Functional Profile:
Refrigerated Display Case Controller
Evaporator Control Object
Overview

This document describes the profile required for a refrigerated display case controller evaporator control object, used on a central or local plant system. This profile supports the standard node object and data file transfer capability. In general this object will be used with other refrigerated display case controller objects either on the same node, or on external nodes in order to provide a complete control solution.

Example Usage

The evaporator object is used in a LONMARK device interacting with one or more of the following refrigerated display case controller objects residing on other LONMARK devices:

- Defrost control object.
- Thermostat 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 applications there may be many instances of the objects listed above.
Evaporator Controller Object

Figure 1 Evaporator Control Object Details
Table 1  SNVT details

<table>
<thead>
<tr>
<th>NV # (M/O)</th>
<th>Name</th>
<th>In Out</th>
<th>SNVT Type (SNVT Index)</th>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (M)</td>
<td>nvoValveOpening</td>
<td>Out</td>
<td>SNVT_lev_percent (81)</td>
<td>I/O</td>
<td>Percentage of valve opening</td>
</tr>
<tr>
<td>2 (M)</td>
<td>nvoEvaporatorState</td>
<td>Out</td>
<td>SNVT_evap_state (118)</td>
<td>I/O</td>
<td>Evaporator object control state</td>
</tr>
<tr>
<td>3 (O)</td>
<td>nviEvapInTemp</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Monitored temperature</td>
</tr>
<tr>
<td>4 (O)</td>
<td>nviEvapOutTemp</td>
<td>Out</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Processed temperature</td>
</tr>
<tr>
<td>5 (O)</td>
<td>nviEvapInTemp</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Monitored temperature</td>
</tr>
<tr>
<td>6 (O)</td>
<td>nviEvapOutTemp</td>
<td>Out</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Processed temperature</td>
</tr>
<tr>
<td>7 (O)</td>
<td>nviForcedValve</td>
<td>In</td>
<td>SNVT_switch (95)</td>
<td>I/O</td>
<td>Force valve opening</td>
</tr>
<tr>
<td>8 (O)</td>
<td>nvoSuperHeatTemp</td>
<td>Out</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Current calculated super heat</td>
</tr>
<tr>
<td>9 (O)</td>
<td>nviThermostatState</td>
<td>In</td>
<td>SNVT_state (83)</td>
<td>I/O</td>
<td>Thermostat object input</td>
</tr>
<tr>
<td>10 (O)</td>
<td>nvoSuperHeatRef</td>
<td>Out</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Superheat reference</td>
</tr>
<tr>
<td>11 (O)</td>
<td>nviDefrostState</td>
<td>In</td>
<td>SNVT_defr_state (122)</td>
<td>I/O</td>
<td>Defrost object input</td>
</tr>
<tr>
<td>12 (O)</td>
<td>nviAirTemp</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Current air temperature</td>
</tr>
<tr>
<td>13 (O)</td>
<td>nviCutOutTemp</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Thermostat cut out temperature</td>
</tr>
<tr>
<td>14 (O)</td>
<td>nviDifference</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Thermostat difference temperature</td>
</tr>
<tr>
<td>15 (O)</td>
<td>nviSuperHeatRef</td>
<td>In</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Superheat reference</td>
</tr>
<tr>
<td>16 (O)</td>
<td>nviPressure</td>
<td>In</td>
<td>SNVT_press (30)</td>
<td>I/O</td>
<td>External liquid pressure</td>
</tr>
<tr>
<td>17 (O)</td>
<td>nvoDeltaTemp</td>
<td>Out</td>
<td>SNVT_temp_p (105)</td>
<td>I/O</td>
<td>Difference between evap in &amp; out</td>
</tr>
<tr>
<td>18 (O)</td>
<td>nvoPressure</td>
<td>Out</td>
<td>SNVT_press (30)</td>
<td>I/O</td>
<td>Internal liquid pressure</td>
</tr>
<tr>
<td>19 (O)</td>
<td>Location label</td>
<td>-</td>
<td>SNVT_str_int (37)</td>
<td>config</td>
<td>Location text</td>
</tr>
<tr>
<td>49 (O)</td>
<td>Max send time</td>
<td>-</td>
<td>SNVT_time_sec (107)</td>
<td>config</td>
<td>Max time before updating outputs</td>
</tr>
<tr>
<td>111 (O)</td>
<td>Super heat reference</td>
<td>-</td>
<td>SNVT_temp_p (105)</td>
<td>config</td>
<td>Maximum reference temperature</td>
</tr>
<tr>
<td>114 (O)</td>
<td>Super heat reference</td>
<td>-</td>
<td>SNVT_temp_p (105)</td>
<td>config</td>
<td>Initial reference temperature</td>
</tr>
<tr>
<td>116 (O)</td>
<td>Super heat reference</td>
<td>-</td>
<td>SNVT_temp_p (105)</td>
<td>config</td>
<td>Minimum reference temperature</td>
</tr>
<tr>
<td>117 (O)</td>
<td>Start up delay</td>
<td>-</td>
<td>SNVT_time_sec (107)</td>
<td>config</td>
<td>Time for reduced opening</td>
</tr>
<tr>
<td>119 (O)</td>
<td>Refrigerant glide</td>
<td>-</td>
<td>SNVT_temp (39)</td>
<td>config</td>
<td>Amount of glide in Kelvin</td>
</tr>
<tr>
<td>120 (O)</td>
<td>Refrigerant type</td>
<td>-</td>
<td>SNVT_refrig_type (xxx)</td>
<td>config</td>
<td>Refrigerant type structure</td>
</tr>
</tbody>
</table>

\(^1\text{M = mandatory, O = optional}\)

**Mandatory Network Variables**

**Valve opening**

```plaintext
network output SNVT_lev_percent nvoValveOpening;
```

The current opening degree of the valve, in percent of fully open.

**Valid Range**

The valid range is 0 - 100%.
**Default Value**
The default value is 0%.

---

**Evaporator state**

network output SNVT_evap_state nvoEvaporatorState;
The current state of the evaporator object.

**Valid Range**

0 EVAP_NO_COOLING  Object not performing cooling (off cycle or disabled).
1 EVAP_COOLING     Object currently cooling.
2 EVAP_EMERG_COOLING Object performing emergency cooling.

**Default Value**
0 EVAP_NO_COOLING.

---

**Optional Network Variables**

**Evaporator Inlet Temperature**

network input SNVT_temp_p nviEvapInTemp;
network output SNVT_temp_p nvoEvapInTemp;

These values indicate the current evaporator inlet (liquid line) temperature. The input can be used if the sensor is external to the evaporator object. The output can be used if the sensor is internal to the evaporator object.

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

**Default Value**
The default value is 0

---

**Evaporator Outlet Temperature**

network input SNVT_temp_p nviEvapOutTemp;
network output SNVT_temp_p nvoEvapOutTemp;

These values indicate the current evaporator outlet (suction line) temperature. The input can be used if the sensor is external to the evaporator object. The output can be used if the sensor is internal to the evaporator object.
**Valid Range**  
The valid range is -100°C to +150°C

**Default Value**  
The default value is 0

---

**Forced Valve**

```plaintext
network input SNVT_switch nviForcedValve;
```

The `nviForcedValve` is used to force the valve to a given opening degree. The evaporator object will stay in this forced mode as long as `SNVT_switch.state` equals TRUE.

**Valid Range**  
The valid range for `SNVT_switch.value` is 0 -100 and TRUE or FALSE for `SNVT_switch.state`.

**Default Value**  
The default value for `SNVT_switch.state` is FALSE.

---

**Super Heat Temperature**

```plaintext
network output SNVT_temp_p nvoSuperHeatTemp;
```

The `nvoSuperHeatTemp` indicates the true evaporator super heat temperature. This variable should be used only when both pressure & temperature are used for calculation. If only temperatures are used then the delta temperature output should be used.

**Valid Range**  
The valid range is -100°C to +150°C

**Default Value**  
The default value is 0

---

**Thermostat State**

```plaintext
network input SNVT_state nviThermostatState;
```

The `nviThermostatState` 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 2 = Disabled.
  Bit 1 = Cooling/no cooling

- **Modulating control**  
  Bit 0 = On,
  Bit 1 = Cooling/no cooling
  Bit 2 = Enabled.
Valid Range

<table>
<thead>
<tr>
<th>Bit No.</th>
<th>Min</th>
<th>Max</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Off</td>
<td>On</td>
<td>Thermostat control on/off</td>
</tr>
<tr>
<td>1</td>
<td>False</td>
<td>True</td>
<td>Cooling required</td>
</tr>
<tr>
<td>2</td>
<td>Disabled</td>
<td>Enabled</td>
<td>Modulating Thermostat</td>
</tr>
<tr>
<td>3</td>
<td>False</td>
<td>True</td>
<td>Night Setback mode</td>
</tr>
<tr>
<td>8..15</td>
<td></td>
<td></td>
<td>Manufacturer specific items</td>
</tr>
</tbody>
</table>

Default Value

Bit 0 = Off.

Super Heat Reference Temperature

network output SNVT_temp_p nvoSuperHeatRef;
network input SNVT_temp_p nviSuperHeatRef;

The nvoSuperHeatRef indicates the current target evaporator super heat temperature. The nviSuperHeatRef is an override input for the target super heat reference. This input should be used when the object is in override.

Valid Range

The valid range is -100°C to +150°C

Default Value

The default value is manufacturer specific.

Defrost State

network input SNVT_defr_state nviDefrostState;

The nviDefrostState 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.

Calculated Air Temperature

network input SNVT_temp_p nviAirTemp;

The nviAirTemp is the calculated case air temperature. An error on the sensor is indicated...
with the error value for SNVT_temp_p (0x7ffe).

**Valid Range**
The valid range is -100°C to +150°C

**Default Value**
The default value is manufacturer specific.

---

**Cut Out Temperature**

```plaintext
network input SNVT_temp_p nviCutoutTemp;
```

The `nviCutoutTemp` 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**

```plaintext
network input SNVT_temp_p nviDifference;
```

The `nviDifference` indicates the value to be added to the `nviCutoutTemp` to get the thermostat cut in limit if cut in / out control is selected.

**Valid Range**
The valid range is manufacturer specific.

**Default Value**
The default value is manufacturer specific.

---

**Delta Temperature**

```plaintext
network output SNVT_temp_p nvoDeltaTemp;
```

The `nvoDeltaTemp` indicates the inferred evaporator super heat temperature. This variable should be used when pressure is not taken into account in the calculation.

**Valid Range**
The valid range is -100°C to +150°C

**Default Value**
The default value is 0
**Liquid Line Pressure**

```c
network input SNVT_press nviPressure;
network output SNVT_press nvoPressure;
```

The pressure of the refrigerant in the liquid (evaporator feed) line.
The input variable would be included on nodes without the hardware interface to read a pressure sensor, whereas the output variable would be included on nodes with pressure sensor hardware.

**Valid Range**
-3276.8... 3276.7 kPa

**Default Value**
The default value is manufacturer specific.

---

**Configuration Properties**

---

**Location Label**

```c
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**

```c
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 value of 0 (zero) will force the evaporator object to only update its output variables when a change occurs.

**Valid Range**
The valid range of the SNVT.
Default Value
10 seconds.

SCPT Reference
SCPTmaxSendTime #49

---

**Superheat reference min & max**

network input config SNVT_temp_p nciSuperHtRefMax;
network input config SNVT_temp_p nciSuperHtRefMin;
The maximum & minimum values of the target super heat nvoSuperHeatRef.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTsuperHtRefMax #118

---

**Superheat reference initialisation**

network input config SNVT_temp_p nciSuperHtRefInit;
The default value of the target super heat nvoSuperHeatRef.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTsuperHtRefInit #114

---

**Start up delay**

network input config SNVT_time_sec nciStartUpDly;
The time delay before unrestricted control begins after power up, defrost or pack fail.

Valid Range
The valid range of the SNVT.
Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTstrtupDelay #111

Start up opening

network input config SNVT_lev_percent nciStartUpOpen;
The maximum valve opening to use after power up, pack fail or defrost.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTstrtupOpen #115

Refrigerant glide

network input config SNVT_temp nciRefGlide;
A value in Kelvin for the 'glide' of the refrigerant in the system.

Valid Range
The valid range is manufacturer specific.

Default Value
The default value is manufacturer specific.

SCPT Reference
SCPTrefrigGlide #117

Refrigerant type

network input config refrig_type nciRefType;
The structure definition used by refrig_type is:

```c
typedef struct
{
   char      refrigerant[6];
   float_type A;
   float_type B;
} refrig_type;
```
This structure indicates the refrigerant type used in the system. Its primary use is for temperature/pressure conversion.

The formula used is:

\[ t = \left( \frac{B}{\ln(p) - A} \right) - C \]

Where:

- \( t \) is temperature in °C.
- \( p \) is the pressure in Bar absolute.
- A, B, C are constants defined for a particular type of refrigerant.

### Table 2 Refrigerant definitions.

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;R12&quot;</td>
<td>9.16371</td>
<td>-1964.26</td>
<td>244.445</td>
</tr>
<tr>
<td>&quot;R13&quot;</td>
<td>9.51870</td>
<td>-1712.13</td>
<td>261.862</td>
</tr>
<tr>
<td>&quot;R13b1&quot;</td>
<td>9.16788</td>
<td>-1761.32</td>
<td>250.260</td>
</tr>
<tr>
<td>&quot;R22&quot;</td>
<td>9.54024</td>
<td>-1938.42</td>
<td>244.296</td>
</tr>
<tr>
<td>&quot;R23&quot;</td>
<td>10.17745</td>
<td>-1812.74</td>
<td>260.556</td>
</tr>
<tr>
<td>&quot;R32&quot;</td>
<td>10.82000</td>
<td>-2373.03</td>
<td>271.848</td>
</tr>
<tr>
<td>&quot;R114&quot;</td>
<td>9.25087</td>
<td>-2235.31</td>
<td>238.180</td>
</tr>
<tr>
<td>&quot;R134a&quot;</td>
<td>9.85263</td>
<td>-2127.77</td>
<td>242.389</td>
</tr>
<tr>
<td>&quot;R142B&quot;</td>
<td>10.36700</td>
<td>-2727.31</td>
<td>273.142</td>
</tr>
<tr>
<td>&quot;R227&quot;</td>
<td>8.85720</td>
<td>-1796.19</td>
<td>220.371</td>
</tr>
<tr>
<td>&quot;R401&quot;</td>
<td>9.87892</td>
<td>-2163.80</td>
<td>246.079</td>
</tr>
<tr>
<td>&quot;R401A&quot;</td>
<td>9.68669</td>
<td>-2065.49</td>
<td>242.441</td>
</tr>
<tr>
<td>&quot;R401B&quot;</td>
<td>9.90256</td>
<td>-2159.11</td>
<td>247.010</td>
</tr>
<tr>
<td>&quot;R402&quot;</td>
<td>10.13620</td>
<td>-2167.38</td>
<td>261.416</td>
</tr>
<tr>
<td>&quot;R402A&quot;</td>
<td>10.13620</td>
<td>-2167.38</td>
<td>261.416</td>
</tr>
<tr>
<td>&quot;R402B&quot;</td>
<td>10.0644</td>
<td>-2149.94</td>
<td>259.074</td>
</tr>
<tr>
<td>&quot;R404A&quot;</td>
<td>10.13710</td>
<td>-2186.78</td>
<td>262.077</td>
</tr>
<tr>
<td>&quot;R407A&quot;</td>
<td>10.42830</td>
<td>-2254.83</td>
<td>255.692</td>
</tr>
<tr>
<td>&quot;R407B&quot;</td>
<td>10.31000</td>
<td>-2193.57</td>
<td>256.255</td>
</tr>
<tr>
<td>&quot;R407C&quot;</td>
<td>10.39780</td>
<td>-2254.81</td>
<td>254.164</td>
</tr>
<tr>
<td>&quot;R500&quot;</td>
<td>9.67274</td>
<td>-2128.85</td>
<td>253.891</td>
</tr>
<tr>
<td>&quot;R502&quot;</td>
<td>9.71691</td>
<td>-2044.59</td>
<td>255.957</td>
</tr>
<tr>
<td>&quot;R503&quot;</td>
<td>9.96526</td>
<td>-1780.01</td>
<td>267.258</td>
</tr>
<tr>
<td>&quot;R507&quot;</td>
<td>9.50128</td>
<td>-1862.85</td>
<td>242.576</td>
</tr>
<tr>
<td>&quot;R717&quot;</td>
<td>10.58284</td>
<td>-2226.36</td>
<td>243.968</td>
</tr>
</tbody>
</table>

**Valid Range**

Refrigerant details & numbers are published by ASHRAE.

**Default Value**

The default value is manufacturer specific.
SCPT Reference
SCPTrefrigType #119

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 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.