Interfacing the Shure® MX412D-MX418D Microphones with Polycom® SoundStructure®

Engineering Advisory 1023

Introduction

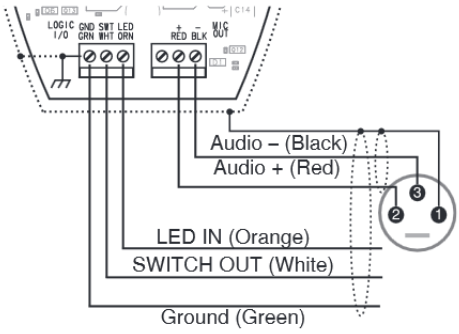
The MX400D Series Specification Sheet on the MX412 and MX418 website lists the following microphone options:

- **MX412D**: 304.8 mm (12 in.) desktop mini-condenser, goose-neck-mounted microphone.
- **MX418D**: 457.2 mm (18 in.) desktop mini-condenser, gooseneck-mounted microphone.

This engineering advisory provides information on using the MX412D/MX418D microphone. The other models listed on the MX412 and MX418 website do not contain any externally controllable logic.

Pinout and Logic Description

The following figure shows the pinout of the MX412D/MX418D microphone from the Shure MX400D Series User Guide.



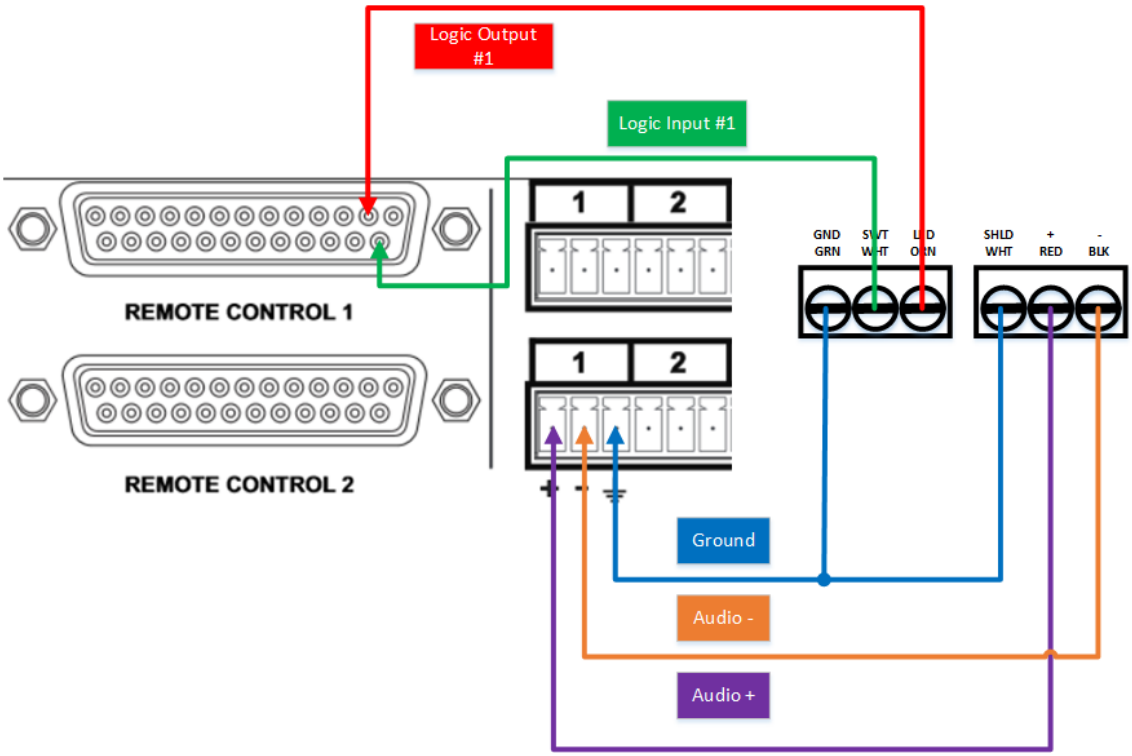
Green (LOGIC GROUND): Connects to the logic ground of an automatic mixer, switcher, or other equipment.

Orange (LED IN): Set DIP switch 3 on to use LED IN. When shorted to LOGIC GROUND, the LED turns on.

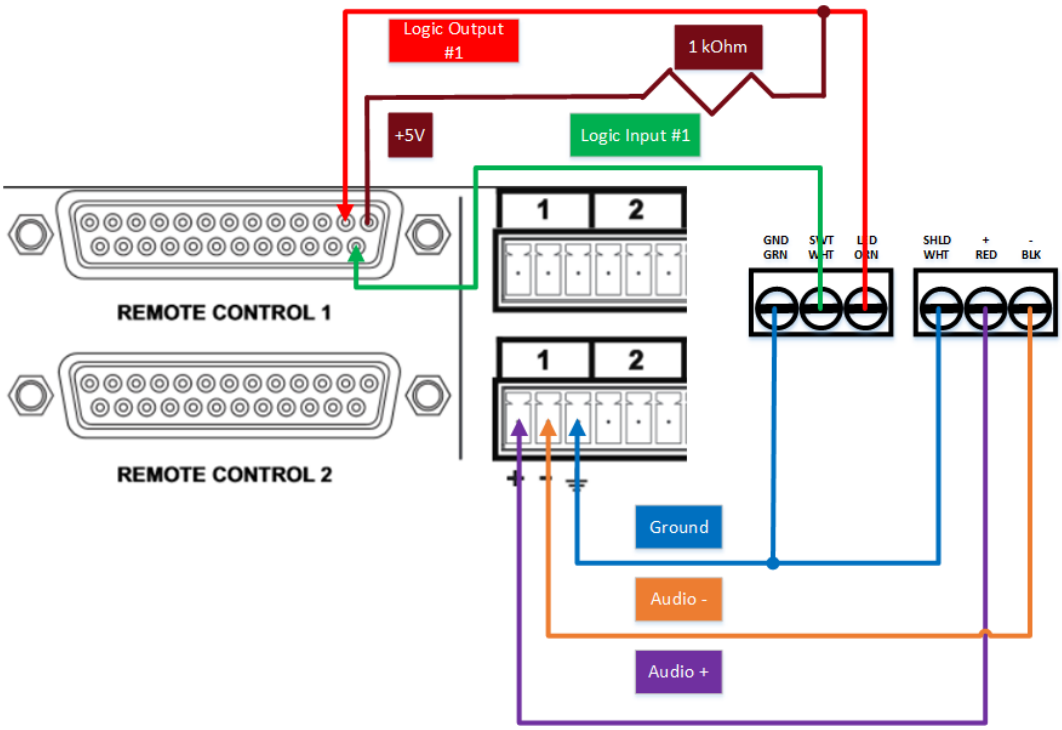
White (SWITCH OUT): Provides TTL logic (0 Vdc or 5 Vdc) in response to the mute button. Set DIP switch 1 for momentary or toggle. When phantom power is applied, logic initializes high (5 Vdc). DIP switch 2 has no effect on SWITCH OUT.

Wiring to SoundStructure

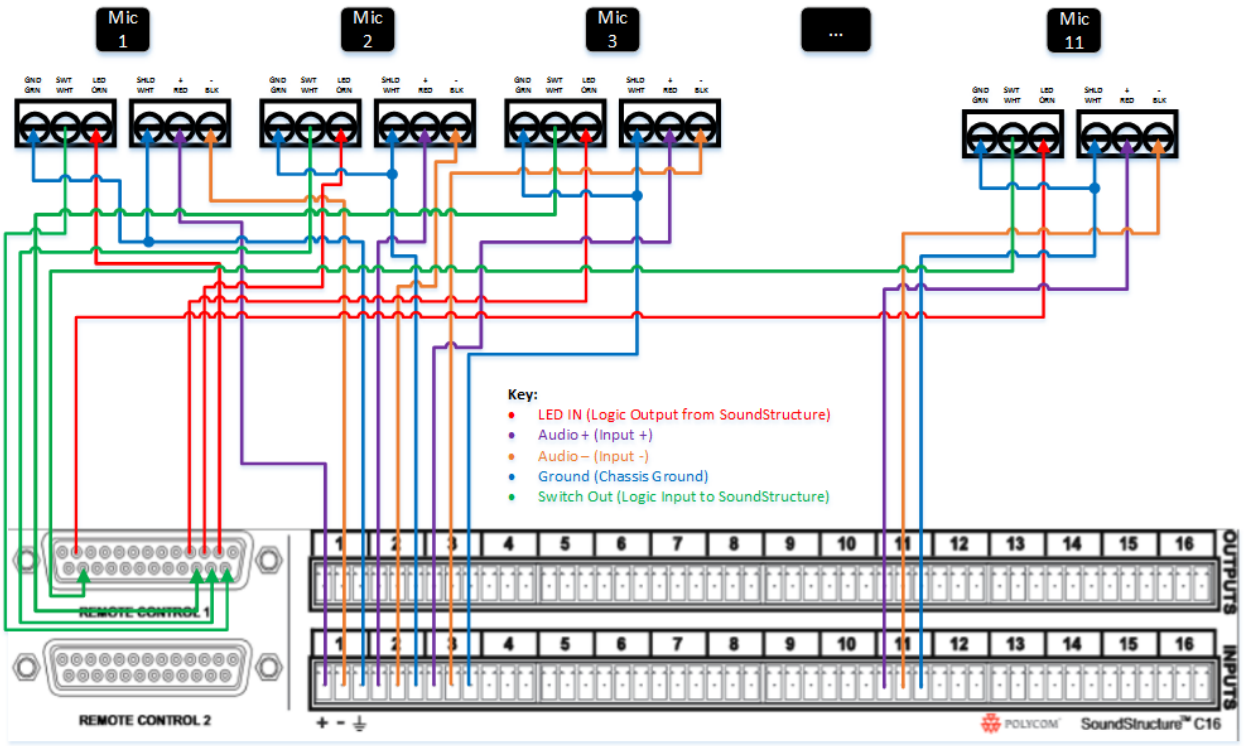
Each microphone needs to connect to a separate Analog channel and a separate Logic channel. In the following figure, the purple and orange signals represent the analog signals from the microphone. The ground signal in blue represents ground for both the analog and the logic signals. Optionally, one can tie the logic ground from the microphone ("GND GRN") to the Analog ground ("SHLD WHT"); however, the microphone will perform just as well without a connection to the logic ground as both grounds are tied together inside the microphone. Similarly, the logic ground and the Analog ground are also tied together inside the Polycom® SoundStructure® chassis.



According to the Shure MX400D Series User Guide, "When LED In is shorted to logic ground, the LED turns on". When the Logic Output is off or inactive, the LED In voltage is approximately +4V DC and this voltage keeps the Shure LED turned off. This condition should be valid for all MX412D/MX418D microphones that are connected to the SoundStructure logic port. If not, you can connect an optional pull-up resistor to the +5V pin on the logic port to ensure the Logic Output voltage returns to a known value when the Logic Output is open inside SoundStructure, as shown in the following figure.



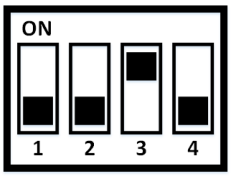
The following figure shows all required connections for up to 11 microphones connected to one logic port. The ground from the logic port is not needed as the internal mic grounds are tied together analog and logic grounds are also tied together inside the SoundStructure. Not shown in the following figure is the optional pull-up resistor to +5V, which is not needed to keep the LED In wire biased to +5V for proper operation.



MX412D/MX418D DIP Switch Configuration

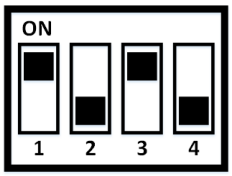
In order for the MX412D/MX418D microphone to work correctly with the SoundStructure, DIP Switch 3 needs to be enabled, as shown in the following figure.

After DIP Switch 3 is enabled, DIP Switch 1 controls the Momentary or Toggle capability of the internal switch, as shown in the following figure.



Momentary
(DIP Switch 1 Disabled):

Push = 0V DC
Release = +5V DC



Toggle
(DIP Switch 1 Enabled):

Initial = +5V DC
Push = 0V DC

SoundStructure Configuration

After the mics are wired to the chassis, use SoundStructure Studio to configure the chassis. Note that the process is the same regardless of the number of microphones or the number of chassis linked via One Big Audio Matrix (OBAM).

Example SoundStructure Microphone Configuration

This example configuration is designed to illuminate the LED when the mute is off and disabled in the SoundStructure, which presents the microphone as on when the LED is on. When the LED is off, then the mute is on and enabled in the SoundStructure, which presents the microphone as off when the LED is off.

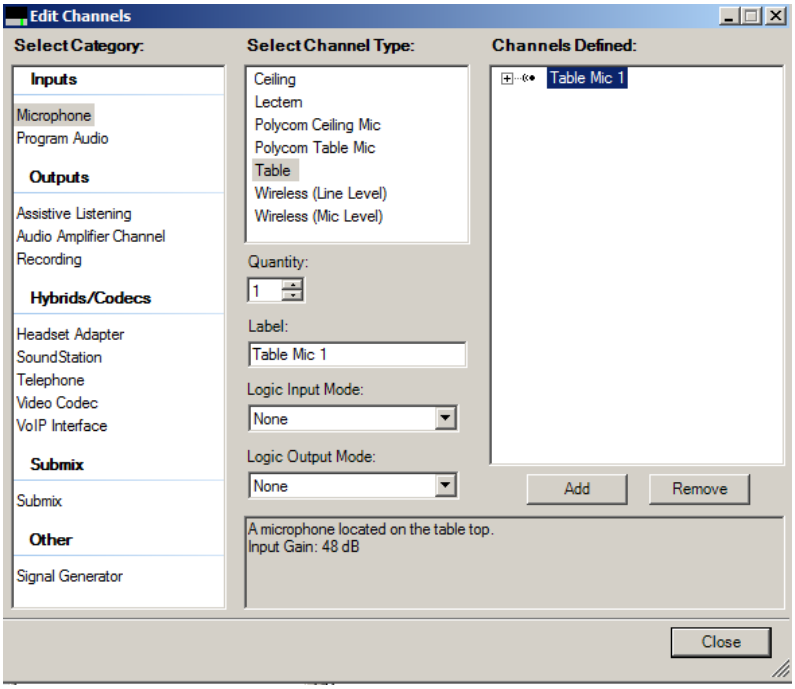
This example configuration also works Momentary and Toggle operation.

In this example, we are adding a Table Mic. Optionally, you could change the Logic Input and Logic Output Modes to populate the Logic and Events quicker. In this engineering advisory, these steps are done manually so as to better explain what is needed to make the design work.

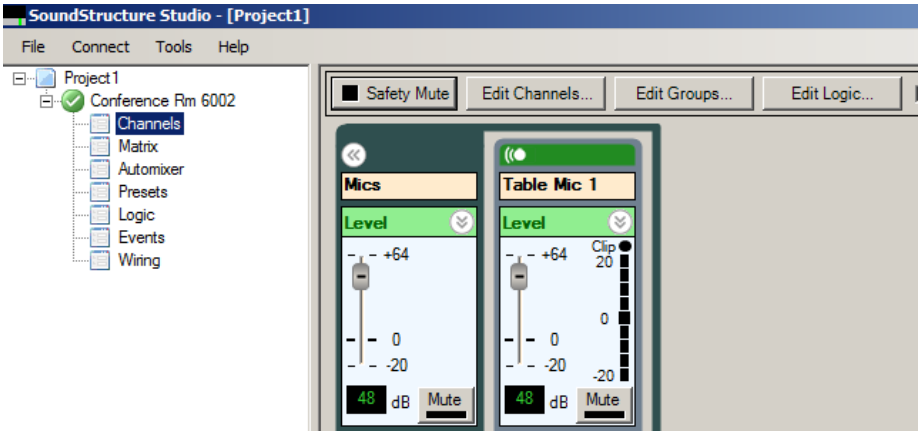
To configure microphones for SoundStructure:

1. Select a **Channel Type** and click **Add**.

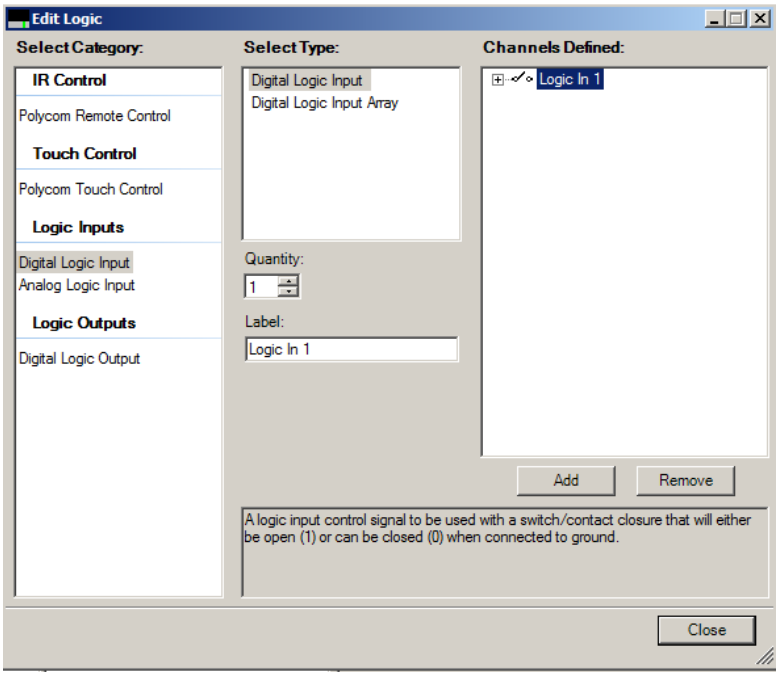
The microphone is displayed in the **Channels Defined** box, as shown next.



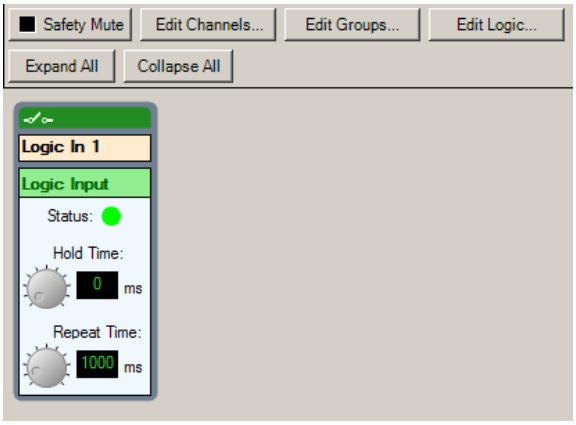
2 Navigate to the **Channels** page and verify that *Table Mic 1* was added.



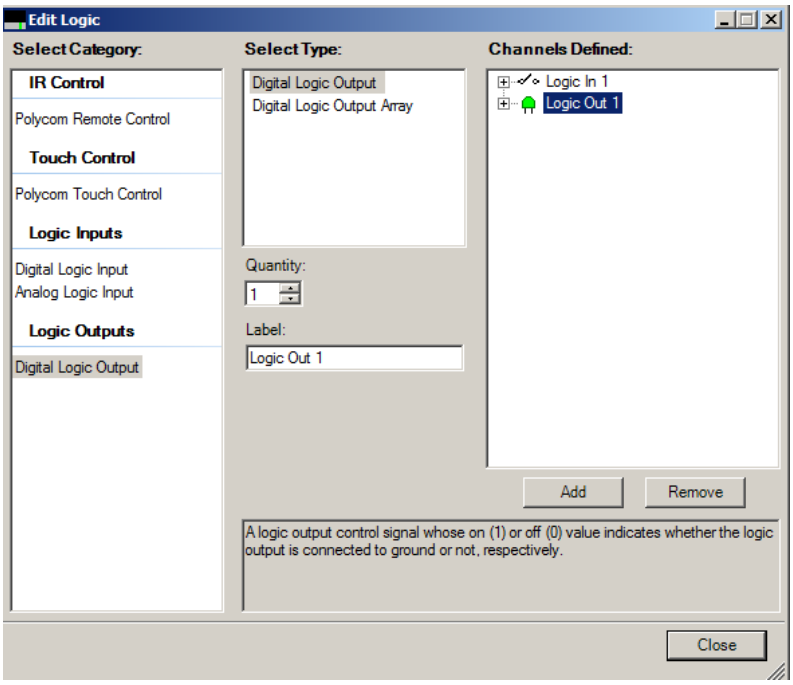
3 Click the **Edit Logic** button at the top of the page, and add a **Digital Logic Input** into the system. In the following figure, the label is changed to *Logic Input 1*.



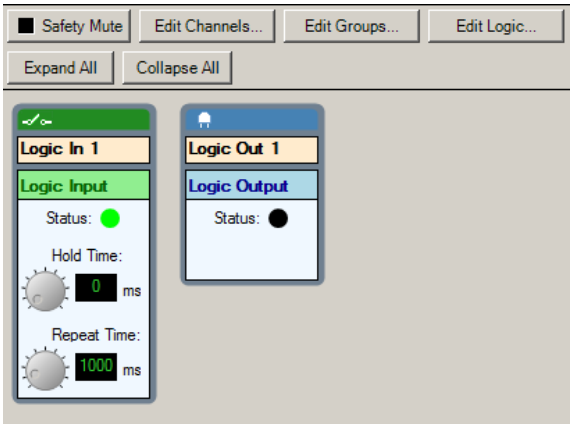
4 Navigate to the **Logic** page and verify that the Digital Logic Input was added, as shown next.



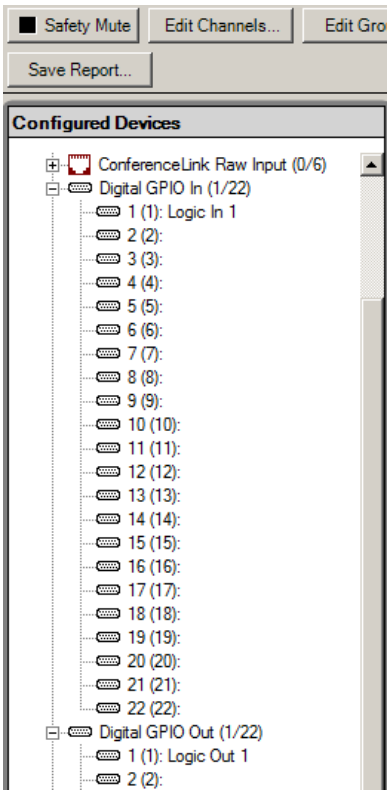
5 Add a **Digital Logic Output** into the system, as shown in the following example where the output is labeled as *Logic Out 1*.



6 On the **Logic** page, verify that the Digital Logic Output was added, as shown in the following figure.



7 Navigate to the **Wiring** page and verify that *Logic Input 1* and *Logic Output 1* are assigned to the correct pins, as shown in the following figure. If not, drag them to the correct pins.

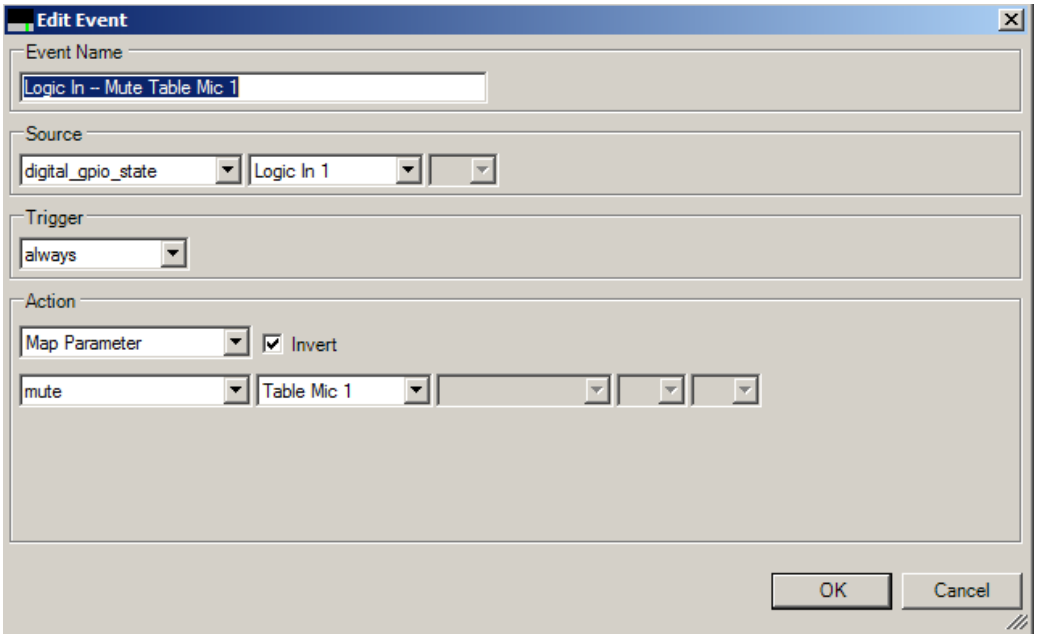


8 Navigate to the **Events** page and click the **Add Event** button and add an event for the Logic Input.

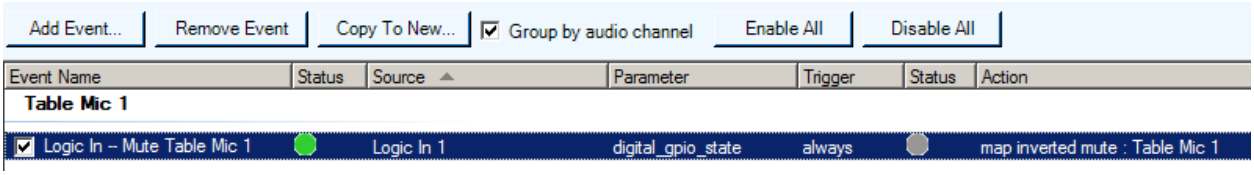
9 On the **Events** page, make the following changes:

- Rename the **Event Name** to something that is descriptive. In the following figure, the event is named *Logic In – Mute Table Mic 1*.
- Make sure the source event is correct. In order for the Logic Input pin to be recognized, the source needs to be **digital_gpio_state** and the channel is set to *Logic In 1*.
- Confirm the trigger is set to **Always**.
- Confirm the action is set as **Map Parameter**.
- Confirm the **Invert** check box is checked. This is explained further in the section Explanation of the Invert Check Box and Logic Input and Negative Logic Output.

  For this example, we want the microphone switch to mute the input so the parameter should be set to **mute** and the source should be *Table Mic 1*, or the group of microphones that are intended to be muted should be visible under in the drop-down field.



Your event should be similar to the following figure.

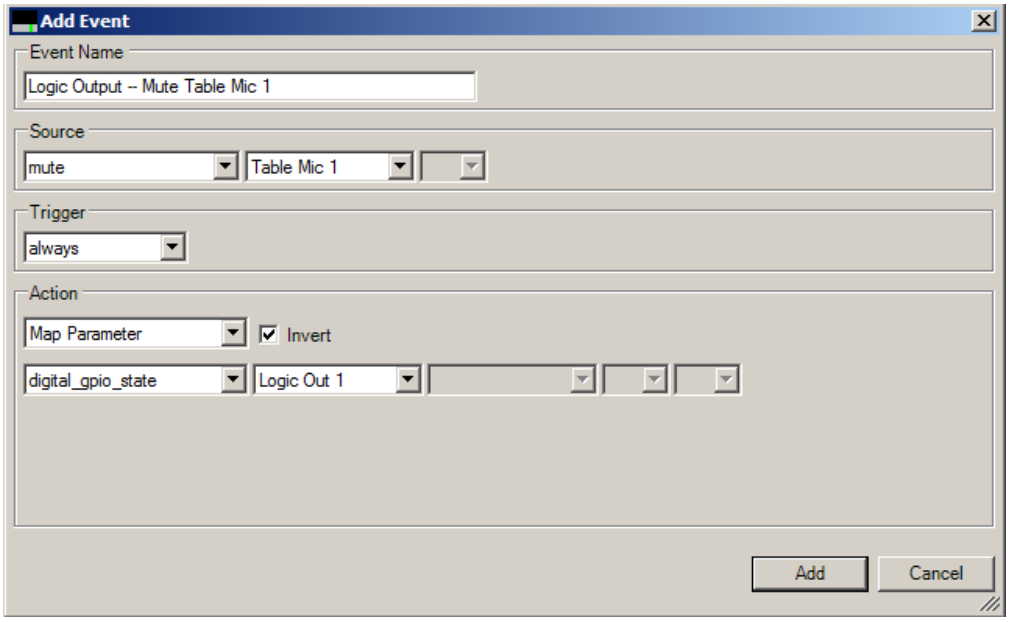


Now, add the Logic Output.

To add the Logic Output:

1. On the **Events** page, click the **Add Event** button.
2. Make the following changes
   - Rename the **Event Name** to something descriptive. In the following figure, the event name is *Logic Output – Mute Table Mic 1*.
   - Make sure the source event is correct. For this microphone, **muting (mute)**, **gating (am_gate)**, or **camera gating (am_camera_gate)** are ideal sources to use.
   - Verify that the channel assigned to the source is correct. In this example, Table Mic 1 is the channel we want to use.
   - Confirm the trigger is set to **Always**.
   - Confirm the action is set as **Map Parameter**.
   - Confirm the **Invert** check box is checked. This is explained further in the section Explanation of the Invert Check Box and Logic Input and Negative Logic Output.
   - Set the parameter to **digital_gpio_state** in order to route the source event to the correct output.

     The resulting action should be tied to the *Logic Out 1* event previously defined, as shown next.



Your event should be similar to the following figure.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
Logic In -- Mute Table Mic 1		Logic In 1	digital_gpio_state	always		map inverted mute : Table Mic 1
Logic Output -- Mute Table Mic 1		Table Mic 1	mute	always		map inverted digital_gpio_state : Logic Out 1

To verify that the SoundStructure logic is working correctly, note the Status indicators. When the Shure MX412D/MX418D microphone switch is open, the *Logic In – Mute Table Mic 1* event source status is high per the details provided in Explanation of the Invert Check Box and Logic Input and Negative Output Logic. The action status is low indicating that the mute command assigned to *Table Mic 1* is low.

For the *Logic Out – Mute Table Mic 1*, the event source status is low because the mute is off for *Table Mic 1*. The Action status is high which reflects the fact that the Logic Output internally to SoundStructure is on or shorted to ground. Again, for a further explanation, see the details provided in Explanation of the Invert Check Box and Logic Input and Negative Output Logic.

After you are finished making your logic and event changes, save the changes to a full preset.

Results – Momentary Action

The default action when the switch is held open is for the LED to be on since the mute is disabled. The Events page and the MX412D/MX418D microphone will look like the following figures.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
Logic In -- Mute Table Mic 1		Logic In 1	digital_gpio_state	always		map inverted mute : Table Mic 1
Logic Output -- Mute Table Mic 1		Table Mic 1	mute	always		map inverted digital_gpio_state : Logic Out 1

When the switch is held closed, the LED turns off as the mute is enabled. The Events page and the MX412D/MX418D microphone will look like:

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
☑ Logic In -- Mute Table Mic 1	●	Logic In 1	digital_gpio_state	always	●	map inverted mute : Table Mic 1
☑ Logic Output -- Mute Table Mic 1	●	Table Mic 1	mute	always	●	map inverted digital_gpio_state : Logic Out 1

If the function of the Status indicators is unclear, see the section Explanation of the Invert Check Box and Logic Input and Negative Output Logic.

Results – Toggle Action

The default action when the mic is first powered is for the LED to be on since the mute is disabled. The Events page and the MX412D/MX418D microphone will look like the following figures.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
☑ Logic In -- Mute Table Mic 1	●	Logic In 1	digital_gpio_state	always	●	map inverted mute : Table Mic 1
☑ Logic Output -- Mute Table Mic 1	●	Table Mic 1	mute	always	●	map inverted digital_gpio_state : Logic Out 1

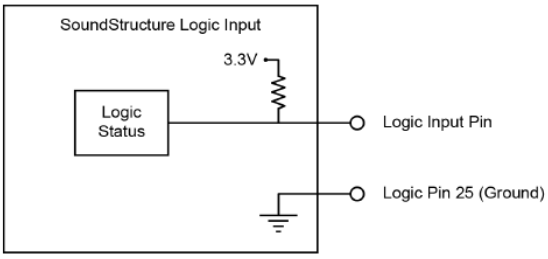
When the switch is pushed, then the MX412D/MX418D microphone registers the button push and keeps the switch closed. The LED turns off as the mute is enabled. The Events page and the MX412D/MX418D microphone will look like the following figures.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
☑ Logic In -- Mute Table Mic 1	●	Logic In 1	digital_gpio_state	always	●	map inverted mute : Table Mic 1
☑ Logic Output -- Mute Table Mic 1	●	Table Mic 1	mute	always	●	map inverted digital_gpio_state : Logic Out 1

Explanation of the Invert Check Box and Logic Input and Negative Output Logic

Logic Input

The SoundStructure Logic Input has an internal pull-up resistor to +3.3V DC to ensure the logic status is at a known state when the Logic Input is not pulled to ground. Thus, the logic port always defaults to 1.



In order for the SoundStructure to recognize a state change on the Logic Input, the Logic Input pin must be pulled to ground. Thus, for the SoundStructure to recognize that something has occurred on the Logic Input, the voltage must be at ground potential, 0V, which is negative logic.

Green (LOGIC GROUND): Connects to the logic ground of an automatic mixer, switcher, or other equipment.

Orange (LED IN): Set DIP switch 3 on to use LED IN. When shorted to LOGIC GROUND, the LED turns on.

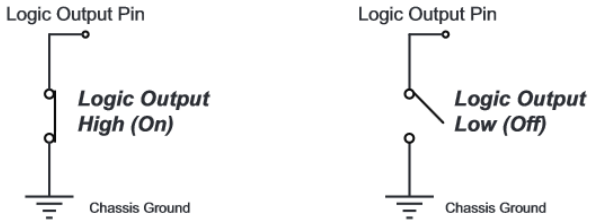
White (SWITCH OUT): Provides TTL logic (0 Vdc or 5 Vdc) in response to the mute button. Set DIP switch 1 for momentary or toggle. When phantom power is applied, logic initializes high (5 Vdc). DIP switch 2 has no effect on SWITCH OUT.

At first power up, the microphone defaults to +5V DC on the Switch Out wire, high. The SoundStructure logic also defaults to a high voltage although the voltage is +3.3V. When the MX412D/MX418D microphone is connected to the SoundStructure, the SoundStructure forces the voltage on the Switch Out to be high, +3.3V.

From a logic voltage perspective, closing the switch in the MX412D/MX418D microphone forces the Logic Input pin to ground which will make the voltage on the Logic Input to equal 0V. Checking the invert check box when designing the events makes the logic easier to understand such that when the switch is open, the event tied to the switch is not executed. When the switch is closed, the event is executed.

Logic Output

So, when the Logic Output is On, then the Logic Output pin is shorted to ground, as shown in the following figure from the Hardware Installation Guide for the Polycom SoundStructure. Conversely, when the Logic Output is Off, then the Logic Output pin is open with respect to ground.



The Logic Output operates via negative logic such that when the Logic Output is off, the voltage on the LED In wire equals +4V and when the Logic Output is on, the voltage on the LED In wire equals 0V. Optionally, the use of the external 1 kOhm resistor shown in the section Wiring to SoundStructure is to act as a pull-up resistor to +5V such that when the Logic Output is off, the LED In wire to the microphone remains at +5V.

Example

Using the example from the section SoundStructure Configuration, assume that the MX412D/MX418D microphone button is open and the *Logic In – Mute Table Mic 1* event source status is high based on the

SoundStructure internal pull-up resistor to +3.3V DC. The action status is low indicating that the mute command assigned to *Table Mic 1* is low since the action was inverted from the event source when the event was created.

For the *Logic Out – Mute Table Mic 1*, the event source status is low because the mute is off for *Table Mic 1*. The Action status is high which reflects the fact that the inverted source state is high since the mute is low and disabled, the inverted state is high. As explained in the Logic Output section, an on state in terms of the Logic Output means that the Logic Output is grounded. In terms of the MX412D/MX418D microphone, this turns the LED on.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
☑ Logic In -- Mute Table Mic 1	●	Logic In 1	digital_gpio_state	always	●	map inverted mute : Table Mic 1
☑ Logic Output -- Mute Table Mic 1	●	Table Mic 1	mute	always	●	map inverted digital_gpio_state : Logic Out 1

From a voltage perspective on the Switch Out wire, the voltage is +3.3V due to the internal pull-up resistor inside the SoundStructure. On the LED In wire, the on state of the SoundStructure Logic Output means that the weak pull-up resistor inside the MX412D/MX418D microphone is grounded so the LED In wire equals +0V DC, which turns on the LED on the MX412D/MX418D microphone.

Now assume that the MX412D/MX418D microphone button is closed; thus, the "Logic In – Mute Table Mic 1" event source status is low based on the shorting of the Logic Input pin to ground. The action status is high indicating that the mute command assigned to *Table Mic 1* is high (since the action was inverted from the event source when the event was created). For the *Logic Out – Mute Table Mic 1*, the event source status is high because the mute is on for Table Mic 1. The Action status is low which reflects the fact that the inverted source state is low (since the mute is high and enabled, the inverted state is low). As explained in the Logic Output section, an off state in terms of the Logic Output means that the Logic Output is open. In terms of the MX412D/MX418D microphone, this turns the LED off.

Event Name	Status	Source	Parameter	Trigger	Status	Action
Table Mic 1						
☑ Logic In -- Mute Table Mic 1	●	Logic In 1	digital_gpio_state	always	●	map inverted mute : Table Mic 1
☑ Logic Output -- Mute Table Mic 1	●	Table Mic 1	mute	always	●	map inverted digital_gpio_state : Logic Out 1

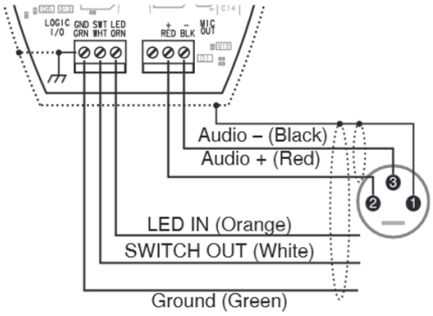
From a voltage perspective on the Switch Out wire, the voltage is 0V DC due to the closure of the MX412D/MX418D microphone switch. On the LED In wire, the SoundStructure Logic Output is off which

means that there is no path to ground for the MX412D/MX418D microphone LED so the LED In wire is +4V DC.

Additional Notes

Grounding

The following figure shows the MX412D/MX418D from the Shure MX400D Series User Guide.



Based on our testing, the logic ground and the Audio ground (Pin 1 of the XLR) are tied together in the MX412D/MX418D microphone. As a result, only one ground connection is needed from the SoundStructure to the mic. The easiest way to ground the mic is via the chassis ground connection on each analog input of the SoundStructure. Inside the SoundStructure, the chassis ground and the logic ground are tied together.

LED In Power

The Shure MX412D/MX418D microphone is based on the Shure MX392. The following figure from MX392 versus MX393; MX392 wiring scheme page on the Shure website shows the difference between the MX392 and MX393.

QUESTION:

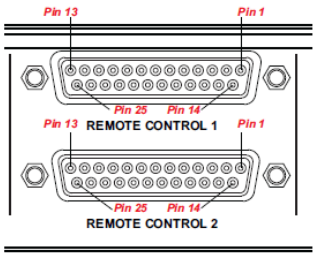
What is the difference between the MX392 and MX393? Besides the cable not being terminated, your catalog says logic input/output capability. What does the logic offer me?

ANSWER:

The LED on the MX392 can be controlled remotely via two conductors in the MX392 cable. Orange wire is LED In; Green wire is Logic Ground. When Orange is connected to Green, the LED will illuminate. NOTE: The operating voltage/current for the LED is supplied by phantom power...not by the Orange LED In wire.

Reference Drawings

The following figure shows the logic port on SoundStructure.



SoundStructure Logic			
Pin	**Signal**	**Pin**	**Signal**
REMOTE CONTROL 1			
1	+5V	14	Logic input 1
2	Logic output 1	15	Logic input 2
3	Logic output 2	16	Logic input 3
4	Logic output 3	17	Logic input 4
5	Logic output 4	18	Logic input 5
6	Logic output 5	19	Logic input 6
7	Logic output 6	20	Logic input 7
8	Logic output 7	21	Logic input 8
9	Logic output 8	22	Logic input 9
10	Logic output 9	23	Logic input 10
11	Logic output 10	24	Logic input 11
12	Logic output 11	25	Ground
13	Analog gain input 1		
REMOTE CONTROL 2			
1	+5V	14	Logic input 12
2	Logic output 12	15	Logic input 13
3	Logic output 13	16	Logic input 14
4	Logic output 14	17	Logic input 15
5	Logic output 15	18	Logic input 16
6	Logic output 16	19	Logic input 17
7	Logic output 17	20	Logic input 18
8	Logic output 18	21	Logic input 19
9	Logic output 19	22	Logic input 20
10	Logic output 20	23	Logic input 21
11	Logic output 21	24	Logic input 22
12	Logic output 22	25	Ground
13	Analog gain input 2		

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