L<small>ON</small>M<small>ARK</small>® Functional Profile: VAV Controller (VAV)

Overview

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

A room temperature sensor input is mandatory and can either reside in the node itself (may be hard-wire connected to the node) or optionally reside on the network in which case the sensor input is provided via network variables. If the flow control option is used (pressure independent box) an integral flow sensor is assumed (hard-wire or network connected).

The VAV Profile is shown below.

VAV Profile
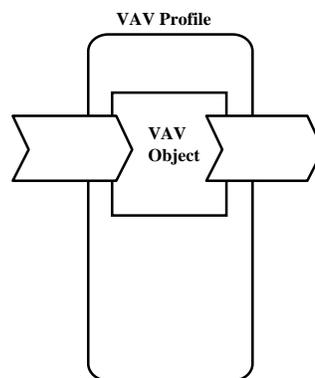
VAV Object

Figure 1 Functional Profile

Example Usage

The VAV 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, application mode)

· monitoring node

· commissioning node (manual positioning for balancing)

Object Details

The VAV object can control damper, reheat and fan outputs directly through hardware outputs. This requires no mandatory controller outputs be available for actuator nodes.
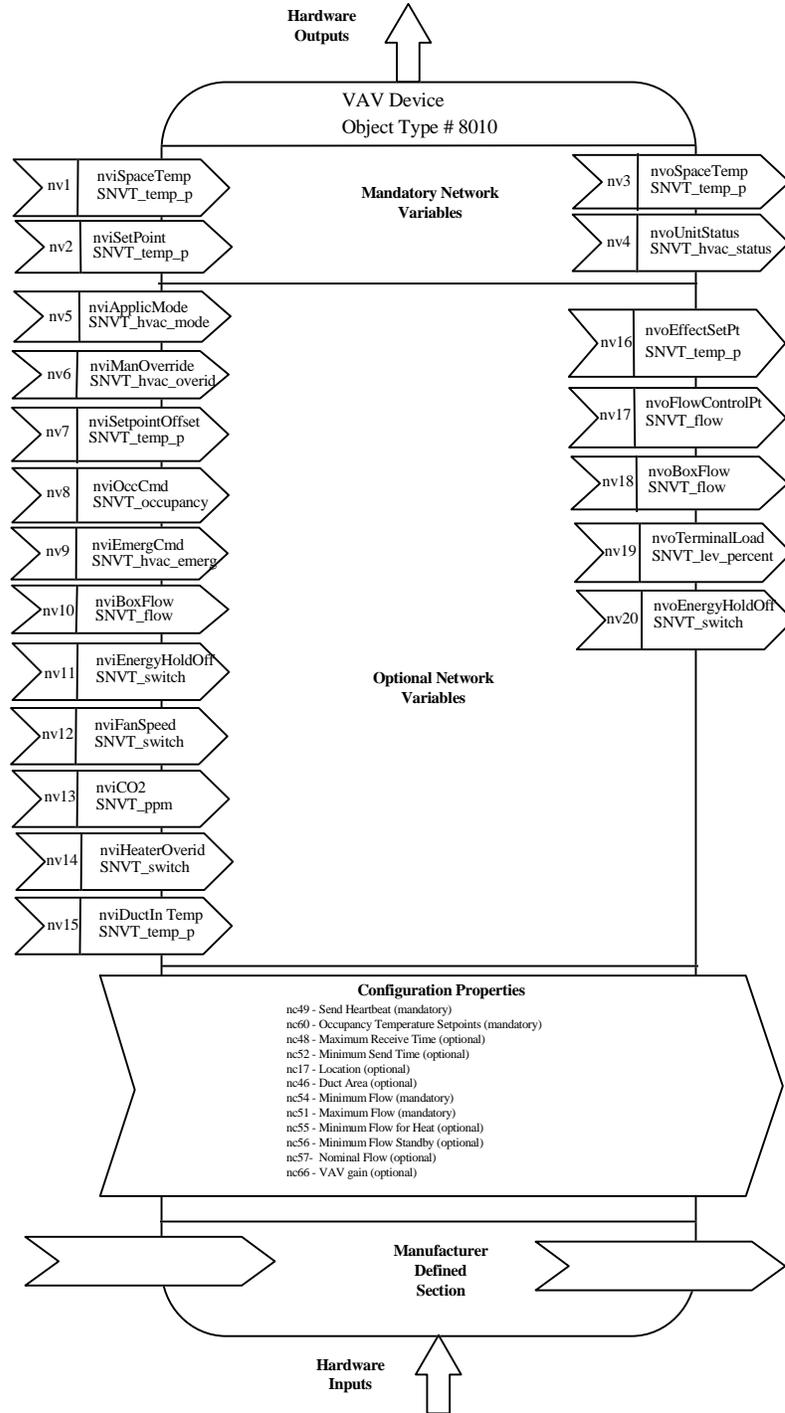
Figure 2 Object Details "VAV"

Mandatory Network Variables

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 VAV Device can have a locally wired space temperature sensor. In any 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.

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 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 until an update receives. In this case, the VAV object will work according tothe configuration of `nciSetPnts`.

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 significantly or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate
There is no maximum update rate.

Default Service Type
The default service type is unacknowledged.

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

OpMode:	HVAC_HEAT, HVAC_COOL, HVAC_MRNG_WRMUP, HVAC_NIGHT_PURGE, HVAC_OFF - HVAC_AUTO is not used, other enumerations are optional
heat_output:	0-100%, 0xFFFF (INVALID)
heat_output_secondary:	0-100%, 0xFFFF (INVALID)
cool_output:	0-100%, 0xFFFF (INVALID)
econ_output:	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 or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate
There is no maximum update rate.

Default Service Type
The default service type is unacknowledged.

Optional Network Variables

Application Mode Input

`network input SNVT_hvac_mode nviApplicMode;`

This network variable input is used to coordinate the VAV object with the air handler control or any other supervisory controller or intelligent human interface device.

Valid Range

HVAC_AUTO:	The control loop automatically changes between application modes if available (e.g. HEAT and COOL) to provide the control objectives.
HVAC_HEAT:	The control loop is in HEAT mode.
HVAC_COOL:	The control loop is in COOL mode.
HVAC_MRNG_WRMUP:	The morning warm up control strategy is in effect.
HVAC_NIGHT_PURGE:	The night purge control strategy is in effect.

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.

VAV Manual Override Input

`network input SNVT_hvac_overid  nviManOverride;`

This input network variable is used for commanding the controller into a manual mode (most importantly when balancing the box). It has the fields: state, percent and flow. For details refer to *The SNVT Master List and Programmer's Guide.*

Valid Range

state:	HVO_OFF:	normal control.
	HVO_POSITION:	set damper to the value in the percent field.
	HVO_FLOW_VALUE:	control flow to value in the flow field.
	HVO_FLOW_PERCENT:	control flow to value calculated from the value in percent field and min/max flow limits.
	HVO_OPEN:	Fully open the damper.
	HVO_CLOSE:	Close the damper.

HVO_MINIMUM:		Control flow to the minimum value (nciMinFlow).
HVO_MAXIMUM:		Control flow to the maximum value (nciMaxFlow).
HVO_NULL: INVALID		(use default).

percent: 0 to 100%

flow: 0 to 65,534 liters/sec

Default Value

The default value is HVO_OFF. This value will be adopted at power-up or if an invalid value is received.

Setpoint Offset Input

```
network input SNVT_temp_p nviSetpointOffset;
```

This input network variable is used to shift the temperature setpoint via the network by adding `nviSetpointOffset` 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°C to +10°C.

Default Value

Default Value is 0°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.

Occupancy Input

```
network input SNVT_occupancy nviOccCmd;
```

This input network variable is used to command the VAV objectinto 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 VAV object should operate in occupied mode as defined by the manufacturer and use the occupied setpoint.
OC_UNOCCUPIED:	The VAV object should operate in unoccupied mode as defined by the manufacturer and use the unoccupied setpoint.
OC_BYPASS:	The VAV object should operate in temporary occupied mode. This input can be commanded from the supervisory node. When the configured bypass time elapses, the VAV Device returns to the original occupancy mode.

OC_STANDBY: The VAV 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.

Emergency Command Input

```
network input SNVT_hvac_emerg nviEmergCmd;
```

This input network variable is used to command the VAV 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.

Box Flow Input

```
network  input  SNVT_flow  nviBoxFlow
```

This variable represents the input to a VAV controller object from a flow sensor on the network. Valid values of nviBoxFlow have priority over local sensor values.

Valid Range

The valid Range is 0 to 65,535 liters/sec. The value 0xFFFF=65,535 liters/sec will be handled as an invalid value.

Default Value

Default Value is 0xFFFF (65,535 liters/sec). 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.

Fan Speed Command

```
network input SNVT_switch nviFanSpeedCmd;
```

This input network variable is used to connect an external fan speed switch to the node or to allow any supervisory device to override the fan speed controlled by the node's control algorithm. `nviFanSpeedCmd` can be used to support multi-state: OFF / SPEED#1 / SPEED#2 / SPEED#3 / ... / SPEED#n / AUTO SPEED#1 / SPEED#2 / SPEED#3 / ... / SPEED#n / AUTO.

Valid Range
The valid range is the range provided by `SNVT_switch` as described below:

state	value			fan speed
0 (OFF)	na			OFF
1 (ON)	0%			OFF
1 (ON)	0.5	...	(1/n) 100%	fan speed #1
1 (ON)	0.5+(1/n) 100%	...	(2/n) 100%	fan speed #2
1 (ON)	0.5+((m-1)/n) 100%	...	(m/n)*100%	fan speed #m
1 (ON)	0.5+((n-1)/n) 100%	...	100%	fan speed #n
0xFF	na			fan AUTO

NOTE: Truncation should be used when computing the above values.

OFF:	The fan should be switched OFF.
fan speed #1:	The fan should always run at the lowest speed (fan speed #1).
fan speed #2:	The fan should always run at the second fan speed stage (fan speed #2)
...	
fan speed #m:	The fan should always run at the fan speed stage #m.
fan speed #n:	The fan should always run at the highest fan speed stage (fan speed#n).
fan AUTO:	The fan is not controlled by the switch.

Default Value
Default value is "fan AUTO", which means there is no external fan speed switch assigned nor any supervisory device overrides the locally wired fan speed switch.

Energy Hold Off Input

```
network input SNVT_switch nviEnergyHoldOff;
```

This input is from a device such as a window contact sensor. Moreover it is used if two or more controllers that share one physical window contact or another device (EnergyHoldOff device) that forces all of them to go to a lower energy consuming operation. If for instance two controllers share one window contact, or a dew point sensor, the controller to which the sensor is physically connected provides the sensor's state on its output, hence the other may obtain the value and switch to EnergyHoldOff (equals to 'stop heating/cooling while still providing frost protection') when necessary. If a physical sensor is connected *and* the network variable is bound, the network variable overrides the physical value, i.e. the network value has precedence over the physical value. See `nvoEnergyHoldOff` for the corresponding output network variable.

Valid Range

The valid range is the range provided by `SNVT_switch`:

EnergyHoldOff (stop heating/cooling) is activated for 'state=1 and value 0%'. 'State=0' or 'state=1 and value=0%' leads to the normal heat/cool control.

Default Value

Default Value is state = FALSE (no Energy Hold Off requested). This value will be adopted at power-up and in case of not receiving an update afterwards.

CO2 Sensor Input

```
network input SNVT_ppm nviCO2;
```

This input network variable measures the CO2 levels in PPM. The VAV object can have a locally wired CO2 sensor. In any 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.

Heater Override Input

```
network input SNVT_switch nviHeaterOverid;
```

This input disables to be turned on by the VAV controller.

Valid Range

((state = 0) or (state =1 & value = 0) or (state = 0xFF)) means HeaterOverride function is OFF.

(state = 1 and value >0) means HeaterOverride function is ON and the heater is disabled.

Default Value

Default value is state = 0xFF (invalid). This value will be adopted at power-up.

Duct Inlet Temperature Input

```
network input SNVT_temp_p nviDuctInTemp;
```

If the duct inlet air temperature sensor is a LONMARK device, the VAV controller object obtains its value through this network variable. The network value has got precedence over the physical value if both are available.

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 = +327.67C. This value will be adopted at power-up and in case of not receiving an update afterwards.

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 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 or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate
There is no maximum update rate.

Default Service Type
The default service type is unacknowledged.

Effective Flow Control Point Output

network output SNVT_flow nvoFlowControlPt

The output network variable is used to inform the effective control point used by the flow control loop.

Valid Range
The valid Range is 0 to 65,535 liters/sec. The value 0xFFFF=65,535 will be handled as an invalid value.

Default Value
The default value is 0%. This value will be adopted at power-up.

When Transmitted
The variable is transmitted immediately when its value has changed significantly.

Update Rate
There is no maximum update rate.

Default Service Type

The default service type is unacknowledged.

Box Flow Output

network output SNVT_flow nvoBoxFlow

The output network variable is used to provide the flow in the box.

Valid Range

The valid Range is 0 to 65,535 liters/sec. The value 0xFFFF=65,535 will be handled as an invalid value.

Default Value

The default value is 0%. This value will be adopted at power-up.

When Transmitted

The variable is transmitted immediately when its value has changed significantly or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate

There is no maximum update rate.

Default Service Type

The default service type is unacknowledged.

Terminal Load Output

network output SNVT_lev_percent nvoTerminalLoad

The output network variable is used to provide the demand for supply energy. Positive numbers are cooling demand and negative numbers are heating demand. This will be used for coordination within the HVAC subsystem and energy management decisions by the supply equipment.

Valid Range

The valid Range is -163.84% to 163.84%. The value 0x7FFF=+163.84% will be handled as an invalid value.

Default Value

The default value is 0%. This value will be adopted at power-up or an invalid value is received.

When Transmitted

The variable is transmitted immediately when its value has changed significantly or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate

There is no maximum update rate.

Energy Hold Off Output

```
network output SNVT_switch nvoEnergyHoldOff;
```

This output is used to convey to other devices the state of an EnergyHoldOff device that is hardwired to the controller. Refer to EnergyHoldOff Input.

Valid Range

The valid range is the range provided by SNVT_switch as described below:

state	value	Energy Hold Off
0 (OFF)	0 %	no Energy Hold Off
1 (ON)	100 %	Energy Hold Off

Default Value

Default Value is 'state=FALSE and value=0% (no Energy Hold Off requested). This value will be adopted at power-up and in case of not receiving an update afterwards.

When Transmitted

The variable is transmitted immediately when its value has changed significantly or after the send heartbeat time if nonzero and a significant change has not occurred in that time.

Update Rate

There is no maximum update rate.

Default Service Type

The default service type is unacknowledged.

Configuration Properties

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 be updated:

- nvoSpaceTemp,
- nvoUnitStatus,
- nvoBoxFlow,
- nvoTerminalLoad
- nvoEffectSetPt
- nvoEnergyHoldOff

Valid Range

The valid range is any value between 0.0 sec and 6,553.4 sec. Setting
`nciSndHrtBt = 0` disables the automatic update mechanism.

Default Value

0 (no automatic update)

SCPT Reference

SCPTmaxSendTime(49)

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

SCPTsetPtns(60)

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 VAV object adopts a default value for
the following:

· `nviSpaceTemp,`
· `nviSetpointOffset,`
· `nviApplicMode,`
· `nviBoxFlow`
· `nviEnergyHoldOff`
· `nviCO2`
· `nviDuctTempIn`

Valid Range

The valid range is any value between 0.0 sec and 6,553.4 sec. Setting
nciRcvHrtBt = 0 disables this network variable receive failure detect mechanism.

Default Value

0 (no failure detect)

SCPT Reference

SCPTmaxRcvTime(48)

Minimum Send Time (optional)

```
network input config SNVT_time_sec nciMinOutTm;
```

This configuration property defines the minimum period of time between output
network variable transitions.

Valid Range

The valid range is any value between 0.0 sec and 6,553.4 sec.

Default Value

0

SCPT Reference

SCPTminSendTime(52)

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)

Duct Area (optional)

```
network input config SNVT_area nciDuctArea;
```

This configuration property can be used to determine the duct area and compute the
flow.

Valid Range
0 to 13.1068 m2

Default Value
The default value is 0.

SCPT Reference
SCPTductArea(46)

Minimum Flow(mandatory)

```
network input config SNVT_flow nciMinFlow;
```
This configuration property defines the minimum flow through the VAV box

Valid Range
0 to 65,535 liters/sec.

Default Value
The default value is 0.

SCPT Reference

SCPTminFlow(54)

Maximum Flow(mandatory)

```
network input config SNVT_flow nciMaxFlow;
```
This configuration property defines the maximum flow through the VAV box

Valid Range
0 to 65,535 liters/sec.

Default Value
The default value is 65,535 liters/sec.

SCPT Reference

SCPTmaxFlow(51)

Minimum Flow For Heat (optional)

```
network input config SNVT_flow nciMinFlowHeat;
```
This configuration property defines the minimum flow the VAV controller will control to when reheat mode is utilized.

Valid Range
0 to 65,535 liters/sec.

Default Value

The default value is 0.

SCPT Reference

SCPTminFlowHeat(55)

Minimum Flow Standby(optional)

```
network input config SNVT_flow nciMinFlowStand;
```

This configuration property defines the minimum flow through the VAV box in the standby mode.

Valid Range

0 to 65,535 liters/sec.

Default Value

The default value is 0.

SCPT Reference

SCPTminFlowStby(56)

Nominal Flow (optional)

```
network input config SNVT_flow nciNomFlow;
```

This configuration property defines the nominal flow through the VAV box.

Valid Range

0 to 65,535 liters/sec.

Default Value

The default value is 0.

SCPT Reference

SCPTnomAirFlow(57)

VAV gain (optional)

```
network input config SNVT_multiplier nciVAVgain;
```

This configuration property defines the gain of the VAV controller objec.

Valid Range

0 to 32.7675.

Default Value

The default value is 1.

SCPT Reference

SCPTgainVAV(66)

Data Transfer

None specified

Power-up State

The input variables are set to their default values. The output network variables will be set to their initial value as follows:

```
nvoSpaceTemp:          INVALID
nvCO2:                 INVALID
nvoBoxFlow:            INVALID
nvoEffectSetPt:        0
nvoFlowControlPt:      0
nvoTerminalLoad:       0
nvoEnergyHoldOff:      state = 0
                       value = 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:           INVALID
fan_output:            0
in_alarm:              0
```

Boundary and Error Conditions

None specified.

Additional Considerations

None specified.