

Application Note



MSR127 Application Cookbook

IMPORTANT: A risk assessment must be completed to assure that all tasks and hazards are considered and confirm that the example circuit will provide adequate risk reduction.

1) Purpose

- The purpose of this cookbook is to describe typical ways in which the MSR127 Minotaur Safety Relay (MSR) can be applied using the various safeguarding devices.
- The MSR127 is a versatile monitoring safety relay. Its performance in a safety system depends on what devices are connected to it.
- In general, designers can view the Minotaur Safety Relay in its basic components: power, inputs, reset & monitoring, and outputs. This cookbook is designed along these lines. The designer must select at least one configuration from each component to complete a design that will achieve the desired risk reduction.

2) References

- S115-CA001A-EN-P, Safety Products Catalog
- ANSI RIA R15.06-1999, Safety Requirements for Industrial Robots and Robot Systems
- ANSI B11.19, Performance Criteria for Safeguarding

3) Product Selection Chart

Terminals	Power Supply	Type	Reset	Catalog Number
Fixed	24VAC/DC	MSR127T	Automatic/Manual	440R-N23126
		MSR127R	Monitored Manual	440R-N23129
	115VAC	MSR127T	Automatic/Manual	440R-N23125
		MSR127R	Monitored Manual	440R-N23128
	230VAC	MSR127T	Automatic/Manual	440R-N23124
		MSR127R	Monitored Manual	440R-N23127
Removable	24VAC/DC	MSR127TP	Automatic/Manual	440R-N23132
		MSR127RP	Monitored Manual	440R-N23135
	115VAC	MSR127TP	Automatic/Manual	440R-N23131
		MSR127RP	Monitored Manual	440R-N23134
	230VAC	MSR127TP	Automatic/Manual	440R-N23130
		MSR127RP	Monitored Manual	440R-N23133

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a) Power supply

- The MSR127 can be purchased with only one power supply. The options are 24VAC/DC, 115VAC or 230VAC. Check the Safety Catalog selection table.
- For all units, the positive side of the voltage supply is connected to A1 and the negative side is connected to A2, as shown in Figure 1.
- Be sure to apply the proper voltage to the unit or the unit will be permanently damaged or will not function properly.
- Internally, all versions operate on an unregulated nominal 24V DC. This voltage can be as high as 35V DC when the internal circuitry is not loaded.

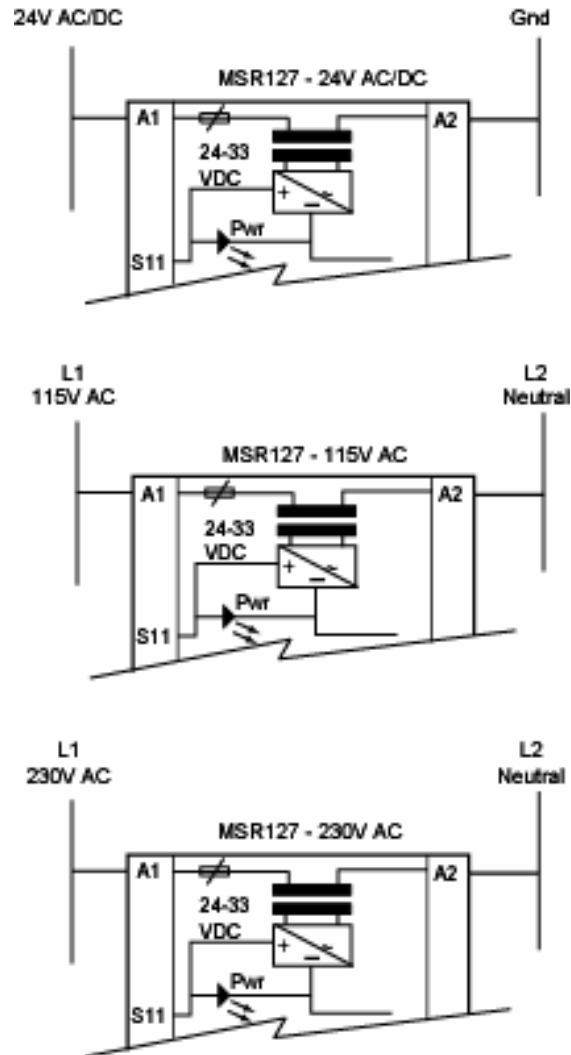


Figure 1. MSR127 Power Supply Connections

b) Inputs

1. Single Channel with Cadet, Elf, MT-GD2 and Trojan

- The Cadet, Elf, MT-GD2 and Trojan are contact type interlocks. An “tongue” shaped actuator is inserted into the switch to change the state of the electrical contacts.
- A single channel consists of a single circuit.
- The circuit is made from S11 (24VDC nominal) to terminals S12 and S52.
- S22 must be connected to S21 to complete the Ch2 circuit.
- The circuit is considered normally closed (NC) when the gate is closed.
- The input circuit arrangements, shown in Figures 2 and 3, meet the requirements of EN954-1 Category 2.

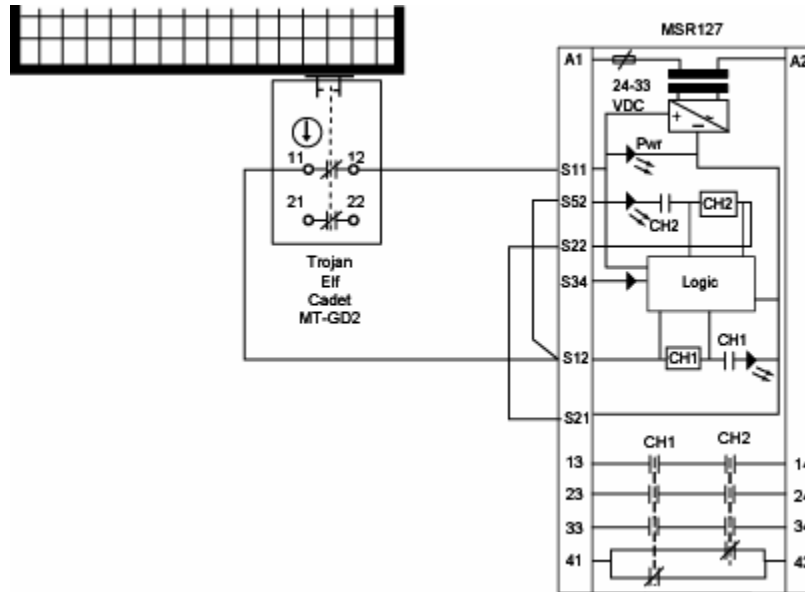


Figure 2. Single Channel with One Tongue Interlock

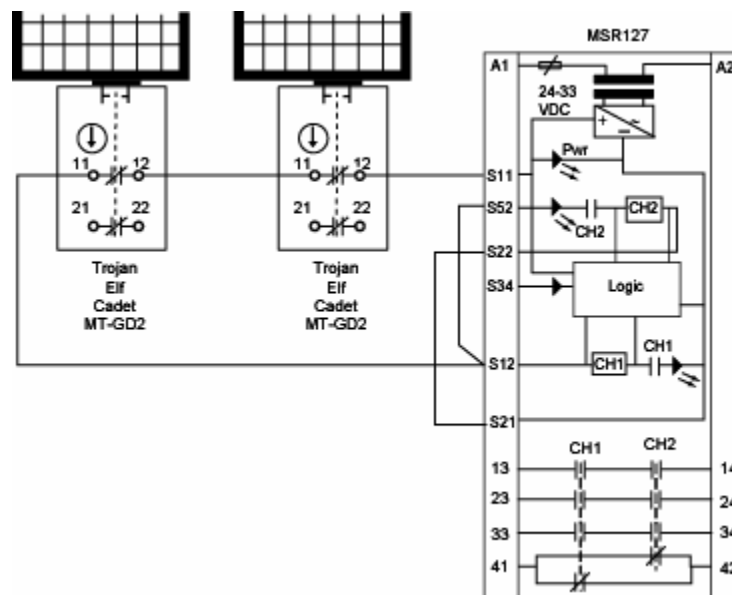


Figure 3. Single Channel with Multiple Tongue Interlocks

2. Single Channel Ferrogard

- a. The Ferrogard is a magnetically actuated non contact interlock. The actuator must be moved to and aligned with the sensor, but should not touch the sensor, to close its electrical contacts.
- b. Most of the Ferrogard safety contacts use the brown and blue wires.
 - (1) The FRS3, 4 and 5 have screw terminals
 - (2) The Ferrogard GD2 uses red and blue wires
- c. The circuit is considered normally closed (NC) when the gate is closed.
- d. The input circuit arrangements, shown in Figures 4 and 5, meet the requirements of EN954-1 Category 2.

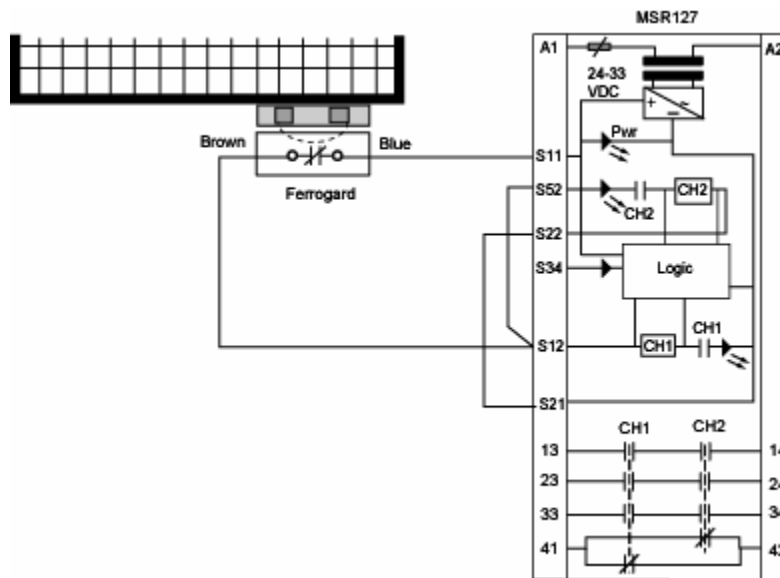


Figure 4. Single Channel with One Ferrogard

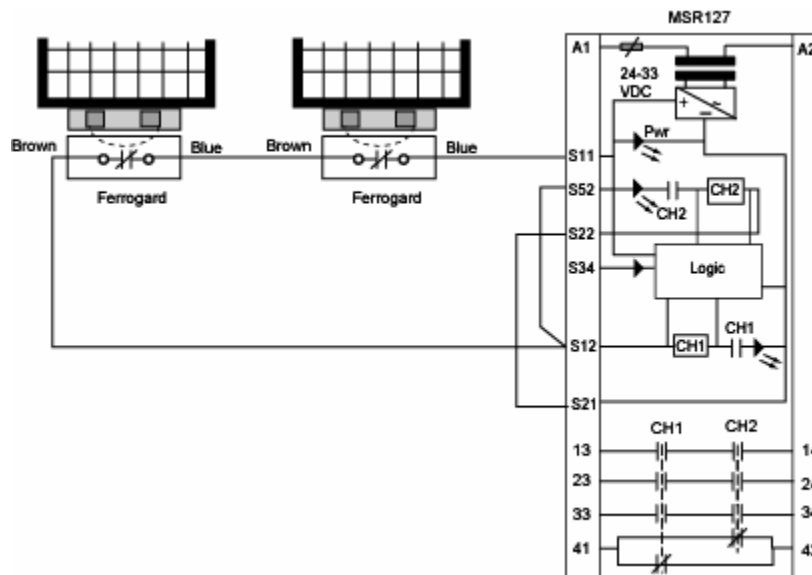


Figure 5. Single Channel with Multiple Ferrogard's

3. Dual Channel Cadet, Elf, MT-GD2 and Trojan

- A dual channel consists of two circuits.
- Channel 1 is pulled up to 24V DC (S12 to S11).
- Channel 2 is pulled down to ground (S22 to S21).
- Both circuits are considered NC when the gate is closed.
- The input circuit arrangement shown in Figures 6 meets the requirements of EN954-1 Category 4.
- The input circuit arrangement shown in Figures 7 meets the requirements of EN954-1 Category 3.

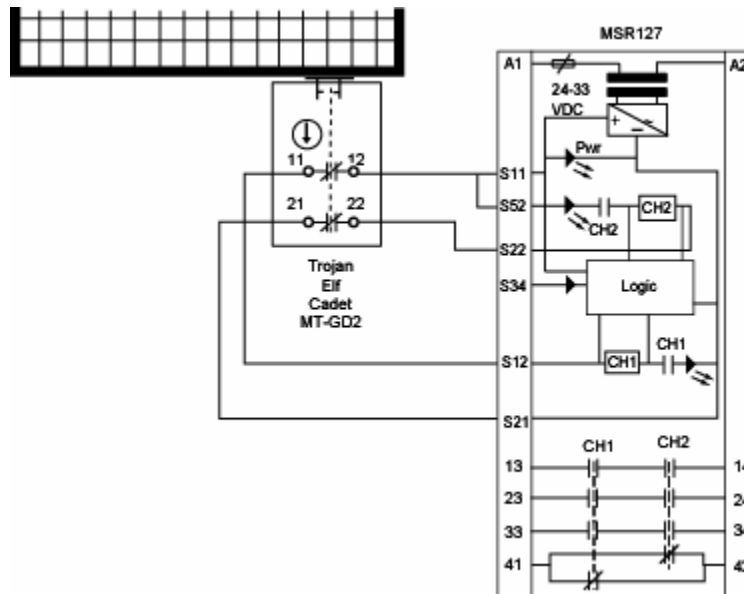


Figure 6. Dual Channel with One Tongue Interlock

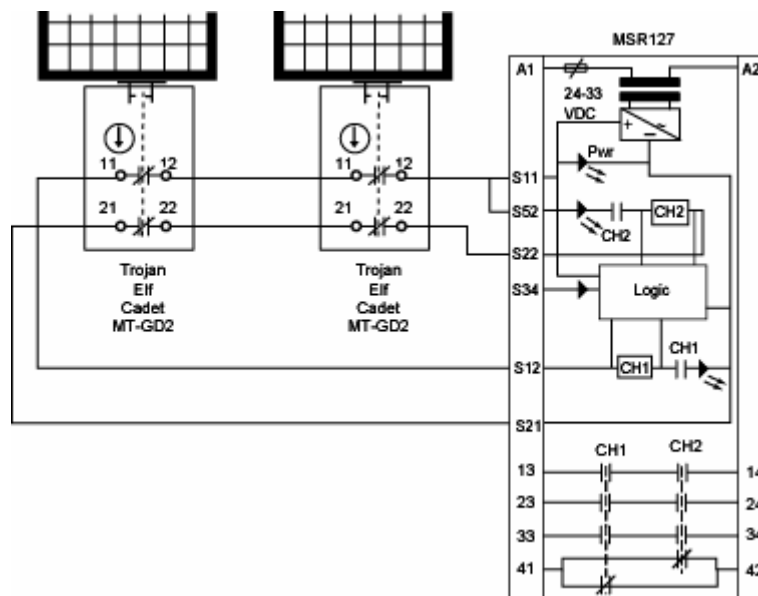


Figure 7. Dual Channel with Multiple Tongue Interlocks

4. Dual Channel Ferrogard

- A dual channel consists of two circuits.
- Channel 1 is pulled up to 24V DC (S12 to S11).
- Channel 2 is pulled down to ground (S22 to S21).
- Both circuits are considered NC when the gate is closed.
- Check the installation instructions for proper wiring colors.
- The input circuit arrangement shown in Figures 8 meets the requirements of EN954-1 Category 4.
- The input circuit arrangement shown in Figures 9 meets the requirements of EN954-1 Category 3.

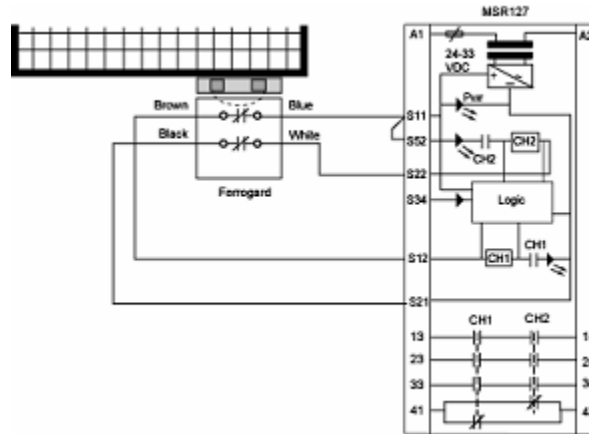


Figure 8. Dual Channel with One Ferrogard

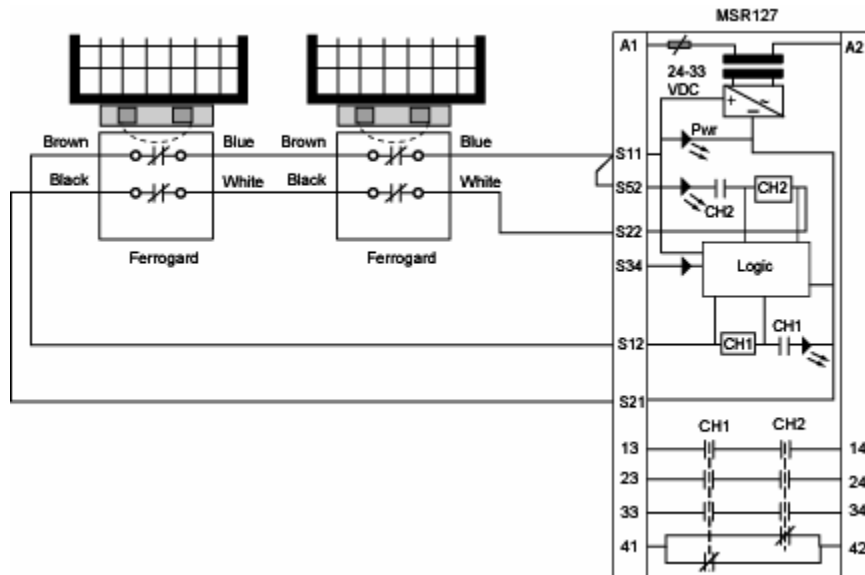


Figure 9. Dual Channel with Multiple Ferrogards

5. TLS1-GD2 Guardlocking

- a. Connect the actuator contacts 11/12. and 21/22 to Channel 1 and Channel 2 of the MSR127.
- b. Remove the factory installed jumper from terminal 12 to 41.
- c. A voltage must be applied to the solenoid A1 to allow the gate to be opened. This can be accomplished by a pushbutton (lock release) or a computer controlled contact. When the voltage is removed, the gate will be locked in the closed position.
- d. The proper voltage must be applied to the solenoid to release the gate. See the Safety Catalog for the desired solenoid voltage (24V AC/DC, 115V AC or 230V AC).
- e. Monitor the status of the solenoid by connecting the 41/42 contact to the monitoring circuit S12/S34 of the MSR127. If the solenoid remains powered (due to fault or other cause), the MSR127 will not allow its safety outputs to be closed.
- f. The actuator auxiliary contact 33/34 and solenoid auxiliary contacts can be connected to a PLC or lamp to provide status indication.
- g. The operation of the TLS1-GD2 contacts is shown in the table below. Note that the solenoid monitoring contact is closed only when the solenoid is de-energized and the actuator is in. Typical operation follows the Steps 1 though 4.

Actuator Position	Solenoid Energized		Solenoid De-energized	
In	Step 2		Step 1	
	11/12	Closed	11/12	Closed
	21/22	Closed	21/22	Closed
	33/34	Open	33/34	Open
	41/42	Open	41/42	Closed
Out	53/54	Closed	53/54	Open
	Step 3		Step 4	
	11/12	Open	11/12	Open
	21/22	Open	21/22	Open
	33/34	Closed	33/34	Closed
	41/42	Open	41/42	Open
	53/54	Closed	53/54	Open

- h. Lock Release Button - When connecting multiple TLS1-GD2's, a pushbutton is recommended at each gate. Gates often become misaligned due to wear, damage or misfits. Sometimes, this causes a gate to be slightly open. If all the solenoids are powered at the same time, then one or more gates may open slightly when the power is removed. If wired per Figure 11, then the safety relay will be satisfied but the monitoring loop will remain open. There will be no indication as to which gate is open. With a pushbutton at each gate, the gate will remain locked unless access is made by pressing the button.
- i. The input circuit arrangement shown in Figures 10 meets the requirements of EN954-1 Category 4.
- j. The input circuit arrangement shown in Figures 11 meets the requirements of EN954-1 Category 3.

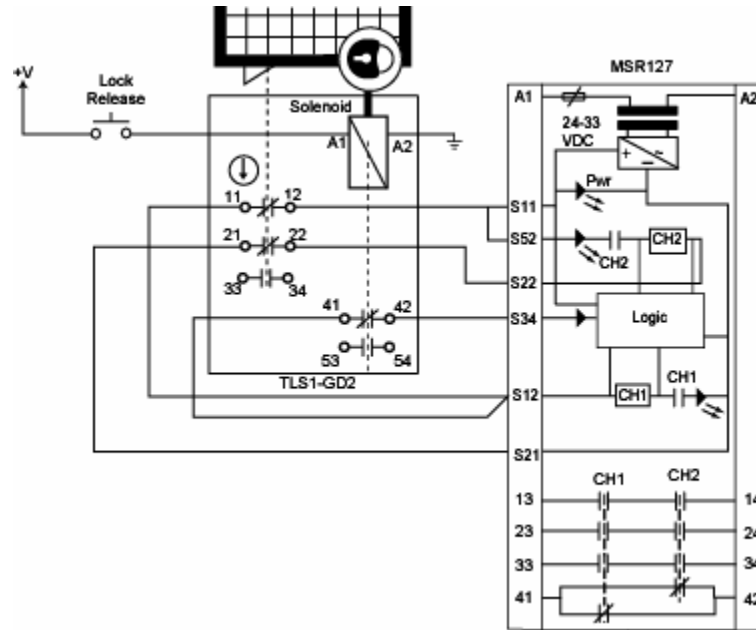


Figure 10. One TLS1-GD2

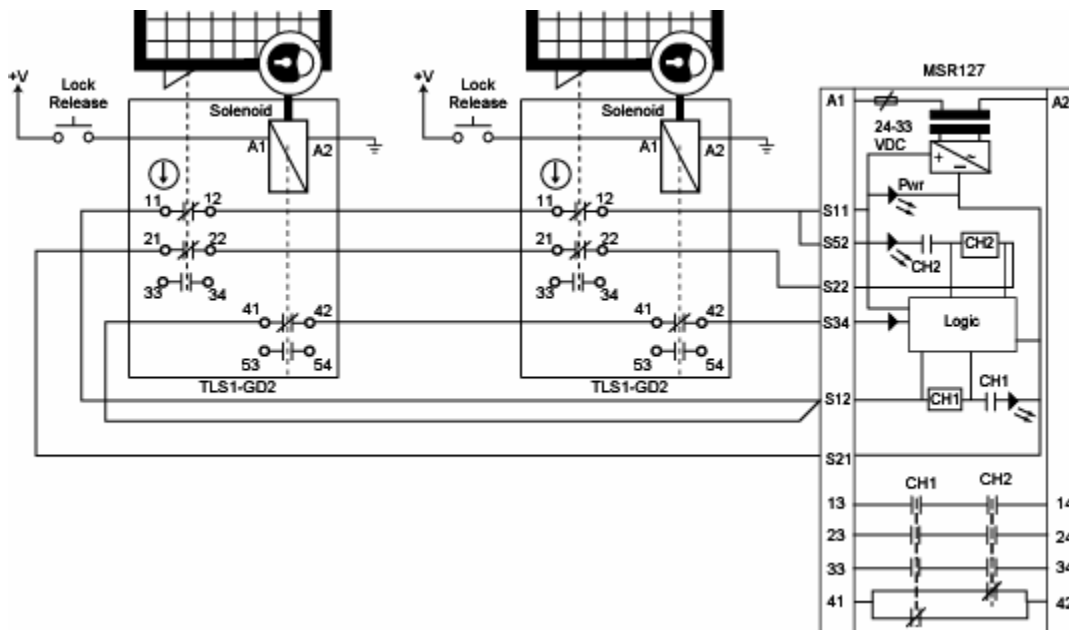


Figure 11. Multiple TLS1-GD2's

6. TLS2-GD2 Guardlocking

- a. Connect the actuator contacts 11/12. and 21/22 to Channel 1 and Channel 2 of the MSR127.
- b. Remove the factory installed jumper from terminal 12 to 41.
- c. A voltage must be applied to the solenoid A1 to lock the gate. This can be accomplished by a pushbutton (lock release) or a computer controlled contact. When the voltage is removed, the gate is unlocked.
- d. The proper voltage must be applied to the solenoid to release the gate. See the Safety Catalog for the desired solenoid voltage (24V AC/DC, 115V AC or 230V AC).
- e. Monitor the status of the solenoid by connecting the 41/42 contact to the monitoring circuit S12/S34 of the MSR127. If the solenoid remains de-energized (due to fault or other cause), the MSR127 will not allow its safety outputs to be closed.
- f. The actuator auxiliary contact 33/34 and solenoid auxiliary contacts can be connected to a PLC or lamp to provide status indication.
- g. The operation of the TLS2-GD2 contacts is shown in the table below. Note that the solenoid monitoring contact is only closed when the solenoid is energized and the actuator is in. The typical operation follows the Step 1 through 4.

Actuator Position	Solenoid Energized		Solenoid De-energized	
In	Step 1		Step 2	
	11/12	Closed	11/12	Closed
	21/22	Closed	21/22	Closed
	33/34	Open	33/34	Open
	41/42	Closed	41/42	Open
Out	53/54	Open	53/54	Closed
	Step 4		Step 3	
	11/12	Open	11/12	Open
	21/22	Open	21/22	Open
	33/34	Closed	33/34	Closed
	41/42	Open	41/42	Open
	53/54	Closed	53/54	Closed

- h. Lock Release Button - When connecting multiple TLS2-GD2's, a pushbutton is recommended at each gate. Gates often become misaligned due to wear, damage or misfits. Sometimes, this causes a gate to be slightly open. If all the solenoids are de-energized at the same time, then one or more gates may open slightly when the power is restored. If wired per Figure 13, then the safety relay will be satisfied but the monitoring loop will remain open. There will be no indication as to which gate is open. With a pushbutton at each gate, the gate will remain locked unless access is made by pressing the button.
- i. The input circuit arrangement shown in Figures 12 meets the requirements of EN954-1 Category 4.
- j. The input circuit arrangement shown in Figures 13 meets the requirements of EN954-1 Category 3.

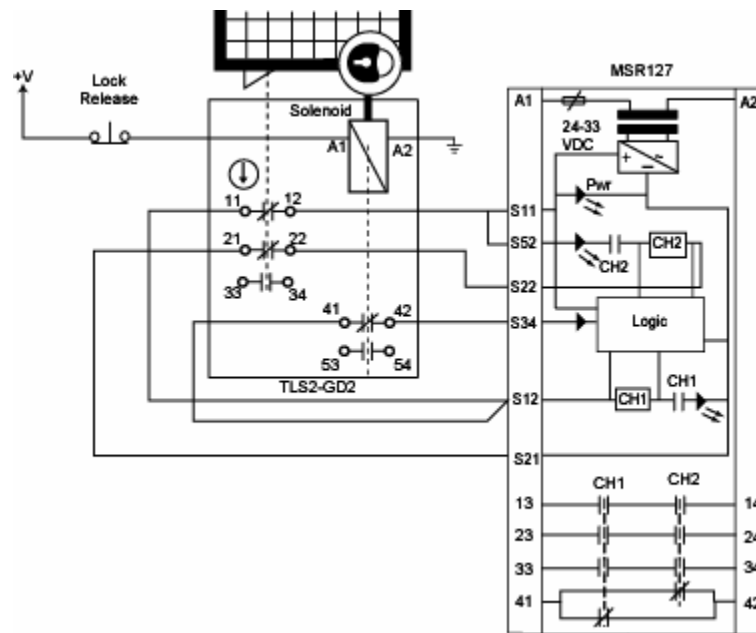


Figure 12. One TLS2-GD2

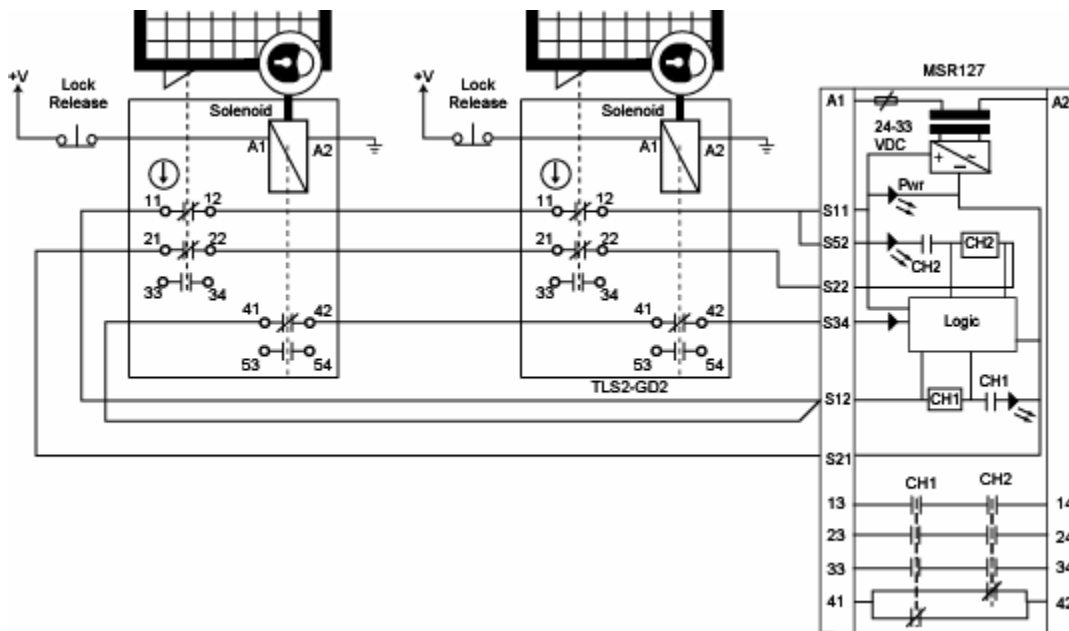


Figure 13. Multiple TLS2-GD2's

7. TLS3-GD2 Guardlocking

- a. Connect the actuator contacts 11/42. and 21/52 to Channel 1 and Channel 2 of the MSR127.
- b. Leave in the factory installed jumpers from terminal 12 to 41 and 22 to 51..
- c. A voltage must be applied to the solenoid A1 to allow the gate to be opened. This can be accomplished by a pushbutton (lock release) or a computer controlled contact. When the voltage is removed, the gate will be locked in the closed position.
- d. The proper voltage must be applied to the solenoid to release the gate. See the Safety Catalog for the desired solenoid voltage (24V AC/DC, 115V AC or 230V AC).
- e. The actuator auxiliary contact 33/34 can be connected to a PLC or lamp to provide status indication.
- f. The operation of the TLS3-GD2 contacts is shown in the table below. NOTE: The solenoid monitoring contacts are closed only when the actuator is in and the solenoid is de-energized.

Actuator Position	Solenoid Energized		Solenoid De-energized	
In	Step 2		Step 1	
	11/12	Closed	11/12	Closed
	21/22	Closed	21/22	Closed
	33/34	Open	33/34	Open
	41/42	Open	41/42	Closed
	51/52	Open	51/52	Closed
Out	Step 3		Step 4	
	11/12	Open	11/12	Open
	21/22	Open	21/22	Open
	33/34	Closed	33/34	Closed
	41/42	Open	41/42	Open
	51/52	Open	51/52	Open

- g. Lock Release Button - When connecting multiple TLS3-GD2's, a pushbutton is highly recommended at each gate, because a wiring fault across one of the contacts will be cleared by one of the other contacts, when solenoid power is removed. In addition, gates often become misaligned due to wear, damage or misfits. Sometimes, this causes a gate to be slightly open. If all the solenoids are powered at the same time, then one or more gates may open slightly when the power is removed. The safety relay will not be satisfied loop will remain open with no indication as to which gate is open. With a pushbutton at each gate, the gate will remain locked unless access is made by pressing the button, and a fault across one of the contacts will be detected.
- h. The input circuit arrangement shown in Figures 14 meets the requirements of EN954-1 Category 4.
- i. The input circuit arrangement shown in Figures 15 meets the requirements of EN954-1 Category 3.

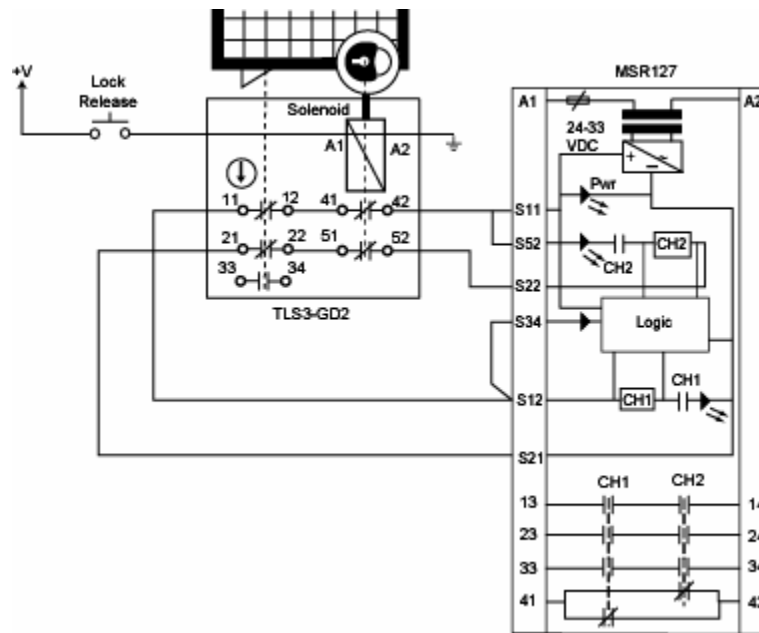


Figure 14. One TLS3-GD2

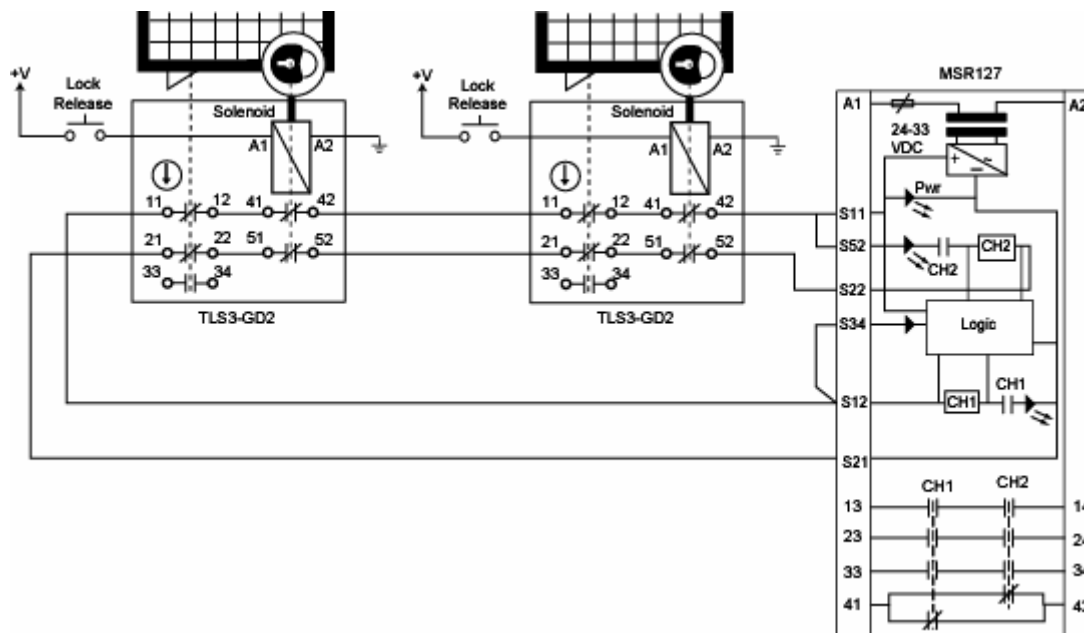


Figure 15. Multiple TLS3-GD2's

8. Spartan Guardlocking

- a. Connect the actuator contacts 11/12. and 21/22 to Channel 1 and Channel 2 of the MSR127.
- b. A voltage must be applied to the solenoid A1 to allow the gate to be opened. This can be accomplished by a pushbutton (lock release) or a computer controlled contact. When the voltage is removed, the gate will be locked in the closed position.
- c. The proper voltage must be applied to the solenoid to release the gate. See the Safety Catalog for the desired solenoid voltage (24V AC/DC, 115V AC or 230V AC).
- d. The auxiliary contact 33/34 can be connected to a PLC or lamp to provide status indication.
- e. Since the Spartan contacts are in-line with the solenoid, the safety contacts 11/12 and 21/22 monitor the status of the solenoid and the actuator at the same time. The table below shows the operation of the contacts. A typical process follows the Steps 1 through 4.

Actuator Position	Solenoid Energized	Solenoid De-energized
In	Step 2 N/C is Open N/O is Closed	Step 1 N/C is Closed N/O is Open
Out	Step 3 N/C is Open N/O is Closed	Step 4 N/C is Open N/O is Closed

- f. Lock Release Button - When connecting multiple Spartan's, a pushbutton is highly recommended at each gate, because a wiring fault across one of the contacts may be cleared by one of the other switches, when solenoid power is removed. In addition, gates often become misaligned due to wear, damage or misfits. Sometimes, this causes a gate to be slightly open. If all the solenoids are powered at the same time, then one or more gates may open slightly when the power is removed. The safety relay will not be satisfied with no indication as to which gate is open. With a pushbutton at each gate, the gate will remain locked unless access is made by pressing the button, and a fault across one of the contacts will be detected.
- g. The input circuit arrangement shown in Figures 16 meets the requirements of EN954-1 Category 4.
- h. The input circuit arrangement shown in Figures 17 meets the requirements of EN954-1 Category 3.

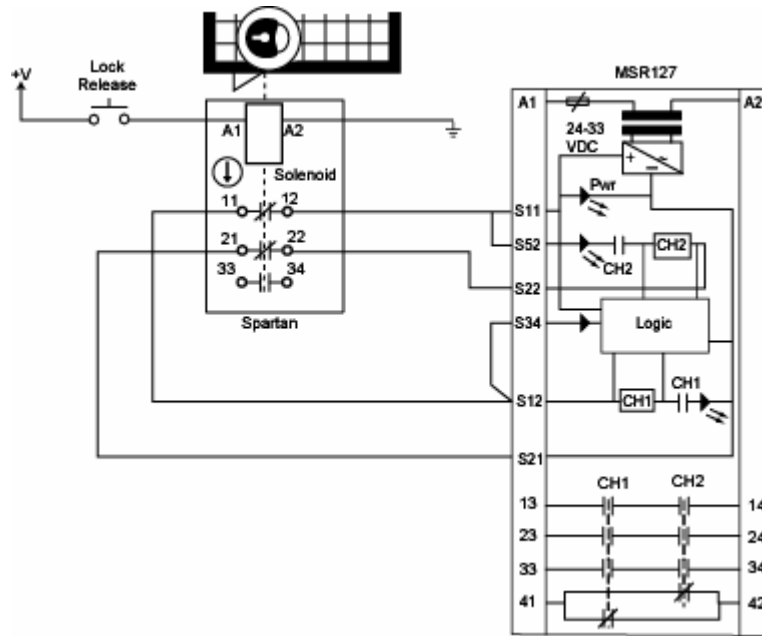


Figure 16. One Spartan

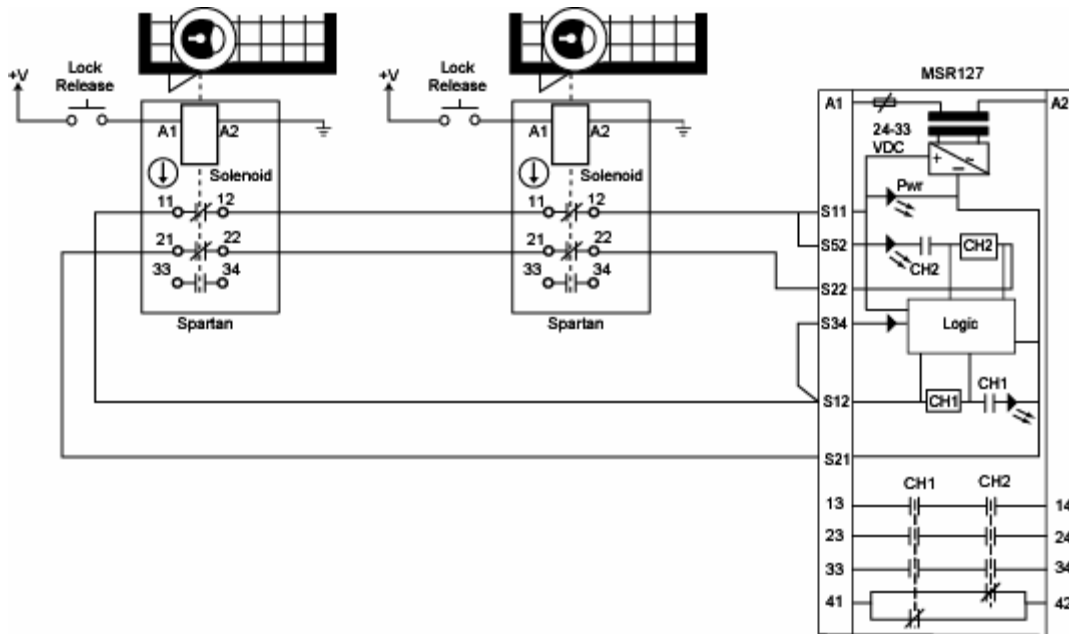


Figure 17. Multiple Spartans

9. Atlas 5 Guardlocking

- a. Connect the actuator and solenoid contacts 5/6 and 7/8 to Channel 1 and Channel 2 of the MSR127.
- b. A voltage must be applied to the solenoid A1 to allow the gate to be opened. This can be accomplished by a pushbutton (lock release) or a computer controlled contact. When the voltage is removed, the gate will be locked in the closed position.
- c. The proper voltage must be applied to the solenoid to release the gate. See the Safety Catalog for the desired solenoid voltage (24V AC/DC, 115V AC or 230V AC).
- d. The actuator auxiliary contact 3/4 can be connected to a PLC or lamp to provide status indication.
- e. Since the Atlas 5 contacts are in series with the solenoid contacts, the safety contacts 5/6 and 7/8 monitor the status of the solenoid and the actuator at the same time.
- f. Lock Release Button - When connecting multiple Atlas 5's, a pushbutton is highly recommended at each gate, because a wiring fault across one of the contacts will be cleared by one of the other switches, when solenoid power is removed. In addition, gates often become misaligned due to wear, damage or misfits. Sometimes, this causes a gate to be slightly open. If all the solenoids are powered at the same time, then one or more gates may open slightly when the power is removed. The safety relay will not be satisfied with no indication as to which gate is open. With a pushbutton at each gate, the gate will remain locked unless access is made by pressing the button, and a fault across one of the contacts will be detected.
- g. The input circuit arrangement shown in Figures 18 meets the requirements of EN954-1 Category 4.
- h. The input circuit arrangement shown in Figures 19 meets the requirements of EN954-1 Category 3.

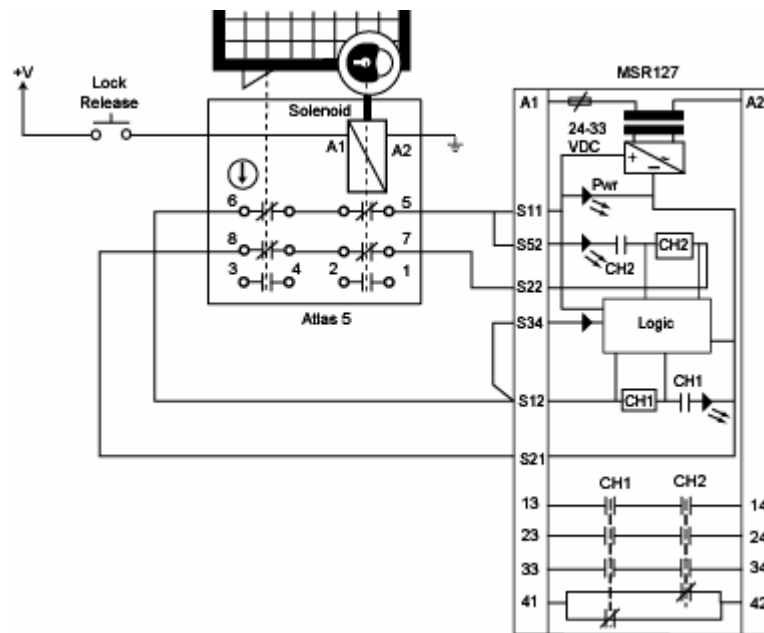


Figure 18 Single Atlas 5

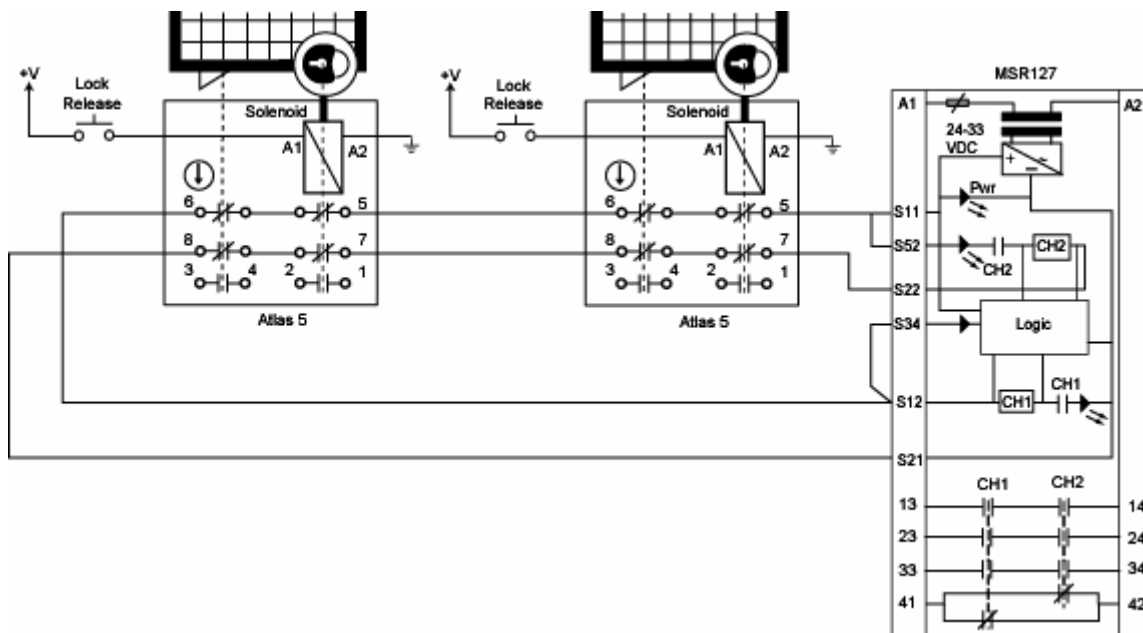


Figure 19. Multiple Atlas 5's

10. Atlas 5 Alternative

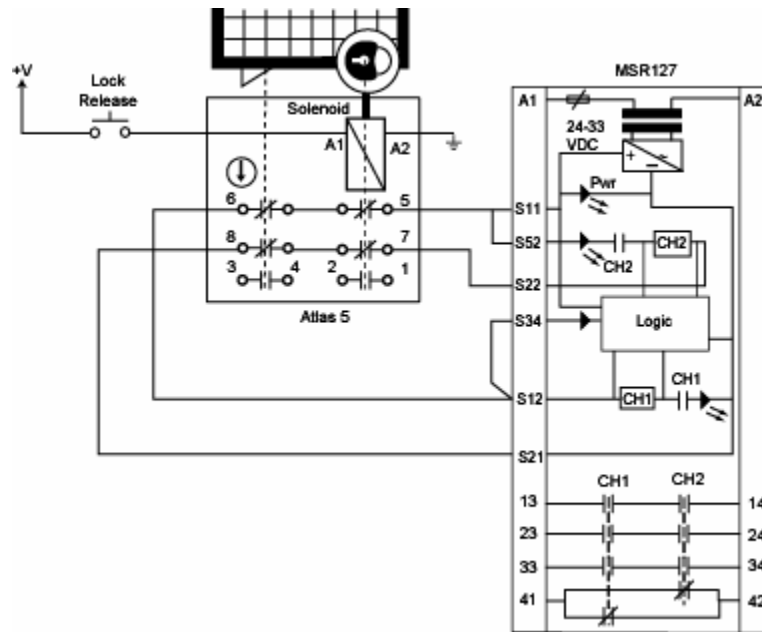


Figure 20. One Atlas (Alternative)

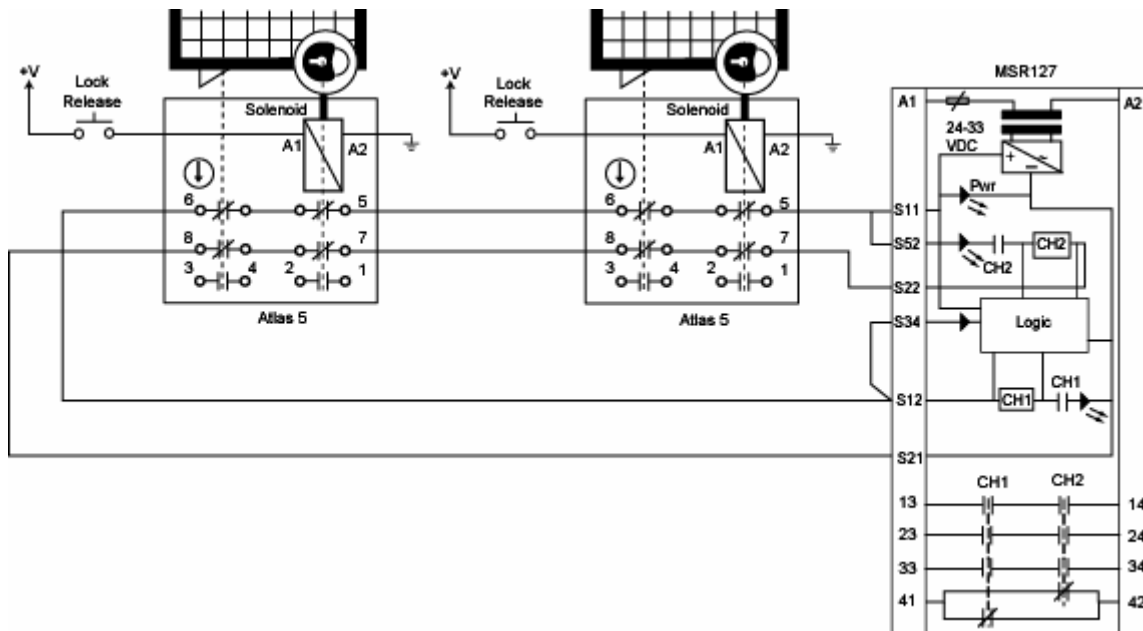
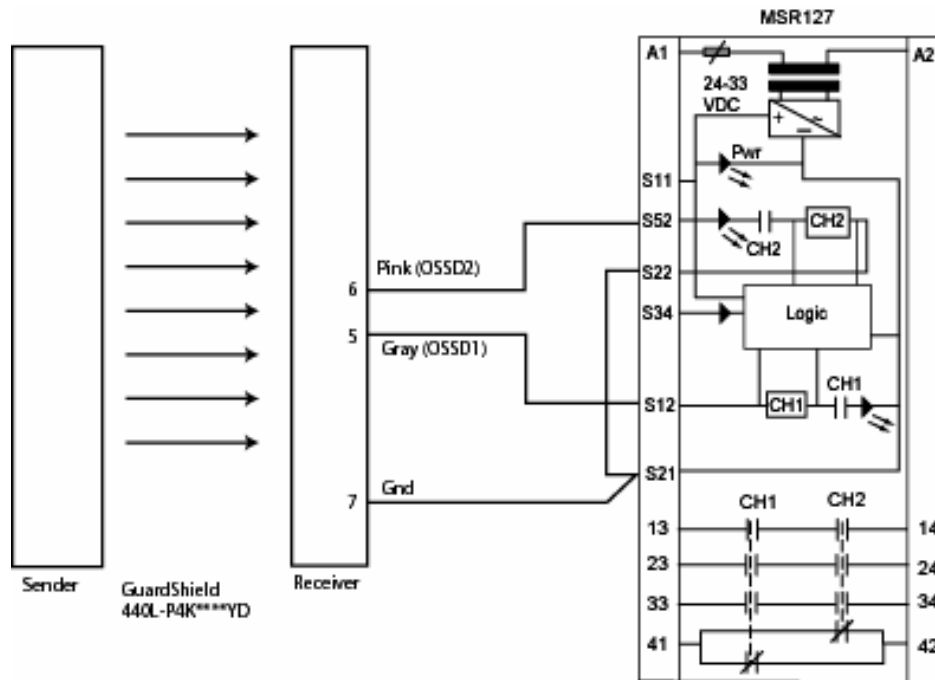


Figure 21. Multiple Atlas 5 Alternative

11. GuardShield Light Curtain

- The GuardShield light curtain has 2 PNP Output Solid-state Switching Device (OSSD) outputs. Both output pull up their loads to 24VDC.
- The ground reference of the GuardShield receiver (QD pin 7) must be connected to the internal ground reference of the MSR127 (terminal S21).

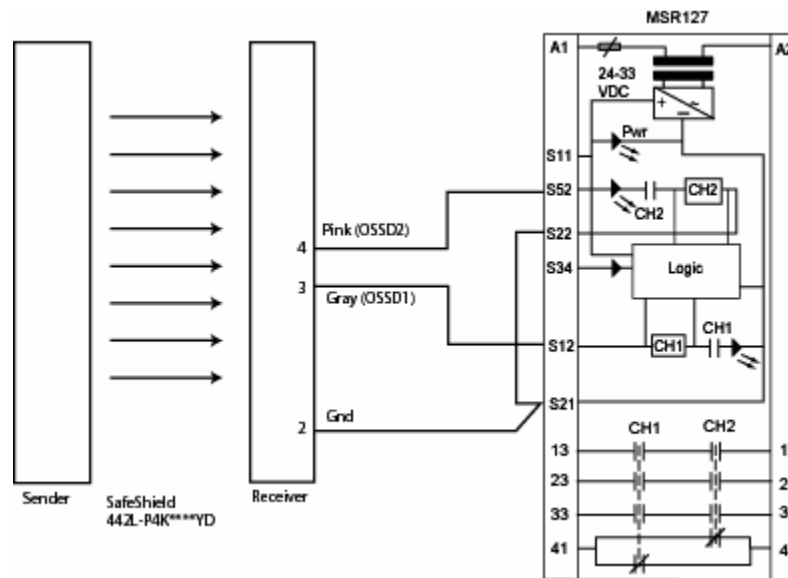


c.

Figure 22. GuardShield

12. SafeShield

- The SafeShield light curtain has 2 PNP Output Solid-state Switching Device outputs. Both outputs pull up their loads to 24VDC.
- The ground reference of the SafeShield (QD pin 2) must be connected to the internal ground reference of the MSR127 (terminal S21).



c.

Figure 23. SafeShield

13. Lifeline 4

- The Lifeline cable pull switches are connected to the MSR127 in fashion similar to the interlock devices: either single channel or dual channel.
- The contacts of the Lifeline switch are closed when the proper amount of tension is placed on the cable – the contacts open when the cable is pulled or if the cable goes slack.

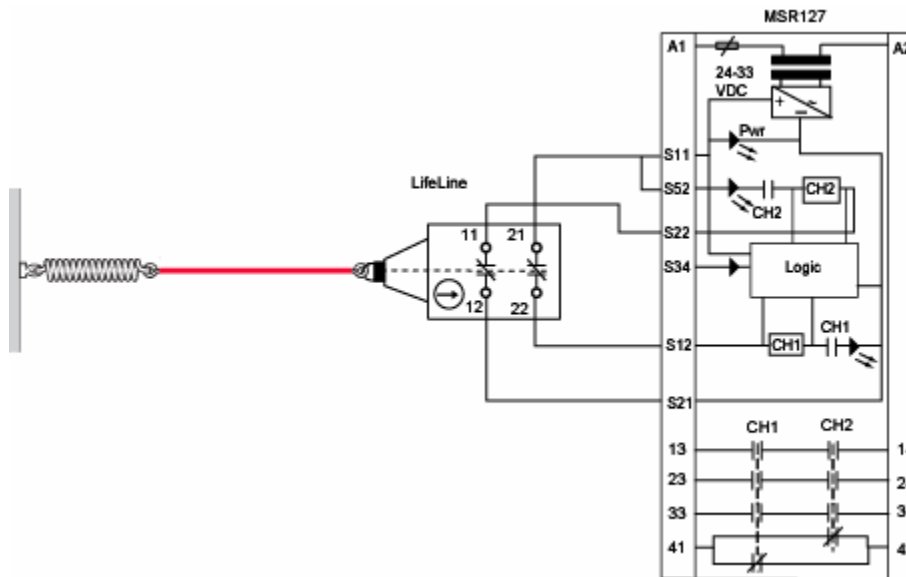


Figure 24. One Lifeline – Dual Channel

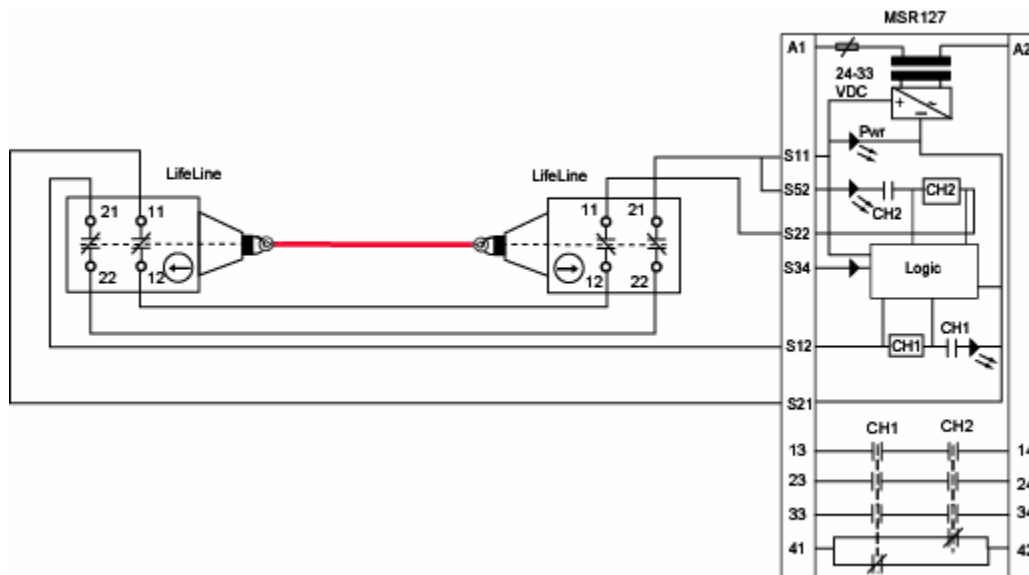


Figure 25. Dual Lifeline's – Dual Channel

14. 9000 Series Photoelectrics

- In some applications (e.g., muting) sensing must be accomplished with photoelectric sensors. The 9000 Series photoelectrics can be connected to the MSR127. Due to overload protection of its outputs, the MiniSight and RightSight photoelectrics cannot be used with the MSR127.
- The 9000 Series has a LT/DK operate switch. With the switch set to LT position, the output of the 9000 Series is on when the receiver is not blocked.
- Ground Reference: When the 9000 Series and the MSR127 are powered by 24VDC, then all devices can be referenced to 24V ground. When the MSR127 is powered on AC and the 9000 Series is powered by DC, then the 9000 Series ground must be connected to terminal S21.

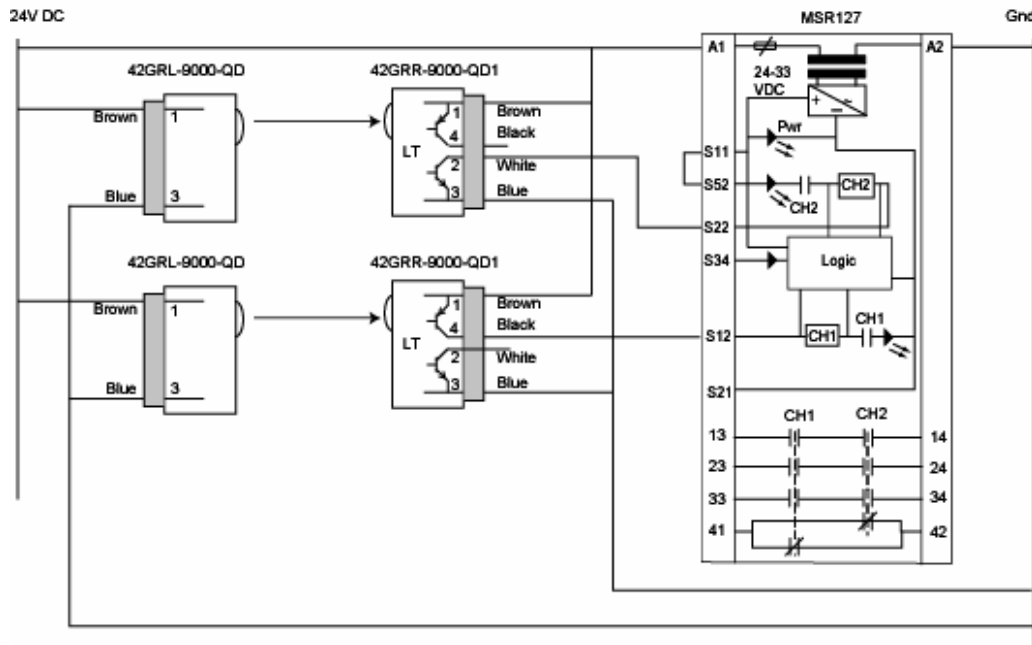


Figure 26. 9000 Series 24VDC

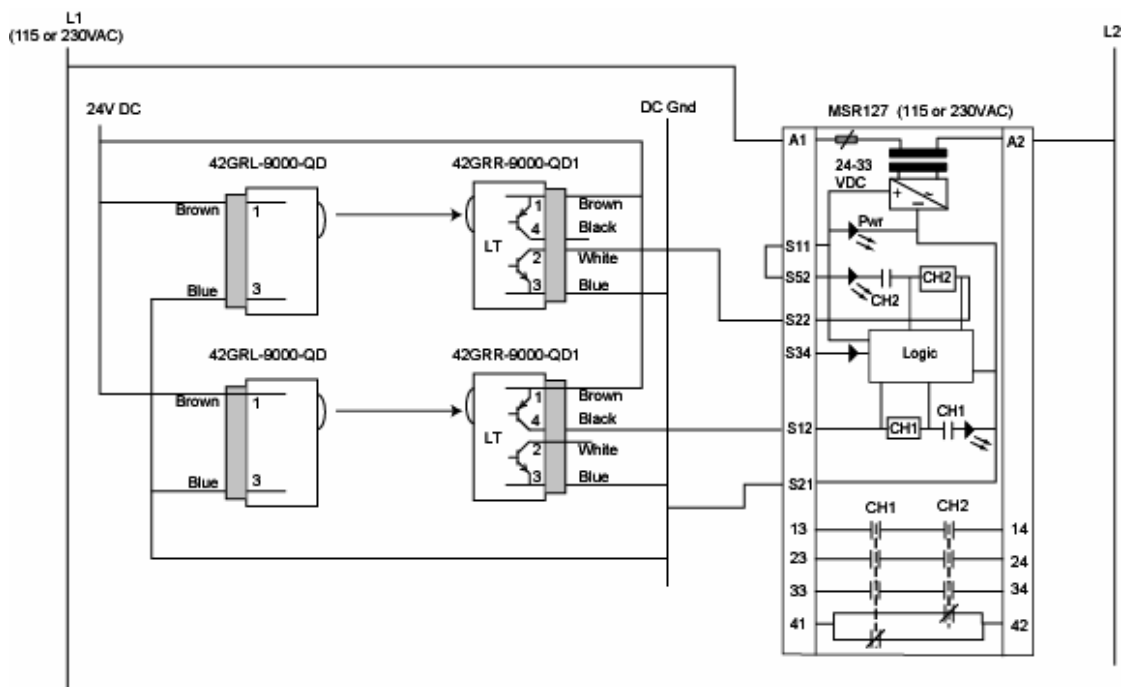


Figure 27. 9000 Series DC, MSR127 AC

c) Resets

- The MSR127 has either automatic/manual or monitored manual reset, depending on the model selected, see Product Selection Chart.
- The reset circuit is connected between terminals S12 and S34.
- The MSR127 checks the reset circuit after its inputs are satisfied.
- Once the output of the MSR127 is energized, the reset circuit is not used until the inputs are cycled again.

2. Automatic/Manual

- The type MSR127T is internally configured for automatic / manual reset.
- This type of reset is sometimes a jumper. A switch or contact can also be added to this circuit,

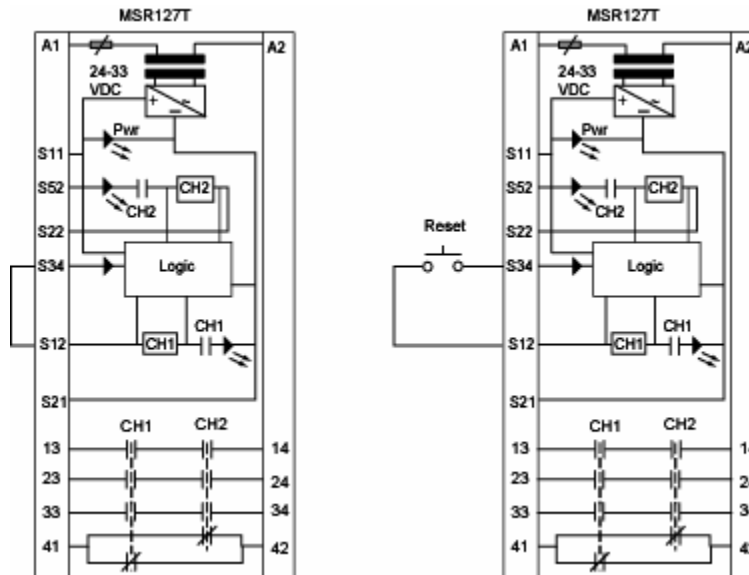


Figure 28. Automatic / Manual Reset Alternatives

3. Monitored Manual

- The type MSR127R is internally configured for monitored manual reset.
- The monitored manual reset requires the reset circuit to be open when the inputs are closed.
- The reset contact is typically operated by hand, but can be operated by a PLC.

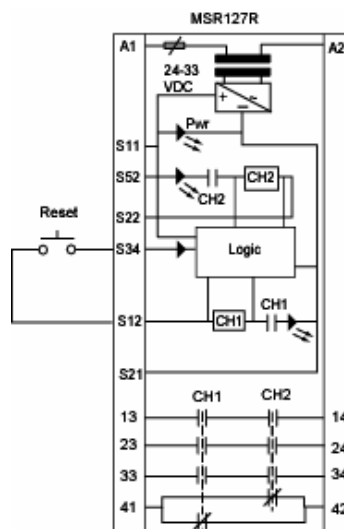


Figure 29. Monitored Manual Reset

d) Monitoring

- Monitoring is used by the MSR127 to determine the status of certain devices.
- The monitoring is accomplished by adding normally closed contacts, in series, in the reset circuit: terminals S12 to S34. The monitored contacts must not be connected in parallel.
- These devices must be in the closed state, prior to the MSR127 energizing its outputs.
- Typical devices are contactors, control relays, expansion relays, and solenoid locking contacts.
- The number of devices that can be monitored is limited by the resistance tolerated by the MSR127. This resistance is 110 ohms.

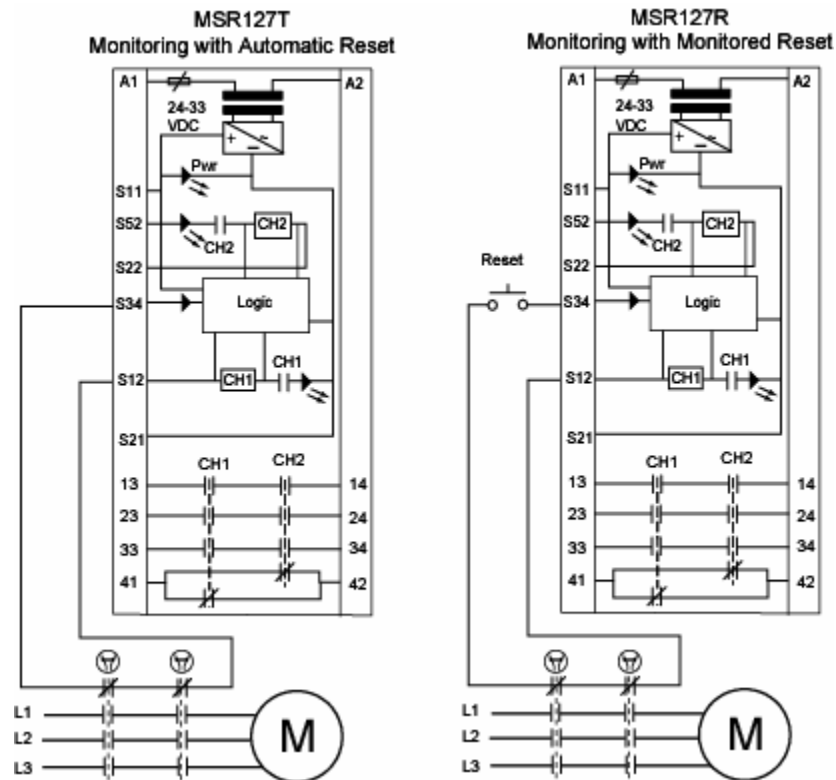


Figure 30. Monitoring of Contactors

e) Outputs

1. Safety Outputs

- The safety outputs of the MSR127 are redundant, voltage free contacts on terminals 13/14, 23/24 and 33/34.
- The number of devices that can be connected to the output is limited by the making and breaking currents.
- The voltage being switched by the safety outputs does not necessarily have to match the supply voltage.
- A 6A slow blow or 10A fast acting fuse is recommended to prevent damage to the MSR127 from unexpected short circuits.

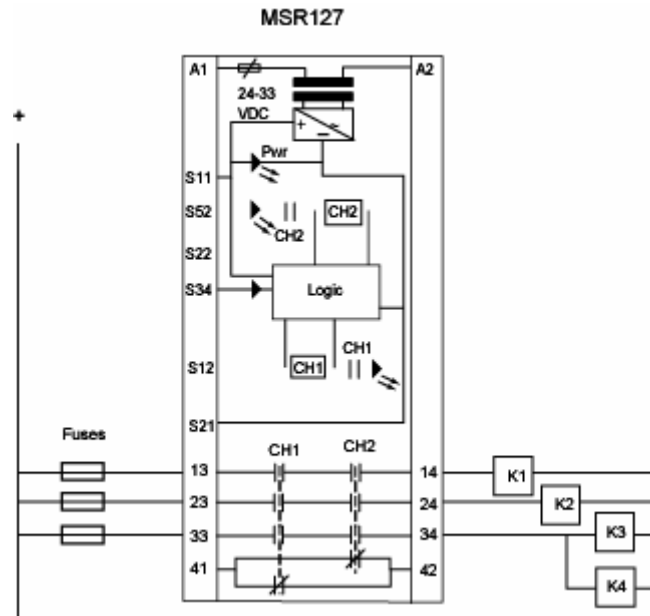


Figure 31. Safety Outputs

2. Auxiliary Outputs

- The auxiliary outputs of the MSR127 are terminals 41/42.
- These outputs are typically used to provide status indication to a plc or lamp. They must not be used to drive devices performing safety functions.
- The auxiliary output is conductive when input Ch1 or input Ch2 or both are open.

f) System Examples

1. GuardShield Monitored Reset, Output Monitoring, Mixed Supply Voltage

- a. The example meets the requirements of Category 4 per EN954-1.

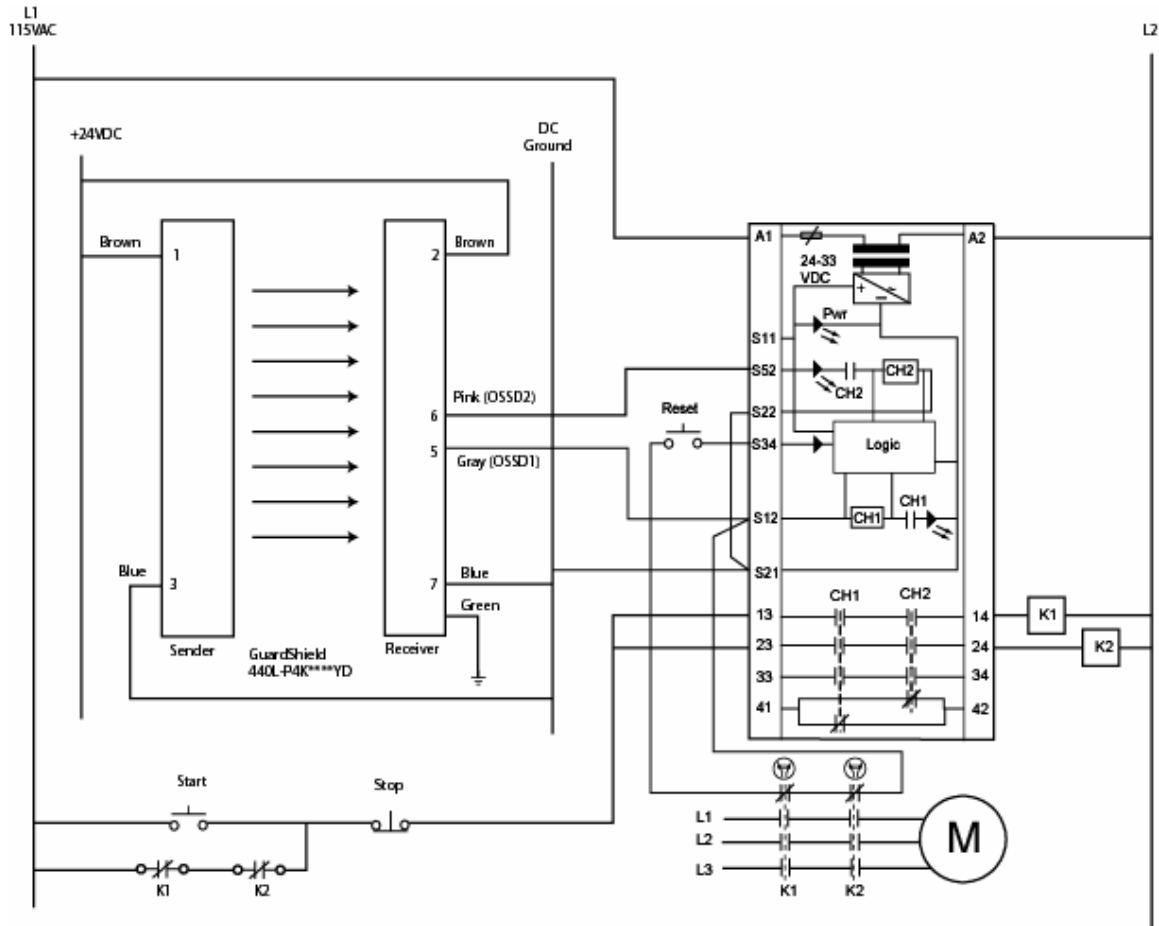


Figure 32. GuardShield, Monitored Reset, Monitored Output, Mixed Voltage Supply