LONMARK®

Functional Profile:

Refrigerated Display Case Controller Thermostat Object

Overview

This document describes the profile required for a refrigerated display case controller thermostat object, used on a central or local plant system. In general this object will be used along side other refrigerated display case objects, either on the same node or on external nodes in order to provide a complete control solution. The thermostat object makes use of the node object for alarm reporting and for day of week information. When using the thermostat object it is mandatory to use the `nvoAlarm` and `nviTimeSet` network variables of the node object.
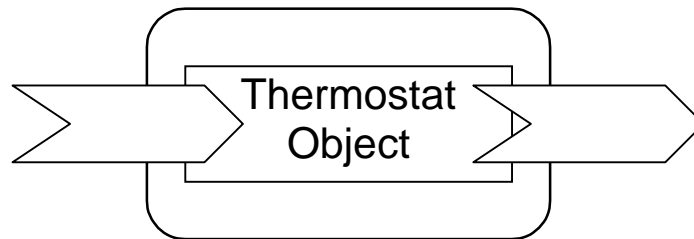

Figure 1 Thermostat Object Functional Profile

Example Usage

The thermostat resides in a LONMARK device and communicates across a LONWORKS network interacting with one or more of the following LONMARK objects:

- Evaporator control object.
- Defrost control object.
- Rail heat control object.
- Fan control object.
- Schedule control object.
- Temperature sensor object.

These objects may all reside in the same node or may be distributed. In slave case applications there may be many instances of the objects listed above.

Thermostat Controller Object

The Thermostat object can be used in controllers where thermostat operation is required. All temperatures are of type `SNVT_temp_p` this gives good resolution over an appropriate temperature range without the need to use floating point or 32 bit arithmetic.

The configuration variables are shown as network variables in the examples. These could be implemented in any form & access made via file transfer or direct memory read / write.
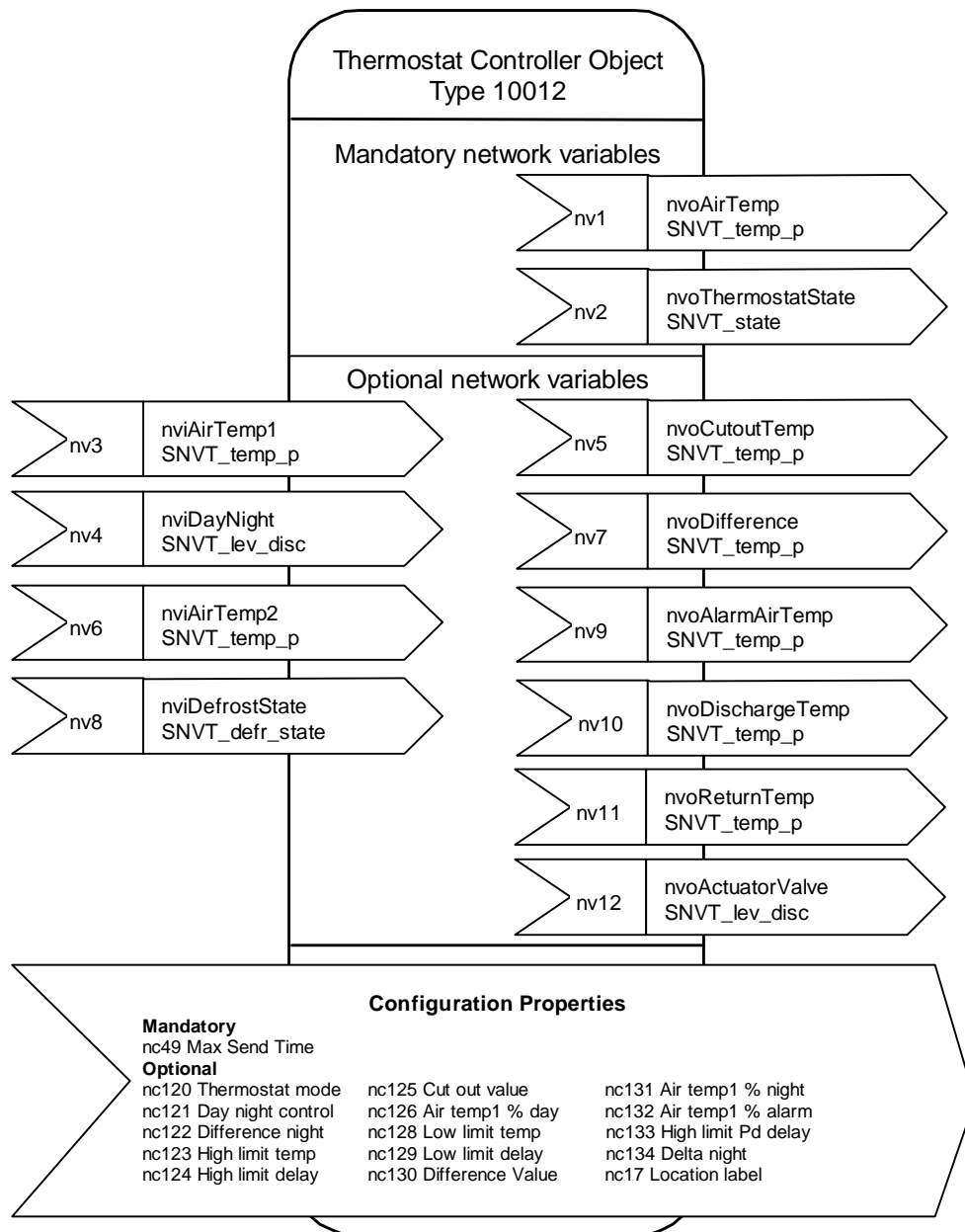

Figure 2 Thermostat Object Functional Profile

Table 1 SNVT and SCPT details

NV # (M/O)[1]	Name	In Out	SNVT Type (SNVT Index)	Class	Description
1 (M)	nvoTemperature	Out	SNVT_temp_p (105)	I/O	Processed control temperature
2 (M)	nviThermostatState	In	SNVT_state (83)	I/O	Operating state of the thermostat
3 (O)	nviAirTemp1	In	SNVT_temp_p (105)	I/O	Monitored temperature
4 (O)	nviDayNight	In	SNVT_lev_disc (22)	I/O	External day / night indicator
5 (O)	nvoCutoutTemp	Out	SNVT_temp_p (105)	I/O	Current cut out value
6 (O)	nviAirTemperature2	In	SNVT_temp_p (105)	I/O	Monitored temperature
7 (O)	nvoDifference	Out	SNVT_temp_p (105)	I/O	Current difference value
8 (O)	nviDefrostState	In	SNVT_defr_state (122)	I/O	Defrost object state
9 (O)	nvoAlarmAirTemp	Out	SNVT_temp_p (105)	I/O	Current alarm air value
10 (O)	nvoDischargeTemp	Out	SNVT_temp_p (105)	I/O	Air discharge (air off coil)
11 (O)	nvoReturnTemp	Out	SNVT_temp_p (105)	I/O	Air return (air on coil)
12 (O)	nvoActuatorValve	Out	SNVT_lev_disc (22)	I/O	Refrigerant valve output
17 (O)	Location label	-	SNVT_str_asc (36)	config	Location text
49 (M)	Max send time	-	SNVT_time_sec (107)	config	Max time before updating outputs
120 (O)	Thermostat mode	-	SNVT_therm_mode (119)	config	Mode of operation
125 (O)	Cut out value	-	SNVT_temp_p (105)	config	Cut out threshold
130 (O)	Difference value	-	SNVT_temp_p (105)	config	Difference between cut in & cut out
122 (O)	Difference night	-	SNVT_temp_p (105)	config	Diff between cut in & out for night
121 (O)	Day night control	-	SNVT_lev_disc (22)	config	Use night & day control
126 (O)	Air temp1 % day	-	SNVT_lev_percent (81)	config	Percent of air 1 & 2 for day control
131 (O)	Air temp1 % night	-	SNVT_lev_percent (81)	config	Percent of air 1 & 2 for night control
132 (O)	Air temp1 % alarm	-	SNVT_lev_percent (81)	config	Percent of air 1 & 2 for alarm
134 (O)	Delta night	-	SNVT_temp_p (105)	config	Offset for night control
123 (O)	High limit temperature	-	SNVT_temp_p (105)	config	High temperature limit
128 (O)	Low limit temperature	-	SNVT_temp_p (105)	config	Low temperature limit
124 (O)	High limit delay	-	SNVT_time_sec (107)	config	High temperature limit delay
133 (O)	High limit defrost delay	-	SNVT_time_sec (107)	config	High temperature limit delay defrost
129 (O)	Low limit delay	-	SNVT_time_sec (107)	config	Low temperature limit delay

[1] M- Mandatory, O - Optional

Mandatory Network Variables

Calculated Air Temperature

```
network output SNVT_temp_p nvoAirTemp;
```

The `nvoAirTemp` is the calculated case air temperature. An error on the sensor is indicated with the error value for `SNVT_temp_p` (0x7fff).

Valid Range
The valid range is -100ºC to +150ºC

Default Value
The default value is manufacturer specific.

Thermostat State

```
network output SNVT_state nvoThermostatState;
```

The `nvoThermostatState` indicates the current state of the Thermostat Object. There are currently three different control methods supported by the Thermostat Object:

No Thermostat	Bit 0 = Off ;Constant cooling required
Cut In/Out control	Bit 0 = On
	Bit 1 = Cooling/no cooling
	Bit 2 = Disabled
Modulating control	Bit 0 = On
	Bit 1 = Cooling/no cooling
	Bit 2 = Enabled

Valid Range

Bit No.	Min	Max	Description
0	Off	On	Thermostat control on/off
1	False	True	Cooling required
2	Disabled	Enabled	Modulating Thermostat
3	False	True	Night Setback mode
8 – 15			Manufacturer specific items

Default Value
Bit 0 = Off.

Optional Network Variables

Measured Air Temperature 1

```
network input SNVT_temp_p nviAirTemp1;
```

The `nviAirTemp1` is to be assigned to discharge or return air as required. An error on the sensor is indicated with the error value for `SNVT_temp_p` (0x7fff).

Valid Range
The valid range is -100ºC to +150ºC

Default Value
The default value is 0

Day Night Indication

```
network input SNVT_lev_disc nviDayNight;
```

The thermostat object can be configured to use this network variable as a day/night indicator. ST_OFF indicates day and ST_ON indicates night.

Valid Range
The valid range is ST_OFF (0) or ST_ON (4). A value other than ST_OFF is interpreted as ST_ON.

Default Value

The default value is ST_OFF.

Measured Air Temperature 2

```
network input SNVT_temp_p nviAirTemp2;
```

The `nviAirTemp2` is to be assigned to discharge or return air as required. An error on the sensor is indicated with a value outside the valid range.

Valid Range
The valid range is -100ºC to +150ºC

Default Value
The default value is 0

Cut out Temperature

```
network output SNVT_temp_p nvoCutoutTemp;
```

The `nvoCutoutTemp` indicates the current cut out limit used by the thermostat object in its algorithms.

Valid Range

The valid range is manufacturer specific.

Default Value

The default value is manufacturer specific.

Difference Temperature

```
network output SNVT_temp_p nvoDifference;
```

The `nvoDifference` indicates the value to be added to the nviCutoutTemp to get the thermostat cut in limit if cut in / out control is selected. If modulating thermostat control is selected, the target temperature is the cut out limit + `nvoDifference` / 2.

Valid Range

The valid range is manufacturer specific.

Default Value

The default value is manufacturer specific.

Defrost State

```
network output SNVT_defr_state nvoDefrostState;
```

The `nvoDefrostState` indicates the current state of the defrost object.

Valid Range

0   DF_STANDBY

1   DF_PUMPDOWN

2   DF_DEFROST

3   DF_DRAINDOWN

4   DF_INJECT_DLY

Default Value

0   DF_STANDBY.

Alarm Air Temperature

```
network output SNVT_temp_p nvoAlarmAirTemp;
```

The `nvoAlarmAirTemp` indicates the current air temperature used by the alarm section of the thermostat object.

Valid Range

The valid range is -100ºC to +150ºC

Default Value

The default value is 0

Discharge Air Temperature

```
network output SNVT_temp_p nvoDischargeTemp;
```

The `nvoDischargeTemp` indicates the current evaporator discharge air temperature used by the thermostat object.

Valid Range

The valid range is -100⁰C to +150⁰C

Default Value

The default value is 0

Return Air Temperature

```
network output SNVT_temp_p nvoReturnTemp;
```

The `nvoReturnTemp` indicates the current evaporator return air temperature used by the thermostat object.

Valid Range

The valid range is -100⁰C to +150⁰C

Default Value

The default value is 0

Actuator Valve

```
network output SNVT_lev_disc nvoActuatorValve;
```

This output can be used to drive a refrigeration valve or compressor.

Valid Range

The valid range is ST_ON - ST_OFF. Any value other than ST_ON should be regarded as ST_OFF.

Default Value

The default value is ST_OFF.

Configuration Properties

Location Label

```
network input config SNVT_str_asc nciLocationLabel;
```

The Location Label can be used as a descriptive physical location description.

Valid Range
Any NULL terminated ASCII string.

Default Value
The default value is an ASCII string containing all zeroes.

SCPT Reference
SCPT_location #17

Max Send Time

```
network input config SNVT_time_sec nciMaxSendTime;
```

Indicates the maximum period of time that expires before the Thermostat object automatically updates its output network variables. A setting of 0 (zero) will force the thermostat object to only update its output variables when a change occurs.

Valid Range
That of SNVT.

Default Value
10 seconds.

SCPT Reference
SCPTmaxSendTime #49

Thermostat Mode

```
network  input config SNVT_therm_mode  nciThermostatMode;
```

The `nciThermostatMode` indicates the control strategy.

Valid Range
0	THERM_NO_CONTROL	Thermostat disabled.
1	THERM_IN_OUT	Cut in / out control.
2	THERM_MODULATING	Modulating control.

0   THERM_NO_CONTROL.

SCPT Reference

SCPTthermMode #120

Cut out Value

```
network input config SNVT_temp_p nciCutoutValue;
```

The `nciCutoutValue` indicates the cut out limit to be used for control purposes. If day night control is selected this value is used during day control.

Valid Range

The valid range is manufacturer specific.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPTcutOutValue #125

Difference Value

```
network input config SNVT_temp_p nciDifferenceValue;
```

The `nciDifferenceValue` indicates the value to be added to the `nciCutoutTemp` to get the cut in limit if cut in/out control is selected. If modulating thermostat control is selected, the target temperature is the `nciCutout` limit + `nciDifferenceValue` / 2.

Valid Range

The valid range is manufacturer specific.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPTdiffValue #130

Day Night Control

```
network input config SNVT_state nciDayNightControl;
```

The `nciDayNightControl` configures the day/night function.

Valid Range

Bit 3	Bit 2	Bit 1	Bit 0	Description
Off	Off	Off	Off	Night setback is not required
Off	Off	Off	On	Change between day & night operation according to nviDayNight.
Off	Off	On	Off	Change between day & night operation according to interval time clock.

Bits 8 - 15 can be used for manufacture specific items.

Default Value

Bit 0 - Bit 2 = Off, Night setback not required - always day control.

SCPT Reference

SCPTdayNightCntrl #121

Air Temperature 1 - Percent Day

```
network input config SNVT_lev_percent nciAirTemp1PercentDay;
```

The `nciAirTemp1PercentDay` **indicates the air temperature weighting to be used during Day control. The** `nviAirTemp2` **portion is automatically calculated.**

For example:

`nviAirTemp1` **measures - 25⁰C and** `nviAirTemp2` **measures - 20⁰C. Required as a regulation parameter is a weighted average consisting of 60%** `nviAirTemp1` **and the rest from** `nviAirTemp2` **(only the** `nviAirTemp1` **share is programmed). This gives a regulating value of**

$$(0.6 \times -25⁰C) + (0.4 \times -20⁰C) = -23⁰C$$

Valid Range
The valid range is 0 - 100%.

Default Value
The default value is 100%, i.e. no `nviAirTemp2` **input required for day operation.**

SCPT Reference
SCPTairTemp1Day #126

Air Temperature 1 - Percent Night

```
network input config SNVT_lev_percent nciAirTemp1PercentNight;
```

The `nciAirTemp1PercentNight` **indicates the air temperature weighting to be used during Day control. The** `nviAirTemp2` **portion is automatically calculated.**

For example:

`nviAirTemp1` **measures - 25⁰C and** `nviAirTemp2` **measures - 20⁰C. Required as a**

regulation parameter is a weighted average consisting of 60% nviAirTemp1 and the rest from `nviAirTemp2` (only the `nviAirTemp1` share is programmed). This gives a regulating value of

$$(0.6 \times -25^oC) + (0.4 \times -20^oC) = -23^oC$$

Valid Range
The valid range is 0 - 100%.

Default Value
The default value is 100%, i.e. no `nviAirTemp2` input required for night operation.

SCPT Reference
SCPTairTemp1Night #131

Delta Night

```
network input config SNVT_temp_p nciDeltaNight;
```

The `nciDeltaNight` indicates the value to be added to the `nciCutoutValue` to get the cut out limit to be used during night control.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTdeltaNight #134

Difference Night

```
network input config SNVT_temp_p nciDifferenceNight;
```

The `nciDifferenceNight` indicates the value to be added to the nciCutoutValue to get the cut in limit if cut in/out control is selected. If modulating thermostat control is selected, the target temperature is the `nciCutout` limit + `nciDifferenceNight` / 2.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference

SCPTdiffNight #122

Air Temperature 1 Percent Alarm

```
network input config SNVT_lev_percent nciAirTemp1PercentAlarm;
```

The `nciAirTemp1PercentAlarm` indicates the weighting of the nviAirTemp1 sensor when calculating the `nviAlarmAirTemp`. The `nviAirTemp2` portion is automatically calculated.

Valid Range

The valid range is 0 - 100%.

Default Value

The default value is 100%, i.e. the `nviAirTemp2` sensor is not used in calculating the `nviAlarmAirTemp`.

SCPT Reference

SCPTairTemp1Alrm #132

High Limit Temperature

```
network input config SNVT_temp_p nciHighLimitTemp;
```

The `nciHighLimitTemp` is the high alarm set point for the `nvoAlarmAirTemp`. When there is night setback operation, the alarm limit is raised by the `nciDeltaNight` value.

Valid Range

The valid range is manufacturer specific.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPThighLimTemp #123

Low Limit Temperature

```
network input config SNVT_temp_p nciLowLimitTemp;
```

The `nciLowLimitTemp` is the low alarm set point for the `nvoAlarmAirTemp`.

Valid Range

The valid range is manufacturer specific.

High Limit Defrost Delay

```
network input config SNVT_time_sec nciHighLimitPdDly;
```

The `nciHighLimitPdDly` is the time limit before high nvoAlarmAirTemp alarm during pull-down. This value will apply until the actual `nvoAlarmAirTemp` has dropped below the `nciHighLimitTemp`. Thereafter shift to `nciHighLimitDelay2`.

Valid Range

The valid range for all fields is any value within the defined limits of SNVT_time_sec.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPThighLimDefrDly #133

High Limit Delay

```
network input config SNVT_time_sec nciHighLimitDelay;
```

The `nciHighLimitDelay` is the time limit before high `nvoAlarmAirTemp` alarm during normal operation.

Valid Range

The valid range for all fields is any value within the defined limits of SNVT_time_sec.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPThighLimDly #124

Low Limit Delay

```
network input config SNVT_time_sec nciLowLimitDelay;
```

The `nciLowLimitDelay` is the time delay before low `nvoAlarmAirTemp` alarm.

Valid Range

The valid range for all fields is any value within the defined limits of SNVT_time_sec.

Default Value

The default value is manufacturer specific.

SCPT Reference

SCPTlowLimDly #129

Data Transfer

The configuration variables are shown as network variables in the examples. These could be implemented in any form & access made via file transfer or direct memory read / write.

The type of data transfer supported can be found by looking at the node object network variables. If `nvoFileDirectory` is present then direct memory read / write is supported. If `nviFileReq` & `nviFileStat` are present then file transfer is supported. Otherwise look for configuration network variables.

Power-up State

The defrost object should power up in a benign state with network inputs set to default values. Network outputs should be updated to their default values & transmitted onto the network.

Boundary and Error Conditions

None specified.

Additional Considerations

None specified.