING → BO → BO1 → BO1 ModE*	MSV.14 - Present Value	40**223**	OFF (Unused)
BO1 Drive Mode	*SETTING → BO →BO1 → BO1 DRV*	MSV.21 - Present Value	40**224**	OnOf (On / Off)
Humidify Control Variable Type	*SETTING → HUMIDIF CONTROL → HUMIDIF VAR TYPE*	MSV.44 - Present Value	40**324**	rH (Relative Humidity)
Humidify Control Mode	*SETTING → HUMIDIF CONTROL → CONTROL ModE*	MSV.32 - Present Value	40**325**	Mod (Modulating)
Humidify Reading Selection	*SETTING → HUMIDIF CONTROL → READ SELECT*	MSV.34 - Present Value	40**327**	SArH (Supply Air RH)
Humidify Control Band	*SETTING → HUMIDIF CONTROL → CONTROL BAND*	AV.43 - Present Value	40**328**	5%
Humidify Control Integral Time	*SETTING → HUMIDIF CONTROL → INTEGRAL*	AV.44 - Present Value	40**329**	0
Humidifying Control Derivative Time	*SETTING → HUMIDIF CONTROL → DERIV*	AV.45 - Present Value	40**330**	0
Cooling / Humidifying dependency	*SETTING → HUMIDIF CONTROL → COOL HUMIDIF DEPEND*	MSV.43 - Present Value	40**323**	Ind (Independent)
Primary display	*DISPLAY → PRIMARY READ*	MSV.51 - Present Value	40**354**	SArH (Supply Air Relative Humidity)
Top Line display	*DISPLAY → TOP LINE DISPLAY SELECT*	MSV.52 - Present Value	40**355**	bL (Blank)

Note: Refer to Annex G - Supplementary Wiring Options for other possible in duct wiring configurations.

Operation Mode

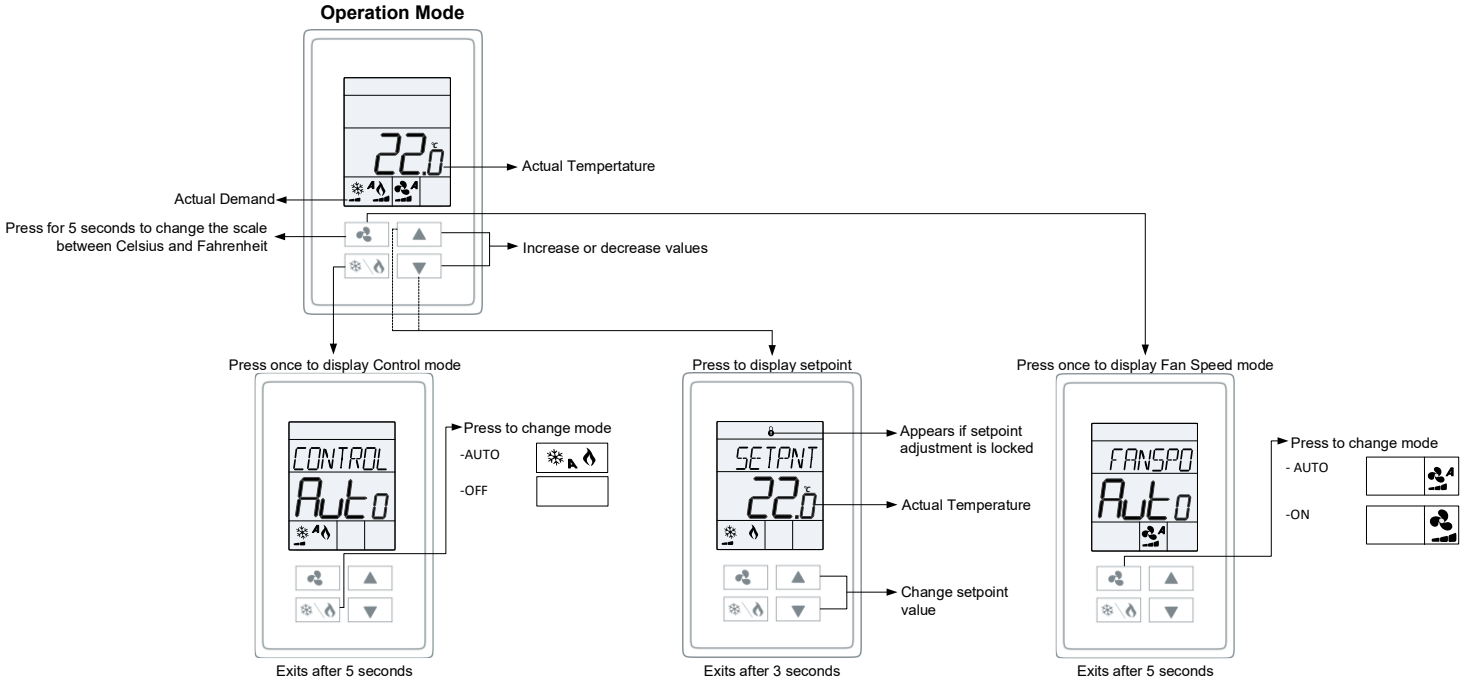
Interface



	Network Communication		*User Lock*		*Programming Mode (Technician Setting)*
	Alarm Status		*Unoccupied Mode*	AM PM	*Time*
°C °F %RH	*°C: Celsius Scale* *°F: Fahrenheit Scale* *%RH: Humidity*	A	*Automatic Mode*		*Cooling*
	Heating		*Fan*		*Humidify/ De-humidify*

The Mode Selector Jumper JP1 must be set to the RUN position (Operation Mode).

Power Up



Upon power up, the LCD illuminates and all segments appear for 2 seconds. The controller then displays its current version for 2 seconds.

LCD Backlight

Pressing any key illuminates the LCD backlight. The display level can be configured for the following three modes:

- Active level
- Occupied Idle level
- Unoccupied Idle level

Display

The controller displays the following values, by default:

- **Current time** - Top Line
- **Room air temperature** - Primary Reading Line

The following other values on the Top Line and Primary Reading Line are displayed based on the configuration values selected in the menu.

Display	Top Line	Primary Reading Line
Blank	Available	Not Available
Time	Available (default configuration)	Not Available
Return Air Relative Humidity	Available	Available
Return Air Temperature	Available	Available (default configuration)
Supply Air Relative Humidity	Available	Available
Supply Air Temperature	Available	Available
External Return Air Relative Humidity	Available	Available
Return Air Dew Point	Available	Available
Supply Air Dew Point	Available	Available
External Dew Point	Available	Available
Cold Surface Temperature	Available	Available

If a sensor is disconnected or short circuited, then the unit displays *999*.

Select Temperature Scale

To toggle the temperature scale between °C and °F, press the button for 5 seconds.

Temperature and Humidity Setpoint Display and Adjustment

To display the setpoints, press either the ▲ or ▼ key and then select and set the Occupied or Unoccupied setpoints. To adjust the setpoints, press the button to enter the menu and select the value(s) required to change and change the values using the ▲ and ▼ keys. If the setpoint adjustment has been locked, the lock symbol appears. The unit automatically exits this menu if you do not press any key for 5 seconds. The changed values will be saved automatically.

Control Mode

To access the Control Mode, press the key. The Control Mode appears for 5 seconds. Press the key to scroll through the following control modes:

- Auto (Automatic Cooling or Heating or Humidify or Dehumidify)
- OFF

Fan Speed Selection Mode

To access the Fan Speed selection mode, press the button. The Control Mode appears for 5 seconds. The button now serves as the override button. Press the button to scroll through the following control modes:

- Auto. The fan will automatically adjust the speed according to the demand.
- ON. ON is an override command that allows the user to turn on the fan manually.

Unoccupied Mode

When the controller enters the **No Occupancy** mode, (the moon ☽ symbol appears) and uses the No OCC setpoints.

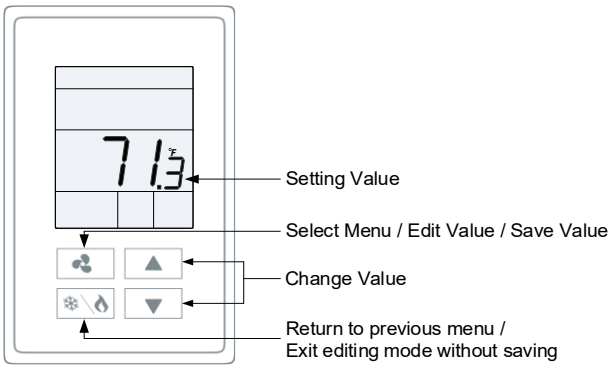
Annexes

Annex A - Programming Mode

Programming Mode

The Mode Selector jumper JP1 must be set to the PGM position (Programming Mode). To exit, set the jumper back to the RUN position (Operation Mode).

*In the Operation mode, press the Mode button for 5 seconds, and then enter the password **637**. The device returns to Operation mode automatically after 1 minute of inactivity.*



Note: Objects appear only if the configuration activates their use.

Access to Menus

The action buttons present on the controller perform different tasks at different levels of menu navigations. The following is a list of tasks that each button performs at each navigation or menu level:

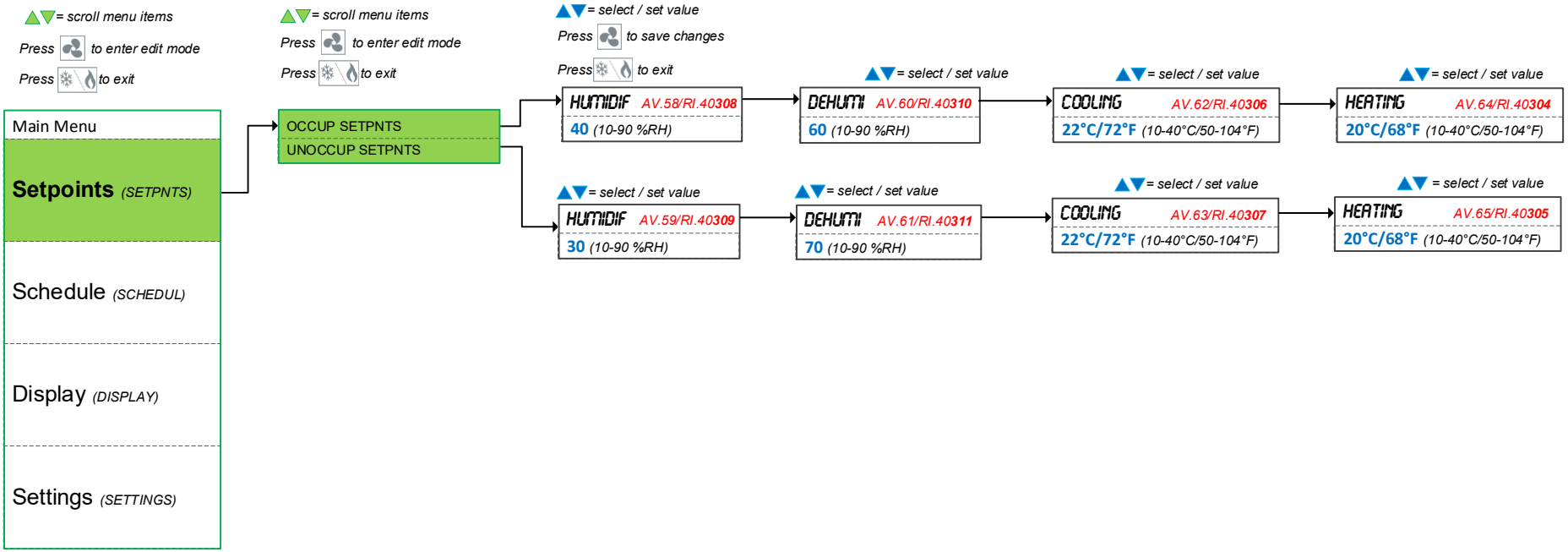
Action Buttons

Menu Level	Action Button	Task
Main		
		Press to access sub menu options.
		Navigate through the main menu categories.
		No action at this level.
Sub		
		Press to access Configuration options.
		Navigate through the sub menu options.
		• Exit the sub menu options. • Return to the main menu categories.
Configuration		
		• Enter Edit mode. The value blinks to indicate that the Edit mode is active. • Save value and exit Edit mode.
		• Navigate through the configuration options. • Change value in Edit mode.
		• Exit the Configuration menu. • Return to the previous sub menu options. • Exit Edit mode without saving.

Setpoints - Menu Overview

Main Menu	Sub Menu	Configuration

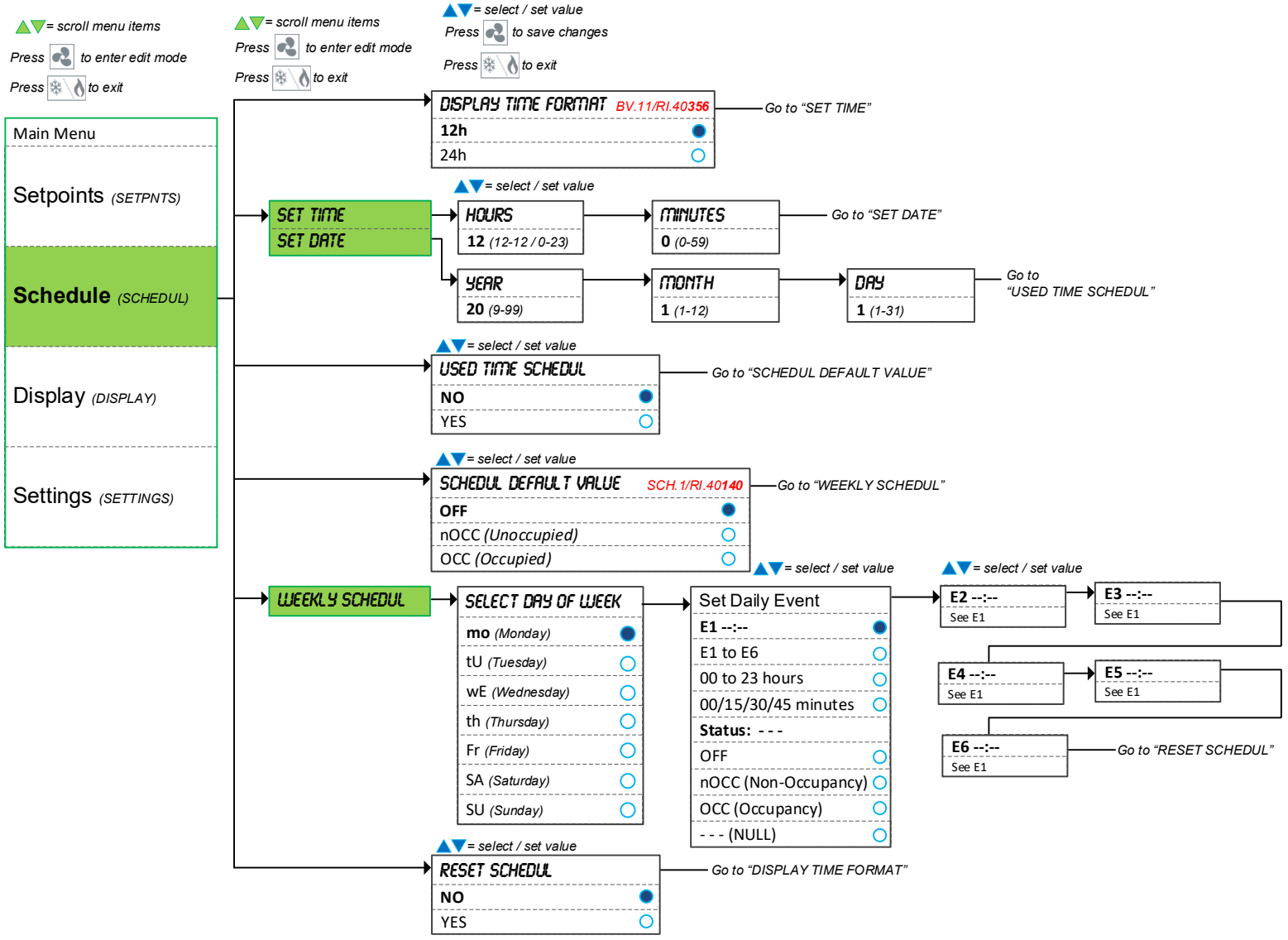
Note: The text in red is the BACnet and Modbus configuration values respectively.



Schedule - Menu Overview

Main Menu	Sub Menu	Configuration

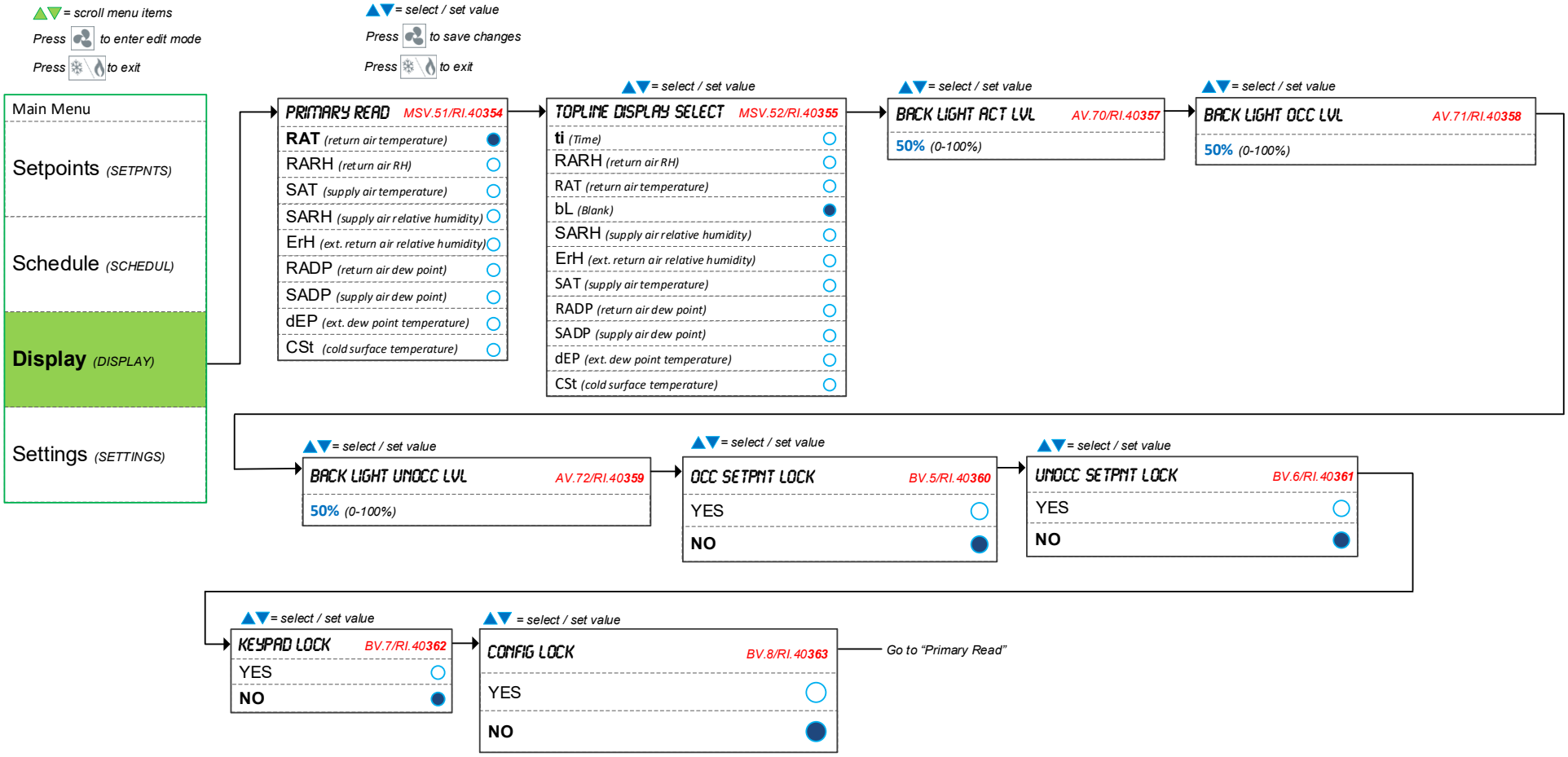
Note: The text in red is the BACnet and Modbus configuration values respectively.



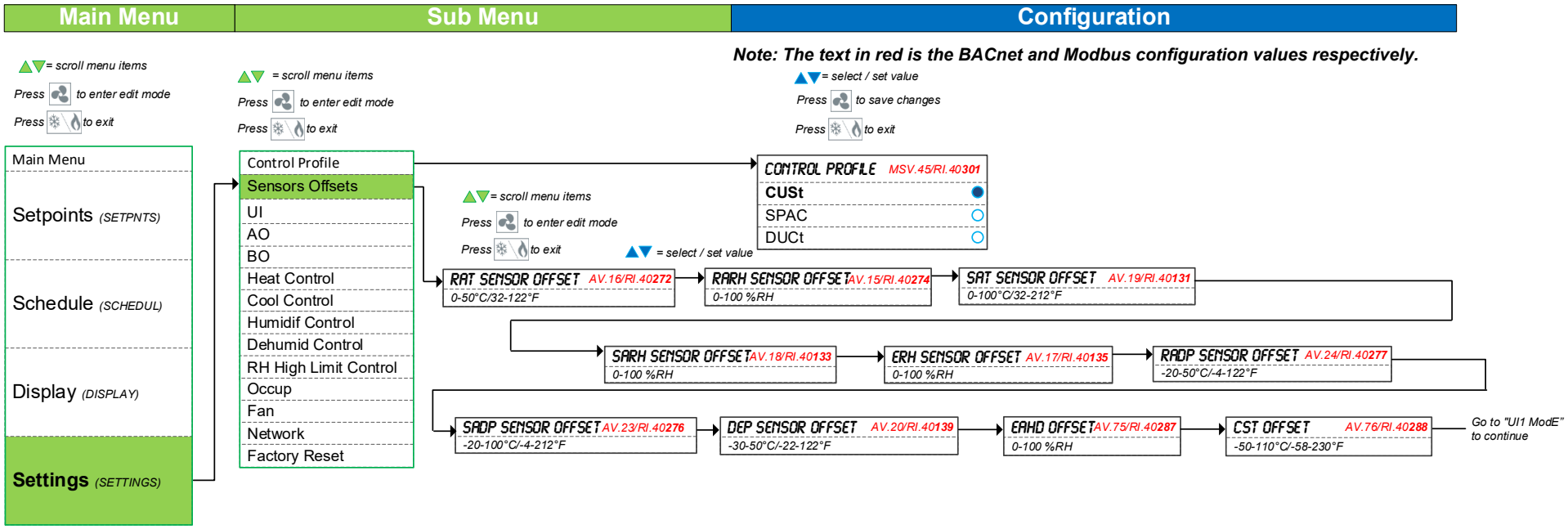
Display - Menu Overview

Main Menu	Sub Menu	Configuration

Note: The text in red is the BACnet and Modbus configuration values respectively.



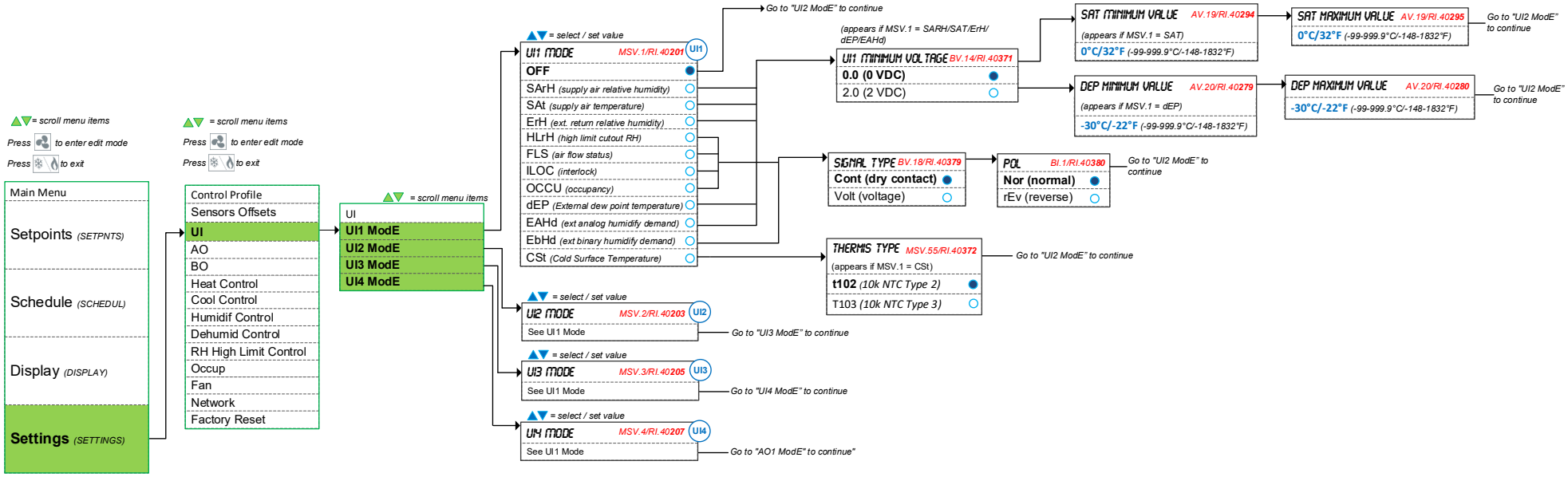
Settings - Menu Overview | Sensors Offsets



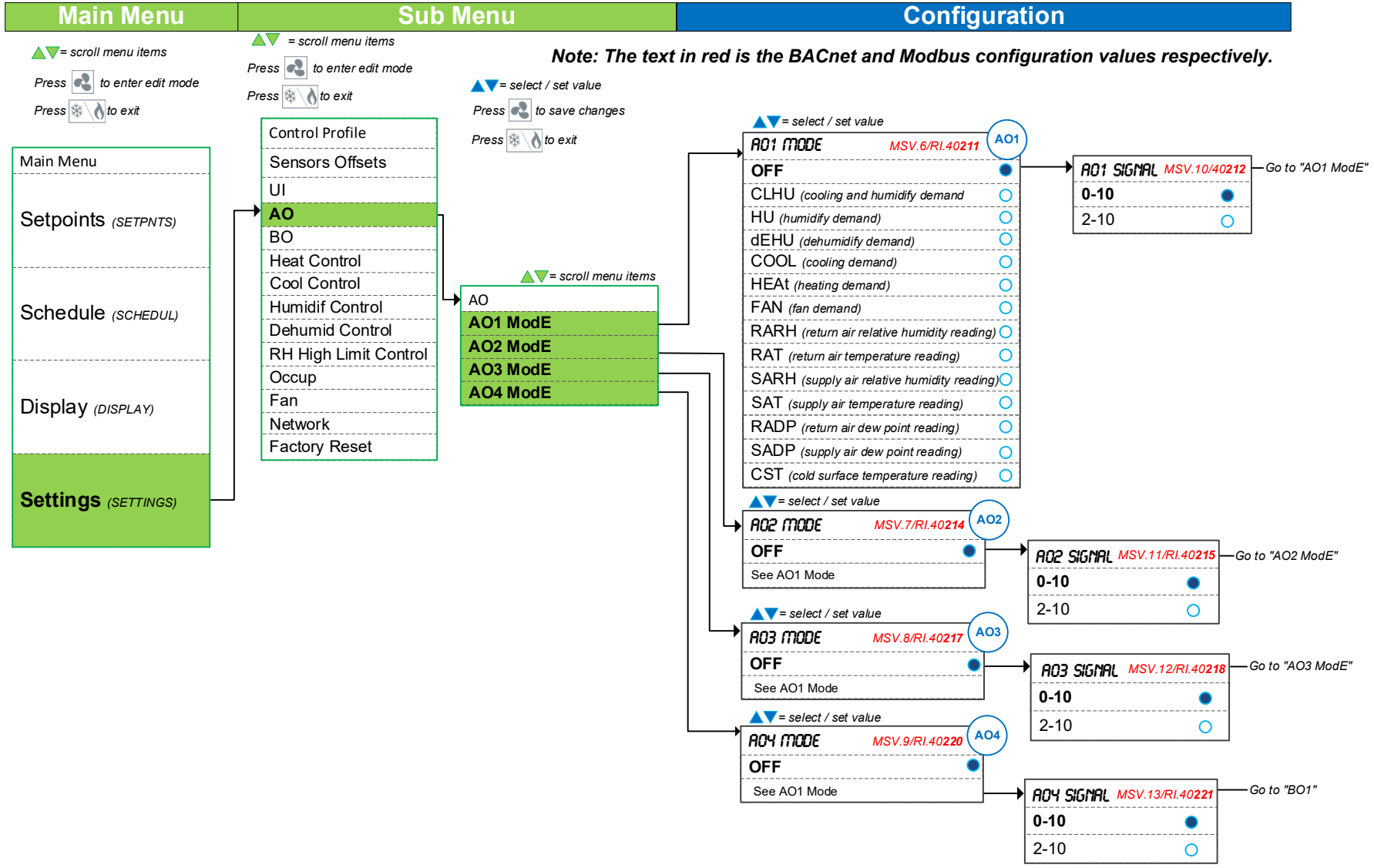
Settings - Menu Overview | Universal Inputs (UI)

Main Menu	Sub Menu	Configuration

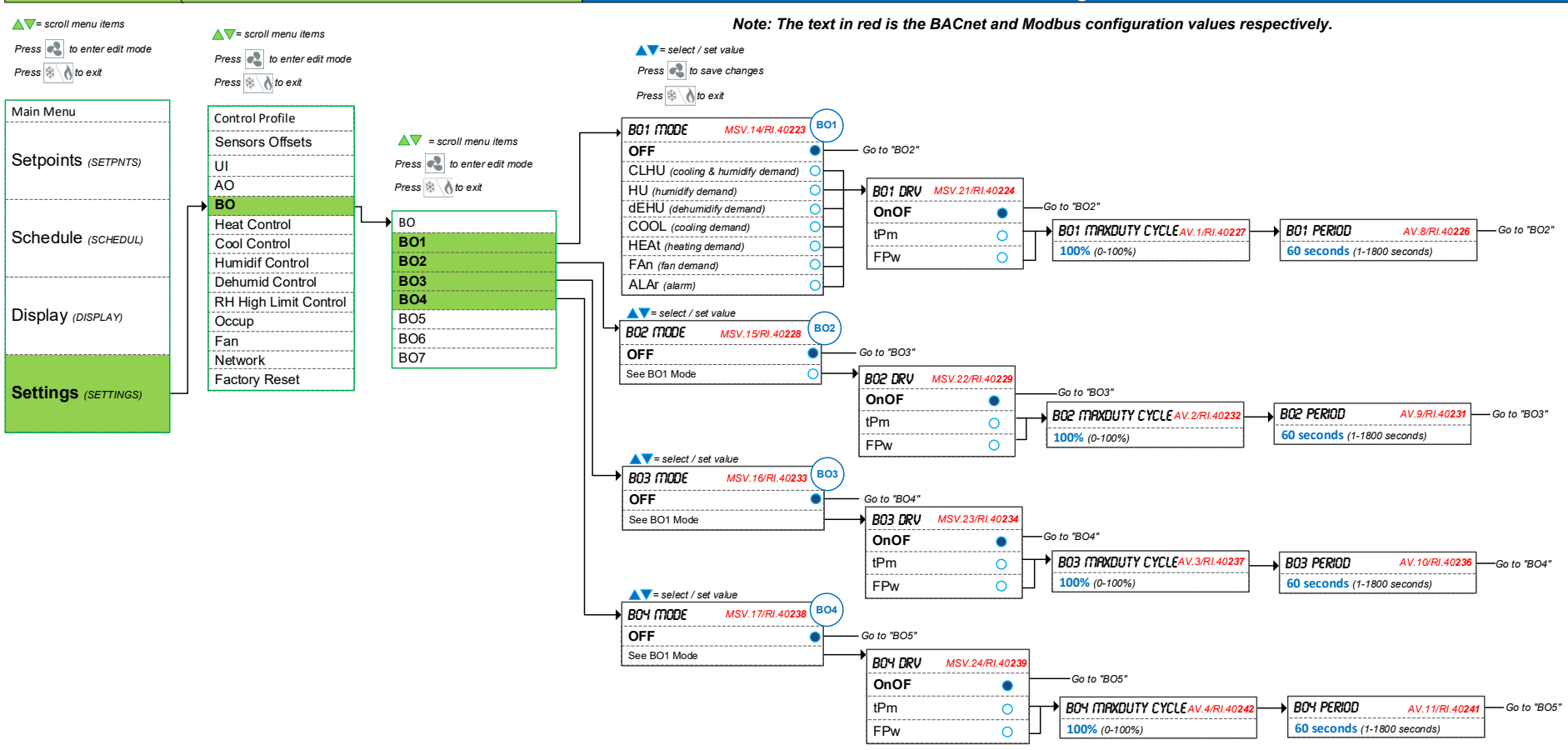
Note: The text in red is the BACnet and Modbus configuration values respectively.



Settings - Menu Overview | Analog Outputs (AO1 to AO4)

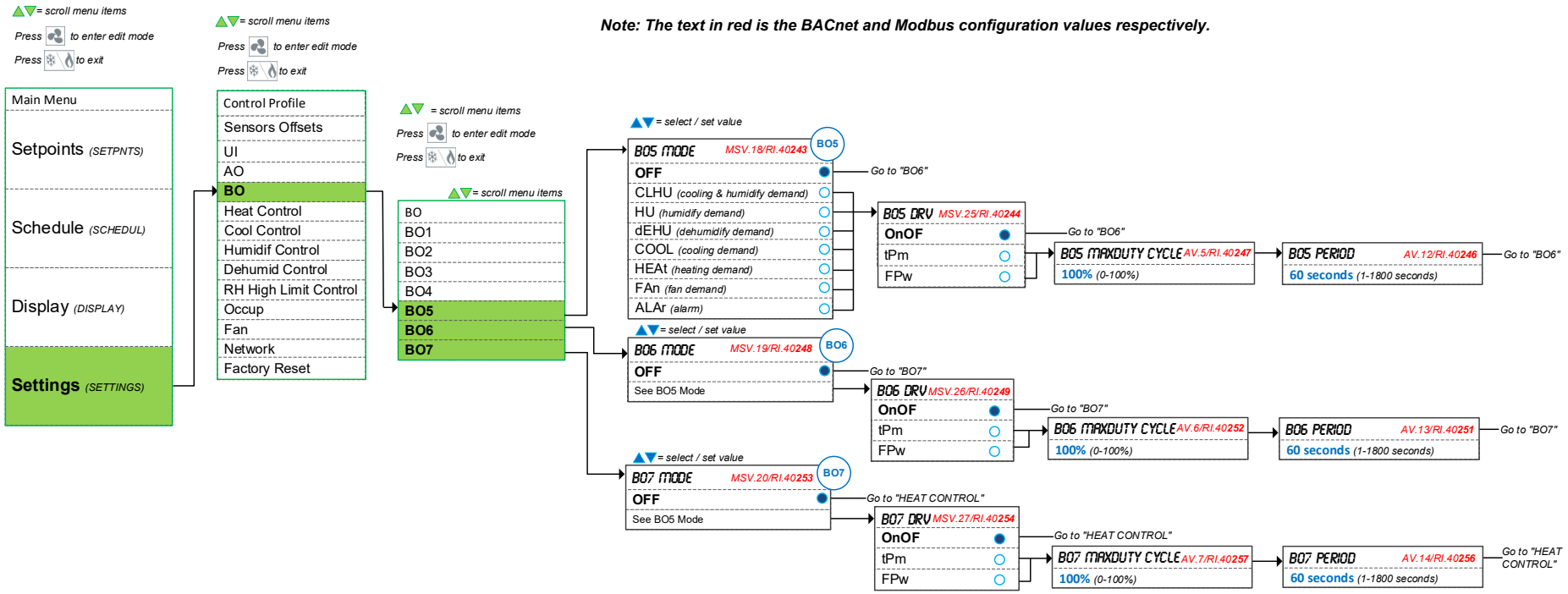


Settings - Menu Overview | Binary Outputs (BO1 to BO4)



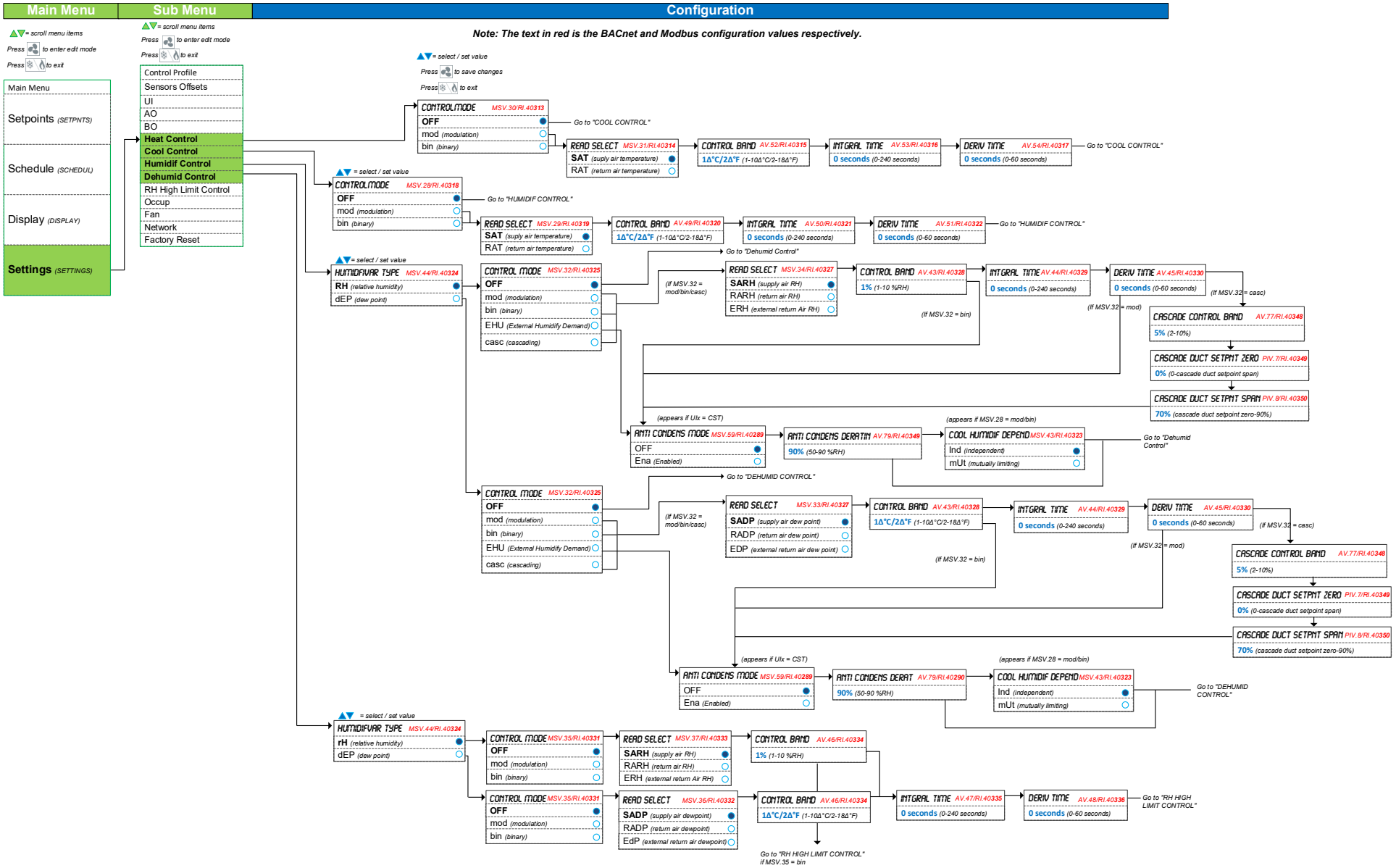
Settings - Menu Overview | Binary Outputs (BO4 to BO7)

Main Menu	Sub Menu	Configuration

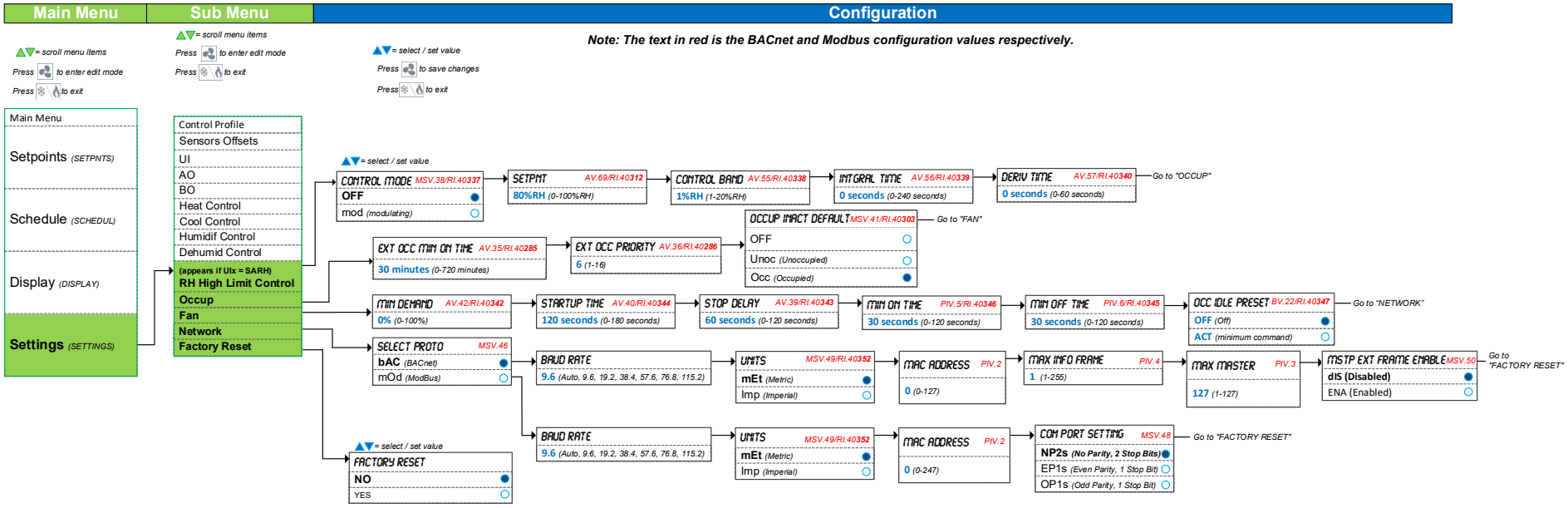


Note: The text in red is the BACnet and Modbus configuration values respectively.

Settings - Menu Overview | Other Settings | Heat to Dehumid Control



Settings - Menu Overview | Other Settings | RH Hi-Limit to Factory Reset



Annex B - Universal Input Features

Universal Inputs

The TRUB is equipped with four configurable inputs that integrate various sensors, either analog or binary. Each sensor can be customized according to specific application requirements.

Select 10 different modes through BACnet, Modbus, or menu configurations with specific input type each.

The following table lists the sensors, signal type, BACnet, and Modbus references:

Sensors and their Configurations

Sensor	Type	Description	Reading (BACnet – Modbus)	
			Reading	Configuration
Supply Air Relative Humidity	Analog	Sensor that measures the relative humidity of outside air and filters.	AV.18 - Present_Value 40**133**	AV.18 - Reading_Bias 40**273**
Supply Air Temperature	Analog	Sensor that measures the temperature of outside air and filters.	AV.19 - Present_Value 40**131**	AV.19 - Reading_Bias 40**271** AV.19 - Max_Pres_Value 40**295** AV.19 - Min_Pres_Value 40**294**
External Return Air Relative Humidity	Analog	Sensor that measures the relative humidity of air that returns from the controlled room.	AV.17 - Present_Value 40**135**	AV.17 - Reading_Bias Reg.40**275**
External Dew Point	Analog	Sensor that measures the current dew point in the controlled room.	AV.20 - Present_Value 40**139**	AV.20 - Reading_Bias 40**278** AV.20 - Max_Pres_Value 40**280** AV.20 - Min_Pres_Value 40**279**
External Analog Humidify Demand	Analog	Input that measures the analog humidify demand from an external device.	AV.75 - Present_Value 40**157**	AV.75 - Reading_Bias Reg.40**287**
High Limit Relative Humidity	Binary	Sensor that determines the relative humidity inside duct.	BV.2 - Present_Value 40**136**	BV.2 - Minimum_On_Time BV.2 - Minimum_Off_Time
Air Flow Status	Binary	Sensor that determines the air flow inside duct.	BV.3 - Present_Value 40**144**	BV.3 - Minimum_On_Time BV.3 - Minimum_Off_Time
Interlock	Binary	Sensor that determines the system interlock status.	BV.4 - Present_Value 40**143**	BV.4 - Minimum_On_Time BV.4 - Minimum_Off_Time
Occupancy	Binary	Sensor that determines current controlled room occupancy.	BV.9 - Present_Value 40**142**	BV.9 - Minimum_On_Time BV.9 - Minimum_Off_Time
External Binary Humidify Demand	Binary	Input that measures the binary humidify demand from an external device.	BV.23 - Present_Value 40**158**	BV.23 - Minimum_On_Time BV.23 - Minimum_Off_Time
Cold Surface Temperature	Analog	Sensor that determines the coldest temperature of a surface.	AV.76 - Present_Value 40**159**	AV.76 - Reading Bias 40**288**

Universal Input Type Parameters

The universal input sensor types have their own configurable parameters. However, the following is the list of parameters that are common for any specific input type:

Type	Parameter	Description	Values
Analog	Minimum Voltage	Configuration to determine the sensor reading range (0-10 Vdc or 2-10 Vdc).	0 Vdc / 2 Vdc
Binary	Signal type	Configuration to determine if the sensor signal is: • 0-10VDC: inactive (0) below 1V, active(1) above 1V • open/close contact	Contact / Voltage
	Signal Polarity	Configuration value to define the sensor polarity.	Normal / Reverse
Thermistor		Configuration value to define the thermistor type.	10k NTC Type 2 / 10k NTC Type 3

Universal Input Reference Mapping

The universal input channels available on the TRUB allow mapping of the configuration parameters to the four available universal inputs. Each entry details the specific reference input reading along with configuration parameters references for the sensor type supported.

Analog Input Type and Thermistor Sensor Reference Mapping

Universal Input (UI) Pin	Reading		Minimum Voltage Configuration	
	BACnet	Modbus	BACnet	Modbus
UI1	AI.1 - Present_Value	40**101**	BV.14 - Present_Value	40**371**
UI2	AI.2 - Present_Value	40**102**	BV.15 - Present_Value	40**373**
UI3	AI.3 - Present_Value	40**103**	BV.16 - Present_Value	40**375**
UI4	AI.4 - Present_Value	40**104**	BV.17 - Present_Value	40**377**

Binary Input Type Sensor Reference Mapping

Universal Input (UI) Pin	Reading		Minimum Voltage Configuration		Signal Polarity	
	BACnet	Modbus	BACnet	Modbus	BACnet	Modbus
UI1	BI.1 - Present_Value	40**105**	BV.18 - Present_Value	40**379**	BI.1 - Polarity	40**380**
UI2	BI.2 - Present_Value	40**106**	BV.19 - Present_Value	40**381**	BI.2 - Polarity	40**382**
UI3	BI.3 - Present_Value	40**107**	BV.20 - Present_Value	40**383**	BI.3 - Polarity	40**384**
UI4	BI.4 - Present_Value	40**108**	BV.21 - Present_Value	40**385**	BI.4 - Polarity	40**386**

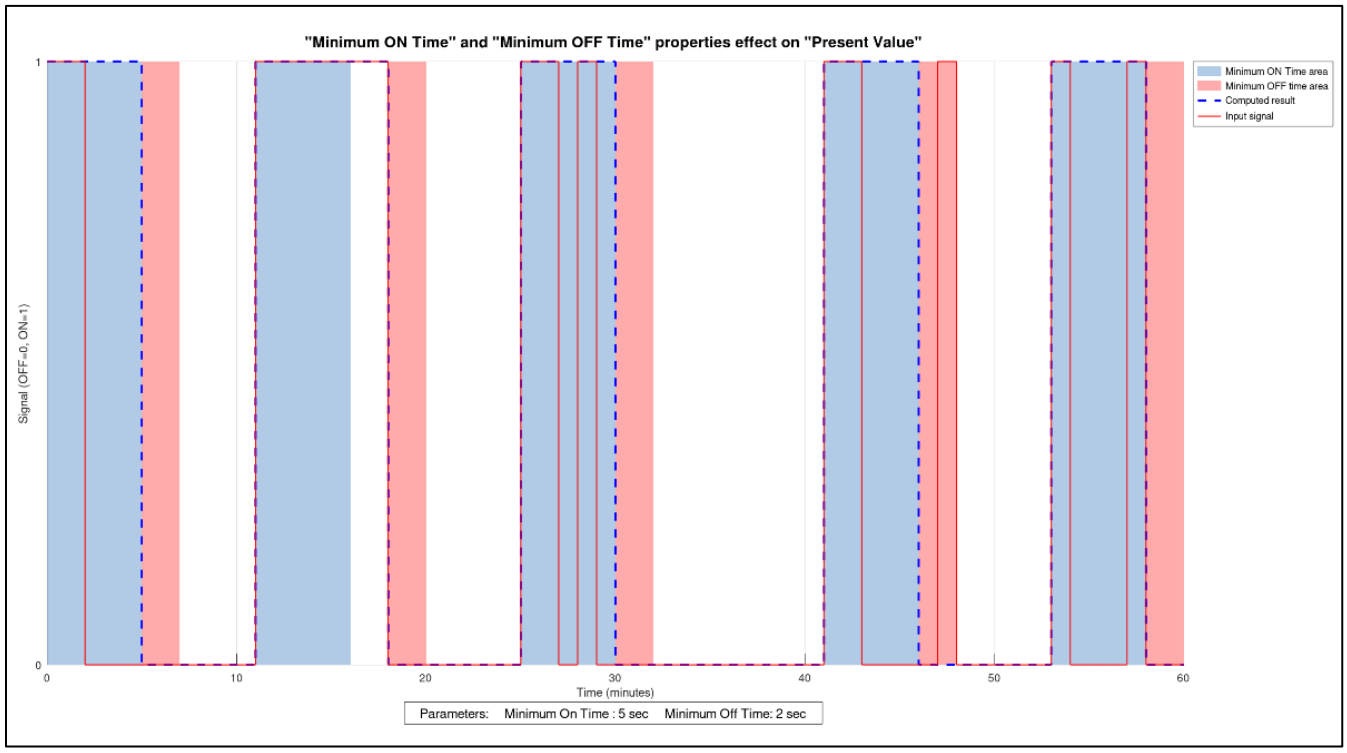
Binary Sensor Values for Time Management

The TRUB allows configuring the minimum on and off time through the binary sensor type on binary value objects. The on and off time determine the minimum amount of time that a state should be in locked status before its value can be changed.

Parameter (property)	Description
Minimum On Time	The minimum time the signal should stay Active (1) before a transition from Active (1) to Inactive (0) can occur.
Minimum Off Time	The minimum time the signal should stay Inactive (0) before a transition from Inactive (0) to Active (1) can occur.

*Note: The **Minimum On Time** and the **Minimum Off Time** properties are configurable (writable).*

The following illustration demonstrates an example of the transition from a binary input object signal to a binary value object.



Annex C - Outputs Features

Outputs

The TRUB is equipped to configure a total of 10 configurable outputs such as:

- Analog Outputs – 4
- Binary Outputs – 7
- Combination of 3 AO + 7 BO or 4 AO + 6 BO (terminal TB1-10 analog or binary, based on JP2 jumper position) – 1

Configure the following seven different modes through BACnet, Modbus, or menu options:

Mode	Description	Analog	Binary
Unused	The Unused mode is the default output mode. The output is mainly **0 (OFF)** and does not act in accordance with control demand. However, the voltage or relay state can still be commanded through the BMS.	N/A	N/A
Cooling and Humidifying	When the Cooling and Humidifying mode is enabled, the selected output is configured to comply with a value between cooling or humidifying demand. The final demand value depends on the "**Cooling humidifying dependency**" (MSV.43 Present_Value) configuration.	Yes	Yes
Humidify	When the Humidify mode is enabled, the selected output is configured to comply with the humidifying demand.	Yes	Yes
Dehumidify	When the Dehumidify mode is enabled, the selected output is configured to comply with the dehumidifying demand.	Yes	Yes
Cooling	When the Cooling mode is enabled, the selected output is configured to comply with the cooling demand.	Yes	Yes
Heating	When the Heating mode is enabled, the selected output is configured to comply with heating demand.	Yes	Yes
Fan	When the Fan mode is enabled, selected output is configured to comply with the fan command.	Yes	Yes
Alarm	*Note: The Alarm mode is only available with binary output.* When this mode is enabled, the output state is active when the device is an alarm state.	No	Yes
Readings*	*Any of the available readings: RARH (return air relative humidity), RAT (return air temperature), SARH (supply air relative humidity), SAT (supply air temperature), RADP (return air dew point), SADP (supply air dew point), CST (cold surface temperature)*	Yes	No

Output Parameters

The output types (analog or binary) have their own configurable parameters. However, the following is a list of parameters that are common for any specific output type:

Type	Parameter	Description	Values
Analog Output	Minimum Voltage	Configuration to determine the signal output range (0-10 Vdc or 2-10 Vdc).	0 to 10 Vdc / 2 to 20 Vdc
Binary Output	Signal Drive	Configuration to determine the binary output signal drive. The TRUB supports various drive modes such as On/Off, Time Pulse Modulation (TPM) and Fixed Pulse Width Modulation (FPW).	On/Off / TPM / FPW
	Signal Polarity	Configuration to define the polarity of the output.	Normal / Reverse
	Minimum On Time	Configuration to determine the minimum time the signal should stay ON when the OFF-ON transition occurs. *Note: Only available when the drive is "On/Off".*	
	Minimum Off Time	Configuration to determine the minimum time the signal should stay OFF when the ON-OFF transition occurs. *Note: Only available when the drive is "On/Off".*	
	Period	Configuration to determine the total time taken to complete one full cycle of the modulation signal. *Note: Only available when the drive is in "TPM" or "FPWM" state*.	1 to 1800 seconds
	Max Duty Cycle	Configuration to determine the maximum proportion of the period during which the signal is active. *Note: Only available when the drive is "TPM" or "FPWM" state.*	0 to 100%

Output Reference Mapping

The output channels available on the TRUB allow mapping of the configuration parameters. Each entry details the specific reference current output along with its configuration parameters.

HW Pin	Current Output (BACnet - Modbus)	Mode Config (BACnet - Modbus)	Signal Type (BACnet - Modbus)	Polarity (BACnet - Modbus)	Minimum On Time (BACnet - Modbus)	Minimum Off Time (BACnet - Modbus)	Period (BACnet - Modbus)	Max Duty Cycle (BACnet - Modbus)
AO1	AO.1 Present_Value 40**111**	MSV.6 Present_Value 40**211**	MSV.10 Present_Value 40**212**	NA	NA	NA	NA	NA
AO2	AO.1 Present_Value 40**112**	MSV.7 Present_Value 40**214**	MSV.11 Present_Value 40**215**	NA	NA	NA	NA	NA
AO3	AO.1 Present_Value 40**113**	MSV.8 Present_Value 40**217**	MSV.12 Present_Value 40**218**	NA	NA	NA	NA	NA
AO4	AO.1 Present_Value 40**114**	MSV.9 Present_Value 40**220**	MSV.13 Present_Value 40**221**	NA	NA	NA	NA	NA
BO1	BO.1 Present_Value 40**115**	MSV.14 Present_Value 40**223**	MSV.21 Present_Value 40**224**	BO.1 Polarity 40**225**	BO.1 Minimum_On_Time --	BO.1 Minimum_Off_Time --	AV.8 Present_Value 40**226**	AV.1 Present_Value 40**227**
BO2	BO.2 Present_Value 40**116**	MSV.15 Present_Value 40**228**	MSV.22 Present_Value 40**229**	BO.2 Polarity 40**230**	BO.2 Minimum_On_Time --	BO.2 Minimum_Off_Time --	AV.9 Present_Value 40**231**	AV.2 Present_Value 40**232**
BO3	BO.3 Present_Value 40**117**	MSV.16 Present_Value 40**233**	MSV.23 Present_Value 40**234**	BO.3 Polarity 40**235**	BO.3 Minimum_On_Time --	BO.3 Minimum_Off_Time --	AV.10 Present_Value 40**236**	AV.3 Present_Value 40**237**
BO4	BO.4 Present_Value 40**118**	MSV.17 Present_Value 40**238**	MSV.24 Present_Value 40**239**	BO.4 Polarity 40**240**	BO.4 Minimum_On_Time --	BO.4 Minimum_Off_Time --	AV.11 Present_Value 40**241**	AV.4 Present_Value 40**242**
BO5	BO.5 Present_Value 40**119**	MSV.18 Present_Value 40**243**	MSV.25 Present_Value 40**244**	BO.5 Polarity 40**245**	BO.5 Minimum_On_Time --	BO.5 Minimum_Off_Time --	AV.12 Present_Value 40**246**	AV.5 Present_Value 40**247**
BO6	BO.6 Present_Value 40**120**	MSV.19 Present_Value 40**248**	MSV.26 Present_Value 40**249**	BO.6 Polarity 40**250**	BO.6 Minimum_On_Time --	BO.6 Minimum_Off_Time --	AV.13 Present_Value 40**251**	AV.6 Present_Value 40**252**
BO7	BO.7 Present_Value 40**121**	MSV.20 Present_Value 40**253**	MSV.27 Present_Value 40**254**	BO.7 Polarity 40**255**	BO.7 Minimum_On_Time --	BO.7 Minimum_Off_Time --	AV.14 Present_Value 40**256**	AV.7 Present_Value 40**257**

Annex D - Occupancy Management

Occupancy Management

The TRUB handles occupancy management by monitoring and controlling the occupancy status in the following three ways:

- **Contact Sensors**: Integrate and configure an external contact sensor to the TRUB that detects the occupancy of a space.
- **Time-based Scheduling**: Configure the occupancy schedule through pre-programmed schedules of the TRUB to identify the expected usage times (during work hours, break-times, or after-hours) and control the space.
- **Building Management System (BMS)**: Configure the occupancy values through the BACnet communication protocol.

Occupancy Status

- **Off**: The TRUB stops humidity, temperature, and fan control.
- **Unoccupied**: The TRUB detects no human presence and controls the space according to the unoccupied setpoints defined by the integrator.
- **Occupied**: The TRUB detects at least one human presence and controls space according to the occupied setpoints defined by the integrator.

Occupancy Status Logic

The occupancy logic enables the TRUB to determine the occupancy status and control the environment as the controller monitors all inputs continuously. Each occupancy input such as a sensor, schedule has a configurable priority level ranging from 1 to 10, with 1 being the highest priority.
The priority level determines the final occupancy status. The input reading with higher priority is used to define the occupancy status over the reading with lower priority. For example:

Sensor	Priority	Occupancy Status/Reading
Schedule	16	-
External occupancy	6	External occupancy sensor value reading is considered to control the environment.

Occupancy Reference Mapping

The following is a list of occupancy inputs, parameters, and their BACnet and Modbus references:

Item	Parameter	Reference	
		BACnet	Modbus
Occupancy status	Reading value	MSV.41 - Present_Value	40**140**
	Default value when input value is not configured	MSV.41 - Relinquish Default	40**303**
External Occupancy	Reading value	BV.9 - Present_Value	40**142**
	Minimum time the signal should be ON when transitioned from OFF-ON.	BV.9 - Minimum_On_Time	-
	Minimum time the signal should be OFF when transitioned from ON-OFF.	BV.9 - Minimum_Off_Time	-
Schedule Occupancy	Reading value	SCHED.1 - Present_Value	-
	Effective Period	SCHED.1 - Effective_Period	-
	Schedule Default	SCHED.1 - Schedule_Default	-
	Priority For writing	SCHED.1 - Priority_For_Writing	-

Annex E - Fan Management

Fan Management

The TRUB controls fan management by reading values through different parameters, and configuring values though BACnet, and Modbus values.

Fan Modes

The TRUB controls the fan through the following two modes:

Mode	Description		
Auto	The device monitors the control demands such as cooling, heating, and humidifying and commands based on the highest control output loop.	MSV.30 Present_Value	40**341**
On	The device sets the fan commands running at 100% of its capacity.		

Fan Parameters

Parameter	Configurable?	Description	Reference (BACnet - Modbus)
Analog reading	No	If the fan is configured to any analog output, it displays the current modulating fan value.	AV.41 Present_Value 40**155**
Binary reading	No	If the fan is configured to any binary output, it displays the current fan state.	BV.1 Present_Value 40**156**
Startup time	Yes	If the **No Airflow Sensor** is configured, determine the maximum time that the control equipment should wait before the equipment is enabled. Otherwise, determine the maximum time that the control equipment should wait before the **no airflow alarm** is triggered. If the airflow is detected during this time, the controller is enabled as soon as it detects the airflow.	AV.40 Present_Value 40**344**
Stop delay	Yes	Determine the post-demand delay for the fan to stop after the control demand(s) has ended.	AV.39 Present_Value 40**343**
Modulating minimum demand	Yes	Determine the minimum demand fan value should be, if there is no demand. It is also the minimum value that the fan command will modulate (value to 100%).	AV.41 Present_Value 40**342**
Occupied Idle preset	Yes	Determine the fan's behavior when there is no demand: • Stop the fan • Run at the minimum configurable demand	BV.22 Present_Value 40**347**
Minimum ON time	Yes	The minimum time the fan must stay ON after the OFF-ON transition. If there is no demand in this period, the fan will run at the minimum configured demand.	PIV.5 Present_Value 40**346**
Minimum OFF time	Yes	The minimum time the fan must stay OFF after the ON-OFF transition.	PIV.6 Present_Value 40**345**

Annex F - Control Loop Management

Control Loop Management

The TRUB provides the following configurable control loops:

- Humidifying and Dehumidifying: Monitor and control the humidity in a specific space.
- Heating and Cooling: Monitor and control the temperature in a specific space.
- Duct RH High Limit: Monitor and control the relative humidity in a duct to prevent humidity saturation in a duct.

Note: The Duct RH High Limit control loop results reduce the humidifying and cooling loop outputs.

Using the above control loops, the TRUB monitors parameters such as temperature and humidity continuously using the inputs and sensors and adjusts the system's components to maintain the desired setpoints. The main component of the control loop is the controller that processes inputs from sensors' and compares it with the pre-defined setpoints. The controller commands the actuators or the equipment to adjust the system operations, based on this comparison.

Control Loops and User Control Mode

When the user sets *User Control Mode* to *Off* to stop the system, the TRUB does not monitor the control loops and sets the value of the outputs and demands to zero. However, the TRUB still monitors the inputs and displays the values to the menu, BACnet or Modbus.

If the user control mode is set to:

- Auto - Enables configuration of TRUB control loops. (MSV.40 Present_Value – Reg.40**302**)
- Off - Stops all TRUB control loops. (MSV.40 Present_Value – Reg.40**302**)

Control Loops and Occupancy Status

The following are the setpoints for occupancy:

- **Occupied State Setpoints**: Specify the setpoint that the device should use when the room is occupied based on the readings from the occupancy sensor or schedule.
- **Unoccupied State Setpoints**: Specify the setpoint that the device should use when the room is not occupied based on the readings from the occupancy sensor or schedule.

The following are the configuration values of the controls and their references:

Control	Occupied Setpoint		Unoccupied Setpoint	
	BACnet	**Modbus**	**BACnet**	**Modbus**
Cooling	AV.62 - Present_Value	40**306**	AV.63 - Present_Value	40**307**
Heating	AV.64 - Present_Value	40**304**	AV.65 - Present_Value	40**305**
Humidifying	AV.58 - Present_Value	40**308**	AV.59 - Present_Value	40**309**
Dehumidifying	AV.60 - Present_Value	40**310**	AV.61 - Present_Value	40**311**
Duct RH High Limit	AV.69 - Present_Value	40**312**	AV.69 - Present_Value	40**312**

Setpoints Restriction

A restriction is added to limit the overlap of heating-cooling, humidifying-dehumidifying setpoints and to prevent enabling both the controls at the same time. The following are the restrictions:

- Temperature Delta Setpoints: A delta of **1°C** is set to prevent the overlap of the cooling and heating setpoints. For example, if the occupied heating setpoint is 22°C, then the occupied cooling setpoint must be 23°C or more.
- Humidity Delta Setpoints: A delta of **5%** (or **2°C**, if the dew point control is enabled) is set to prevent the humidifying and dehumidifying setpoints from overlapping. For example, if the occupied humidifying setpoint is 25%, the occupied dehumidifying setpoint must be 30% or more.

Variable Source

A variable source for a specific control is the reading input that is monitored continuously and the inputs from the monitoring are used to the control environment. So, for each control type, a targeted input reading can be determined. The following is a list of the available variable sources and the targeted control input reading:

Control	Variable Type	References		Options
		BACnet	Modbus	
Cooling	N/A	MSV.29 - Present_Value	40**319**	• Supply Air Temperature (SAT) • Return Air Temperature (RAT)
Heating	N/A	MSV.31 - Present_Value	40**314**	
Humidifying	Relative Humidity	MSV.34 - Present_Value	40**327**	• Supply Air Relative Humidity (SARH) • Return Air Relative Humidity (RARH) • External Relative Humidity (External RARH)
	Dew Point	MSV.33 - Present_Value	40**326**	• Supply Air Dew Point (SADP) • Return Air Dew Point (RADP) • External Dew Point (External DP)
Dehumidifying	Relative Humidity	MSV.37 - Present_Value	40**333**	• Supply Air Relative Humidity (SARH) • Return Air Relative Humidity (RARH) • External Relative Humidity (External RARH)
	Dew Point	MSV.36 - Present_Value	40**332**	• Supply Air Dew Point (SADP) • Return Air Dew Point (RADP) • External Dew Point (External DP)
Duct RH High Limit	N/A	N/A	N/A	• Supply Air Relative Humidity (SARH)

Control Loop Mode

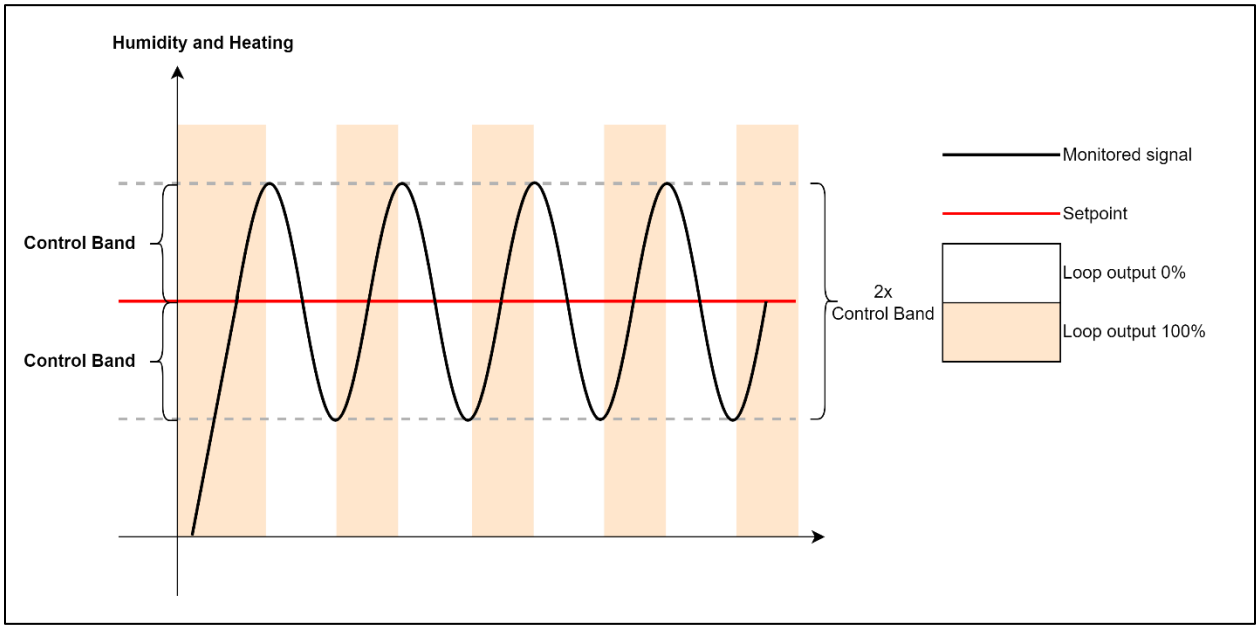
To monitor the parameters using the control loops, the following strategies are used:

Modulating Control: Monitors and controls the output by:

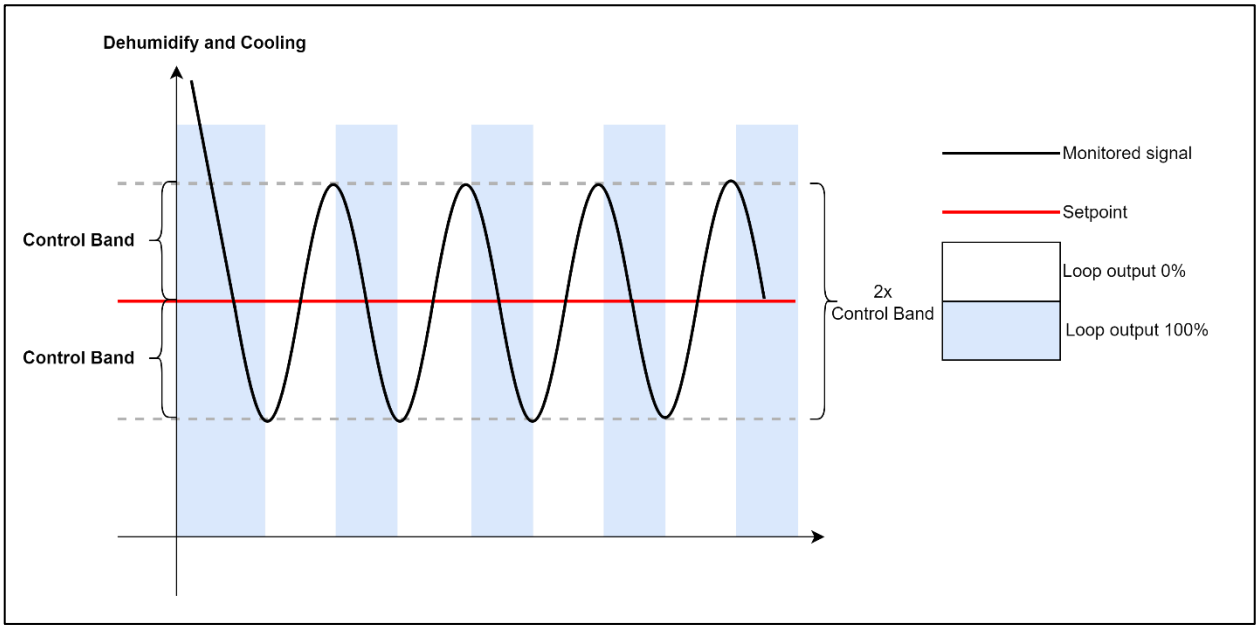
- Adjusting the output based on the current error value, which is the difference between the setpoint and the measured value.
- Addressing the accumulated past errors to eliminate the steady-state error.
- Predicting the future error based on the rate of change helping to dampen the system response (PID).

Binary Control: Operates on the on/off principle with a control band. The binary control is recommended for non-modulating systems, and the only parameter is the control band.

- For heating and humidifying:
  - The equipment is activated when the reading is equal or less than the "**setpoint - control band**".
  - The equipment is deactivated when the reading is equal or more than the "**setpoint + control band**".



- For cooling and dehumidifying control:
    - The equipment is activated when the reading is equal or less than the "**setpoint + control band**".
    - The equipment is deactivated when the reading is equal or more than the "**setpoint - control band**".



External demand: Only available for the humidifying control loop, this mode gets external demand received from input PIN, bypasses the device loop, and sets the retrieved value to the output loop. Fan management and airflow proofing is respected if either of them is enabled.

Cascade (Humidifying)

Note: The Cascade mode is only available for the humidifying control loop.

The Cascade mode allows you to control a humidity value in a ventilation duct while maintaining the humidity in the controlled environment. To achieve it, a new control setpoint is evaluated based on the following:

- User configured setpoint
- Control source value

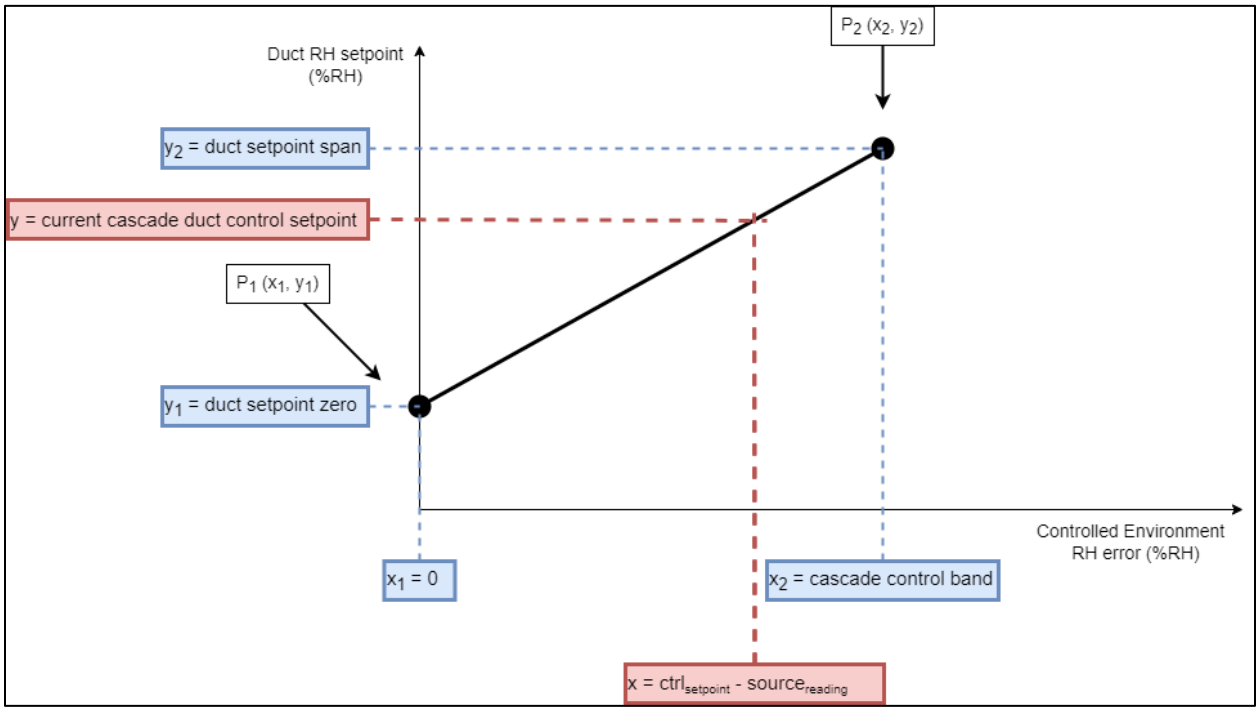
The following additional parameters are required to be configured:

Parameter	Configurable	Description	References	
			BACnet	Modbus
Duct computed setpoint	No	If the fan is configured to any analog output, the current modulating fan value is displayed.	AV.78 Present_Value	40**160**
Duct setpoint zero	Yes	Configuration value to specify the duct minimum setpoint when the control environment demand is at its lowest, it indicates that the reading is equal to the control variable source).	PIV.7 Present_Value	40**349**
Duct setpoint span	Yes	Configuration value to specify the duct maximum setpoint when the control environment's demand is at its highest.	PIV.8 Present_Value	40**350**
Cascade control band	Yes	Configuration value to specify cascade control band.	AV.77 Present_Value	40**348**

To determine the current humidity demand in this mode, the following inputs are used:

Object	Reference	Value
Cascade Control Duct Setpoint	AV.78 Present_Value / 40**160**	Setpoint
Supply Air Relative Humidity Reading	AV.18 Present_Value/ 40**133**	Reading

The **Cascade Control Duct Setpoint** is then evaluated by the linear approximation according to the mentioned configuration parameters.



Humidifying Anti-Condensation

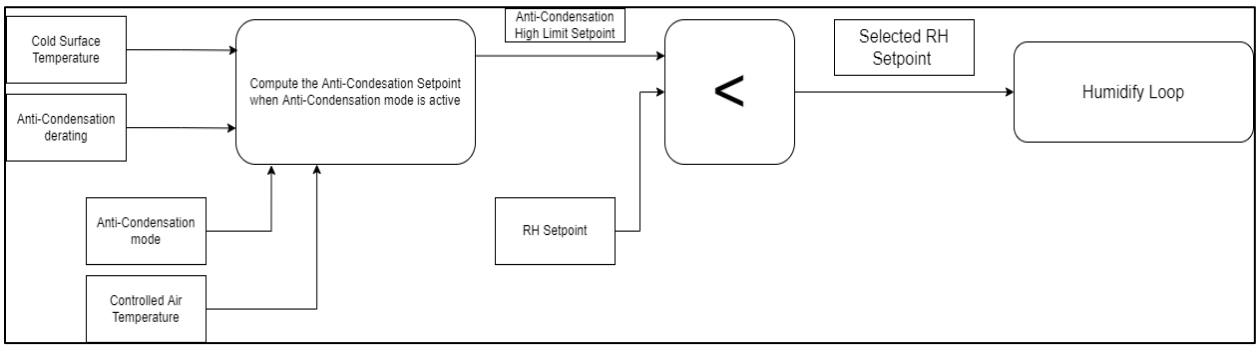
The Anti-Condensation feature limits the relative humidity during humidification based on the present temperature. This option avoids the condensation from forming on the windows.
To use the Anti-Condensation feature, do the following:

- Configure one of the universal input features to Cold Surface Temperature (CST)
- Connect a thermistor of 10K NTC Type 2 or 3

Then do the following:

- Place the thermistor close to the coldest surface in the room
- Enable the Anti-Condensation mode
- Set the Derating value

The derating value corresponds to the desired maximum percentage of the relative humidity at the Cold Surface Temperature; the default value is 90%. The Anti-Condensation Setpoint is calculated according to the Cold Surface Temperature and the Humidify control loop (the lesser value between that setpoint and the user setpoint).



Anti-Condensation Configuration

Parameter	Description	References	
		BACnet	Modbus
UI(x) Mode	Configuration to use Cold Surface Temperature (CST).	MSV.1 to 4 Present_Value	40**369** 40**371** 40**373** 40**375**
UI(x) Thermistor Type	Configuration value to select the Thermistor Type: • 10K NTC Type 2 • 10K NTC Type 3	MSV.55 to 58 Present_Value	40**370** 40**372** 40**374** 40**376**
CST Sensor Offset	Reading bias of the Cold Surface Temperature	AV.76 Reading_Bias	40**286**
Anti-Condensation Mode	Configuration to enable the Anti-Condensation mode: • OFF • Enabled	MSV.59 Present_Value	40**159**
Anti-Condensation Derating	Configuration value to specify the desired maximum %RH at Cold Surface Temperature: 50 to 90%	AV.79 Present_Value	40**160**
Anti-Condensation Setpoint	Setpoint calculated to avoid condensation.	AV.80 Present Value	40**161**

Cooling Humidifying Dependency

For cooling and humidifying loops, the output loop is limited by the lowest value of the last result. The device compares both the loop outputs and replaces the highest value with the lower value. This is possible for Adiabatic systems.
Note: This option is only available if both the Cooling and Humidifying controls are enabled.

Option	Description	References	
		BACnet	Modbus
Independent	The humidifying and cooling control loop outputs are independent and do not match with each other.	MSV.43 Present_Value	40**323**
Mutually Limiting	The humidifying and cooling control loop outputs are dependent on each other and the limiting loop output result to the lowest value.		

Output and Demand Objects

The results from the Modulating, Binary, and External Demand control modes are saved into the device database in their respective Loop Output object. This loop output signals the fan to start. This is possible only when the airflow confirms that the control loop value is transferred to the actual demand.

Thus, the Loop Output objects represent the respective PID, binary, or external demand control logic, and the Active Demand objects represent the current demand to be sent to the equipment.

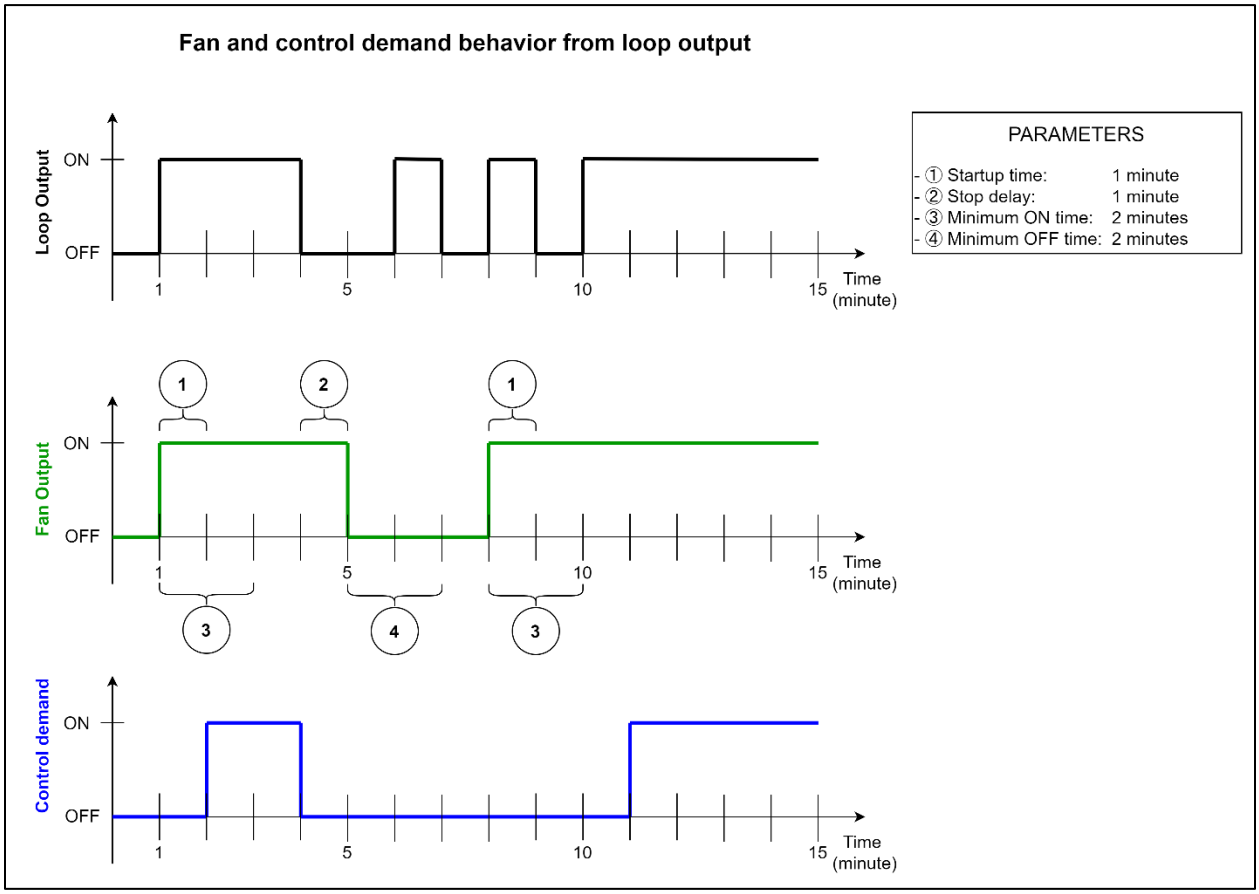
The following table shows the reference for each output and its demand, according to the control type:

Control	Loop Output Value		Active Demand Value	
	BACnet	Modbus	BACnet	Modbus
Cooling	AV.30 - Present_Value	40**148**	AV.29 - Present_Value	40**147**
Heating	AV.32 - Present_Value	40**146**	AV.31 - Present_Value	40**145**
Humidifying	AV.26 - Present_Value	40**150**	AV.25 - Present_Value	40**149**
Dehumidifying	AV.28 - Present_Value	40**152**	AV.27 - Present_Value	40**151**
Duct RH High Limit	AV.34 - Present_Value	40**154**	AV.33 - Present_Value	40**153**

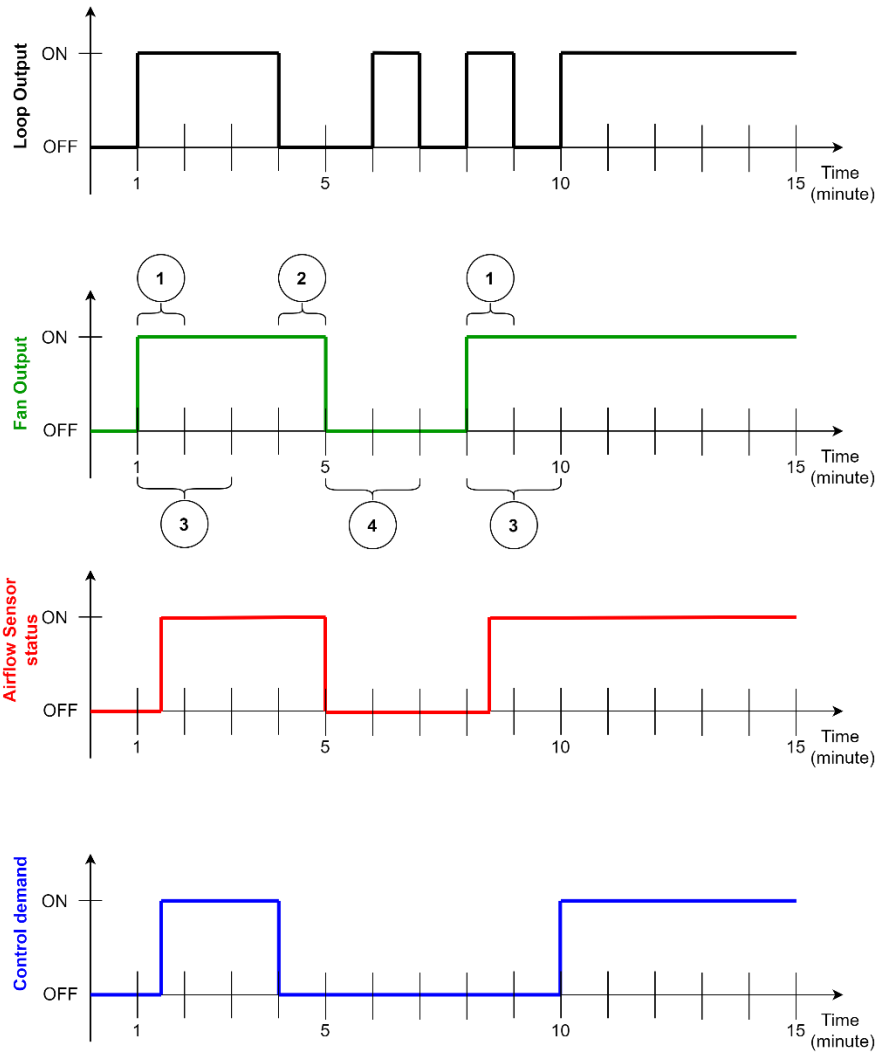
Loop Output, Fan, and Control Demand Mechanism

The behavior for demand can change depending on the device configuration whether the airflow sensor is configured or not.

The following illustration shows the connection among the loop output, fan, and control demand when the airflow sensor is not configured. The demand is enabled only after the startup time has elapsed and is disabled when the loop output goes back to “OFF” status. When the airflow sensor is configured, the demand is enabled when the airflow is detected.



Fan and control demand behavior depending on loop output with airflow sensor enables

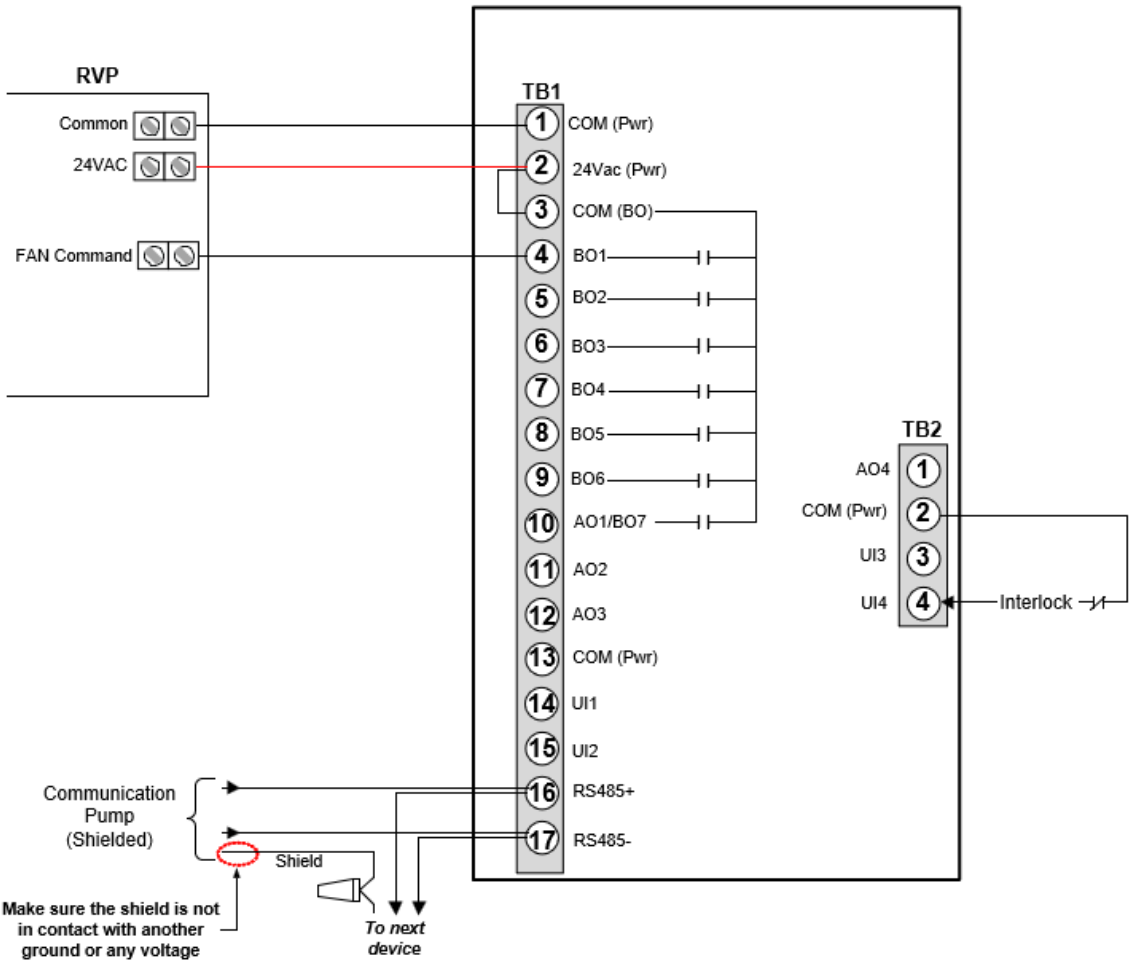


PARAMETERS

- ① Startup time: 1 minute
- ② Stop delay: 1 minute
- ③ Minimum ON time: 2 minutes
- ④ Minimum OFF time: 2 minutes

Annex G - Supplementary Wiring Options

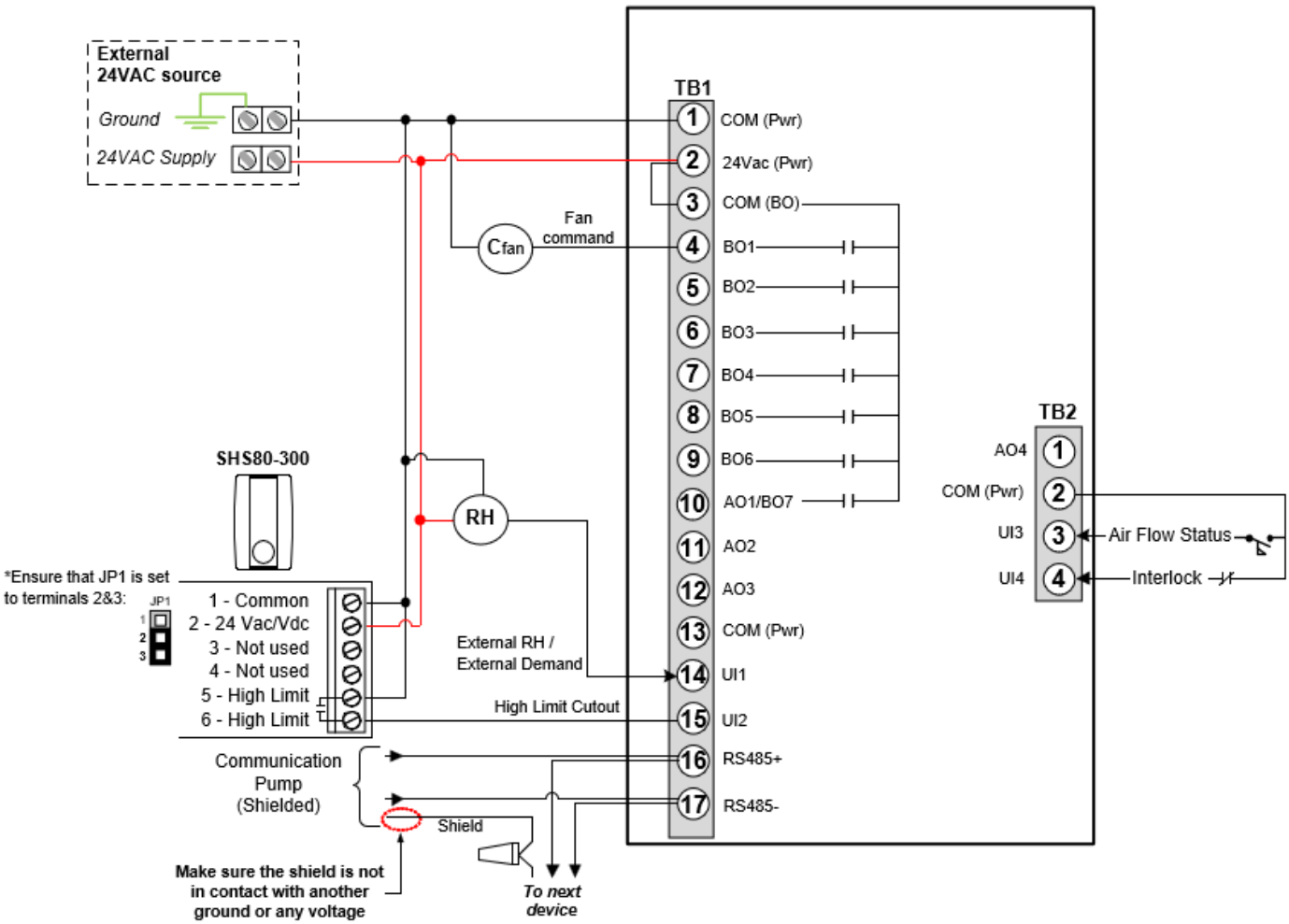
In-Space Wiring (RVP with MDU Option)



Additional Manual Configuration

Function	Parameter	Menu Path	BACnet Reference	Modbus Reference	Value
Fan Command	BO1 Mode	*SETTING → BO → BO1 → BO1 ModE*	MSV.14 - Present Value	40**223**	FAn (Fan)
	BO1 Drive Mode	*SETTING → BO →BO1 → BO1 DRV*	MSV.21 - Present Value	40**224**	OnOf (On / Off)
	Fan Start-up Time	*SETTING → FAN → SARTUP TIME*	AV.40 - Present Value	40**344**	15 seconds
	Fan Stop Delay	*SETTING → FAN → STOP DELAY*	AV.39 - Present Value	40**343**	20 seconds

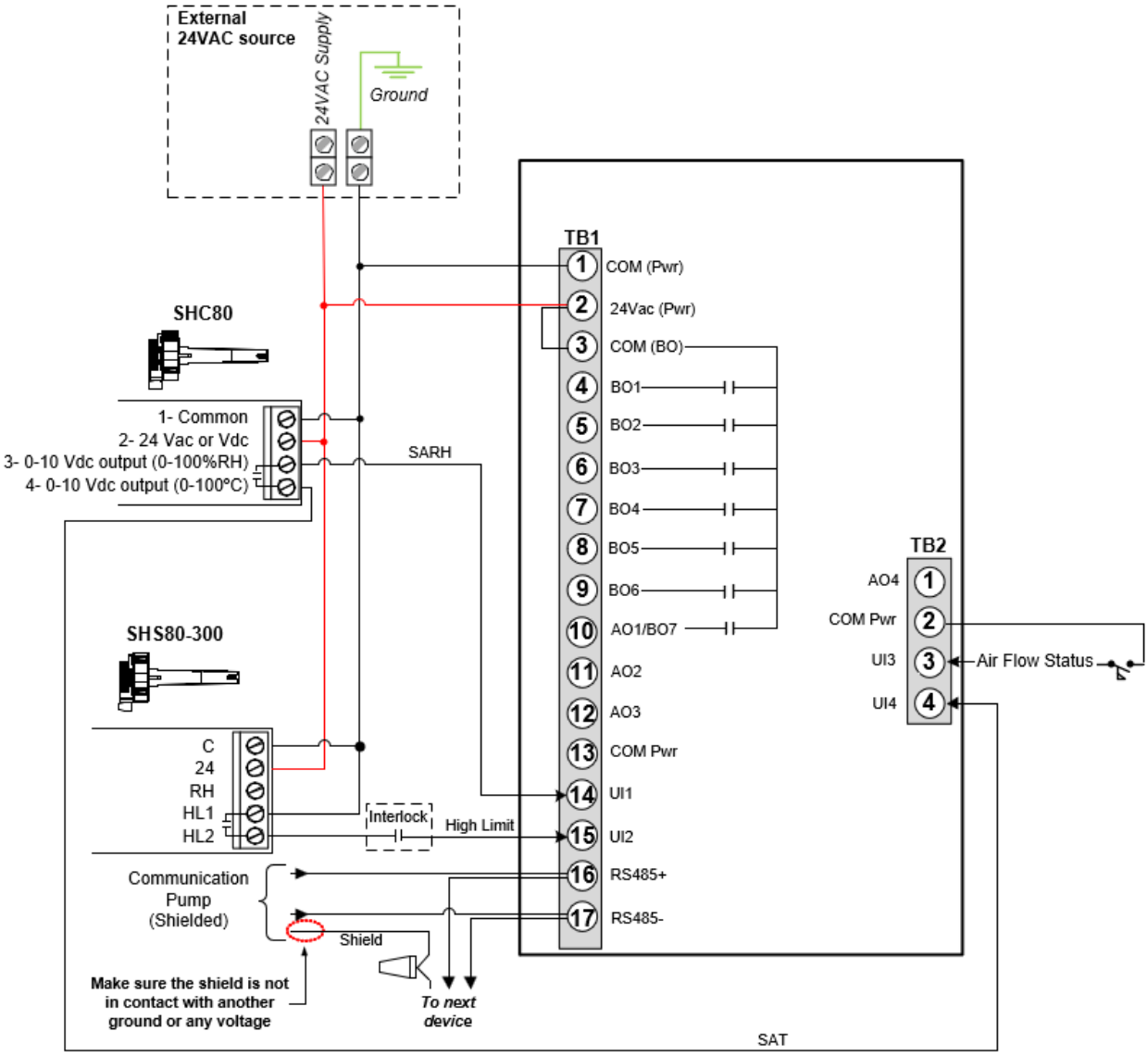
In-Space Wiring (Optional Control Components)



Additional Manual Configuration

Function	Parameter	Menu Path	BACnet Ref.	Modbus Ref.	Value
RH High Limit Cutout	UI2 Mode	*SETTING → UI → UI2 ModE*	MSV.2 - Present Value	40**203**	HLrh (High Limit Relative Humidity)
Airflow Status	UI3 Mode	*SETTING → UI → UI3 ModE*	MSV.3 - Present Value	40**205**	FLS (Airflow)
External RH	UI1 Mode	*SETTING → UI → UI1 ModE*	MSV.1 - Present Value	40**201**	ErH (External RH)
	Humidify Control Variable Type	*SETTING → HUMIDIF CONTROL → HUMIDIF VAR TYPE*	MSV.44 - Present Value	40**324**	rH (Relative Humidity)
	Humidify Control Mode	*SETTING → HUMIDIF CONTROL → CONTROL ModE*	MSV.32 - Present Value	40**325**	Mod (Modulating)
	Humidify Reading Selection	*SETTING → HUMIDIF CONTROL → READ SELECT*	MSV.34 - Present Value	40**327**	ErH (External RH)
	Humidify Control Band	*SETTING → HUMIDIF CONTROL → CONTROL BAND*	AV.43 - Present Value	40**328**	5%
	Humidify Control Integral Time	*SETTING → HUMIDIF CONTROL → INTEGRAL*	AV.44 - Present Value	40**329**	0
	Humidifying Control Derivative Time	*SETTING → HUMIDIF CONTROL → DERIV*	AV.45 - Present Value	40**330**	0
	Cooling / Humidifying dependency	*SETTING → HUMIDIF CONTROL → COOL HUMIDIF DEPEND*	MSV.43 - Present Value	40**323**	Ind (Independent)
External Demand	UI1 Mode	*SETTING → UI → UI1 ModE*	MSV.1 - Present Value	40**201**	EAHd (External Analog Humidity Demand)
	Humidify Control Variable Type	*SETTING → HUMIDIF CONTROL → HUMIDIF VAR TYPE*	MSV.44 - Present Value	40**324**	rH (Relative Humidity)
	Humidify Control Mode	*SETTING → HUMIDIF CONTROL → CONTROL ModE*	MSV.32 - Present Value	40**325**	EHU (External Humidity)
	Cooling / Humidifying dependency	*SETTING → HUMIDIF CONTROL → COOL HUMIDIF DEPEND*	MSV.43 - Present Value	40**323**	Ind (Independent)
Fan Command	BO1 Mode	*SETTING → BO → BO1 → BO1 ModE*	MSV.14 - Present Value	40**223**	FAn (Fan)
	BO1 Drive Mode	*SETTING → BO →BO1 → BO1 DRV*	MSV.21 - Present Value	40**224**	OnOf (On / Off)
	Fan Start-up Time	*SETTING → FAN → SARTUP TIME*	AV.40 - Present Value	40**344**	15 seconds
	Fan Stop Delay	*SETTING → FAN → STOP DELAY*	AV.39 - Present Value	40**343**	20 seconds

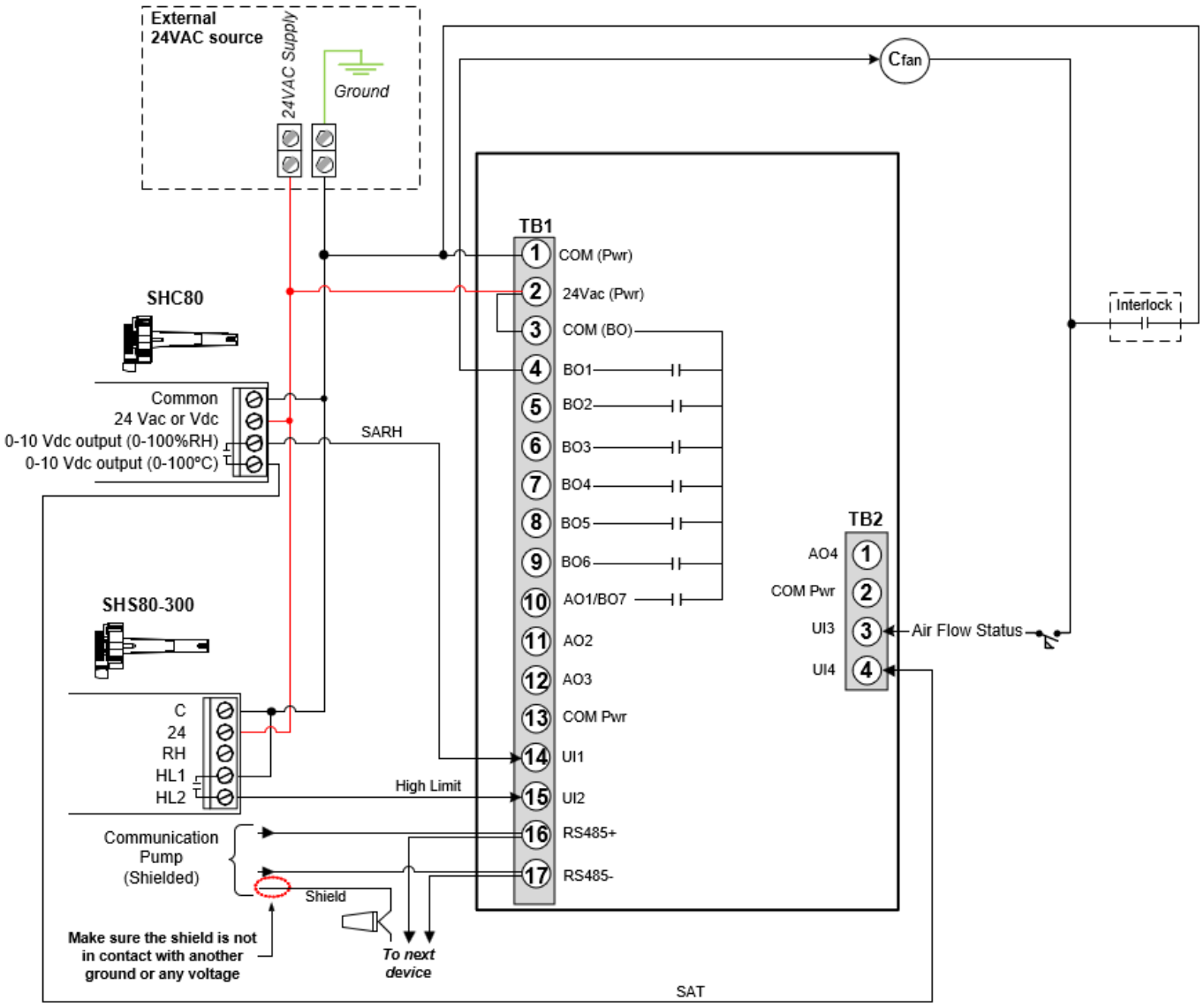
In-Duct Wiring (SAT Option)



Additional Manual Configuration

Function	Parameter	Menu Path	BACnet Reference	Modbus Reference	Value
Supply Air Temperature	UI4 Mode	*SETTING → UI → UI4 ModE*	MSV.4 - Present Value	40**207**	SAt (Supply Air Temperature)

In-Duct Wiring (SAT and Fan Command Options)



Additional Manual Configuration

Function	Parameter	Menu Path	BACnet Reference	Modbus Reference	Value
Supply Air Temperature	UI4 Mode	*SETTING → UI → UI4 ModE*	MSV.4 - Present Value	40**207**	SAt (Supply Air Temperature)
Fan Command	BO1 Mode	*SETTING → BO → BO1 → BO1 ModE*	MSV.14 - Present Value	40**223**	FAn (Fan)
	BO1 Drive Mode	*SETTING → BO →BO1 → BO1 DRV*	MSV.21 - Present Value	40**224**	OnOf (On / Off)
	Fan Start-up Time	*SETTING → FAN → SARTUP TIME*	AV.40 - Present Value	40**344**	120 seconds
	Fan Stop Delay	*SETTING → FAN → STOP DELAY*	AV.39 - Present Value	40**343**	20 seconds

	Recycling at end of life: please return this product to your Neptronic local distributor for recycling. If you need to find the nearest Neptronic authorized distributor, please consult **www.neptronic.com**.