MIMO2+, Multiple Input – Multiple Output Module
Technical Appendix

Z-Wave™ INFORMATION

Node Information Frame (NIF): Always listening flag set, Optional functionality flag set
Manufacturer ID 0x0084
Product ID varies

Device Type / Supported Command Classes - Root Device
Generic Device Type: GENERIC_TYPE_SENSOR_MULTILEVEL
Specific Device Type: SPECIFIC_TYPE_NOT_USED

COMMAND_CLASS_ZWAVEPLUS_INFO_V2
COMMAND_CLASS_VERSION_V2
COMMAND_CLASS_MANUFACTURER_SPECIFIC_V2
COMMAND_CLASS_DEVICE_RESET_LOCALLY_V1
COMMAND_CLASS_ASSOCIATION_GRP_INFO (Info about Root Associations)
COMMAND_CLASS_ALARM_V2 (Power Management alarm handling)
COMMAND_CLASS_ASSOCIATION_V2 (Refer to Association Section)
COMMAND_CLASS_MULTI_CHANNEL_ASSOCIATION_V3 (Refer to Association Section)
COMMAND_CLASS_POWERLEVEL
COMMAND_CLASS_BASIC (Sets or resets REL1)
COMMAND_CLASS_SWITCH_BINARY (Sets or resets REL1)
COMMAND_CLASS_SENSOR_MULTILEVEL_V9 ('General Purpose Value' type for 12-bit ADC analog SIG1 input)
COMMAND_CLASS_CONFIGURATION
COMMAND_CLASS_SECURITY
COMMAND_CLASS_MULTI_CHANNEL_V4 (allows Endpoints to be commanded/status'ed)
COMMAND_CLASS_FIRMWARE_UPDATE_MD_V2

Device Type / Supported Command Classes - Endpoints 1 & 2 (SIG1 & SIG2)
Generic Device Type: GENERIC_TYPE_SENSOR_MULTILEVEL
Specific Device Type: SPECIFIC_TYPE_NOT_USED

COMMAND_CLASS_SENSOR_MULTILEVEL ('General Purpose Value' type for 12-bit ADC analog inputs)
COMMAND_CLASS_ASSOCIATION_GRP_INFO (Info about Endpoint Associations)
COMMAND_CLASS_ASSOCIATION_V2 (Basic Command Class SET sent if input is triggered/untriggered)
COMMAND_CLASS_MULTI_CHANNEL_ASSOCIATION_V3 (See Association Command Class above)

Device Type / Supported Command Classes - Endpoints 3 & 4 (REL1 & REL2)
Generic Device Type: GENERIC_TYPE_SWITCH_BINARY
Specific Device Type: SPECIFIC_TYPE_NOT_USED

COMMAND_CLASS_SWITCH_BINARY (Sets or resets REL1 or REL2)
COMMAND_CLASS_BASIC (Sets or resets REL1 or REL2)
COMMAND_CLASS_ASSOCIATION_GRP_INFO (Info about Endpoint Associations)

Device Configuration

COMMAND_CLASS_CONFIGURATION (all parameters, except the signal thresholds, are one byte values)

- Parameters 1 and 2 are for output Relays only.
- Parameter 3-7 are for SIG1 input only
- Parameters 9-13 are for SIG2 input only.
- The thresholds (for parameters 4-7 and 10-13) are used for determining triggering and represent the upper 8 most-significant bits of a 12-bit value with the remaining lower 4 bits of threshold set to 0. These are used for comparison to the 12-bit Analog-to-Digital converted value to see if triggering conditions are met.

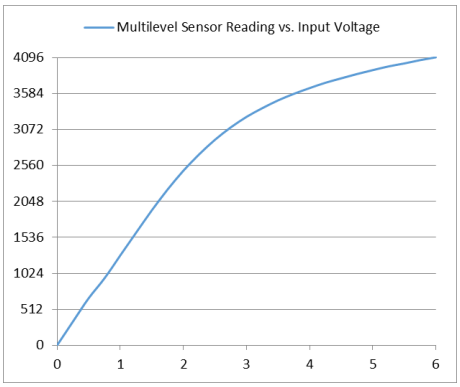
Configuration Command Class Parameters

PARAMETER	DESCRIPTION	DEFAULT VALUE	SIZE (bytes)	POSSIBLE VALUES
** Notes: 1) All configuration parameter values are 1 byte in size, except for the SIGx thresholds *which can be 1 byte or 2 bytes*. One byte allows for unsigned values from 0 to 255, signed values from -128 to 127, and hexadecimal values from 0x00 to 0xFF. If your Z-Wave controller uses signed values, see the **Calculating Threshold Values** section below to learn how to convert 1 byte values over 127 to their signed numerical value. 2) For the SIGx thresholds, any value from 0 to 4095 can be sent. However, because of the way the values are stored, the values are changed into the next lowest integer divisible by 16 and reported as such. For example, if parameter 4 is set as 2310, then it will be stored and reported as 2304. So, 2310/16=144.375; dropping the part to the right of the decimal results in 144*16=2304 being reported.				
1	REL1 Configuration • b7..b5: Input-to-Relay Mapping (REL1 Basic/Binary Switch commands ignored); see Relay Mapping section below • b4..b0: Momentary latch count (resolution 100ms, 0=non-momentary)	5 (=00000101b) No relay mapping; moment. latch for 0.5s	1	-128..127 (0x00..0xFF)
2	REL2 Configuration • b7..b5 Input-to-Relay Mapping (REL1 Basic/Binary Switch commands ignored); see Relay Mapping section below • b4..b0: Momentary latch count (resolution 100ms, 0=non-momentary)	5 (=00000101b) No relay mapping; moment. latch for 0.5s	1	-128..127 (0x00..0xFF)
3	SIG1 Multilevel Trigger Settings • b7: Trigger Between Thresholds (1=true) • b6: Periodic Sends (=0) or Send when Change-of-Trigger (=1) • b5-b0: Periodic Send Interval for Lifeline (30s resolution, 0=no periodic sends)	-88 (=10101000b) Trigger between; send every 20 minutes	1	-128..127 (0x00..0xFF)
4	SIG1 Lower Threshold, High (Unsigned value must be less than Upper Threshold Low and greater than Lower Threshold Low)	-112 (Unsigned Value = 144)	1	-128..127 (0x00..0xFF)
		2304	2	0..4095 (0x00..0xFFF)
5	SIG1 Lower Threshold, Low	-128 (Unsigned Value = 128)	1	-128..127 (0x00..0xFF)
		2048	2	0..4095

				(0x00..0xFFF)
6	SIG1 Upper Threshold, High	-1 (Unsigned Value = 255)	1	-128..127 (0x00..0xFF)
		4080	2	0..4095 (0x00..0xFFF)
7	SIG1 Upper Threshold, Low (Unsigned value must be greater than Lower Threshold High and less than Upper Threshold High)	-2 (Unsigned Value = 254)	1	-128..127 (0x00..0xFF)
		4064	2	0..4095 (0x00..0xFFF)
8	(not used)			
9	SIG2 Multilevel Trigger Settings • b7: Trigger Between Thresholds (1=true) • b6: Periodic Sends (=0) or Send when Change-of-Trigger (=1) • b5-b0: Periodic Send Interval for Lifeline (30s resolution, 0=no periodic sends)	-88 (=10101000b) Trigger between; send every 20 minutes	1	-128..127 (0x00..0xFF)
10	SIG2 Lower Threshold, High (Unsigned value must be less than Upper Threshold Low and greater than Lower Threshold Low)	-112 (Unsigned Value = 144)	1	-128..127 (0x00..0xFF)
		2304	2	0..4095 (0x00..0xFFF)
11	SIG2 Lower Threshold, Low	-128 (Unsigned Value = 128)	1	-128..127 (0x00..0xFF)
		2048	2	0..4095 (0x00..0xFFF)
12	SIG2 Upper Threshold, High	-1 (Unsigned Value = 255)	1	-128..127 (0x00..0xFF)
		4080	2	0..4095 (0x00..0xFFF)
13	SIG2 Upper Threshold, Low (Unsigned value must be greater than Lower Threshold High and less than Upper Threshold High)	-2 (Unsigned Value = 254)	1	-128..127 (0x00..0xFF)
		4064	2	0..4095 (0x00..0xFFF)

Analog Input Voltage Conversion (SIG1 and SIG2) and Triggering

The input signal voltage conversion to Multilevel Sensor value (ADC reading or count) is non-linear. We recommend use of the linear portion of the ADC values between 0V and 5V (this is where most of the sensors are outputting a voltage proportional to the signal measured). A typical conversion curve (SIG1 or SIG2 Input Voltage to ADC reading) is shown below. These are the values returned via the Multilevel Sensor report in response to a Multilevel Sensor Get request for a specific Endpoint. The conversion is a 12-bit conversion which allows values from 0 to 4095. Note: SIG1 and SIG2 will reach 4095 counts at or slightly below 6V.



Calculating Signed Threshold Values

The threshold values may be either 1 byte or 2 bytes as noted above. For setting the 1 byte threshold values, the lower four least-significant bits of the equivalent binary number are dropped so that the triggering configuration value is an 8-bit value (0 to 255 unsigned counts). For example, to set a trigger at approximately 2 Volts, the conversion will read approx. 2150 decimal counts. This corresponds to 866 hex counts. The corresponding trigger point would be 86 hex (8-bit) counts or 134 decimal (unsigned) because the lower 4 bits would be dropped. Since 134 is greater than 127 (refer to rules below), subtract 256 to obtain -122, which is the actual signed configuration parameter value.

Calculation from an unsigned count value greater than 127 to a negative parameter value
Parameter Value = Unsigned Value – 256

Calculation from a negative parameter value to unsigned count value …
Unsigned Value = Parameter Value + 256

(If the value is between 0 and 127, no conversion is necessary)

Triggering Notes

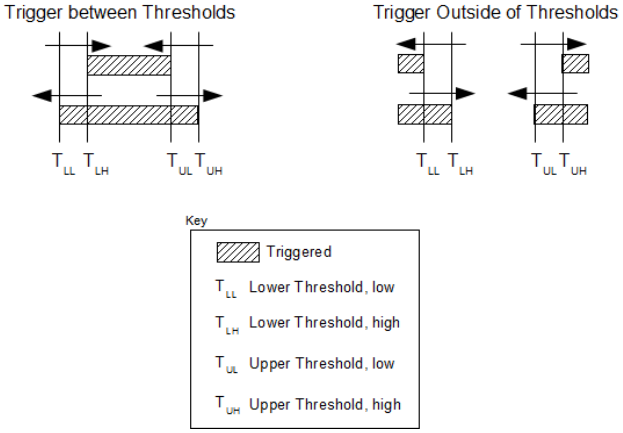
It is recommended to test triggering points using the Multilevel Sensor Command class to verify that configured trigger points correspond to the desired input voltage levels.

The default trigger configuration for the analog inputs, SIG1 and SIG2, is a threshold around 1.85V. That is, the inputs will trigger when the input is untriggered and the level goes above approximately 1.85V and will reset when the level is triggered and the level goes below approximately 1.60V.

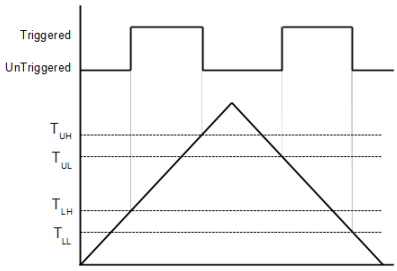
The trigger ranges for SIG1 and SIG2 are very flexible and can be changed to meet many application requirements. The triggering can be configured to trigger between two thresholds or outside of the two thresholds. Also, a hysteresis can be configured for each endpoint of the range so that the input is not constantly triggering and untriggering due to small changes in input voltage.

These triggering ranges are configured *for each endpoint* using the Configuration Command Class, Parameters 3 through 7 (SIG1) or Parameters 9 through 13 (SIG2). Refer to the Configuration Command Class Parameters section above for details about these parameters.

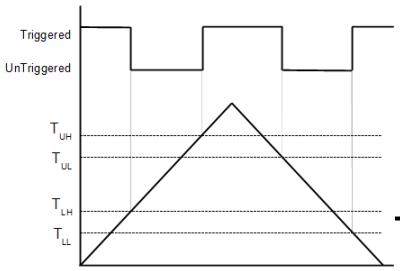
The following diagrams show the triggering ranges based on which way the input voltage is changing. For example, if 'Trigger between Thresholds' is enabled, then the input will trigger when the voltage rises across the T_{LH} threshold. Similarly, the input will 'untrigger' if already triggered and the voltage falls across the T_{LL} threshold.



The following diagrams illustrate another way of considering this triggering capability. The X-axis in these diagrams represent time passing (from left to right). The diagrams show the triggering state as the input voltage rises from zero to a certain point and then falls back to zero.



Trigger between Thresholds



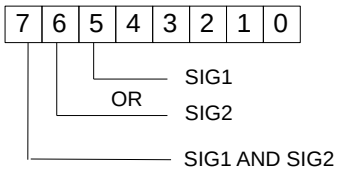
Trigger Outside of Thresholds

Input-to-Relay Mapping

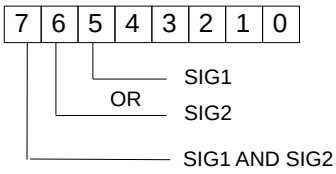
MIMO2+ or MIMO3 can be configured to automatically turn a relay on/off when an input or several inputs trigger or untrigger. The Configuration Command Class, Parameters 1 and 2, is used to set this mapping for REL1 and REL2, respectively. When this mapping is enabled, Z-Wave™ commands to set a relay are ignored or overridden and the relay state is determined by the hardware. The default for each relay is no input-to-relay mappings.

Each Relay mapping can be a logical (AND/OR) combination of the MIMO2+ inputs. Configuration Command Class parameters 1 and 2 are shown in the following diagrams. *Note that for each parameter, bits 0-4 settings are not shown below, but are the momentary latch count as described in the Configuration Command Class section above.* These parameters are one-byte parameters (as are all Configuration Command Class parameters).

Parameter 1: REL1



Parameter 2: REL2



EXAMPLES (where SIGx represents the input trigger state):

1) If all the bits are set for the REL1 configuration, then the mapping equation is:

   REL1 state = (SIG1 AND SIG2) OR SIG1 OR SIG2

   ⇨ REL1 is set if SIG1 is triggered or if SIG2 is triggered; cleared otherwise

2) If only bit 7 is set for the REL2 configuration, then the mapping equation is:

   REL2 state = SIG1 AND SIG2

   ⇨ REL2 is set if SIG1 and SIG2 are both triggered; cleared otherwise

3) If only bit 5 is set for the Relay 1 configuration, then the mapping equation is:

   REL1 state = SIG1

   ⇨ REL1 is set if SIG1 is triggered, cleared otherwise

POWER DROPOUT

A periodic Power Dropout status blink (see above indication table) is shown if the supplied power drops below approx. 11.5 Volts. In addition, the MIMO2+ implements the Alarm Command Class (Version 2), which provides for a 'power dropout' alarm report to be sent when the supplied power drops. By default, this report is enabled and sent to Node 1 (assumed to be the controller). It can be disabled or enabled by the command ALARM_SET_V2. The node sending the ALARM_SET_V2 command is the node to which the MIMO2+ sends the alarm report. After a power dropout alarm event, the MIMO2+ sends a 'power applied' alarm report when the supplied power rises above approx. 12 Volts. Also, during the power dropout, input signal triggering is not active.

For sending the alarm signal, the MIMO2+ relies on residual power in the MIMO2+ circuitry when power completely drops out. Typically, this will be sufficient to perform this action.