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# **LONMARK<sup>®</sup>**

# **Functional Profile:**

# **Roof Top Unit (RTU)**

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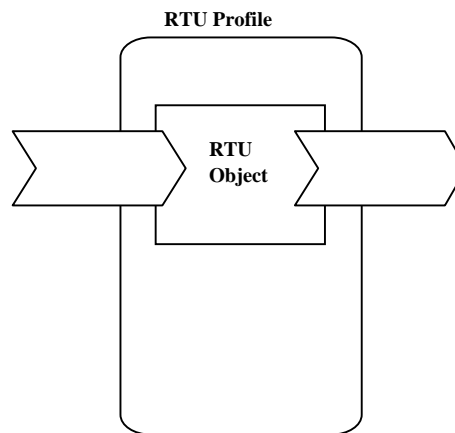
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## Overview

This document describes the profile used for a RTU controller which has self-contained hardware inputs and outputs for sensors and actuators such that it can provide stand-alone control functionality. The RTU object is used to control sensed room temperature by controlling heating and cooling actuator outputs (staged or modulating).

A room temperature sensor input is mandatory and it resides either in the node itself (may be hard-wire connected to the node) or optionally resides on the network in which case the input is via a network variable.

The RTU Profile is shown below.



**Figure 1** Functional Profile

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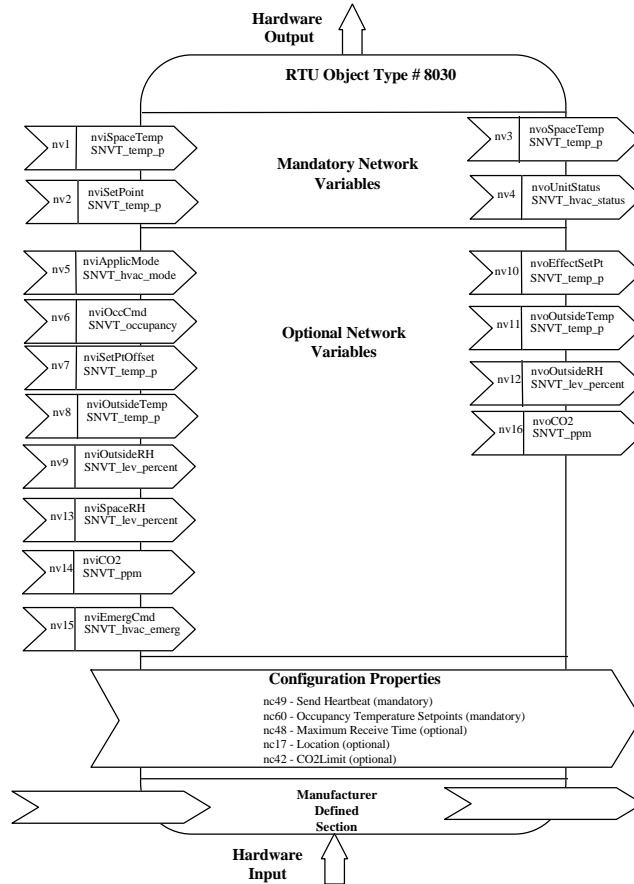
## Example Usage

The RTU object interacts with one or more of the following LONMARK devices:

- room temperature sensor node
- remote wall module (including temperature sensor, setpoint)
- supervisory node (occupancy mode, heat/cool changeover)
- monitoring node

# Object Details

The RTU object can control heat, cool, economizer and fan outputs directly through hardware outputs. This requires no mandatory controller outputs be available for actuator nodes.



**Figure 2** Object Details “RTU”

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## Mandatory Network Variables

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### Space Temperature Input

```
network input SNVT_temp_p nviSpaceTemp;
```

This input network variable is used to connect an external space temperature sensor to the node. It is mandatory to the profile, but it does not have to be bound to a sensor node. The RTU device can have a locally wired space temperature sensor. In either case, valid values of `nviSpaceTemp` have priority over local sensor values.

#### *Valid Range*

The valid Range is -10°C to 50°C. The value 0x7FFF=+327.67°C will be handled as an invalid value.

#### *Default Value*

Default Value is 0x7FFF (= +327.67°C). This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

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### Temperature Setpoint Input

```
network input SNVT_temp_p nviSetPoint;
```

This input network variable is used to allow the temperature setpoint for the occupied and standby mode to be changed via the network. The individual heat/cool setpoints for occupied and standby mode then derive from `nviSetpoint` minus/plus half the occupancy zero-energy-bands calculated from `nciSetPnts` i.e.

```
zeb_occ = occupied_cool - occupied_heat;
```

```
zeb_standby = standby_cool - standby_heat
```

where the zero-energy-band is defined as the range where neither heating nor cooling is active.

Although this network variable input is mandatory to the profile, it does not have to be bound to any setpoint node. If a valid setpoint value is written to `nviSetPoint`, it will be used as the center setpoint. If an invalid setpoint is in `nviSetPoint`, either a locally wired setpoint knob or the appropriate setpoint as configured in `nciSetPnts` will be used.

#### *Valid Range*

The valid Range is 10°C to 35°C.

#### *Default Value*

Default Value is 0x7FFF (= +327.67°C). This value will be adopted at power-up and remains in effect until an update is received. In this case, the RTU object will function according to the configuration of `nciSetPnts`.

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## Space Temperature Output

network output SNVT\_temp\_p nvoSpaceTemp;

This output network variable is used to send the value of the controlled space temperature (either from a locally connected space temperature sensor or from the nviSpaceTemp input) to other nodes. It is mandatory to the profile.

### *Valid Range*

The valid Range is -10°C to 50°C. The value 0x7FFF=+327.67°C will be handled as an invalid value in case of a sensor failure.

### *When Transmitted*

The variable is transmitted immediately when its value has changed. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration nciSndHrtBt.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

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## Unit Status Output

network output SNVT\_hvac\_status nvoUnitStatus;

This output network variable is available to report the object status. It combines the operating mode, the capacity of heating and cooling used and an indication if any alarms are present in the object.

### *Valid Range*

mode: HVAC\_HEAT, HVAC\_COOL, HVAC\_OFF -  
HVAC\_AUTO is not used, other enumerations are optional

heat\_output\_primary: 0-100%, 0xFFFF (INVALID)

heat\_output\_secondary: 0-100%, 0xFFFF (INVALID)

cool\_output: 0-100%, 0xFFFF (INVALID)

econ\_output: 0-100%, 0xFFFF (INVALID)

fan\_output: 0-100%, 0xFFFF (INVALID)

in\_alarm: 0 Means there is no alarm

Not 0 Means there is an alarm.

A filter alarm will also be indicated using this field.

### *When Transmitted*

The variable is transmitted immediately when its value has changed significantly. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration nciSndHrtBt.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

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## *Optional Network Variables*

### **Application Mode Input**

```
network input SNVT_hvac_mode nviApplicMode;
```

This network variable input is used to coordinate the RTU Device with any supervisory controller or intelligent human interface device.

### *Valid Range*

**HVAC\_AUTO:** The control loop automatically changes between application modes (e.g. HEAT and COOL) to provide the control objectives. In this case both, heat and cool supply is presumed to be available.

**HVAC\_HEAT:** The control loop is in HEAT mode.

**HVAC\_COOL:** The control loop is in COOL mode.

**HVAC\_OFF:** The control loop is off and all outputs are off position.

The other enumerations provided by SNVT\_hvac\_mode are optional.

### *Default Value*

The default value is HVAC\_AUTO. This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow failure reaction.

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### **Occupancy Input**

```
network input SNVT_occupancy nviOccCmd;
```

This input network variable is used to command the RTU object into different occupancy modes. It is typically set by a supervisory node.

### *Valid Range*

The valid range is described in the table below:

**OC\_OCCUPIED:** The RTU object should operate in occupied mode as defined by the manufacturer and use the occupied setpoint.

**OC\_UNOCCUPIED:** The RTU object should operate in unoccupied mode as defined by the manufacturer and use the unoccupied setpoint.

**OC\_BYPASS:** The RTU object should operate in temporary occupied mode. This input can be commanded from the supervisory node. When the configured bypass time elapses, the RTU returns to the original occupancy mode.

**OC\_STANDBY:** The RTU object should operate in standby mode as defined by the manufacturer and use the standby setpoint.

**OC\_NUL:** This is the initial value after power-up and it remains until another value is received. It is used to operate according manufacturer-specific defaults.

### *Default Value*

The default value is `OC_NUL = 0xFF`.

---

## Setpoint Offset Input

```
network input SNVT_temp_p nviSetPtOffset;
```

This input network variable is used to shift the temperature setpoint via the network by adding `nviSetPtOffset` to the current setpoint. It is typically bound to a supervisory node providing outside air temperature compensation or to an external wall module having a relative setpoint knob. This setpoint shifting operates only on occupied and standby setpoints and does not affect the unoccupied setpoint.

### *Valid Range*

The valid Range is  $-10^{\circ}\text{C}$  to  $+10^{\circ}\text{C}$ .

### *Default Value*

Default Value is  $0^{\circ}\text{C}$  to disable the setpoint offset. This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

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## Outside Temperature Input

```
network input SNVT_temp_p nviOutsideTemp;
```

This input network variable is the current outside air temperature.

### *Valid Range*

The valid Range is  $-40^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ . The value `0x7FFF` ( $+327.67^{\circ}\text{C}$ ) will be handled as an invalid value in case of a sensor failure.

### *Default Value*

Default Value is `0x7FFF` ( $+327.67^{\circ}\text{C}$ ). This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

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## Outside Humidity Input

```
network input SNVT_lev_percent nviOutsideRH;
```

This input network variable is the current outside air relative humidity.

### *Valid Range*

The valid Range is 0 to 100%..



### *Default Value*

Default Value is 0x7FFF. This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

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## Effective Setpoint Output

network output SNVT\_temp\_p nvoEffectSetPt

The output network variable is used to inform the effective setpoint temperature when the setpoint is changed by `nciSetPnts`, `nviSetPoint`, `nviSetPointOffset` or local means.

### *Valid Range*

The valid Range is 10°C to 35°C. The value 0x7FFF= +327.67°C will be handled as an invalid value in case of a sensor failure.

### *When Transmitted*

The variable is transmitted immediately when its value has changed significantly. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration `nciSndHrtBt`.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

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## Outside Temperature Output

network output SNVT\_temp\_p nvoOutsideTemp;

This output network variable is the current outside air temperature.

### *Valid Range*

The valid Range is -40°C to 50°C. The value 0x7FFF= +327.67°C will be handled as an invalid value in case of a sensor failure.

### *When Transmitted*

The variable is transmitted immediately when its value has changed. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration `nciSndHrtBt`.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

---

## Outside Humidity Output

```
network output SNVT_lev_percent nvoOutsideRH;
```

This output network variable is the current outside air relative humidity.

### *Valid Range*

The valid Range is 0 to 100%..

### *When Transmitted*

The variable is transmitted immediately when its value has changed. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration `nciSndHrtBt`.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

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## Space Humidity Input

```
network input SNVT_lev_percent nviSpaceRH;
```

This input network variable measures the space relative humidity. It could be a sensor in the space or a sensor in the return air duct.

### *Valid Range*

The valid Range is 0 to 100%..

### *Default Value*

Default Value is 0x7FFF. This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

---

## CO2 Sensor Input

```
network input SNVT_ppm nviCO2;
```

This input network variable measures the CO2 levels in PPM. The RTU Device can alternatively have a locally wired CO2 sensor. In either case, valid values of `nviCO2` have priority over local sensor values.

### *Valid Range*

The valid Range is 0 to 5000 PPM..

### *Default Value*

Default Value is 0x7FFF. This value will be adopted at power-up and in case of a bound input not receiving an update within the specified receive heartbeat time to allow default behavior.

---

## Emergency Command Input

network input SNVT\_hvac\_emerg nviEmergCmd;

This input network variable is used to command the RTU object into different emergency modes. It is typically set by a supervisory node.

### *Valid Range*

The valid range is described in the table below:

EMERG_NORMAL:	Normal Condition
EMERG_PRESSURIZE:	Start the EMERG_PRESSURIZE operation
EMERG_DEPRESSURIZE:	Start the EMERG_DEPRESSURIZE operation
EMERG_PURGE:	Start smoke Purge operation.
EMERG_SHUTDOWN:	Start SHUTDOWN operations.
EMERG_NUL:	Invalid mode.

### *Default Value*

The default value is EMERG\_NORMAL.

---

## CO2 Sensor Output

network output SNVT\_lev\_percent nvoCO2;

This output network variable is the CO2 measurement.

### *Valid Range*

The valid Range is 0 to 5000 PPM.

### *When Transmitted*

The variable is transmitted immediately when its value has changed significantly. Additionally this network variable will also be transmitted as a heartbeat output on a regular basis as dictated by the optional Maximum Send Time configuration nciSndHrtBt.

### *Update Rate*

There is no maximum update rate.

### *Default Service Type*

The default service type is unacknowledged.

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## Configuration Properties

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### Send Heartbeat (Mandatory)

```
network input config SNVT_time_sec nciSndHrtBt;
```

This configuration network variable defines the maximum period of time that expires before the following network variable outputs will automatically being updated:

- nvoSpaceTemp,
- nvoOutsideTemp,
- nvoOutsideRH,
- nvoUnitStatus,
- nvoEffectSetPt
- nvoCO2

#### *Valid Range*

The valid range is any value between 0.0 sec and 600 sec. Setting `nciSndHrtBt = 0` disables the automatic update mechanism.

#### *Default Value*

0 (no automatic update)

#### *SCPT Reference*

SCPTmaxSendTime(49)

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### Occupancy Temperature Setpoints (Mandatory)

```
network input config SNVT_temp_setpt nciSetPnts;
```

This configuration property defines the occupancy temperature setpoints for heat and cool mode. The setpoint will have an assigned upper and lower limit for each state defined below within the min. and max. range.

#### *Valid Range and Default Value*

	Minimum	Maximum	Default
occupied_cool	10 °C	35 °C	23 °C
standby_cool	10 °C	35 °C	25 °C
unoccupied_cool	10 °C	35 °C	28 °C
occupied_heat	10 °C	35 °C	21 °C
standby_heat	10 °C	35 °C	19 °C
unoccupied_heat	10 °C	35 °C	16 °C

#### SCPT Reference

SCPTsetPnts(60)

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## Configuration Properties Optional

### Receive Heartbeat (optional)

```
network input config SNVT_time_sec nciRcvHrtBt;
```

This configuration property is used to control the maximum time that elapses after the last update to a bound network input before the RTU object adopts a default value for the following:

- nviSpaceTemp,
- nviSetPtOffset,
- nviOutsideTemp,
- nviOutsideRH,
- nviApplicMode,
- nviSpaceRH
- nviCO2

#### *Valid Range*

The valid range is any value between 0.0 sec and 600 sec. Setting `nciRcvHrtBt = 0` disables this network variable receive failure detect mechanism.

#### *Default Value*

0 (no failure detect)

#### *SCPT Reference*

SCPTmaxRcvTime(48)

---

### Location Label (optional)

```
network input config SNVT_str_asc nciLocation;
```

This configuration property can optionally be used to provide more descriptive physical location information than can be provided by the Neuron Chip's 6 byte location string. The location relates to the object and not to the node.

#### *Valid Range*

Any NULL terminated ASCII string of 31 bytes total length.

#### *Default Value*

The default value is an ASCII string containing all zeros (“\0”).

#### *SCPT Reference*

SCPT\_location (17)

---

## CO2 Limit (optional)

```
network input config SNVT_ppm nciCO2Limit;
```

This configuration property defines the threshold value; if the sensed CO2 value exceeds the limit then the controller will reduce the CO2 concentration in space by increasing the ventilation.

### *Valid Range*

300 to 1200 PPM.

### *Default Value*

The default value is 0xFFFF.

### *SCPT Reference*

SCPTlimitCO2(42)

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## Data Transfer

None specified.

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## Power-up State

Upon power-up the input variables are set to their default values. The output network variables will be set to their initial value as follows:

```
nvoSpaceTemp:          INVALID
nvoOutsideTemp:        INVALID
nvoOutsideRH:          INVALID
nvoCO2:                 INVALID
nvoEffectSetPt:        0
```

The fields in nvoUnitStatus will be set to the initial values :

```
mode:                   HVAC_OFF
heat_output_primary:    0
heat_output_secondary: 0
econ_output:            0
fan_output:             0
in_alarm:               0
```

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## Boundary and Error Conditions

None specified.

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## Additional Considerations

None specified.