Combining Relay Outputs

Introduction

Relay outputs for Senva products can be joined together in series, in parallel, or a combination of both to create more advanced logic. This can be used to create redundancy for critical applications or add complexity in applications with different types of signals. The limit of connections will generally be based on power limits, losses in cables, noise, and isolation requirements.

Relay Logic

Relays may be one of two types and some devices have both available:

- **Normally Open (NO) ─┤├─.** Relay is open and no electricity can flow unless active. When active it will close and allow a signal to run through.
- **Normally Closed (NC) ─┤/├─.** Relay is closed and electricity can flow unless active. When active it will open and prevent a signal from running through.

In some cases relays will be referred to as a type of "form" or as a "dry contact". "Dry contact" is just another name for a relay output. "Form" on the other hand describes a type of relay. In short, the three forms are as follows:

- **Form A:** a relay that is normally open (NO).
- **Form B:** a relay that is normally closed (NC).
- **Form C:** a single relay that is both NO and NC, by having three leads instead of two.

NOTE	The term "relay" is commonly misused, including in this app note. Relays operate with the above mentioned logic but by an electromechanical means. The term is often used when the same logic is applied via a different means, such as transistors. This app note will not go further into naming conventions of relays. Look online for further details on naming conventions if needed.

The nature of relays allows for more than one to be wired together to form more complex or redundant logic. Devices of different types and from different manufacturers can be mixed into these logic networks. A single network of logic will allow something like a controller to see all these devices on one input. Note that the controller in this case will not be able to differentiate the devices from each other.

Series and Parallel

As relays only have two leads and two states (on or off), there’s only two ways to wire the two relays together: in series or parallel. Choosing between these two methods will dictate how they behave as one. The possible ways of wiring relays increases with the number of relays present. Regardless of the number of permutations, the relays will still be wired either in series or in parallel with respect to each other.

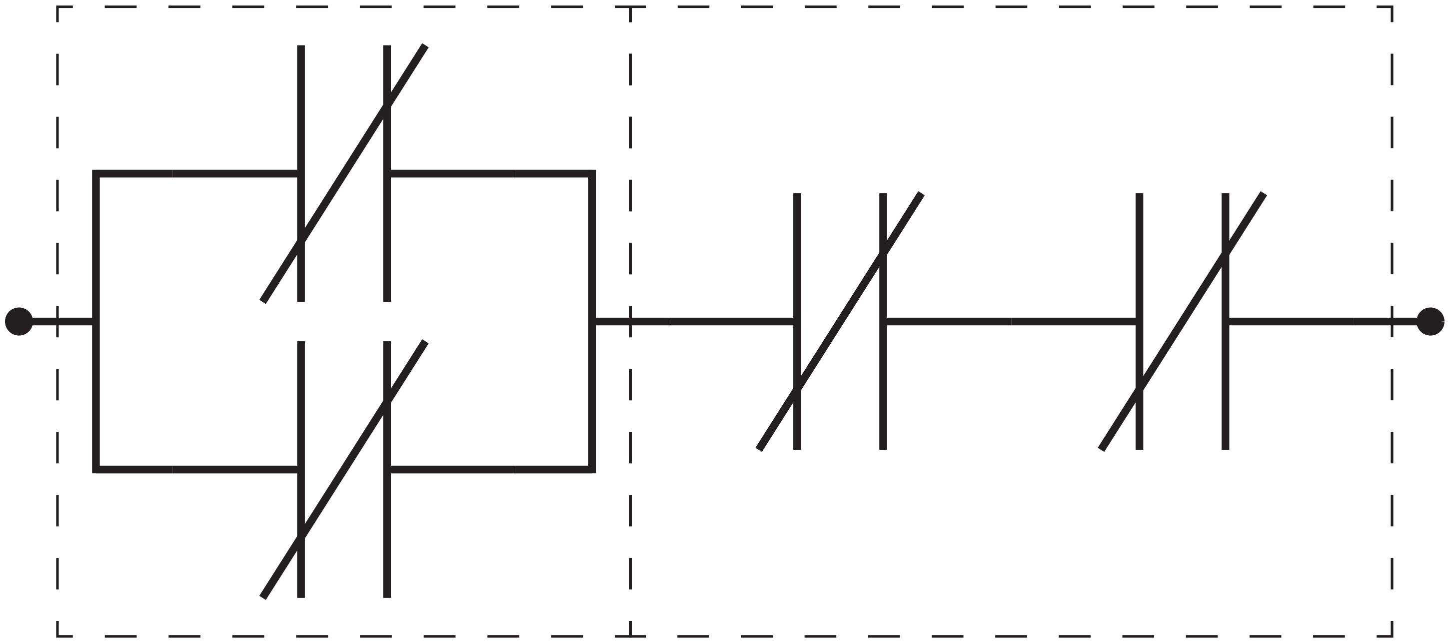

Figure 1. ***Parallel****, left dotted box, has the relays wired side-by-side.* ***Series****, right dotted box, has the relays wired end-to-end.*

The sky is the limit with what can be done with just the two ways of wiring them together when increasing their number. Only simple cases are looked at here, but to get more information read up on digital logic.

Redundancy

Chaining together relays can be done so that multiple devices of the same type can back each other up in case of failure. How this is done depends on if the devices are NC, NO, or a combination. See the first example below.

Added Complexity

Wiring together relays in other ways will create complex logic statements. The complexity grows exponentially with the number of relays. Normally open (NO) relays in parallel create an OR function, meaning only one of the relays needs to be closed to change the whole network active. Alternatively NO relays in series create an AND function, in which all relays must be closed for the network to activate. See the second example below for adding complexity.

Product Considerations

While this note applies to any Senva product with a relay output, the examples will use the WD-1 and TG product lines.

WD-1 only has a single normally closed (NC) relay for its output. The NC relay opens with the presence of water or other non-corrosive liquid with similar conductivity as water with minerals.

Figure 2. Senva WD-1 is a compact and simple device used to detect the presence of water.

Toxic Gas (TG) sensors by Senva detect various gasses that vary with model number. All TG sensors will have two sets of outputs. Te first output is for running one or more fans to clear out the detected gas. The second output is an alarm for when the gas levels get too high; the alarm output is a higher level than the fan output.

NOTE

Inputs and Outputs

As mentioned, this note applies to all Senva products that have a relay for an output.

Digital inputs can typically be grouped together in a similar manner, but won't be looked at in this note.

Examples

One Condensate Pan, Two WD-1 Sensors

A simple example of redundancy when using the WD-1 is having a back up WD-1 for a single condensate pan. Condensate pans collect condensation runoff for a piece of equipment, such as an evaporator on an air conditioner. These pans need to be drained or pumped or they will overflow in the condition that condensation collects faster than evaporation. These pans can also become very dirty over time which may clog a drain, but can also damage the water detector. The risk of overflow and damage to the sensor may call for a redundant sensor.

Two or more of Senva's WD-1 when wired in series will act as a single sensor. That way if any number of the sensors detects water the electricity stops flowing and the controller, or other end device, sees a detection of water. In this case they need to be all wired in series as they are NC devices. If the devices were NO, then they would all need to be in parallel. The end device needs to see the whole network change logic when water is detected, but only one WD-1 needs to be triggered.

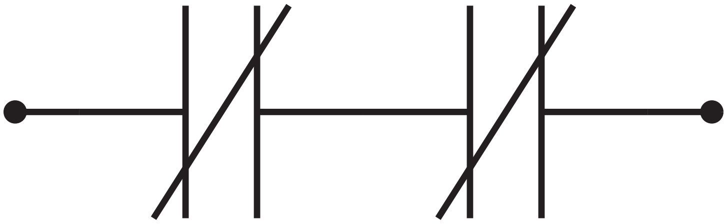

Figure 3. Running two normally closed (NC) relays from two similar devices adds redundancy.

Multiple Toxic Gas Sensors in a Parking Garage

The same rule applies to any product with a relay even when adding complexity. Parking garages in most places require toxic gas sensors to detect and warn of unsafe buildup of emissions from vehicles. In this case the end device is looking for any single sensor detecting toxic gas, which there could be many of. The end device could also break this logic network into multiple smaller networks if needed, such as having separate signals for each floor of the garage. While not applicable in this example, the logic could instead be setup such that all sensors on a floor must active for an action to take place. That would be another example of adding complexity, but in this example, only the one network will be used.

Senva's dual toxic gas (TG) sensor with carbon monoxide (CO) and nitrogen dioxide (NO2) is the correct sensor for this application and has a series of Normally Open (NO) relays. The TG sensor has multiple outputs, but for the sake of simplicity only the alarm output will be used.

NOTE	Senva's toxic gas sensor line does not have a true normally open (NO) relay, it uses a normally closed (NC) relay that is held open when powered on and not activated. This is so that in a power loss or device failure the relay defaults to a state of alarm.

If more than one TG sensor is used with their NO relays in parallel, then any one of the sensors can trigger the alarm signal.

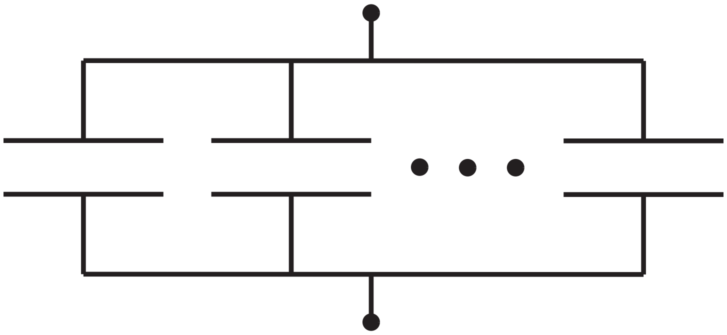

Figure 4. Running any number of parallel NO relays will only require one of the relays to close to activate the whole network.

Limit on the Number of Devices

As there are a handful of variables in the maximum number of devices that can be present when grouping devices, it's not possible to give a definitive number. Apart from isolation issues, there's no real danger in going beyond the limit here when using appropriate voltages. The sections below go over these variables in more detail.

Isolation

CAUTION Not isolating products properly can damage them. Refer to each device's manual.

IMPORTANT Isolation issues can include grounding problems.

The simplest way to avoid issues with isolation is to ensure all devices on the network are in themselves isolated or all share the same power supply and have the same grounding requirements. Products may indicate that outputs are isolated or not to connect to earth ground. All products in a network must have their wiring requirements satisfied; this is easy when all the devices are of the same type. If devices have different requirements, then the easiest solution may be to split the network into multiple networks. In the case of running multiple logic networks, some logic function may need to be done in a controller or similar.

Power Limits

As relays require no power, the power limit only applies to keeping an eye on the voltage and current rating of all relays in the network and not exceeding any of them. It is always easiest to keep all products at a site using the same control voltage. There are only a few common control voltages.

Cable Losses and Noise

Length of cable run, size of cable, location of cable routing, and shielding will all place limits on the number of usable devices. In all these cases, going over the limit will degrade the signal but doesn't pose a direct hazard. As it's not possible to give a limit of devices here, it's best to keep to best practices to minimize the above effects.

- **Cable length:** Apply standard voltage drop calculations if running long cable.
- **Size of cable:** Keep wire the appropriate size as specified by all devices in network. Use a wire large enough to satisfy the minimum wire size requirement of all devices. If wire size is not specified, use standard wire sizing rules based off voltage and current.
- **Cable routing:** Route all control wire separately and away from power wire or noisy devices. Cross power wiring such that they are perpendicular to each other.
- **Shielding:** Use shielded wire and grounded conduit when possible.

Conclusion

As shown above, with just a few considerations simple relays can be greater than the sum of their parts when used together. These networks can provide complex logic as well as redundancy.

For help with this or any other questions, please contact Senva's technical support team.

https://www.senvainc.com/en/service