



LONMARK[®]

Functional Profile:

Scheduler

SFPTscheduler

Overview

The Scheduler functional profile defines a standardized interface for describing daily schedules. Schedules may become active on specified days of the week, or based on date events identified by a Calendar functional block, or other functional block that identifies date events. A Scheduler functional block can provide data to other functional blocks that is dependent on date and time.

The Scheduler functional profile has a single mandatory output that may be defined as any standard network variable type. This output may optionally be a changeable type to allow the network integrator to select the type of data to be scheduled. Additional outputs may be implemented to allow multiple inputs to be controlled by the same schedule.

A schedule is a series of time-value pairs to be processed while the schedule is active. A schedule is typically active over a 24-hour period, though a schedule may be active for up to 48 hours to accommodate events that span multiple days. A schedule may be identified as a temporary schedule, in which case it is deleted at the end of the day that it is active.

Scheduler functional blocks can share configuration and status information with other high-level functional blocks on other devices using the Event Generator functional block. The Event Generator functional block can be used to provide a schedule look-ahead capability as required by optimizers.

The Scheduler functional profile makes use of optional interfaces through Node Object and Event Generator functional blocks as described in this document.

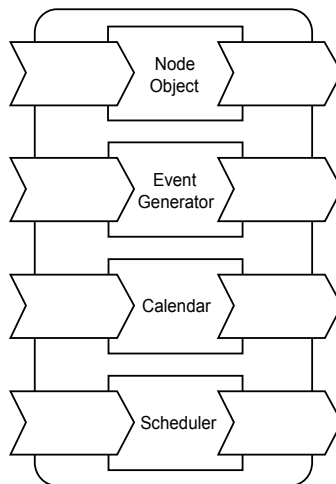


Figure 1 Device Concept

Requirements

The Scheduler functional block shall meet the following requirements:

1. A single nvoPresentValue network variable output shall be provided that may be defined as any network variable type defined in a resource file. This output may be a changeable type to allow the network integrator to select the type of data to be scheduled. This output may be defined as a SNVT_tod_event value, or may support being changed to a SNVT_tod_event value if a changeable type output is supported.
2. A scheduler may implement additional static outputs, or may support the addition of dynamic outputs. Each of these outputs shall have the same behavior as the nvoPresentValue output, but may be implemented with the same or different types.
3. The nvoPresentValue output shall automatically be restored in the event the device is reset or the date or time input to the device is changed. The restorative behavior is manufacturer defined. As an example, a schedule may be restored assuming that each day's schedule is circular in nature. That is, if the device is reset after midnight but before the first regularly scheduled event, then the value of the last event for that day is used as the initial value. If some other value is desired, then the desired value must be entered as an event at 00:00. An alternate and preferable restorative behavior is to do a full search for the last event after a reset. In this case, if no event is found, the default value is used. The nvoPresentValue output is set to the value specified by the default-output configuration property if there are no scheduled events for the day as specified by the active schedules.
4. An optional nviEnable input may be provided to externally enable or disable the scheduler. The output value is set to the invalid value and not updated after the initial setting when the scheduler is disabled.
5. A SCPTdefOutput configuration property shall be included to specify a default output. The nvoPresentValue output is set to the value specified by the SCPTdefOutput configuration property if an override request is received by the node object and the override behavior is set-to or defined-as going to the default value. The nvoPresentValue output is also set to the value specified by the SCPTdefOutput configuration property if there are no active schedules, or if the schedule value specified by all active schedules is invalid.
6. SCPTovrBehave and SCPTovrValue configuration properties may be included to specify override behavior and the override value. If a SCPTovrBehave configuration property is not included, the override behavior shall be to retain the last setting. If a SCPTovrValue configuration property is not included, the override value shall be the last setting if the override behavior is to go to a specified level.
7. The nvoPresentValue output shall be updated whenever the output changes, or based on an optional heartbeat rate.
8. If the type of the nvoPresentValue output is set to SNVT_tod_event, the scheduler may set the next_state and time_to_next_state fields in addition to the current_state field. Support for the next_state and time_to_next_state fields is optional—these fields shall be set to

OC_NUL and 0 respectively if support is not provided or if the scheduler cannot find a next state.

9. The scheduler shall support multiple schedules, where each schedule consists of a priority, a set of time-value pairs for a schedule period starting at midnight, and an optional name. The schedule period shall be a minimum of 24 hours and may be extended to up to 48 hours. Each time-value pair shall specify time-of-day (one-minute resolution over 48 hours) and a schedule value. To support sharing of schedules between multiple functional blocks and providing multiple outputs of different types, the schedule value may be translated to one or more output values using value-definition arrays. A schedule value may be used as an index into the associated value-definition arrays. An optional value-name array may be provided to assign names to each of the values, for example, names such as "On" and "Off" may be assigned. If all entries in the value-definition array are invalid, the schedule value shall be used as the schedule output.
10. The Scheduler may support an optional weekly schedule, where the weekly schedule specifies an active schedule for each day of the week.
11. The Scheduler shall support identification of active schedules by a Calendar functional block on the same device, or by a *date event* input to the Node Object functional block on the same device. The date event input receives date events typically generated by Calendar functional blocks on other devices. A date event specifies the name of a schedule as well as the number of days that the schedule has been active or inactive, and the number of days until the next time the schedule will be active or inactive.
12. The Scheduler may support *temporary schedules*, where a temporary schedule is defined as a schedule that is deleted at the end of the day that it is active.
13. Any device implementing a scheduler may have an nviDateEvent input and an nvoDateResync output on the Node Object functional block. If provided, the input shall be used to identify the status of all externally controlled schedules, and the output shall be used to request a resynchronization of all externally controlled schedules, for example, following a power cycle on a scheduler device. Up to 256 schedules may be externally controlled. An externally controlled schedule input shall be ignored or deleted on the second midnight after its last update.
14. Multiple schedules may be active at the same time. For example, a schedule specified by the weekly schedule and schedules specified by one or more date events might all be active at the same time. Schedule priorities shall be used to determine the appropriate output from the scheduler. The output of a Scheduler functional block shall be determined by the highest priority output that is not invalid. If multiple schedules of the same priority specify valid outputs at the same time, the one with the numerically lower index number shall be used.
15. If temporary schedulers are supported, schedules specified as temporary schedules shall be deleted at the end of the day that they are active.

Example Usage

A Scheduler functional block may be used as a single functional block on a device, or in conjunction with other functional blocks including a node object, event calendar, event generator, real-time keeper, and additional schedulers. A Scheduler functional block may maintain its own real-time clock or it may receive time from a Node Object or Real-Time Keeper functional block.

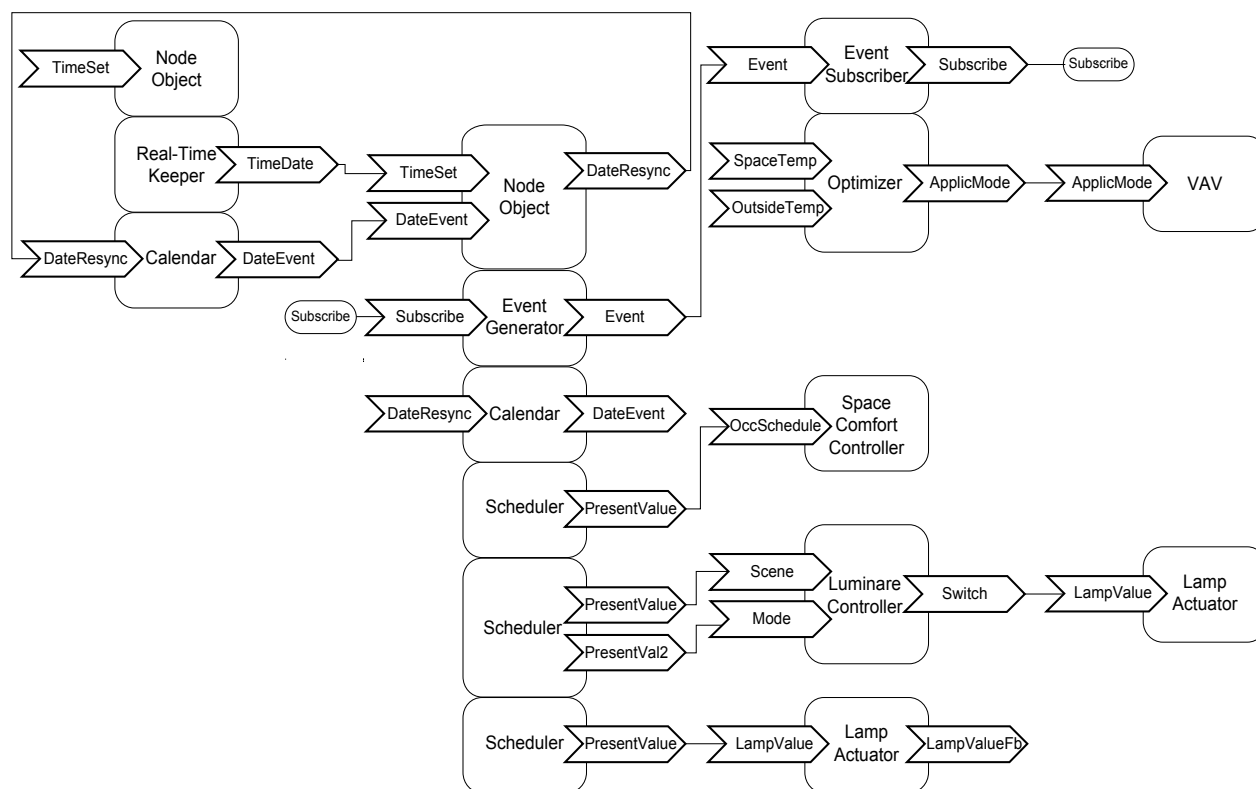


Figure 2 Example Usage

Object Details

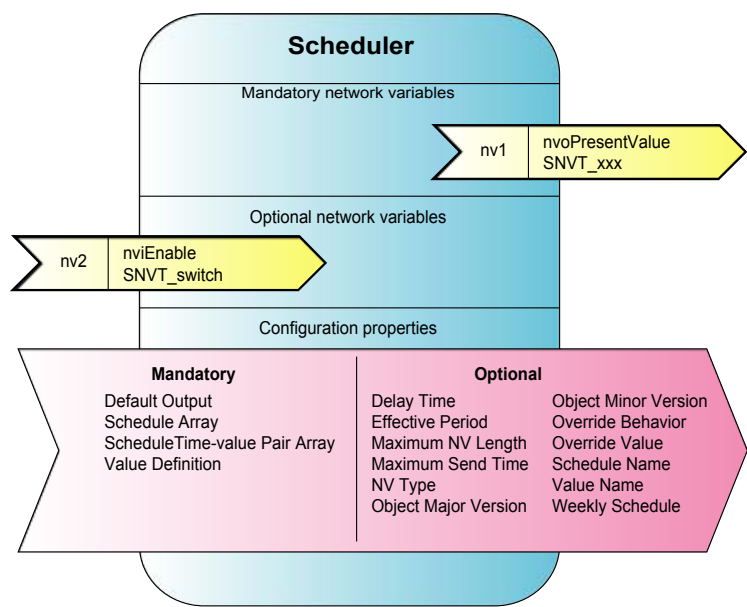


Figure 3 Profile Details

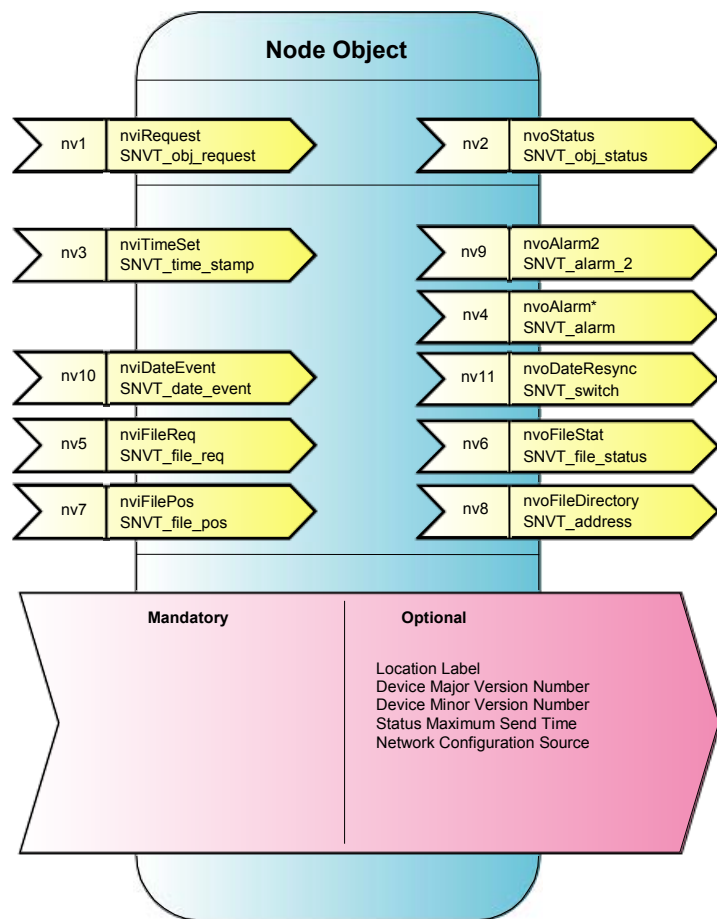


Figure 4 Node Object Details

Table 1 Network Variable Members

NV # (M/O)*	Variable Name	SNVT Name	SNVT Index	Description
1 (M)	nvoPresentValue	SNVT_xxx	Any	A time-related value, or optionally, an array of time-related values
2 (O)	nviEnable	SNVT_switch	95	Enables this scheduler

* M = mandatory, O = optional

Table 2 Configuration Property Members

Man. Opt. *	SCPT Name	SCPT Index	Associated NVs **	Description
Man	SCPTdefOutput	7	nv1	Default output
Opt	SCPTdelayTime	96	nv1	Delay time from scheduled time
Opt	SCPTEffectivePeriod	272	Entire FB	Effective period for the schedule
Opt	SCPTmaxNVLength	255	nv1	Maximum type size for a changeable type output
Opt	SCPTmaxSendTime	49	nv1	Heartbeat time
Opt	SCPTnvType	254	nv1	Network variable type for the output
Opt	SCPTobjMajVer	167	Entire FB	Functional block implementation major version number
Opt	SCPTobjMinVer	168	Entire FB	Functional block implementation minor version number
Opt	SCPTovrBehave	32	nv1	Output behavior when an override request is received
Opt	SCPTovrValue	33	nv1	Output value when an override request is received
Man	SCPTschedule	274	Entire FB	Array of schedule descriptions, each including a priority and an index into the SCPTscheduleTimeValue time-value list
Opt	SCPTscheduleName	279	Entire FB	Array of schedule names for the schedules defined by the SCPTschedule array
Man	SCPTscheduleTimeValue	275	Entire FB	Array of time-value pairs, organized as terminated lists. Specifies time-value pairs to be evaluated when a schedule is active
Man	SCPTvalueDefinition	276	nv1	Output value definition
Opt	SCPTvalueName	277	nv1	Output value name
Opt	SCPTweeklySchedule	278	Entire FB	Structure containing a schedule for each day of the week

* Man = mandatory, Opt = optional

** List of NVs to which this configuration property applies.

Table 3 Node Object Network Variable Members

NV # (M/O)*	Variable Name	SNVT Name	SNVT Index	Description
1 (M)	nviRequest	SNVT_obj_request	1	A requested mode for a specified functional block in the device
2 (M)	nvoStatus	SNVT_obj_status	2	Reports the status of the requested functional block in the device
3 (M**)	nviTimeSet	SNVT_time_stamp	3	Synchronize the device's internal real time clock with an external time source
10 (O)	nviDateEvent	SNVT_date_event	176	Provides the status of each defined exception
11 (O)	nvoDateResync	SNVT_switch	95	Requests an update for all defined exceptions via the nviDateEvent input

* M = mandatory, O = optional, M** = mandatory for this profile

Mandatory Network Variables

nvoPresentValue Output

```
network output bind_info(ackd) SNVT_xxx nvoPresentValue;
```

This output network variable indicates the current value of the schedule. The output is determined by the current time, the currently active schedules, and the schedule value to output value mapping defined by a SCPTvalueDefinition array. If all entries in the SCPTvalueDefinition array are invalid, the schedule value shall be used as the nvoPresentValue output.

Active schedules may be identified by a SCPTweeklySchedule array, by a Calendar functional block on the same device, and by *date event* inputs to the Node Object functional block on the same device. The date event input receives date events typically generated by Calendar functional blocks on other devices. A date event specifies the name of a schedule as well as the number of days that the schedule has been active or inactive, and the number of days until the next time the schedule will be active or inactive.

Multiple schedules may be active at the same time. For example, a schedule specified by the weekly schedule and schedules specified by one or more date events might all be active at the same time. Schedule priorities shall be used to determine the appropriate output from the scheduler. The output of a Scheduler functional block shall be determined by the highest priority output that is not invalid. If multiple

schedules of the same priority specify valid outputs at the same time, the one with the numerically lower index number shall be used.

The `nvoPresentValue` output is automatically restored in the event the device containing the Scheduler functional block is reset or the date or time input to the device is changed. The restorative behavior is manufacturer defined. As an example, a schedule may be restored assuming that each day's schedule is circular in nature. That is, if the device is reset after midnight but before the first regularly scheduled event, the value of the last event for that day is used as the initial value. If some other value is desired, the desired value must be entered as an event at 00:00. An alternate and preferable restorative behavior is to do a full search for the last event after a reset. In this case, if no event is found, the default value is used.

Valid Range

This network variable may be implemented with a changeable type or fixed type. The following types are recommended for fixed type implementations:

- *SNVT_switch* may be used for turning equipment on and off at scheduled times.
- *SNVT_hvac_mode* may be used for HVAC applications to set the HVAC mode.
- *SNVT_tod_event* may be used for HVAC applications that require time-of-day events that include information on previous and next events. The Event Generator functional block is preferred for this type of application, but *SNVT_tod_event* may be used for backward compatibility. The *SNVT_tod_event* type is a structure with three fields. The *current_state* field is required. The additional fields, *next_state* and *time_to_next_state*, are optional. They can be used for control strategies that provide improved transitions between states. If supported, these fields must be set to the next state and time to next state. If not supported, these fields must be set to *OC_NUL* and 0.
- *SNVT_setting* may be used for lighting applications and other applications requiring a shared mode output. *SNVT_setting* is a combination of a byte defining the functional area source, and a byte defining the mode for the functional area source. The functional area source specifies functions such as time, energy management, and HVAC. The mode specifies the current mode for the functional area such as occupied hours for lighting or energy reduction level 3 for energy management.

The valid range is any value within the defined limits of the SNVT concerned.

Default Value

The default value specified by SCPTdefOutput. If SCPTdefOutput is set to the invalid value, the default value is the default value for the type selected for the PresentValue output. The nvoPresentValue output is also set to the value specified by the SCPTdefOutput configuration property if there are no active schedules, or if the schedule value specified by all active schedules is invalid.

Configuration Considerations

The transmission of this network variable is regulated by the time specified in the SCPTmaxSendTime configuration property, if implemented, unless the configuration property has a value of 0, or other invalid value; in which case, the network variable is not regulated by the SCPTmaxSendTime value.

When Transmitted

Data is only transmitted when the value has changed due to the time-of-day reaching the next scheduled event, or due to a change in the date event inputs. This network variable will also be transmitted as a heartbeat output as dictated by the optional SCPTmaxSendTime configuration property.

Default Service Type

The default service type is acknowledged.

Optional Network Variables

nviEnable Input

```
network input SNVT_switch nviEnable;
```

This input network variable enables the scheduler. The scheduler is enabled when the state value is one (1) and the level value is greater than zero (0). The output value is set to the invalid value and not updated after the initial setting when the scheduler is disabled.

Valid Range

The state value may be zero (0) or one (1). The level value may be zero (0) to 200.

Default Value

On {1, 200}.

Configuration Considerations

None.

Configuration Properties

The Scheduler SCPTs and SCPT arrays will be used to define schedules. These SCPTs may be shared across multiple Scheduler and Calendar functional blocks on a device. The following figure illustrates the relationships between the Scheduler SCPTs that are used to define schedules.

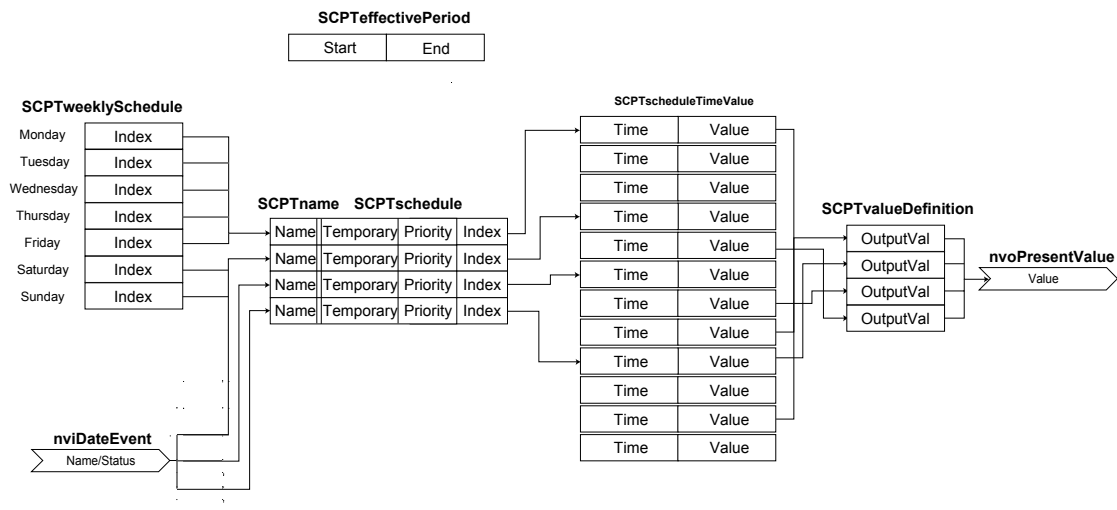


Figure 4 Schedule SCPTs

Default Output (Mandatory)

This configuration property specifies the **nvoPresentValue** output when no schedules are active, or when an override request is received for the functional block. The override behavior may be defined by the optional **Override Behavior** and **Override Value** configuration properties. The **nvoPresentValue** output is also set to the value specified by the **SCPTdefOutput** configuration property if there are no active schedules, or if the schedule value specified by all active schedules is invalid.

Valid Range

The valid range of this configuration property is any value within the defined limits of the **nvoPresentValue** output network variable type.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTdefOutput (7)

Delay Time (Optional)

This configuration property specifies a delay from the scheduled time. This allows multiple outputs within a Scheduler functional block, or multiple Scheduler functional blocks on a device, to share a common schedule but stagger on and off times to reduce peak load.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition, which is zero (0) seconds (no delay).

Configuration Requirements/Restrictions

This configuration property may be modified at any time.

SCPT Reference

SCPTdelayTime (96)

Effective Period (Optional)

This configuration property defines the time period during which the Scheduler functional block is effective. During the effective period, the output of the scheduler will be defined by the values in the current time-value entry within the highest priority active schedule that specifies a valid value. Outside the effective period, the value of output will be the undefined value for the selected network variable type, or the default output value if an invalid value is not defined. The effective period is defined by a start date and an end date. If the start date is undefined, it means any date up to and including the end date. If the end date is

undefined, it means any date from the start date. If both are undefined, it means the Scheduler functional block is always active.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTeffectivePeriod (272)

Maximum Network Variable Length (Optional)

This configuration property specifies the maximum length of a type that may be assigned to the nvoPresentValue output network variable. It is used with SCPTnvType.

Valid Range

1 .. 31 bytes. A zero (0) value represents invalid data.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property is a constant.

SCPT Reference

SCPTmaxNVLength (255)

Maximum Send Time (Optional)

This configuration property is used to control the maximum period of time that expires before the Scheduler functional block automatically transmits the current value of the nvoPresentValue output network variable. This provides a heartbeat output that can be used by destination objects to ensure that the object is still healthy.

Valid Range

0.0 .. 6553.4 sec (0.1 sec). The value 0xFFFF represents invalid data.

Default Value

The default value is specified by the SCPT definition, which is 0.0, heartbeat disabled.

Configuration Requirements/Restrictions

This configuration property may be modified at any time.

SCPT Reference

SCPTmaxSendTime (49)

Network Variable Type (Optional)

This configuration property specifies the type of the nvoPresentValue output network variable. When a new value is specified for a SCPTnvType configuration property, the Scheduler functional block shall validate that it supports the new setting, and report an error via the Node Object functional block if the new setting is not supported, or change the application processing required for the network variable based on the new type if the new type is supported. A SCPTmaxNVLength configuration property may be used with the SCPTnvType configuration property to specify the maximum type length supported.

Valid Range

The valid range for this configuration property is any value within the defined limits of the SNVT_nv_type network variable type.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTnvType (254)

Object Major Version (Optional)

This configuration property sets the major version number for a functional block implementation. It is used with the SCPTobjMinVer configuration property. See the *LONMARK Application-Layer Interoperability Guidelines* for details on usage.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value is manufacturer-defined.

Configuration Requirements/Restrictions

This configuration property is Constant.

SCPT Reference

SCPTobjMajVer (167)

Object Minor Version (Optional)

This configuration property sets the minor version number for a functional block implementation. It is used with the SCPTobjMajVer configuration property. See the *LONMARK Application-Layer Interoperability Guidelines* for details on usage.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value is manufacturer-defined.

Configuration Requirements/Restrictions

This configuration property is Device Specific.

SCPT Reference

SCPTobjMinVer (168)

Override Behavior (Optional)

This configuration property is used to define the behavior of the nvoPresentValue output when an override request is received. If a SCPTovrBehave configuration property is not included, the override behavior shall be to retain the last setting.

Valid Range

The valid range for this configuration property is any value within the defined limits of the SNVT_override network variable type. The Scheduler can retain its last setting, go to a specified value, or go to the default-output value.

Default Value

The default value is for the functional block output to retain its last setting (OV_RETAIN).

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTovrBehave (32)

Override Value (Optional)

This configuration property is used to set the value the nvoPresentValue output should adopt when it is overridden and the value of Override Behavior is OV_SPECIFIED. If a SCPTovrValue configuration property is not included, the override value shall be the last setting if the value of Override Behavior is OV_SPECIFIED.

Valid Range

The valid range for this configuration property is any value within the defined limits of the SNVT_xxx concerned.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTovrValue (33)

Schedule (Mandatory)

This configuration property describes the attributes of a schedule definition. It is used to create an array of schedule descriptions, each including a schedule priority and an index into the time-value list defined by the SCPTscheduleTimeValue array. A schedule is active for a minimum of 24 hours, and may be extended to up to 48 hours to accommodate events that span multiple days. The size of the SCPTschedule array is manufacturer-defined. An optional SCPTscheduleName array may be implemented, where each entry in the SCPTscheduleName array provides a name for the corresponding entry in the SCPTschedule array. When multiple schedules are active, the first schedule with a valid output in the SCPTschedule array of the highest priority (lowest value) is used.

A Scheduler may support *temporary schedules*, where a temporary schedule is defined as a schedule that is deleted at the end of the day that it is active.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTschedule (274). Replaces SCPTtimeEvent, SCPT 104.

Schedule Name (Optional)

This configuration property is used to create an array of schedule names. Each entry provides a name for the corresponding entry in a SCPTschedule array. The array will typically be shared by all Calendar and Scheduler functional blocks on a device.

If a Scheduler functional block supports temporary schedules, and a schedule name is only referenced by temporary schedules and exception dates, the schedule name shall be deleted when all the referencing schedules and exception dates are deleted.

No more than 256 schedules may be reported by an nvoDateEvent output. None, any, or all of the schedules may be active at the same time. The maximum for a particular implementation may be less than 256.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTscheduleName (277)

Schedule Time-Value Pair (Mandatory)

This configuration property specifies the time and value for a scheduled event. It is used to create an array of time-value pairs, organized as terminated lists. The time-value pairs are evaluated when a schedule is selected. Each time-value pair specifies a time and a value. The value must be a schedule value that is used as the schedule output, or is used as an index into a SCPTvalueDefinition array, which in turn specifies the output value. The SCPTvalueDefinition array is used unless all entries in the array are invalid; in which case the value specified by the time-value pair is used as the output of the Scheduler functional block. The size of the SCPTscheduleTimeValue array is manufacturer-defined.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTscheduleTimeValue (275). Replaces SCPTtimeEvent, SCPT 104.

Value Definition (Mandatory)

This configuration property is an array of values that determine the output of the Scheduler functional block when at least one schedule is active and specifies a valid output. The value of a schedule is a SNVT_sched_val value which is used as an index into the Value Definition array. For example, a time-value event may specify a value of 1 at 0800 and a value of 0 at 1700. If a Value Definition array is declared that is called cpValueDef, the value to be produced by the scheduler at 0800 is

specified by cpValueDef[1] and the value to be produced by the scheduler at 1700 is specified by cpValueDef[0].

A name may be assigned to each of the values in a Value Definition array using an optional Value Name array.

This configuration property may be shared by multiple outputs from a scheduler, or by multiple schedulers, as long as all outputs are the same type.

Valid Range

The valid range of this configuration property is any value within the defined limits of the nvoPresentValue output network variable type.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTvalueDefinition (276)

Value Name (Optional)

This configuration property is an array of values that specify an array of value names for each of the values defined in a Value Definition array. For example, a SNVT_switch value of “100.0 1” can be given a name of “On” and a value of “0.0 0” can be given a name of “Off.”

This configuration property may be shared by multiple outputs from a scheduler, or by multiple schedulers, as long as all outputs are the same type.

Valid Range

The valid range of this configuration property is any value within the defined limits of the nvoPresentValue output network variable type.

Default Value

The default value is application specific.

Configuration Requirements/Restrictions

This configuration property may only be modified when the functional block is disabled.

SCPT Reference

SCPTvalueName (277)

Weekly Schedule (Optional)

This configuration property is a structure identifying an active schedule for each day of the week. Each schedule includes a priority that is used to select between the weekly schedule and any active schedules specified by date events. The highest priority (lowest value) with a valid value is used. If multiple schedules with the same priority are selected, the first schedule with a valid output within the SNVT_sched_val array is used.

Valid Range

The valid range specified by the SCPT definition.

Default Value

The default value specified by the SCPT definition.

Configuration Requirements/Restrictions

This configuration property may only be modified when the device is offline.

SCPT Reference

SCPTweeklySchedule (278). Replaces SCPTdefWeekMask, SCPT 102.

Data Transfer

None specified.

Power-up State

There is no immediate network action on power-up. If a SCPTmaxSendTime configuration property is specified, the output will be updated on the next heart beat.

Boundary and Error Conditions

None specified.

Additional Considerations

None specified.

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