Keysight Technologies
Introduction to the Keysight SD1000A Safety Disconnect Relays
**Introduction**

The Keysight SD1000A Safety Disconnect Relays (SDR) is an accessory for the Keysight RP7900A series of regenerative power system (RPS). Since the RPS can output high power (up to 10 kW) and high voltage (more than 500 V), operator safety is a primary concern. Keysight engineers designed the SDR with both the safety of operators as well as the safety of units under test (UUTs) in mind. There is even redundancy in all the safety features so that a single point failure will not make the system unsafe.

The SD1000A is designed to only work with the RP7900 RPS and it will not work with any other Keysight power supplies. It also cannot be used as a standalone product. Presently, the SDR is rated for a maximum of 500 V and 60 A. The SDR is designed to handle the parallel combination of a 5 kW RPS and a 10 kW RPS. If additional current is required, each paralleled RPS would require a separate SD1000A.

The SD1000A SDR is controlled entirely by the RP7900 RPS. There is a communication cable between the SDR and RPS that handles the information flow. All programming and front panel commands for the SDR get sent to the RPS and is communicated to the SDR from there. When the RPS receives an output on command, the relays in the SDR close automatically. Conversely, when the RPS receives an output off command, the relays in the SDR automatically open. As a protective measure, there is a watchdog timer that will put the system into a protect mode if communication is lost between the SDR and the RPS. The time on the watchdog timer is fixed at approximately 2.5 ms (note that this is different than the watchdog timer protection in the RPS). The SDR will also open up the relays whenever there is a protection event on the RPS (for example an over voltage event). Essentially, any time that the output of the RPS is disabled, the SDR will open both the sense and output relays.

Figure 1 shows a simplified diagram of the SD1000A SDR. The output path is depicted on the right side of the diagram. There are two relays in series on each output line as well as two in each of the sense lines. The redundant relays are a safety measure. If one of the relays fails in the closed position, the second relay will still open so that the path is still disconnected and the end user is safe from any hazardous voltages. There are auxiliary contacts on the output relays that report the status of the relays so that if the relay is not in the expected status, the system will shut down. There are also two 50 kΩ resistors across the output path that are each in series with a relay. These relays are connected when the output is turned off to help discharge external capacitance quickly so that the output is at safe levels sooner. There is redundancy here as well. Only one resistor is needed.

On the left side of Figure 1 is a block titled Control Logic. This block is the “brains” of the SD1000A SDR where all the relay switching decisions are made. The “Coil Control” block controls the state of the relays. The SDR sends the enable and disable states to the relays based on user input and the state of the RPS. The data that controls front panel LEDs and the parsing of the inputs and output from the rear panel originate in this block.

At the bottom left of the diagram, it shows the AC input section. The SD1000A SDR has a universal AC input so it can be plugged into any standard AC voltage and operate at 100 Vac to 240 Vac. Inside the SDR, this AC voltage is used to create the +24 V DC that operates the relays.

![Figure 1. Simplified SDR block diagram](image)
Figure 2 shows the front panel of the SDR. Since the SDR is focused on automated test system usage, the front panel has a few indicators, but the only user controllable input is the power switch. There are three different colored LEDs:

- The green “Power On” LED indicates that the line switch is set to the on position and the SDR is being powered.
- The yellow “Connected” light indicates that the relays are closed and power is being applied to the unit under test. This means that it is possible that voltages as high as 500 V are present and that caution is required. If the light is off, the relays are open and it is safe.
- The “Reset” LED indicates that there is an error or protect event and the unit needs to be reset before operating. Depending on the cause, this is accomplished by either power cycling the SDR or by pressing a reset switch that is wired to one of the rear panel inputs. Any information about the protect event or an error can be read from the RPS unit.

There is no need to purchase a rack mount kit for the SD1000A. The rack ears are built into the front panel for easy system integration.

Figure 3 shows the rear panel connections of the SDR. Starting from the left of Figure 3, these are:

- The “RPS Control” connection uses a Cat 6 cable. This cable handles all of the communication between the RPS and the SDR. It is important to know that though it looks like a standard LAN connector, it is not. Note that the cable that comes with the RPS must be used; a standard LAN cable will not work.
- The “Remote Interface” connection controls remote LEDs, accepts inputs from an emergency stop (estop) switch, and the reset switch. A reset switch must be wired to the unit for it to function properly.
- The “Fixture Cover” connection accepts inputs from a switch that disables the power system when a fixture cover or a rack door is open.
- The “DI/DO” connection can be used as a digital output or as a control for an AC Contactor.
- The “RPS” connection is where the output of the power supply is connected. There are both output and sense connections. If local sense is required, the sense leads should be directly connected to the RPS connection right next to it.
- The “UUT” connection is where the unit under test power lines are connected. There are both output and sense connections. If local sense is required, the sense leads should be directly connected to the UUT output located directly next to it.
- There is also a universal AC input connection that accepts a standard line cord.
The “Remote Interface” connection serves a triple purpose. The first purpose is that an emergency stop (ESTOP) switch can be wired to the SDR. When the ESTOP switch is pressed, the system will shut down, the relays inside the SDR will open, and the reset lamp will be lit. This is a safety measure so that if there are any issues, the ESTOP switch can be pressed and the RPS will turn its outputs off and all of the relays in the SDR will open. There are two redundant connections for the ESTOP switch in case one of the paths opens. The normal state of the switch must be closed and when the ESTOP button is pressed, both paths open. If the two inputs do not have the same state, the SDR will be in a protect state. ESTOP causes what is referred to as a latched protection event. A latched protection event means that the user will need to remove the cause of the protection and reset the unit before being able to output any power.

The second purpose is the reset line shown in Figure 4 between pins 7 and 8. A reset is caused by momentarily shorting pins 7 and 8. This is used to reset an ESTOP protect as well as some other errors.

The third item included on the remote interface connection is output control for remote LEDs. These remote LEDs will mimic the front panel LEDs so that the state of the SDR can be monitored remotely. There is no need for external power, the SDR will directly drive the LEDs. The Keysight RPS user’s guide has a list of part numbers for green, yellow, and blue LEDs that will work with the SDR. In addition, the blue LED that is recommended has a button built into it that can also act as the reset switch.

The “Fixture Cover” connection is intended to be wired to a switch that is connected to a safety cover over the UUT or wired to the door of the test system. For safety purposes, there are two redundant switches. When the object that the switch is wired to is closed (in a safe state), the inputs are shorted and the unit operates normally. When the cover or door is opened, the switches open and the output of the power system is shut down. This protection is what is referred to as a live protection event. Live protection means that once the cover is closed again and the switches are closed, the unit will resume its previous operation with no input from the user. The power system does not need to be reset.

The DI/DO connection is configured primarily to control and monitor an external AC contactor. The end user can wire an external AC contactor to control the AC in to their UUT. The AC contactor is not meant to be connected to the AC input of the RPS. This connection can also be used as a general purpose +24 VDC digital output.
There are four connections on the connector for an AC contactor. Pins 1 and 2 (see Figure 6) control the 24 VDC signal to drive the coil of the AC contactor. Pins 3 and 4 are meant to be wired to a Normally Closed (NC) auxiliary contact on the AC contactor that is used to monitor the state of the contactor. The SDR uses this auxiliary contact to read what state the AC contactor is in. If the AC contactor is not in the expected state, the SDR will go into a protect state and shut down. The only way to reset this type of protection is to cycle power to the SDR. There are front panel controls and programming commands that will control the state of the AC contactor. In terms of protection, the SDR will open the AC contactor in case of any protect events. The AC contactor follows the same rules as the output concerning a live or latching protection event. If there is a latching protect event (such as an ESTOP), the user will need to rectify the protect event and then re-enable the AC contactor. If there is a live protection event (such as opening a safety cover), the AC Contactor will turn on once the protection is removed, with no need to reset the output state.

The SDR can also be run without an AC Contactor connected. If this is the case, pins 3 and 4 need to be shorted. The +24 VDC output can also be used to control external devices such as relays while in this configuration. Note that this output has less than 500 mA of drive current. It is mainly intended to drive relays. There are many safety features in the Keysight SD1000A Safety Disconnect Solution with the safety of the operator in mind. It is fully integrated with the RP7900 RPS making its programming of easy. All the safety features have redundancy built in so that no single failure will make the system unsafe. When using a high power, high voltage power supply such as the RP7900 Regenerative Power System, it is very important to protect automated test set operators, and the SDR is designed with their safety in mind.
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