# Application Note

# BRTSYS_AN_043

# LDSBus 2CH Relay & 2CH Relay + iSENSE

**Version 1.0**

**Issue Date: 12-08-2024**



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# 1 Introduction

The LDSBus 2CH Relay Controllers provide precise control over electrical circuits with two latching SPDT relays, which can also be operated as if they were SPST. The iSENSE variant includes load current measurement capabilities, enhancing monitoring and utility. Both variants have a system status LED and an LED per channel indicating the status of the contact. For detailed electrical specifications and further information, readers are encouraged to consult the LDSBus 2CH Relay & 2CH Relay+iSENSE Datasheet.

The LDSBus 2CH Relay Controllers may be used in a variety of applications. In home automation, they can be used as lighting or appliance switches. In industrial automation, they can be used for machinery control, process automation and energy usage monitoring. As a motor controller, they may be used as gate, shutter, awning, and rain curtain controllers. They are also ideal in agriculture and aquaculture where they can be used to maintain water level and circulation, or as aeration pump controllers and including feeding systems.

The following sections cover the following:

- Connection diagrams
- Controller configuration
- Host integration

# 2 Connection Diagrams

The LDSBus 2CH Relay and LDSBus 2CH Relay + iSENSE controllers signal names are described in the following table. The 1 or 2 subscripts in the name refers to the relay channel number.

| Relay and Relay Position Names | Description |
|---|---|
| COM | Common, where n denotes the channel |
| NC | Normally Closed terminal |
| NO | Normally Opened terminal |
| IP+ | iSENSE input for current measurement. In DC circuits, connect the more positive input into IP+ |
| IP- | iSENSE input for current measurement. In DC circuits, connect the more negative input into IP- |
| COM-NC | The COM and NC pins are contacted (closed). The relay is set to this position whenever it powers up. |
| COM-NO | The COM and NO pins are contacted (closed) |

**Table 1 – LDSBus 2CH Relay and LDSBus 2CH Relay + iSENSE Controller Signal Names**

## 2.1 Generic Switch

The following wiring diagrams illustrate the controller wired as a generic AC switch. This configuration is suitable to control the activation and deactivation of a load such as a lamp or pump.

### 2.1.1 LDSBus Relay Controller

Figure 1 shows the wiring diagram for the relay controller channels. AC Live signal is connected to the COM terminal and the load is connected to the NO terminal. The NC terminal is left unconnected.

**CAUTION**

It should be noted that whenever COM-NC is closed, AC Live signal appears at the corresponding NC terminal. This applies to all the circuit configurations below.

Upon receiving an activation signal from the LDSBus Host controller, the relay breaks the COM-NC connection and makes the COM-NO position. AC Live current flows into the load (lamp or pump) are turned on and begins to operate. When the host controller deactivates the relay, the COM-NO circuit is broken, and the COM-NC circuit is made, and the load (lamp or pump) is turned off.

This opening and closing of the circuit makes the relay operate as a SPST switch.

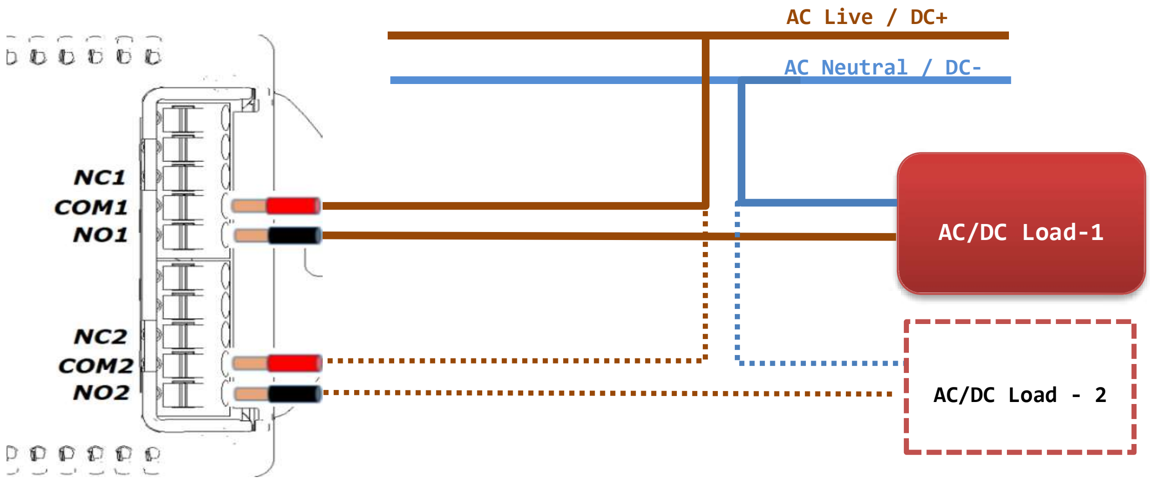


**Figure 1 – LDSBus Relay Controller - Generic Switch Wiring Diagram**

### 2.1.2 LDSBus Relay Controller + ISENSE

Figure 2 shows the iSENSE version of the Relay Controller connected as a switch to measure the current flowing into the load. The current measurement circuit is connected in series with the load with the NO terminal connected to the IP+ terminal and the IP- terminal connected to the load. Now, when the load (lamp or pump) is turned on, the current passes through the IP+ and IP- terminals and the internal ammeter measures the current flowing in the circuit.

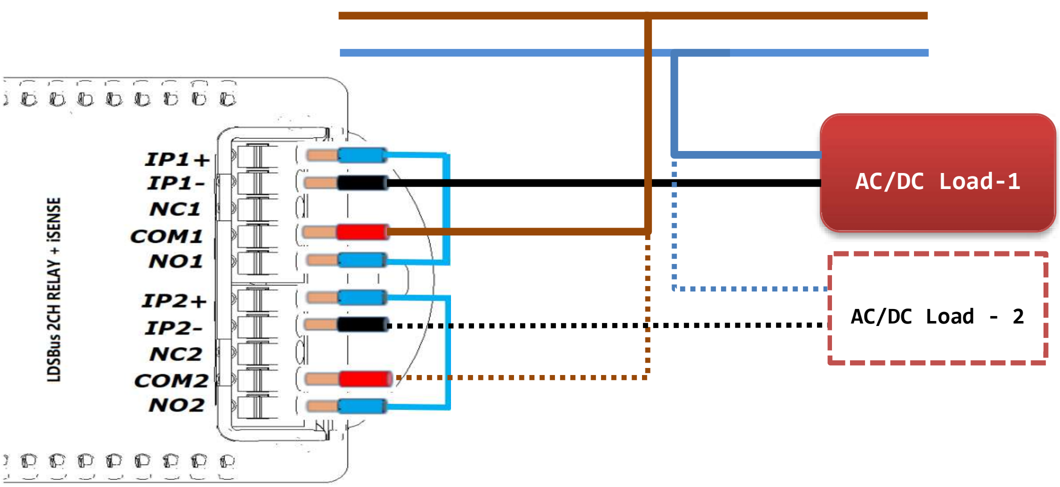


**Figure 2 – LDSBus Relay Controller - Generic Switch Wiring Diagram with ISENSE**

## 2.2 3-wire or 4-wire AC/DC Motor

Figure 4 shows the wiring diagram for a 3-wire AC/DC motor that can be switched on to rotate in the forward direction or reverse direction. A 4-wire AC/DC motor has separate return (AC Neutral or DC-) signals instead of a common return. Both relay channels are used to control a single 3-wire motor. Channel 1 is used for the AC Live or DC+ signal control in SPST fashion and Channel 2 is used in SPDT fashion to route the AC Live or DC+ signal to the forward and reverse direction terminals of the motor. When the device is powered on, COM1-NC1 and COM2-NC2 are closed (made) and COM1-NO1 and COM2-NO2 are opened (broken) and no current flows into the COM2 terminal. Whenever COM1-NO1 is opened, no current flows in the circuit and the motor stops. For the motor to turn in the forward direction, COM2-NC2 must be first closed followed by closing COM1-NO1 and for the reverse direction, COM2-NO2 must be first closed followed by closing COM1-NO1. This sequence ensures the safe operation of the motor.

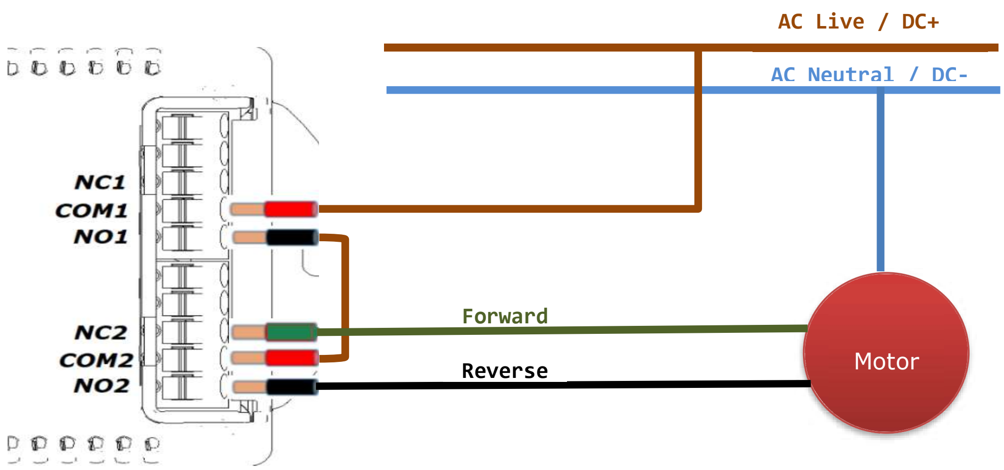


**Figure 3 – 3-Wire/4-Wire Bi-directional Motor Connection Diagram**

**Note:** The wire colors depicted in the connection diagram are for illustrative purposes only. For the actual motor wiring, please refer to the motor specifications to determine the appropriate wire color codes for both power and direction control.

# 3 Inductive Loads

Relays connected to inductive loads, including motors, solenoids, transformers, or coils, are susceptible to transient voltage effects. The inductive nature of these loads can lead to large voltage spikes during switching and can potentially cause damage to the relays and downline circuit components. High transient voltages can cause relay contacts to weld together through arcing or cause pitting in the contacts and degrade the reliability and performance of the relay. To protect the relays and downline circuit components, a transient voltage suppressor is required.

Using a Metal Oxide Varistor (MOV) is a common and effective way to protect relays from transient voltage spikes. A MOV is usually applied across the relay contacts to suppress the transient voltage and dissipate excess power as heat.

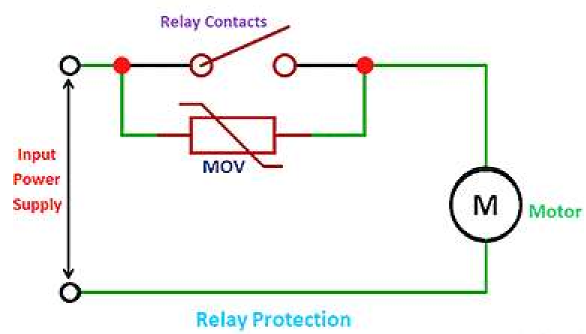


**Figure 3 – Example application of a MOV across an inductive load**

In the following diagram (Figure 4), a two-wire inductive motor load is connected to Channel 1. A Metal Oxide Varistor (MOV) has been added across the COM1 and NO1 terminals to suppress transient voltages that occur when switching the motor on and off. At initial conditions, the COM1-NO1 is not connected and no current flows in the circuit. The voltage across the MOV is zero and the MOV is non-conductive. When COM1-NO1 is closed, current begins to flow across COM1-NO1 and the inductance in the motor causes a large transient voltage to develop across COM1-NO1. When the transient voltage exceeds the MOV's rated voltage, the MOV becomes conductive, clamps the voltage, and dissipates the transient power as heat. Once steady state is achieved, the MOV returns to its non-conductive state. Similarly, when the circuit is opened, the inductance causes a reverse transient voltage spike and the MOV becomes conductive again and clamps the transient voltage.

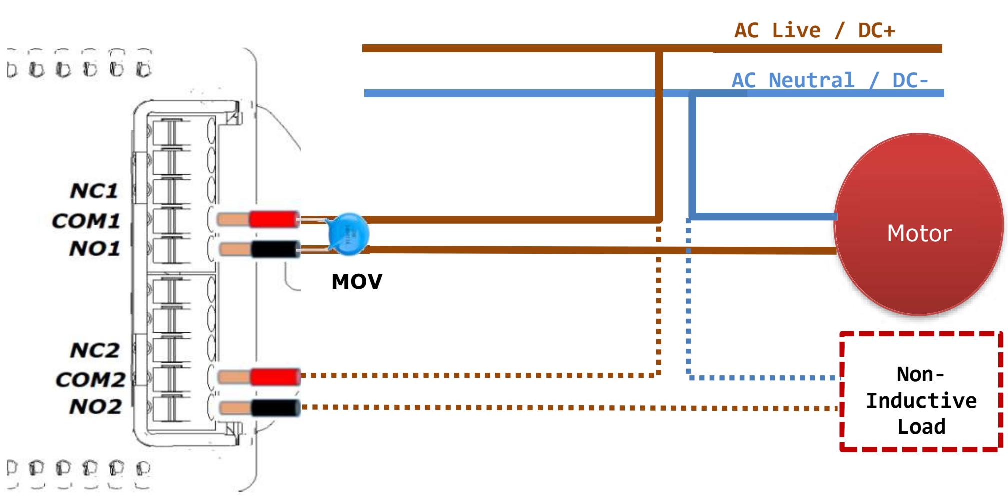


**Figure 4 – LDSBus Relay Controller - Generic Switch Wiring Diagram for Inductive Load**

## 3.1 MOV Selection

In this section, we provide an example of how to select a Metal Oxide Varistor (MOV) for a 230V/1.5A AC induction motor application.

Given the following parameters –

Nominal Operating voltage: 230V AC

Operating current: 1.5A

Current rise time: 1ms

**Step 1:** Calculate the Maximum Continuous Operating Voltage (MCOV)

Peak voltage calculation:

V (Peak) = √2 x Nominal Operating Voltage
V (Peak) = √2 x 230 VAC
V (Peak) = 325 VAC

Adding a safety margin between 25% to 50% in the peak voltage.
Peak Voltage with Margin: 406~487 VAC

Maximum Continuous Operating Voltage (MCOV) should be at least higher than 406VAC with 487VAC being preferred.

**Step 2:** Calculate transient voltage

Transient Voltage, V(T) for the Induction AC motor is:

V(T)= L(dI/dt) ………. where L is the Inductance and dI/dt the rate of change of current.

Rate of change of current dI/dt calculation based on the load operating current (1.5A) and relay contact switching time (1mS).

dI/dt = (1.5A-0.0A)/0.001s

dI/dt = 1500 A/s

Given that L=1H and dI/dt is 1500 (Based on Operating current)

Transient Voltage V(T) = 1x1500
Transient Voltage V(T) = 1500V

**Step 3:** Calculate the Energy Rating(E)
The energy stored in the inductance and released during the transient event,

$E = \frac{1}{2} LI^2$

$E = 0.5 \times 1 \times 1.5^2$

E = 1.125 J

Look for an MOV that can absorb a lot of energy without getting damaged. Higher energy ratings mean better protection. Based on IEEE C62.41.2 industries standard, assume that the surge current to be 3000A under category B.

Adding a 50% margin and get 4500A surge current.

We have calculated all the information to select a MOV to protect our circuit.

For a 230V, 1.5A induction motor with 1H inductance:

The calculated transient voltage V(T) = 1500V.

The energy to be dissipated, E = 1.125J.

MCOV = 406~487 VAC

Peak Current Rating: 4500A

A suitable MOV would be the Bourns MOV-14D431K with the following specifications:

MCOV: 430V

Max. Clamping Voltage: 710V

Energy Rating: 100J

Peak Current Rating: 4500A

This MOV would be suitable for the application. However, we have made assumptions about the power factor and motor breakdown voltage. We have also added a liberal safety factor to the energy rating. It is important to always consult the specific motor's specifications for its surge withstand capability and consider the MOV's lifetime and the expected frequency of transients in the end application. For critical applications, consult with the MOV manufacturer and conduct laboratory tests to ensure the protection is adequate.

# 4 Hardware Configuration

The LDSBus 2CH Relay and LDSBus 2CH Relay + iSENSE are factory configured for operation as generic switches and can be immediately used in an LDSBus setup. The factory defaults are:

1. LDSU ID = 126
2. Nickname = "LDSBus 2CH Relay" or "LDSBus 2CH Relay + iSENSE"
3. Termination = OFF
4. Application Type = None (Defaults to Generic Switch)

The LDSU ID is the address of the controller on the bus and valid values are from 1 to 126. Care shall be taken to ensure that there are no duplicate IDs. The Nickname is a convenient feature to easily identify the device, especially when there is more than one relay in the bus. Change the Nickname to something meaningful, e.g., Nutrient Pump Controller. If this device is the last device on the bus, then its Termination must be set to ON, otherwise, it may be left as OFF. These factory defaults may be changed using the LDSBus Configuration Utility. Please refer to the LDSBus Configuration Utility Guide for more information. In the next section, we shall discuss the fourth parameter, Application Type.

## 4.1 Application Type

The Application Type parameter describes the application of the relay controller. The 2 main applications for the relay controller are as a generic switch or as a motor controller. When an LDSBus Host reads the Application Type parameter, the host loads appropriate driver software to operate the relays. Note that when the Application Type is set to "None" or "Generic DOUT," its operation defaults to a generic switch. When the Application Type is set to "4 Wire Motor", it refers to 3-Wire/4-Wire motor control. The following figure shows the Application Type selection.


**Figure 5 – Application Type Configuration**

# 5 Host Integration

The LDSBus 2CH Relay controllers work with any LDSBus Host. The following devices incorporate an LDSBus Host:

- IoTPortal
- PanL Smart Living (PSL) Hubs
- LDSBus SDKs

## 5.1 IoTPortal

LDSBus 2CH Relay controllers are supported in the IoTPortal. However, at present, the IoTPortal R2.0.0 supports Generic Switch Application Type only and future updates of the IoTPortal shall support additional Application Types. To add the LDSBus 2CH Relay and variants, follow the instructions in the IoTPortal User Guides. In the following examples, we have used the web interface, and the same actions may be performed using the IoTPortal mobile applications. In the following example, the LDSBus 2CH Relay is connected to LDSBus Port 2. Click on the LDSUs button of the LDSBus Port 2 card and a list of LDSUs attached to bus Port 2 will be shown. Confirm that the LDSBus 2CH Relay is listed.

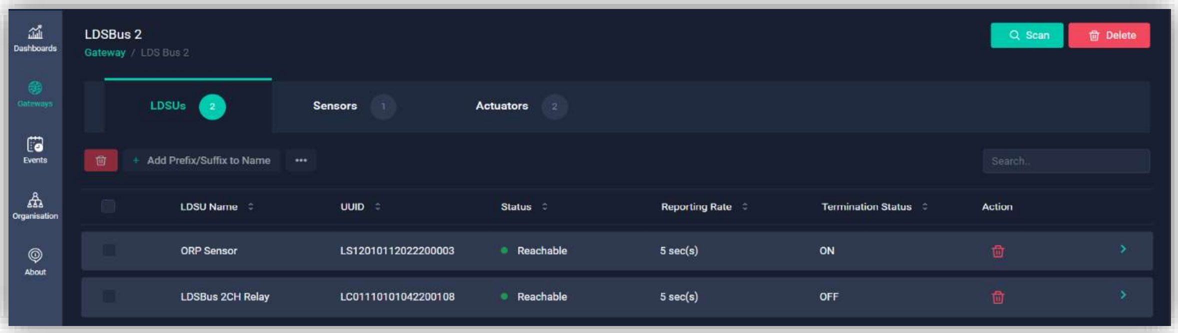


**Figure 6 – LDSU List**

Next, select the Actuators tab and Relay Channel 1 and Relay Channel 2 will be listed. Our focus in this section is to explain how to configure and operate the relay channel manually and automatically through events. Click the arrow button to access channel settings and the following screen will be shown. Observe the Configuration options and you will find Control, Mode, and Polarity settings.

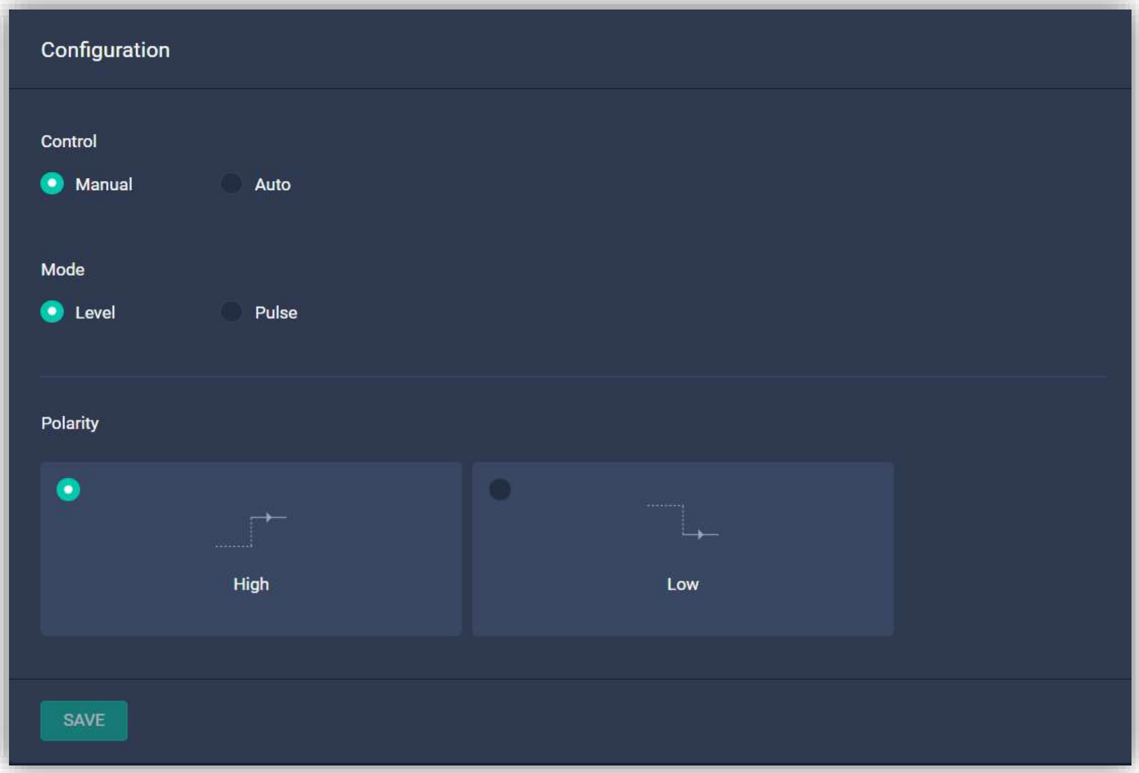


**Figure 7 – LDSBus Relay Channel Function Configuration**

**Control** has 2 selections, namely, *Manual* and *Auto*. When Control is set to Manual, the relay channel can be activated and deactivated by the user and when Auto control is selected, the relay channel is controlled automatically via event actions.

Polarity selects whether COM-NO or COM-NC contacts are closed upon activation and opened upon deactivation. When Polarity is Positive, activation closes COM-NO contacts and deactivation opens COM-NO contacts. When Polarity is negative, activation opens COM-NO contacts and deactivation closes COM-NO contacts. Note that when COM-NO contacts open, COM-NC contacts are closed and vice versa.

Mode selects the switching behavior of the relay. When Level mode is selected, the relay makes a single transition and when Pulse mode is selected, it makes two transitions separated by timing parameters, T1 and T2 specified in seconds. T1 specifies the duration of activation and T2 specifies the duration after deactivation before a new activation command is accepted by the relay channel. Under some exceptional circumstances, it may be necessary to abort an activation sequence, and the Deactivation Option provides three choices, namely "Immediate," "Immediately after T1", and "Immediately after T2". When "Immediate" is chosen, any deactivation request takes effect immediately and when "Immediately after T1" is selected, then a deactivation request is held until the T1 duration is completed and similarly, for "Immediately after T2", the deactivation request is held until the T2 duration is completed.

Figure 8 shows the pulse mode configuration.

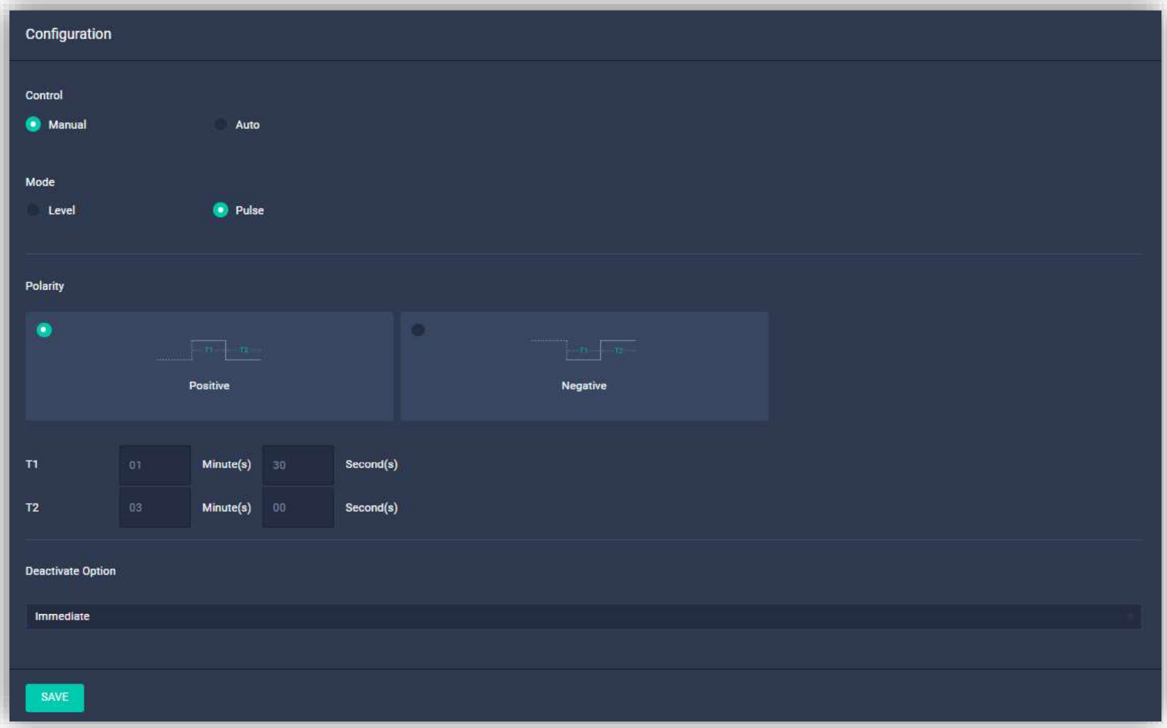


**Figure 8 – Pulse Mode Configuration Options**

## 5.2 PanL Smart Living

PanL Smart Living (PSL) is designed as an all-encompassing platform to replace multiple standalone smart solutions, enabling easy access to many benefits of living the smart way in today's living spaces whether it's in a home, hotel or in an office building. For more information Start Here - PanL Smart Living (brtsys.com)

In the PanL Smart Living system, the LDSBus 2CH Relay can be used as a generic switch to switch on and off non-dimmable lighting or appliances and as a motor controller to control motorized curtains, blinds, and shades. The Application Type parameter must be chosen corresponding to the above applications.

When configured as a generic switch, the two channels are discovered as 2 separate switches and the PSL mobile applications provide on/off control of the switches. When configured as a motor controller, the PSL system discovers a curtain object which can be renamed as a curtain, shade, or blind to reflect the real-world object. PSL mobile applications provide the curtain open, close, and stop control functionality when a curtain object is discovered. For more details, refer to the PanL Smart Living User Guides.

## 5.3 LDSBus SDK

The LDSBus SDKs (Python & .NET) provide software libraries for use in a variety of host operating systems (Microsoft Windows, Linux, Raspberry Pi 3/4/5 and Raspberry Pi2040). Further, the Python version of the SDK is also available, as Circuit Python library on the Bridgetek series of display panels (IDM2040-7A and IDM2040-43a). Built for customized and standalone development, the LDSBus SDKs come with several sample applications that demonstrate communication and control of LDSBus sensors and actuators. An LDSBus USB Adapter provides the physical connection between the host operating system (Microsoft Windows, Linux, Raspberry Pi 3/4/5) and the LDSBus, while the IDM2040 comes built-in with an LDSBus port.

Using the SDKs, the developer has a choice to rely on the Application Type parameter retrieved from the device or ignore it and operate the channels in unison or individually in combinations of SPDT or SPST operations.

# 6 Contact Information

Refer to https://brtsys.com/contact-us/ for contact information.

# Appendix A – References

## Document References

LDSBus Configuration Utility Guide

IoTPortal User Guides

PanL Smart Living User Guides

LDSBus 2CH Relay & 2CH Relay + iSENSE Datasheet

LDSBus Python SDK V3.1.0 Guide

LDSBus .Net SDK V3.0.0 Guide

## Acronyms and Abbreviations

| Terms | Description |
|---|---|
| AC | Alternating Current |
| DC | Direct Current |
| MOV | Metal Oxide Varistor |
| MCOV | Maximum Continuous Operating Voltage |
| LDSU | Long Distance Sensor Unit |
| LDSBus | Long Distance Sensor Bus |
| SDK | Software Development Kit |
| SPDT | Single Pole Double Throw |
| SPST | Single Pole Single Throw |

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# Appendix C – Revision History

Document Title: BRTSYS_AN_043 LDSBus 2CH Relay & 2CH Relay + iSENSE

Document Reference No.: BRTSYS_000114

Clearance No.: BRTSYS#085

Product Page: http://brtsys.com/

Document Feedback: Send Feedback

| Revision | Changes | Date |
|---|---|---|
| 1.0 | Initial Release | 12-08-2024 |