



Lighting Relay Controller

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Revision History

November 14, 2001	Draft 1	Sent to Douglas, Gentec and GE
November 20, 2001	Draft 2	Sent to Douglas, Gentec, GE and Leviton <ul style="list-style-type: none">• Reformatted paragraphs• Made it clearer that load shedding command are 0%, 1%, 2%, 3% and 4% and that any other value is simply to be ignored.• Made it clearer that load shedding is of the highest precedence but applies only to relays and not to the relay group.• Transformed certain UCPT to their corresponding SCPT• Clarified why there is no MinSendTime• Clarified that object enable/disable state must be kept in non-volatile memory• Clarified usage of requests on object 0• Added the concept that groups can be LOW or MED and the related concept of even wear• Clarified terminology to better differentiate a maintenance override from a temporary override
November 28, 2001	First Issue	<ul style="list-style-type: none">• Lighting Panel Controller renamed Lighting Relay Controller• Remove the _X from the CP names since the same names can be used for many objects• Clarified power-up and reset issues that could cause lights to flicker if certain nvis were received before others (in particular, schedule versus occupancy sensors or schedule versus photocell). See the "Upon reset" paragraph.• Added refresh of nviTimeSet by the LRC. See "nviTimeSet" paragraph.• Modified usage of set1 and set2 when EvenWear is false. Instead of reverting to set1 only, it is now recommended to "or" set1 and "set2" together.
January 29, 2002	Revision 1	<ul style="list-style-type: none">• Updated profile picture to show more information• Corrected lower case letter following an SCPT• Added SCPT or UCPT prefix to all CP paragraphs for readability• Added paragraph numbers for requirements traceability• Corrected text related to even wear: The first set of relays is always ORED with the second set <u>when</u> EvenWear is False.• Use the new Micro Thermo Technologies name• Added that by default, all objects shall be enabled• A value of SCPTholdTime of 6553.5 is now used to indicate that nviGrpOccup is not to be acted upon.• Clarified that if a SCPTmaxRcvTime is set to 0, the corresponding nvi is never to be considered stale (is always valid)• Added a requirement to support the in_override bit in nvoStatus.• Made it clearer that when an object is disabled, it must not do anything.• Added paragraph entitled 'Refreshing the Relays' to clarify the conditions under which relays are expected to be refreshed.• When a SCPTmaxRcvTime is set to 0, the last received value of the associated nvi, must be considered valid.• Corrected SCPTmaxRcvTime test: used to consider <u>nviLuxLevel</u> stale...
March 12, 2002	Revision 2	<ul style="list-style-type: none">• Updated profile picture to show the SCPTpwrUpDelay.• Erased "(do not act on it upon reset)" in the paragraph 3.1 nviRequest to avoid confusion concerning Default Value.• Added the paragraph 4.2 as a requirement to support the SCPTpwrUpDelay.• Revised the paragraphs 5.1 and 7.1 to use the most up to date data instead the next nvi received after enabling an object.• Replaced in the section 15.3 Upon reset the "two minutes" with SCPTpwrUpDelay.

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1 Document Purpose

This document is written in response from a Douglas request to implement a lighting panel controller that would be compatible with the existing MT Alliance Software Platform and existing MT Lighting Scheduler node so that a level of integration comparable to the Gentec Controller can be achieved.

Micro Thermo presently realizes that LonMark Lighting Profiles have considerably evolved since we started our lighting product line. It is our intent in the upcoming versions to re-engineer our system to make it as LonMark compliant as we possibly can. However, this will take a few months. In the meantime, Douglas wants to be able to sell their panels on sites controlled by the existing MT Alliance.

The intent of the present document is to devise a new profile that does not divulge any of Gentec intellectual property but simply describes basic grouping of relays. Features of the Gentec nodes not already used by Micro Thermo's own lighting nodes will not be part of the new profile. The new profile has to be compatible with GenTec hardware, Douglas hardware, GE hardware and Leviton hardware.

2 Introduction to the Lighting Panel Controller

2.1 Groups of Relays

A Lighting Relay Controller (LRC) is an electronic control module that can turn relays "on" or "off". The number of relays controlled can vary from 8 to 24. Usually, the electricians will use more than one relay to control similar loads. For example, it may take 5 relays to control all the parking lights. These 5 relays can be any of the 24 relays available. But all parking lights are usually turned "on" and "off" at the same time. A group represents relays that you always want to turn "on" or "off" at the same time.

So a means of assigning one or more relays to a group must be provided. Once a relay has been assigned to a group, it cannot be assigned to another group.

In the event that more than one LRC is installed on a site, parking lights may well use relays on one LRC and relays on another LRC. In this case, a group will be created on each LRC. A single parking light schedule will be connected to both LRC groups so that all parking light relays are turned "on" and "off" at the same time even if they are on separate LRCs.

Relays that are not assigned to a group (orphan relays) can only be controlled if the optional input network variable `nviRelay` have been implemented (unlikely for panels of 16 or 24 relays because the node will run out of network variables).

2.2 Groups and Lighting Levels

The scheduler node can send a schedule command of OFF, LOW/MED or HIGH/ON. It is easy to understand what OFF and ON do. The LOW/MED command represents a lower overall lighting level for the relay group. This is achieved by turning "on" only certain relays within the relay group and keeping the other relays "off". In order to keep an even wear on all the lights, the two sets of relays belonging to the group are used alternatively. When the schedule command changes from HIGH/ON to LOW/MED, the set with the highest runtime is turned "off". When the schedule command changes OFF to LOW/MED, the set with the lowest runtime is turned "on".

2.3 Energy Management

The Energy Manager object in the LRC shall receive a load shedding command from an external energy management node. The load shed command is a switch that can take the following values: 0 (no shedding), 1, 2, 3 and 4. A load shed command level of 1 means that unimportant lighting relays can be turned “off” until further notice (until 0 is received). A load shed command level of 4 means that all relays should be turned “off” except those who are considered critical.

When the load shed command is 1 to 4, selected relays are turned “off” and cannot be turned back “on” by maintenance overrides, by an occupancy sensor, by an temporary override or by the schedule/photocell. The Energy Manager is the only feature that works directly on relays instead than working on the group state. It is the highest priority feature in the LRC.

2.4 Maintenance Overrides

It shall be possible to override a group “on” or “off” until a certain time from the MT Alliance for maintenance purposes. Typical maintenance override durations would be a few days, a few weeks or until further notice.

The mechanism used by the MT Alliance is as follows: for each group, a CP is used to define the override end time and another CP is used to select the override value. If the time presently calculated by the LRC is after the override end time, then the override value is ignored. If the present time is before the override end time, then the override value is acted upon. A permanent override is issued by sending an override for about 100 years. After a reset, if the LRC has not received the time yet, it cannot act on this feature.

2.5 Occupancy Sensors

It shall be possible to turn “on” a group of relays when a standard LonMark Occupancy sensor (a motion detector) detects that an area is occupied. That feature shall have precedence over the override switch and the schedule commands described below. If the group is unoccupied, than the other group commands can be acted upon. This is expected to be used in offices and in the back store only. Occupancy sensors always turn the relay group to “on”.

2.6 Temporary Overrides

It shall be possible to override a group temporarily using a LonMark Switch (usually 15 minutes to a few hours). A local panel of switches or distributed switches can be used with the LRC. Local switches should always be momentary switches that simply toggle the current state of the group. So the group state has to be sent back to the switch. In order for a timed override to work, the switch must set its MaxSendTime to 0 to disable the send heartbeat feature. The switch value must be sent only when a user presses the switch. The value sent is always the reverse of the current group state. If the group is “on” or “low/med”, pressing the switch will turn it “off”. If the group is “off”, pressing the switch will turn it “on”. It shall be possible to have switch fan-ins to override a group.

The MT Alliance platform shall also be able via a group plug-in to override the group in the same way.

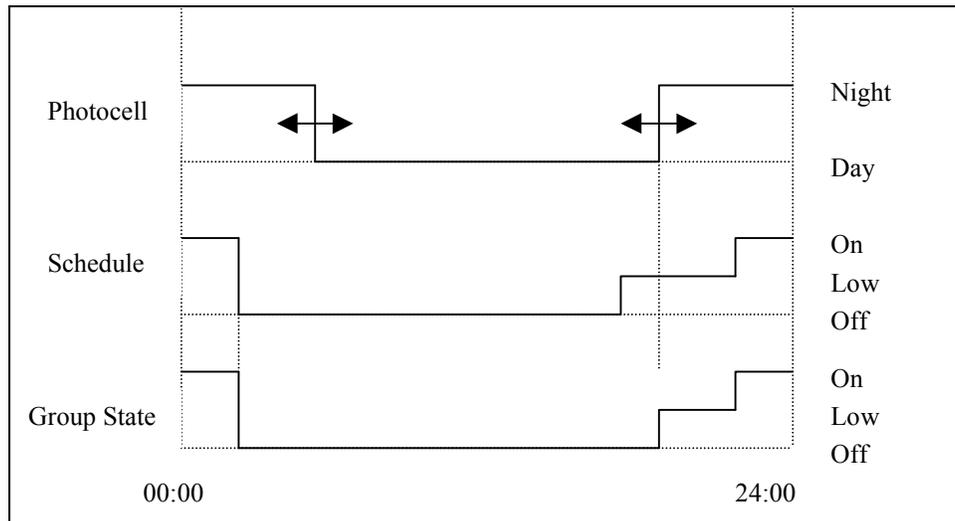
2.7 Light Sensors and Schedule Commands

Digital or analog photocells shall be supported via a network variable. The network variable will carry the standard measured lux level. The LRC will determine that it is day if the measured lux level is greater than a setpoint plus the hysteresis value for a certain time. The LRC will determine that it is night if the measured lux level is smaller than the setpoint minus the hysteresis value for a certain time. The lux level will come in only when it has changed by a significant amount. Even if it has not changed, it will come in if a heartbeat has been set in the photocell node.

The photocell can be associated with any relay group. For a particular group, the photocell is combined with the schedule command coming from the scheduler node. The following choices are available:

- Use schedule only (do not use the photocell)
- Use photocell AND schedule
- Use photocell OR schedule

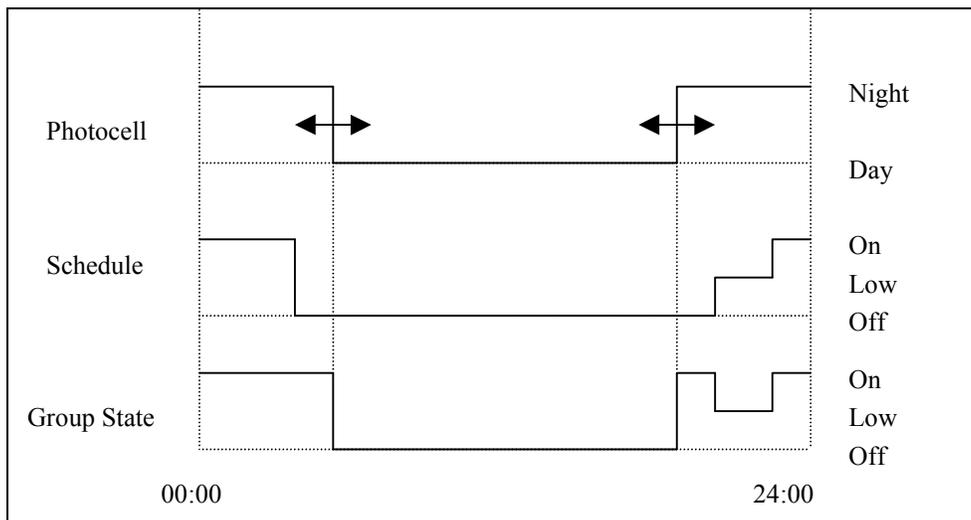
2.7.1.1 Photocell AND Schedule



This allows turning outside lights “on” only when it is dark enough, but allows to completely turn “OFF” the lights in the early morning even if it is still dark outside. In this case, if the photocell sensor fails and indicates Night all the time, the group state will follow the schedule. If the photocell fails and indicates Day all the time, the outside lights will never turn “on” (which is not good).

The Photocell object generates a signal with two states: Night(1) or Day(0). The schedule received has three states: Off, Low/Med, High/On. The effect of performing a logical “AND” operation is that the desired group state is equal to the schedule command when the photocell says “night”. If the photocell says “day”, the desired group state is always “off”.

2.7.1.2 Photocell OR Schedule

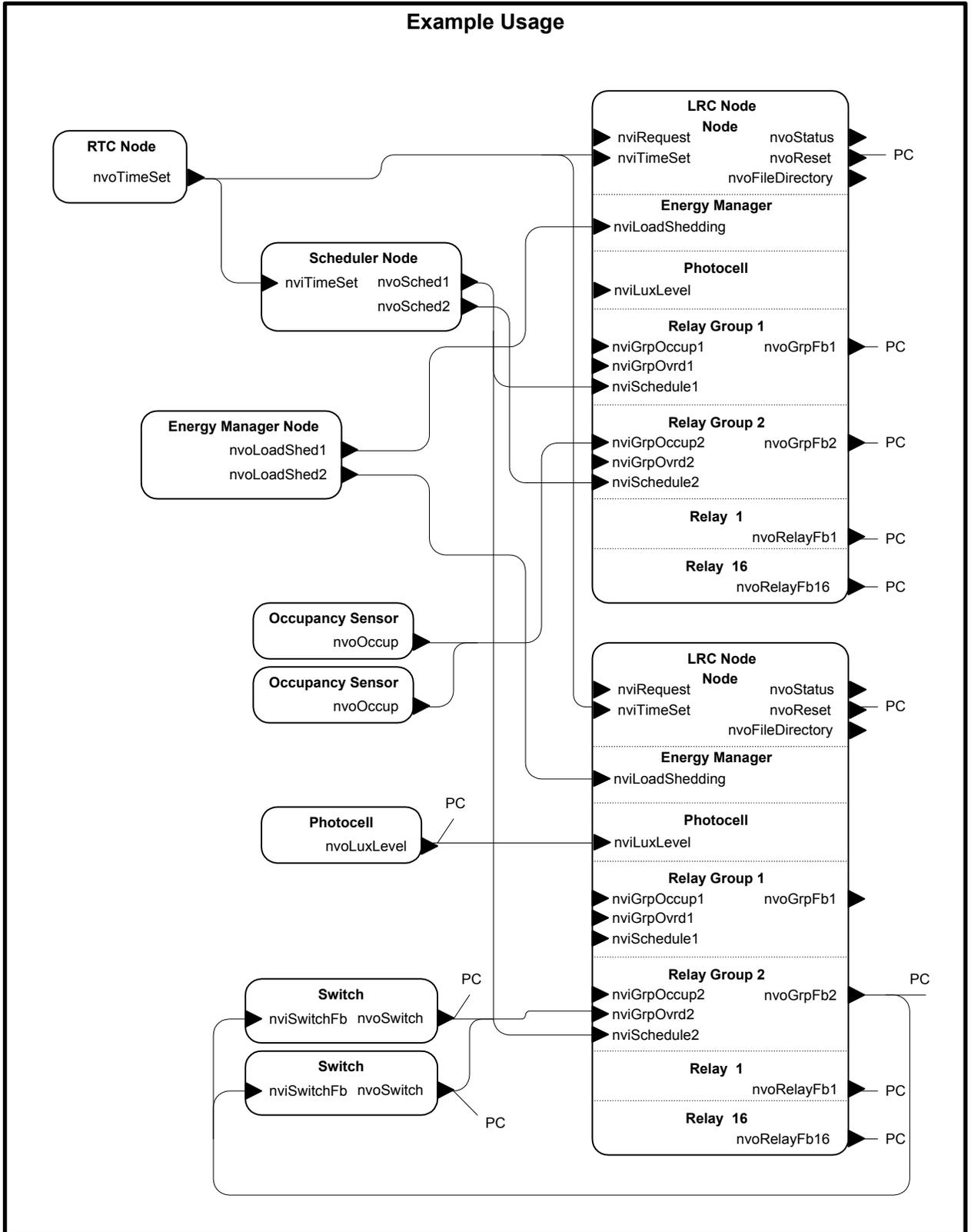


This allows turning outside lights “on” only when it is dark enough and turning “OFF” the lights when the sun rises. The schedule in this case acts as a protection against photocell failure. If the photocell fails in the ‘Day’ position, the group state will follow the schedule. If the photocell fails in the ‘Night’ position, the outside lights will remain “on” all the time (which is not good).

However, if a photocell node can stop transmitting the lux value when the physical sensor is short or open, then we can use the receive heartbeat feature of the photocell object to ignore the photocell and fall back on the schedule without any undesirable side effect.

The Photocell object generates a signal with two states: Night(1) or Day(0). The schedule received has three states: Off, Low/Med, High/On. The effect of performing a logical “OR” operation is that the desired group state is equal to the schedule command when the photocell says “night” with one exception: when the schedule command is “off” the desired group state will be “on”. If the photocell says “day”, the desired group state is always equal to the schedule command.

Example Usage



3 Node (Object 0) Variables

3.1 nviRequest

Declaration	Network input SNVT_obj_request
Description	Used to get an object status, an object mask and to enable or disable objects.
Valid range	Object_id : 1 to 8 Object_request : RQ_NORMAL, RQ_ENABLE, RQ_DISABLED, RQ_UPDATE_STATUS, RQ_REPORT_MASK
Structure details	Unsigned long object_id Object_request_t object_request
Default Value	0, RQ_NORMAL
Action when received	Return nvoStatus
Scope	Mandatory

It shall be possible to enable (RQ_NORMAL or RQ_ENABLE) or disable (RQ_DISABLED) the energy manager object (1), the photocell object (2) and all relay group objects (3 to 8). This is not required for Relay Objects. When disabled, a relay group shall not attempt to turn “on” or “off” any of its associated relays. If no relays have been associated, an enabled relay group does not do anything. The enable/disable state of the above objects shall be kept in non-volatile memory so they are remembered when the node is powered up.

Examples : enabling relay group 4 will be done by sending nviRequest = 6, RQ_NORMAL.
disabling relay group 5 will be done by sending nviRequest = 7, RQ_DISABLED

It shall be possible to request the report mask and the status of an object. These are the minimum status bits that shall be supported (invalid_id and invalid_request are implicitly supported and are not supposed to be raised when returning the report mask):

Bit name in mask	Energy Manager	Photocell	Relay Group	Relay
disabled	Yes	Yes	Yes	No
in_override	No	No	Yes	No

A nviRequest to enable or disable object 0 shall be ignored but not considered an invalid request. When asking to report the status of object 0, return all 0s in nvoStatus.

Objects 1 to 8 shall be enabled by default.

If the implementer wishes to provide support for more bits in the object status for troubleshooting purposes, he is welcome to do so.

3.2 nvoStatus

Declaration	Network output SNVT_obj_status
Description	Used to return an object status or an object mask.
Valid range	Object_id : 1 to 8 disabled: 0 or 1 in_override: 0 or 1
Structure details	Unsigned long object_id Unsigned disabled Unsigned in_override
Default Value	0, all bits at 0
When transmitted	Every time an nviRequest is made.

Update rate	Not applicable
Scope	Mandatory

The nvoStatus is used as described above to report the enable/disable status of the Energy Manager Object, the Photocell Object and the Relay Group Objects. It is also used to report if a group is presently in a temporary override or maintenance override. When asking nviRequest = RQ_REPORT_MASK for a valid object number, the nvoStatus must not raise the invalid id and invalid command bits.

3.3 nviTimeSet

Declaration	Network input SNVT_time_stamp
Description	Time stamp from real-time clock that synchronizes the entire network. Used by LRC to verify if a relay group maintenance override is in effect or not.
Valid range	Any value within the defined limits of SNVT_time_stamp
Structure details	Unsigned long year Unsigned short month Unsigned short day Unsigned short hour Unsigned short minute Unsigned short second
Default Value	All zeroes
Action when received	Synchronize internal Neuron Timer to the value received.
Scope	Mandatory

The nviTimeSet will be received approximately every minute. The LRC must keep calculating hours, minutes and seconds, day, month, year by itself after receiving the nviTimeSet. It shall do that based on a Neuron C timer so that it drifts by at most +/- 20 seconds per day. The LRC must calculate leap years (February 29) properly in the 2000-2150 range.

The time is used for only one purpose: to find out if “Now” is greater or less than “OvrEndTime” (the maintenance override end time). The manOvrTime (temporary override time) shall be based on elapsed time and not this absolute time so it is not affected by adjusting the RTC time.

Since there is no nvoTimeSet variable on the profile, the LRC shall write to its nviTimeSet at least every 15 seconds so we can test the date/time changes performed by the node.

3.4 nvoReset

Declaration	Network output SNVT_lev_disc
Description	Node reset indication. Will change from ST_OFF to ST_ON every time the reset clause is executed. Allows PC to detect Power-up resets, reset pins and watchdog internal resets.
Valid range	ST_OFF and ST_ON
Structure details	None
Default Value	ST_OFF
When transmitted	Every time the node is reset (ST_OFF followed by ST_ON)
Update rate	Not applicable
Scope	Mandatory

The nvoReset is bound to the PC so that MT Alliance can detect immediately when a node is reset. In this case, the Alliance will retransmit the system time immediately. The Alliance will also log that the node has been reset so we can troubleshoot power problems with the board.

The ST_ON must follow the ST_OFF with a delay of at least 0.1 seconds.

3.5 nvoFileDirectory

Declaration	Const network output SNVT_address
Description	Used to point to the CP information in the address space of the Neuron Chip.
Scope	Mandatory

The CPs shall be implemented using the memory read/write technique.

4 Node (Object 0) Configuration Properties

4.1 SCPTmaxSendTime

Declaration	SCPTmaxSendTime of type SNVT_time_sec (49)
Description	Used to refresh the value of nvoGrpFb and nvoRelayFb if they have not changed.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	120 sec
Scope	Mandatory

All nvoGrpFb and nvoRelayFb shall be output every max send time even if they have not changed. This ensures that the PC and the LonMark override switches will get a precise value of the current group state and individual relays even if the data network is temporarily disconnected. The MaxSendTime will usually be set to 1 or 2 minutes. This specifies the time between two network updates for a given variable such as nvoGrpFb1. The default value is higher than the usual 90 secs because of the number of nvos that have to be refreshed in that period.

Note that a MinSendTime CP is not required. The relay group feedback or relay feedback is expected to be output the moment its state has changed.

4.2 SCPTpwrUpDelay

Declaration	SCPTpwrUpDelay of type SNVT_time_sec (72)
Description	Used at start-up to allow to the LRC to receive all the nvis (including the network time stamp), to evaluate them and to determine the priority they must be processed.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	120 sec
Scope	Mandatory

After a power-up or a reset the LRC node needs to know the absolute date and time to properly update its calculated time and to be able to handle the activated maintenance overrides. The LRC could receive configuration changes, temporary overrides or nvis that could affect the status of the groups while it is still waiting for nviTimeSet. To avoid troubles related to the network synchronization, unknown status and processing priority, the LRC listens the network messages during the SCPTpwrUpDelay and then it treat them in accord with their priority. The default value is 2 minutes to allow the acquisition of the network time stamp and groups' schedule updated approximately every minute. For complementary information see the section 15.3 Upon reset.

5 Energy Manager (Object 1) Variables

5.1 *nviLoadShedding*

Declaration	Network input SNVT_switch
Description	Used to indicate which relays are to be turned “off” when a load shed command is issued.
Valid range	Value: 0%,1%,2%,3%,4% State: 0 (off) or 1 (on), 0xFF (undefined)
Structure details	Unsigned value Signed state
Default Value	(0%, 0)
Action when received	Immediately turn “off” relays that should be “off” or return some relay states to their group state if (0%,0) is received.
Scope	Mandatory

The Energy Manager works with 5 levels (value field). A value of (0%, 0) means that the Energy Manager must not apply any shedding. This means that all relays shall immediately take on a value represented by the current relay group state.

A value of (1%,1) means that all relays identified with a 0 bit in the Lev1Relays16 and Lev1Relays32 CPs must immediately be turned “off”. A value of (2%,1) means that all relays identified with a 0 bit in the Lev2Relays16 and Lev2Relays32 CPs must immediately be turned “off”. The same applies to values (3%,1) and (4%,1). Other percentage values are to be ignored.

The idea here is that there will be more and more relays with 0 (to turn “off”) when the load shedding level is increased. A load shedding level of 1 means to load shed non-essential lighting. A load shedding value of 4 means to keep only essential lighting.

You can expect the external Energy Manager node to periodically refresh this input variable. This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received. The value shall be considered as (0%, 0) if it has not been received after the MaxRcvTime period.

It is expected that the Energy Manager bases its decisions on the most up to date data acquired either when it is enabled or not. Hence, it will not act upon reception of a *nviLoadShedding* while it is disabled but it will use the last received one when it will be enabled.

6 Energy Manager (Object 1) Configuration Properties

6.1 *UCPTLev1Relays16*

Declaration	UCPTLev1Relays16 of type SNVT_state
Description	Used to indicate which relays are to be turned “off” when a level 1 load shed command is issued.
Valid range	Bit0 = relay 1, 0=turn off, 1=do not change state ... Bit15 = relay 16, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Mandatory

6.2 UCPTLev1Relays32

Declaration	UCPTLev1Relays32 of type SNVT_state
Description	Used to indicate which relays are to be turned "off" when a level 1 load shed command is issued.
Valid range	Bit0 = relay 17, 0=turn off, 1=do not change state ... Bit15 = relay 32, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Optional (for boards with more than 16 relays only)

6.3 UCPTLev2Relays16

Declaration	UCPTLev2Relays16 of type SNVT_state
Description	Used to indicate which relays are to be turned "off" when a level 2 load shed command is issued.
Valid range	Bit0 = relay 1, 0=turn off, 1=do not change state ... Bit15 = relay 16, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Mandatory

6.4 UCPTLev2Relays32

Declaration	UCPTLev2Relays32 of type SNVT_state
Description	Used to indicate which relays are to be turned "off" when a level 2 load shed command is issued.
Valid range	Bit0 = relay 17, 0=turn off, 1=do not change state ... Bit15 = relay 32, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Optional (for boards with more than 16 relays only)

6.5 UCPTLev3Relays16

Declaration	UCPTLev3Relays16 of type SNVT_state
Description	Used to indicate which relays are to be turned "off" when a level 3 load shed command is issued.
Valid range	Bit0 = relay 1, 0=turn off, 1=do not change state ... Bit15 = relay 16, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Mandatory

6.6 UCPTLev3Relays32

Declaration	UCPTLev3Relays32 of type SNVT_state
Description	Used to indicate which relays are to be turned "off" when a level 3 load shed command is issued.

Valid range	Bit0 = relay 17, 0=turn off, 1=do not change state ... Bit15 = relay 32, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Optional (for boards with more than 16 relays only)

6.7 UCPTLev4Relays16

Declaration	UCPTLev4Relays16 of type SNVT_state
Description	Used to indicate which relays are to be turned “off” when a level 4 load shed command is issued.
Valid range	Bit0 = relay 1, 0=turn off, 1=do not change state ... Bit15 = relay 16, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Mandatory

6.8 UCPTLev4Relays32

Declaration	UCPTLev4Relays32 of type SNVT_state
Description	Used to indicate which relays are to be turned “off” when a level 4 load shed command is issued.
Valid range	Bit0 = relay 17, 0=turn off, 1=do not change state ... Bit15 = relay 32, 0=turn off, 1=do not change state
Structure details	Unsigned bit0 to bit15
Default Value	All bits at 1
Scope	Optional (for boards with more than 16 relays only)

The following example illustrates that more and more relays will be prevented to turn “on” as the load shed level command is increased from level 1 to level 4. Note that even a relay that is asked to remain “off” in level 1,2, and 3 can be “on” at level 4 if desired (e.g: b3):

	b0	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15
Lev 1	1	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1
Lev 2	1	1	0	0	0	1	0	1	1	1	1	1	0	1	0	1
Lev 3	1	0	0	0	0	1	0	1	1	1	1	1	0	0	0	1
Lev 4	0	0	0	1	0	0	0	1	1	1	1	0	0	0	0	0

6.9 SCPTmaxRcvTime

Declaration	SCPTmaxRcvTime of type SNVT_time_sec (48)
Description	Used to consider nviLoadShedding stale (0%,0) if it has not been received after the heartbeat time.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	300 sec (5 mins)
Scope	Mandatory

The receive heartbeat timer is restarted every time nviLoadShedding is received. A value of 0 for SCPTmaxRcvTime is used to indicate the nviLoadShedding is never considered stale

and shall always be acted upon. When this CP is set to 0, then the last value of nviLoadShedding received shall be acted upon.

7 Photocell (Object 2) Variables

7.1 *nviLuxLevel*

Declaration	Network input SNVT_lux
Description	Intensity level of light detected by the remote photocell
Valid range	0..65535 lux
Default Value	0
Action when received	calculate “Day” or “Night” based on the LuxSetpoint, OnOffHyster and the Day and Night delays.
Scope	Mandatory

You can expect the external Photocell node to periodically refresh this input variable. This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received. The value shall be ignored (considered stale) if it has not been received after the MaxRcvTime period. A stale value means that the photocell object cannot be combined with a schedule. In this case, simply follow the schedule whether LightLogic is “AND” or “OR”.

It is expected that the Photocell object bases its decisions on the most up to date data acquired either when it is enabled or not. Hence, it will not act upon reception of a *nviLuxLevel* while it is disabled but it will use the last received one when it will be enabled.

8 Photocell (Object 2) Configuration Properties

8.1 *SCPTluxSetpoint*

Declaration	SCPTluxSetpoint of type SNVT_lux (82)
Description	if <i>nviLuxLevel</i> is above (Luxsetpoint + OnOffHyster) for a certain time than it is day. if <i>nviLuxLevel</i> is below (LuxSetpoint – OnOffHyster) for a certain time than it is night.
Valid range	0..65535
Default Value	100
Scope	Mandatory

8.2 *UCPTOnOffHyster*

Declaration	UCPTOnOffHyster of type SNVT_lux
Description	if <i>nviLuxLevel</i> is above (Luxsetpoint + OnOffHyster) for a certain time than it is day. if <i>nviLuxLevel</i> is below (LuxSetpoint – OnOffHyster) for a certain time than it is night.
Valid range	0..65535
Default Value	80
Scope	Mandatory

8.3 *UCPTDayDelay*

Declaration	UCPTDayDelay of type SNVT_time_sec
Description	The <i>nviLuxLevel</i> must be continuously greater than LuxSetpoint + OnOffHyster during the delay period before the photocell can conclude that it

	is day.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	300 sec (5 mins)
Scope	Mandatory

We do not expect the delay feature to be more precise than +/- 1 second.

8.4 UCPTNightDelay

Declaration	UCPTNightDelay of type SNVT_time_sec
Description	The nviLuxLevel must be continuously smaller than LuxSetpoint – OnOffHyster during the delay period before the photocell can conclude that it is night.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	300 sec (5 mins)
Scope	Mandatory

We do not expect the delay feature to be more precise than +/- 1 second.

8.5 SCPTmaxRcvTime

Declaration	SCPTmaxRcvTime of type SNVT_time_sec (48)
Description	Used to consider nviLuxLevel stale if it has not been received after the heartbeat time.
Valid range	0 to 6553.4 by steps of 0.1s
Default Value	300 sec (5 mins)
Scope	Mandatory

The receive heartbeat timer is restarted every time nviLuxLevel is received. A value of 0 is used to indicate the nviLuxSetpoint is never considered stale and shall always be acted upon. When this CP is set to 0, then the last value of nviLuxLevel received shall be acted upon.

9 Relay Group (Objects 3 to 8) Variables

This paragraph applies equally to all 6 Relay Group objects in the lighting relay controller node. All nvis are ignored when the Relay Group object is disabled. When it is re-enabled, it will act on the nvis it receives.

9.1 *nviGrpOccup*

Declaration	Network input SNVT_occupancy nviGrpOccupX (X=1 to 6)
Description	Indicates that the relay group should be turned “on” if an occupied value is received from an occupancy sensor. Otherwise follow the temporary override command or schedule command.
Valid range	OC_OCCUPIED, OC_BYPASS = occupied OC_UNOCCUPIED, OC_STANDBY, OC_NUL = unoccupied.
Default Value	OC_UNOCCUPIED
Action when received	If occupied, Immediately turn “on” group relays. If a maintenance override is in effect (Now < OvrEndTime), occupied is ignored. If a load shed command is active, certain relays of the group will remain “off”.
Scope	Mandatory

This variable will be sent at regular intervals from the occupancy sensor. We consider an occupied signal as a signal to turn “on” the relay group. This is not to be acted upon if a maintenance override is in effect. If a load shed command is in effect, certain relays of the group may remain “off” even if we receive an occupied signal.

This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received. Every time an “occupied” value is received, the hold on timer is restarted according to the value of HoldTime. The “occupied” value will become stale only after the expiration of the HoldTime. The value shall be considered “unoccupied” if it is no longer received after the expiration of the HoldTime. The value shall be considered “unoccupied” if the HoldTime is set to the undefined value of 6553.5 seconds.

9.2 *nviGrpOvrd*

Declaration	Network input SNVT_switch nviGrpOvrdX (X= 1 to 6)
Description	Indicates that a temporary override is required. The relay group should be turned “on” or “off” for a pre-determined duration.
Valid range	Value: 0 .. 100 State: 0 (off) or 1 (on), 0xFF (undefined)
Structure details	Unsigned value Signed state
Default Value	(0%, 0) (off)
Action when received	Override the relay group state immediately. Do not do anything if a maintenance override is in progress or if the area is occupied. Certain relays may not turn “on” if a load shedding command is active.
Scope	Mandatory

This variable will be received only when the user presses the LonMark switch or asks for a temporary override from the MT Alliance user interface. The LonMark switch will be a momentary contact that will toggle the current relay group state. In order to work, the LonMark switch has to be fed back the current relay group state. Furthermore, the LonMark switch must not have a send heartbeat feature activated.

This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received. Accept all (xxx%, 0) as “off” and all (xxx%, 1) as “on”. Ignore all the following values (xxx%, 0xFF).

9.3 nviSchedule

Declaration	Network input SNVT_lev_disc nviScheduleX (X= 1 to 6)
Description	Used to receive a command coming from a 7 day schedule.
Valid range	ST_OFF, ST_LOW, ST_MED, ST_HIGH, ST_ON, ST_NUL (ST_OFF = off, ST_NUL = ignored (no action) ST_LOW, ST_MED = use Set1 or Set2 if EvenWear is TRUE ST_LOW, ST_MED = on if EvenWear is FALSE ST_ON, ST_HIGH = on)
Default Value	ST_OFF
Action when received	Set the relay group state according to the value received. Do not do anything if a maintenance override is in progress or if the area is occupied or if a temporary override is in progress. Certain relays may not turn “on” if a load shedding command is active.
Scope	Mandatory

This variable will be sent periodically by the external scheduler node. This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received. If LOW or MED is received and EvenWear is TRUE the following can happen:

- if the previous group state was OFF than the set with the lowest runtime is turned “on”
- if the previous group state was ON than the set with the highest runtime is turned “off”

9.4 nvoGrpFb

Declaration	Network output SNVT_switch nvoGrpFbX (X= 1 to 6)
Description	State of current relay group.
Valid range	9.4.1.1.1 (100%, 1)=on (0%, 0)=off
Structure details	Unsigned value Signed state
Default Value	(0%, 0)
When transmitted	Every time the state of the relay group changes. If the state does not change, it shall be output every MaxSendTime.
Scope	Mandatory

This variable will be sent every time the relay group state changes whatever the reason (maintenance override, group occupancy change, temporary override or schedule change). The value at power up must not be transmitted until the relay group state is known. A group state of “low/med” is reflected as “on” for this nvo.

10 Relay Group (Objects 3 to 8) Configuration Properties

This paragraph applies equally to all 6 Relay Group objects in the lighting relay controller node.

10.1 SCPTlocation

Declaration	SCPTlocation of type SNVT_str_asc (17)
Description	Provides description information about the relay group.

Valid range	A NUL terminated ASCII string of 31 bytes (including the NUL)
Default Value	"Relay Group X" where X=1 to 6
Action when received	None.
Scope	Mandatory

Since the LRC node itself is usually located in the mechanical room, this description will be used to name the relay group such as: "back store", "offices", "parking lot", etc.

10.2 UCPTSet1Relays16

Declaration	UCPTSet1Relays16 of type SNVT_state
Description	Indicates which relays belong to the first set of the group.
Valid range	bit 0 = relay 1 bit 15 = relay 16 1= belongs to the first set of this group. 0= does not belong to the first set of this group.
Default Value	all 0s
Action when received	Turn "on" or "off" all relays in the group according to the present group state (except for those under load shed command). The state of the relays that are no longer part of the group shall remain unchanged
Scope	Mandatory

This CP tells the group that these relays belong to the first set. The first set of relays is always ORED with the second set when EvenWear is False. It is the responsibility of the configuration tool to ensure that a given relay is not assigned to multiple relay groups.

10.3 UCPTSet1Relays32

Declaration	UCPTSet1Relays32 of type SNVT_state
Description	Indicates which relays belong to the first set of the group.
Valid range	bit 0 = relay 17 bit 15 = relay 32 1= belongs to the first set of this group. 0= does not belong to the first set of this group.
Default Value	all 0s
Action when received	Turn "on" or "off" all relays in the group according to the present group state (except for those under load shed command). The state of the relays that are no longer part of the group shall remain unchanged
Scope	Optional

This CP tells the group that these relays belong to the first set. The first set of relays is always ORED with the second set when EvenWear is False. It is the responsibility of the configuration tool to ensure that a given relay is not assigned to multiple relay groups.

10.4 UCPTSet2Relays16

Declaration	UCPTSet2Relays16 of type SNVT_state
Description	Indicates which relays belong to the second set of the group.
Valid range	bit 0 = relay 1 bit 15 = relay 16 1= belongs to the second set of this group. 0= does not belong to the second set of this group.
Default Value	all 0s
Action when received	Turn "on" or "off" all relays in the group according to the present group state (except for those under load shed command). The state of the relays that

	are no longer part of the group shall remain unchanged
Scope	Mandatory

This CP tells the group that these relays belong to the second set. The first set of relays is always ORED with the second set when EvenWear is False. It is the responsibility of the configuration tool to ensure that a given relay is not assigned to multiple relay groups.

10.5 UCPTSet2Relays32

Declaration	UCPTSet2Relays32 of type SNVT_state
Description	Indicates which relays belong to the second set of the group.
Valid range	bit 0 = relay 17 bit 15 = relay 32 1= belongs to the second set of this group. 0= does not belong to the second set of this group.
Default Value	all 0s
Action when received	Turn "on" or "off" all relays in the group according to the present group state (except for those under load shed command). The state of the relays that are no longer part of the group shall remain unchanged
Scope	Optional

This CP tells the group that these relays belong to the second set. The first set of relays is always ORED with the second set when EvenWear is False. It is the responsibility of the configuration tool to ensure that a given relay is not assigned to multiple relay groups.

10.6 UCPTEvenWear

Declaration	UCPTEvenWear of type SNVT_count
Description	Indicates if the group will alternate between two sets of relays or only simply "or" both sets as if it was a single set.
Valid range	0= no evenwear, use both sets as a single set 1= evenwear, alternate between the two sets of relays according to their corresponding runtimes.
Default Value	0
Action when received	If was 1 and 0 is received, then set all the relays of set1 and set 2 according to the desired group state. If it was 0 and 1 is received, set all relays of set 1 according to the desired group state and start counting run time of the set that is on when the schedule command is low/med
Scope	Mandatory

The runtime of each set must be kept in non-volatile memory. However it is not recommended to write to the flash continuously. If the runtime can be measured with a precision of +/- 1 min for each set transition, that means that every day the number can increase up to 24 x 60 min = 1440 min. That counter can be in RAM. It is acceptable that the daily minute counter be lost if the node is reset. When the day changes, the daily counter can be stored in non-volatile memory (added with the previous value of the non-volatile daily counter). This means we can keep track of about 45 days of runtime (which can be much more than 45 calendar days) for each set. When the non-volatile daily counter gets too close to its wrap-around value of 65535, then both set runtime counters can be reset simultaneously. Before deciding which set to turn "on" or which set to turn "off", the non-volatile counter of each set must be added with their respective RAM counters to get an exact runtime at the moment the decision is taken. There is no point in totaling On/High runtime because both sets are always on.

10.7 UCPTOvrValue

Declaration	UCPTOvrValue of type SNVT_switch
Description	This is the maintenance override value as requested by the MT Alliance. This feature is not expected to be used very often which is why CPs in non-volatile memory are used.
Valid range	(xxx%, 1)= on, (xxx%, 0)= off, (xxx%,0xFF) is ignored
Default Value	(0%, 0)
Action when received	If (Now < OvrEndTime) than the relay group state becomes the OvrValue.
Scope	Mandatory

The system time must have been received before this feature can be acted upon.

10.8 UCPTOvrEndTime

Declaration	UCPTOvrEndTime SNVT_time_stamp
Description	Indicates the end time of the maintenance override value. For a permanent override, this value is received as (Now + 100 years).
Valid range	2000-01-01 00:00:00 to 2150-01-01 23:59:59.
Default Value	2000-01-01 00:00:00
Action when received	If (Now < OvrEndTime) than the relay group state becomes the OvrValue.
Scope	Mandatory

It is important that when transmitting a new maintenance override, the override value CP be transmitted before the override end time CP so as not to cause any unwanted flicker of the relays. If the override end time is received while a maintenance override is currently in progress, the new end time is expected to be acted upon immediately. The system time must have been received before this feature can be acted upon.

10.9 SCPTmanOvrTime

Declaration	SCPTmanOvrTime of type SNVT_time_min (35)
Description	When the nviGrpOvr is received ("on" or "off"), the desired temporary override value is maintained for the number of minutes specified by this CP. If a new value of nviGrpOvr is received, the timer is restarted.
Valid range	0..1440 minutes (0 to 24 hours). A value > 1440 will be considered = 1400.
Default Value	15 minutes
Action when received	None
Scope	Mandatory

A value of 0 can be used to disable the temporary override feature. If the temporary override time is changed while a temporary override is in progress, the LRC is not expected to immediately use the new duration. Upon receiving the next nviGrpOvr value however, it is expected that the new duration will take effect.

10.10 UCPTLightLogic

Declaration	UCPTLightLogic of type SNVT_count
Description	Indicates how the photocell is to be used with this relay group
Valid range	0= do not use photocell 1= photocell AND schedule 2= photocell OR schedule
Default Value	0
Action when received	The schedule is expected to be combined with the photocell to create a

	desired relay group state upon the next reception of the nviSchedule variable.
Scope	Mandatory

The resulting desired group state can be: “off”, “low/med” or “on”. “low/med” is to be treated as “on” when EvenWear is False.

10.11 SCPTHoldTime

Declaration	SCPTHoldTime of type SNVT_time_sec (91)
Description	Set the hold time value before considering that the area is unoccupied. The HoldTime timer is retriggered each time an “occupied” value is received from the sensor.
Valid range	1.0 to 6553.4 by steps of 0.1s
Default Value	300 sec (5 mins)
Action when received	The “occupied” nviGrpOccup shall be considered stale only after the HoldTime has expired.
Scope	Mandatory

The resolution of 0.1 sec is used only to follow the existing LonMark lighting profiles. We are expecting the LRC to have a hold time precision of +/- 1 second.

A mechanism to ignore the nviGrpOccup is also required. Since a value is 0 is not allowed for SCPTHoldTime, we will use a value of 6553.5 sec (undefined).

11 Relay (Objects 9 to 32) Variables

This paragraph applies equally to all 8, 16 or 24 Relay objects in the lighting relay controller node. Some features below are optional.

11.1 nviRelayCmd

Declaration	Network input SNVT_switch nviRelayCmdX (X= 1 to 8)
Description	Used to turn a relay “on” or “off”. Applies only for orphan relays (relays that are not a member of a group).
Valid range	(xxx%, 0) = off (xxx%, 1) = on where xxx = don't care
Default Value	(0%, 0)
Action when received	Immediately turn the relay “on” or “off”. If a load shed command is active, the relay may not turn “on”.
Scope	Optional

This variable will only be implemented on boards with less than 16 relays. Otherwise we will run out of SNVTs on the node.

This command is to be completely ignored as soon as a relay is assigned to a relay group. This variable shall be acted upon whether it is bound or not. The value shall be ignored on initial power-up until a value is received.

11.2 nvoRelayFb

Declaration	Network output SNVT_switch nvoRelayFbX (X= 1 to 8,16,24)
Description	Report the current state of the relay.

Valid range	(0%, 0)=off, (100%,1)=on
Structure details	Unsigned value Signed state
Default Value	(0%, 0)
Scope	Mandatory

This network variable must immediately reflect the status of the relay upon power-up or reset. The only two values allowed are: (0%, 0) and (100%, 1). If the relay status cannot be established at power-up, then return (0%, 0).

12 Relay (Objects 9 to 32) Configuration Properties

This paragraph applies equally to all 8, 16 or 24 Relay objects in the lighting relay controller node.

12.1 SCPTlocation

Declaration	SCPTlocation of type SNVT_str_asc (17)
Description	Provides description information about the relay.
Valid range	A NUL terminated ASCII string of 31 bytes (including the NUL)
Default Value	"Relay X" where X=1 to 8,16,24
Action when received	None.
Scope	Optional

This will be used to provide a description of the purpose of this relay such as: "back store", "meat prep room", etc.

13 Constraints

The following development constraints are imposed:

- The node software must support two domains
- The node must support 15 address table entries
- The node has to be compiled with the maximum number of aliases possible. A minimum of 16 is required for proper operation due to the fan-out of nvoGrpFb.
- The node software must allow a physical method to unconfigure the node. (e.g.: by holding the service pin down for at least three seconds after power-up)
- The node software must allow a physical method to identify when the node is on-line
- The node software must allow a physical method to identify when the node is winked. That method must last at least 60 seconds after the wink command is issued.
- The XIF and XFB must be provided to Micro Thermo. If the hardware allows the program to be downloaded, then the APB must be provided.
- Provide ENU, FMT, FPT and TYP files for the CPs
- All CPs flags byte are 80 (no restrictions for reading and writing)
- All CPs are to be retained in non-volatile memory
- The self documentation must be filled according to LonMark 3.1 guidelines so that all objects, their variable and their CPs can be properly associated.
- The Program ID shall be: "xx:xx:xx:xx:xx:xx:04:xx" so that the transceiver id = free-topology.

14 Network Bandwidth Control Parameters

This section summarizes the effect of the various network bandwidth control parameters and their associated network variables.

14.1 Network Variable Outputs

All output network variables must be controlled through a set of network bandwidth control parameters. For each nvo, the table below indicates the associated CP name and its default value.

Nvo name	Min Send Time	Max Send Time
nvoStatus	n/a	n/a
nvoReset	n/a	n/a
nvoFileDirectory	n/a	n/a
nvoGrpFbX	n/a	SCPTmaxSendTime (120s)
nvoRelayFbX	n/a	SCPTmaxSendTime (120s)

14.2 Network Variable Inputs

All input network variables that are ignored if they are not received periodically must be parameterized with a receive heartbeat. For each nvi, the table below indicates the associated CP name and its default value.

Nvi name	Receive Heartbeat
nviRequest	n/a
nviTimeSet	n/a
nviLoadShedding	Energy Manager SCPTmaxRcvTime (300s)
nviLuxLevel	Photocell SCPTmaxRcvTime (300s)
nviGrpOccupX	Relay Group SCPTholdTime (300s)
nviGrpOvrX	Relay Group SCPTmanOvrTime (15m)
nviScheduleX	n/a
nviRelayCmdX	n/a

15 Additional Information

15.1 Precedence clarification

To make things clearer, the following paragraph details the order of precedence (from highest to lowest) of each of the Relay Group features. To determine if a relay group should be “on” or “off” the following precedence applies:

- A maintenance override in effect ($\text{Now} < \text{OvrEndTime}$). The relay group is “on” if the OvrValue is “on”. The relay group is “off” if the OvrValue is “off”.
- If the group occupancy indicates “occupied” then relay group is turned “on”. If it indicates “unoccupied”, then follow the precedence below.
- If a temporary override command has been received and $\text{Now} < (\text{receive time} + \text{manOvrTime})$ then the relay group state changes according to the group override command (on or off)
- The schedule command is acted upon. If the Photocell object is enabled and if the LightLogic is “AND” or “OR” and if the LuxLevel value is not stale (exceeds the receive heartbeat) then the “Day” or “Night” calculated value of the photocell is combined with the schedule command according to the selected LightLogic.

A particular relay can remain “off” even if the above precedence rules has determined a value of “on”. If the Energy Manager object is enabled and if a load shed request other than 0 has been received and it is not stale, then certain relays of the group shall remain “off” even if the group state determine above is “on”.

15.2 Refreshing the Relays

It is expected that whenever there is a group state change (or a set state change) from “off” to “on”, or from “on” to “off”, that all relays associated with this group (or set) are refreshed by the LRC software. Relays are not expected to be refreshed when there is no change in group state. This means that it is possible to physically toggle an individual relay within the panel and it will keep that position until the next group state change (or set state change).

Furthermore, the relation between a group and its relays is unidirectional. A change in the group refreshes the relays but a change locally at the relay does not affect the group. The group can be OFF and someone can set all its relays to ON and the group state will still be OFF. In other words, the group does not rely on the status of its relays to determine its state, its state is determined by the changes in its network variable inputs only.

15.3 Upon reset

Upon reset, the LRC shall not change the state of any relay until a nviTimeSet is received. Otherwise, it would be possible to defeat a temporary override. This means that if there is a problem with the data line and the LRC is reset, no lights will change until the problem with the data line is fixed and a valid system time is received.

Another problem that can occur is the order in which nvis can be received. The nodes that send nviLoadShedding , nviLuxLevel , nviGrpOccup , nviGrpOvr and nviSchedule are inherently asynchronous. When the LRC node is reset, it can receive these nvis in any order. The problem is that these nvis have a precedence level and therefore react differently according to the order in which they are received.

For this reason, after a reset, the LRC shall listen and remember the values of nviLoadShedding, nviLuxLevel, nviGrpOccup, nviGrpOvrd and nviSchedule during SCPTpwrUpDelay. Internally the node will determine the precedence level but will not actually change the state of the group and the state of the relays. When SCPTpwrUpDelay has elapsed and if nviTimeSet was received then the LRC shall update the group and relay state. So the order in which the nvis have been received will no longer matter. For this to work, we expect the sending nodes to have a send heartbeat feature of 1 minute or less.

15.4 Final Notes

The temporary override using a LonMark switch will only work if the LonMark switch has implemented the following optional items : nviSwitchFb and MaxSendTime. However, nviSwitchFb is not required if the override switch will be used to turn on only, or turn off only.