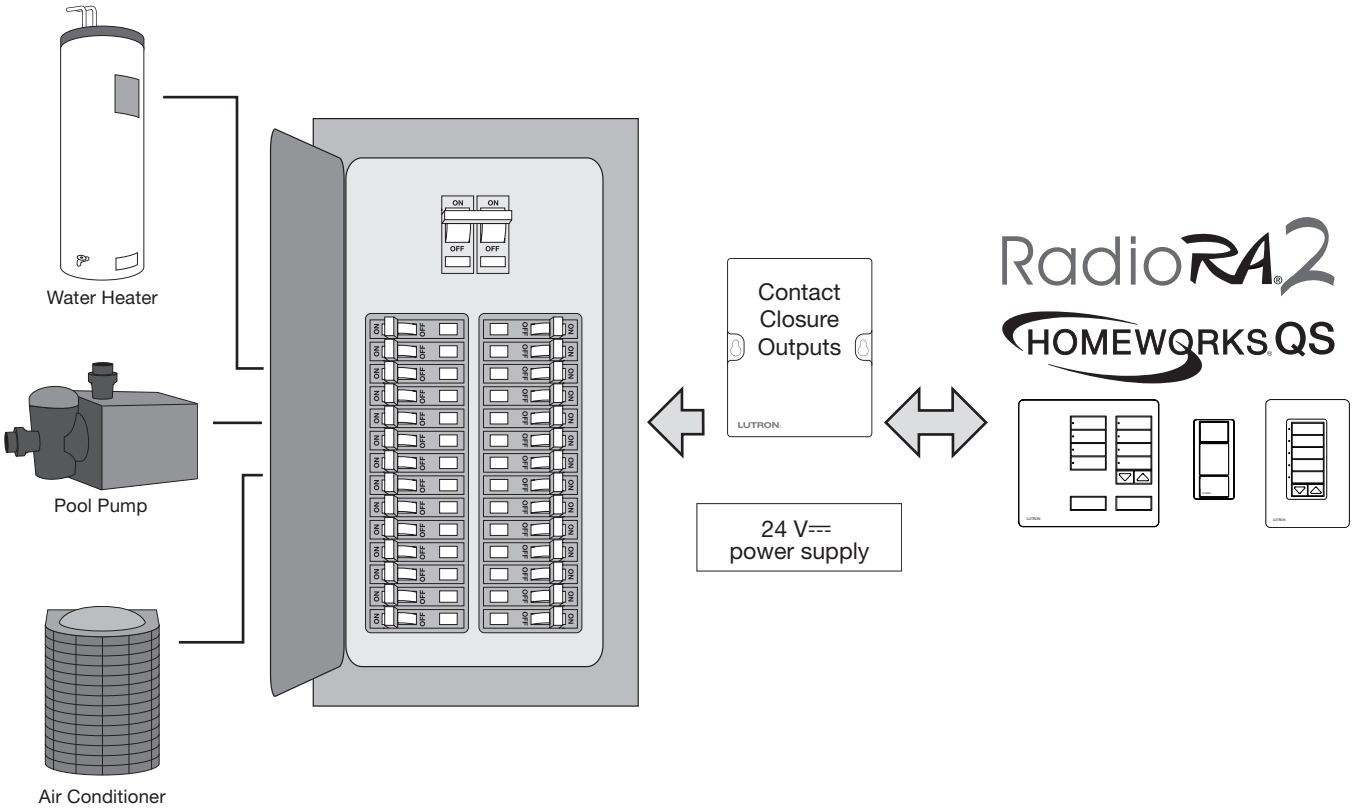
Using Lutron® Systems To Control Smart Breakers

Overview:

Lutron® systems are used to achieve energy savings in the home through control of lighting, window treatments, HVAC, and automation. There are large sources of energy consumption in a home that are typically wired directly to a circuit breaker, and not controlled with an energy savings strategy. Remotely controlled “smart breakers” can be used to turn off large loads such as water heaters, pool pumps, and air conditioners to prevent them from operating during particular times of the day when energy savings is desired.

Eaton® Corporation has a line of remotely controlled Smart Breakers that fit the needs of various voltage and current capabilities, and they can be controlled using contact closures through Lutron® systems such as RadioRA® 2, and HomeWorks® QS. This application note provides examples of the smart breaker equipment that is available, and provides instructions for how to wire and program a Lutron® lighting system to control the breakers directly.



Recommended Smart Breaker Options:

Eaton® Corporation

The following Eaton® remote control breaker options are available through Electrical Distributors:

Table 1. Eaton® Breaker Summary

Breaker Family	Load Center Mounting	Load Center Type	# Poles available	Voltage options	Current options
BRRP	Plug in	BR	1, 2	120 V~, 120/240 V~	15 A – 50 A
CLRP	Plug In	CL – Classified listing for 3rd party load centers (see below)	1, 2	120 V~, 120/240 V~	15 A – 50 A

Classified Remote Control Breakers (Type CLRP) are compatible with the following 3rd party load centers:

- Square D® HOMELINE®
- Siemens®
- General Electric®
- Crouse-Hinds®
- Murray™
- Thomas and Betts®

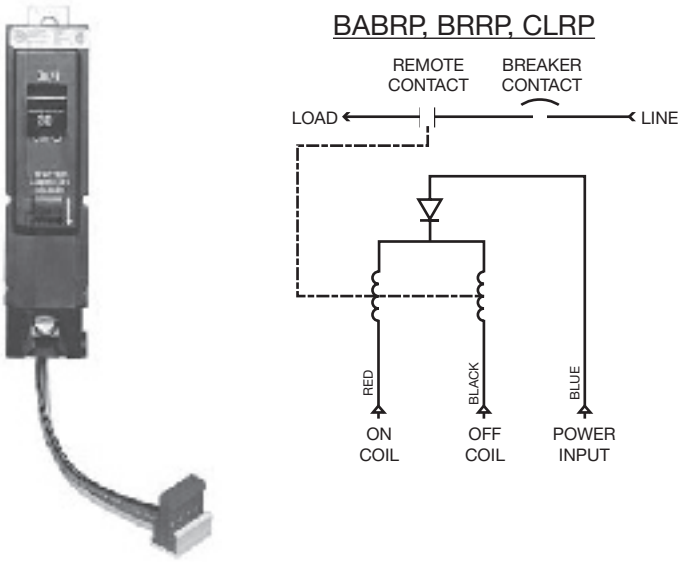


Figure 1. Eaton® Breaker and equivalent circuit

Table 2. Eaton® Breaker Electrical Characteristics

Parameter		Specification
Power Input		
Nominal		24 V⎓ or V~
Minimum (-15%)		20.4 V⎓ or V~
Maximum (+10%)		30 V⎓ or V~
Control Waveform		
⎓	Minimum	25 ms
	Maximum	300 ms
~	Minimum	3 cycles (50 ms)
	Maximum	18 cycles (300 ms)
Duty Cycle		
Maximum (per minute)		6 (open/close)
Current Draw per Pole (at Nominal Voltage)		
Open		2 A
Close		2 A

Table 3. Eaton® Part Numbers

Eaton® Remote Control Breakers				
Breaker Type	Number of Poles	Ampere (A) Rating	V∼ (50/60Hz)	Eaton® Catalog Number*
BRRP	1	15	120 V∼	BRRP115
		20	120 V∼	BRRP120
		25	120 V∼	BRRP125
		30	120 V∼	BRRP130
	2	15	120/240 V∼	BRRP215
		20	120/240 V∼	BRRP220
		25	120/240 V∼	BRRP225
		30	120/240 V∼	BRRP230
		40	120/240 V∼	BRRP240
		50	120/240 V∼	BRRP250
CLRP	1	15	120 V∼	CLRP115
		20	120 V∼	CLRP120
		25	120 V∼	CLRP125
		30	120 V∼	CLRP130
	2	15	120/240 V∼	CLRP215
		20	120/240 V∼	CLRP220
		25	120/240 V∼	CLRP225
		30	120/240 V∼	CLRP230
		40	120/240 V∼	CLRP240
		50	120/240 V∼	CLRP250

Description	Eaton® Catalog Number*
60 in (1524 mm) wire pigtail provides a connection from a single breaker control plug to the breaker controls (contact closures and power supply). Each box contains 12 pigtails. Wires are 22 AWG (0.5 mm^2), 600 V∼. Order in multiples of 12.	SLBKRPTL1

*Contact your local Eaton® electrical distributor for pricing and availability

Typical Installation diagram:

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

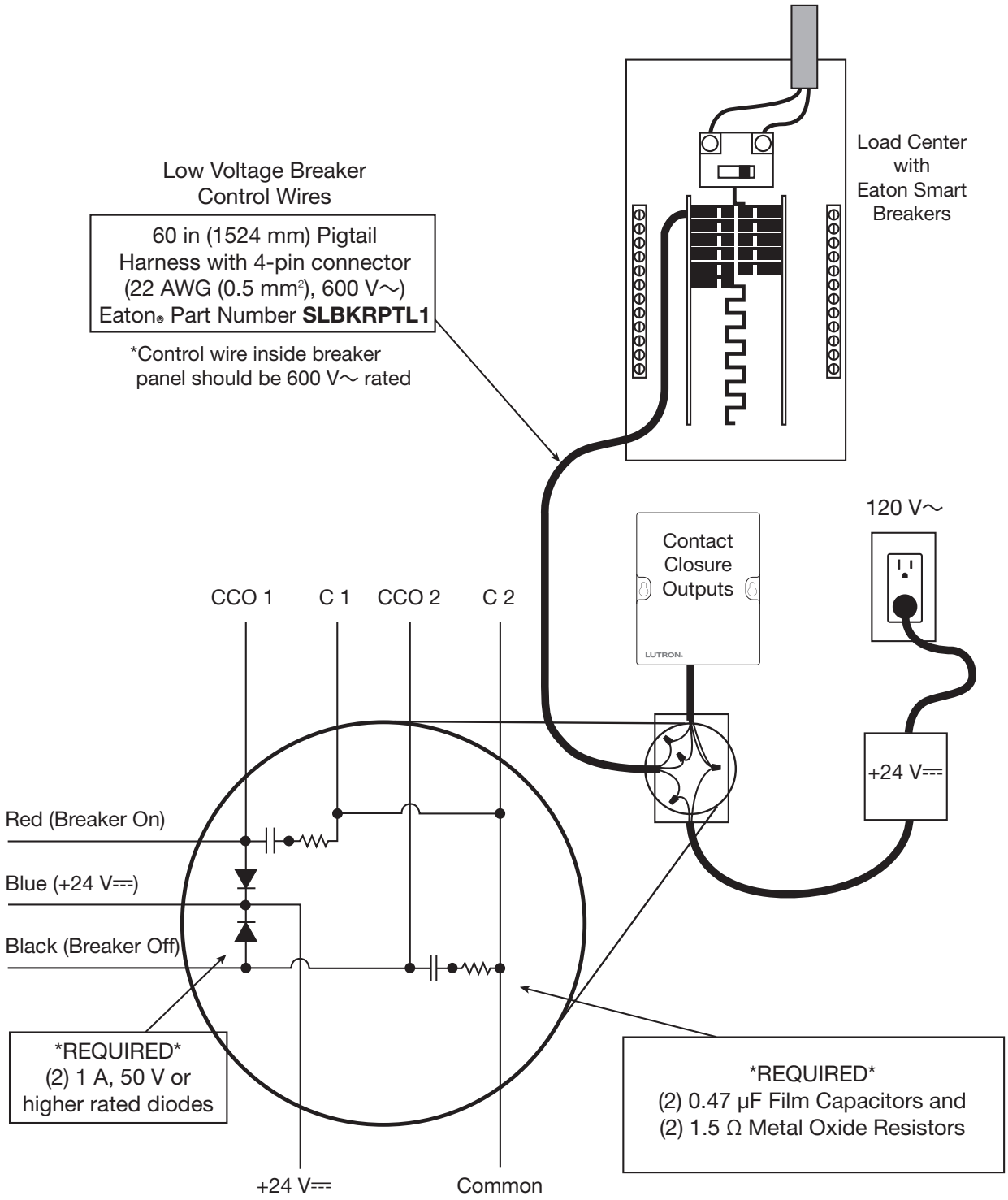


Figure 2. Typical Installation

Subpanel Based Installation diagram

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

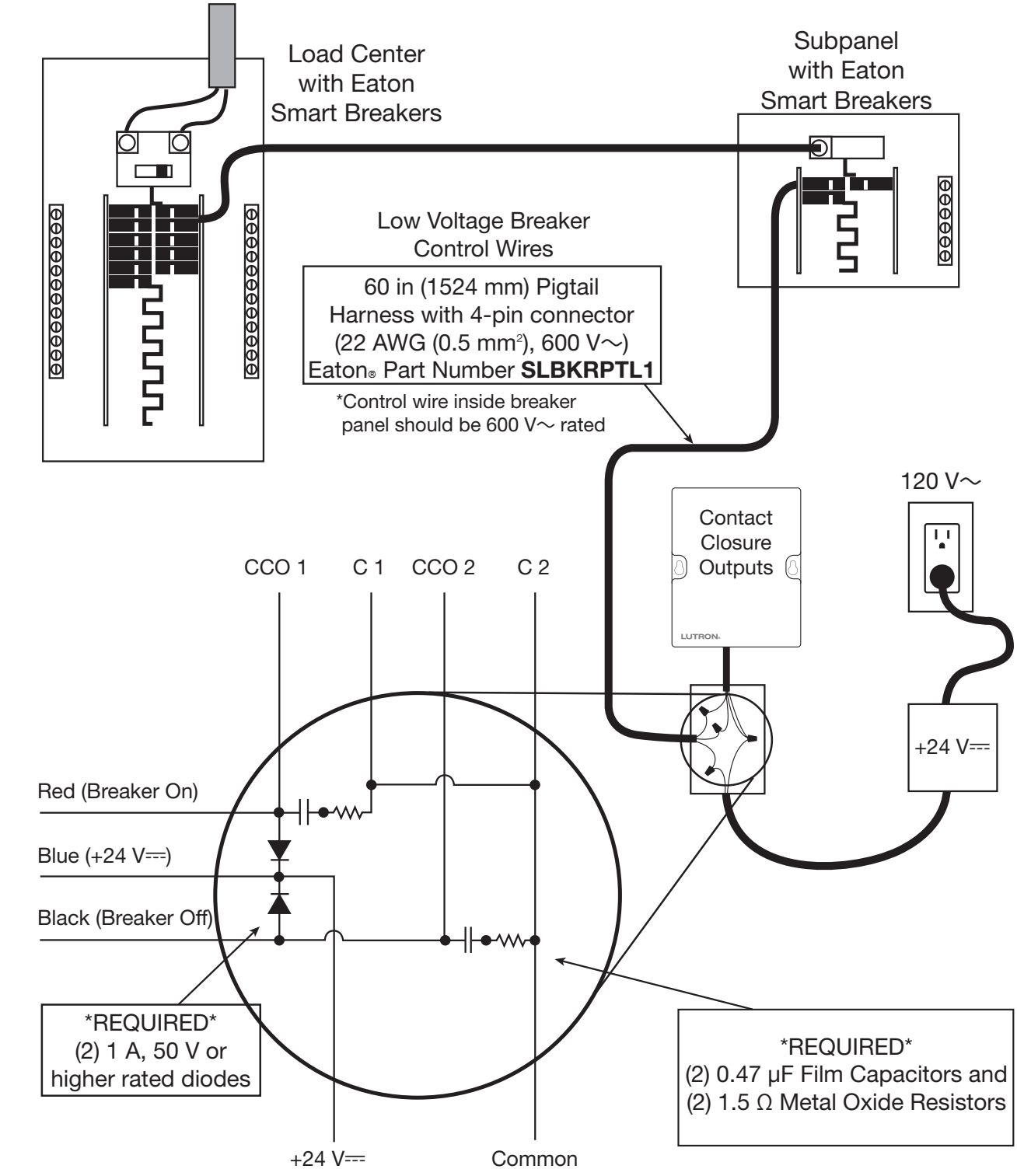


Figure 3. Typical Sub-panel Installation

Installation Requirements

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

WARNING - Entrapment hazard. To avoid the risk of entrapment, serious injury, or death, these controls must not be used to control equipment which is not visible from every control location or which could create hazardous situations such as entrapment if operated accidentally. Examples of such equipment which must not be operated by these controls include (but are not limited to) motorized gates, garage doors, industrial doors, microwave ovens, heating pads, etc. It is the installer's responsibility to ensure that the equipment being controlled is visible from every control location and that only suitable equipment is connected to these controls. Failure to do so could result in serious injury or death.

- One breaker maximum per pair of CCO outputs for on/off breaker control (on RR-VCRX-WH, HQR-VCRX-WH or QSE-IO). A 2-pole breaker can be driven by the same pair of CCOs.
- 1 A, 50 V or higher rated diode must be installed for each CCO output (see wiring diagrams below) due to the inductive nature of the breaker solenoid. Be sure to install the diodes using the correct polarity, otherwise the diodes may be damaged. Specifications, distributor information and part options are listed below for recommended diodes.
- A 0.47 µF film capacitor and 1.5 Ω (metal oxide) resistor must be wired in series between each CCO output and Common to prevent arcing of the contacts. LUT-MLC may be purchased from Lutron for the capacitor. The LUT-MLC has insulated flying leads (stranded wires) to make installation easier, compared to a standard capacitor with shorter bare metal through-hole leads. Specifications, distributor information, and part options are listed below for recommended resistors and capacitors.
- One QSPS-P1-50-1 power supply should be used per pole of each breaker (IE, BRRP120 = one QSPS-P1-50-1 power supply; BRRP220 = two QSPS power supplies). A 2-pole breaker requires twice as much current as a 1-pole breaker, thus the 24 V⎓ output of two QSPS-P1-50-1 power supplies should be wired in parallel when providing control power to the breaker.
- Consult Lutron for power supply specifications if a power supply other than the QSPS-P1-50-1 is to be used for this application. The Lutron® power supplies listed above have been tested specifically for this application. Use of another 24 V⎓ power supply may not provide desired breaker operation.
- 600 V~ or higher, 22 AWG (0.5 mm^2) or larger wire should be used for breaker control wire inside the breaker panel. Eaton® part number SLBKRPTL1 is a 60 in (1.5 m) wire harness that includes the connector needed to easily connect to the breaker control wires. This Eaton® wire harness is recommended for installing each breaker.
- Control wires should be kept at least 0.25 in (6.3 mm) from all high voltage wires.
- Maximum wiring distance from 24 V⎓ power supply, to CCO, to breaker should not exceed 75 ft (22.8 m).
- 6 on/off cycles of the breaker per minute should not be exceeded.

Resistor/Capacitor/Diode Requirements:

Resistor Specifications

Resistance: 1.5 Ω
Tolerance: not to exceed a maximum of +/- 5%
Type: Metal Oxide
Power rating: 1 W (minimum)

Table 4. 1.5 Ω Resistor Options

Distributor	Distributor Part Number	Manufacturer	Manufacturer's Part Number	Description
Mouser Electronics®	660-MOSX2CT52R1R5J	KOA Speer™	MOSX2CT52R1R5J	Metal Oxide Resistors RSS2 1.5 5% TR
Digi-Key®	P1.5W-1BK-ND	Panasonic®	ERX-1SJ1R5	RES 1.5 OHM 1W 5% METAL FILM
	P1.5W-2BK-ND	Panasonic®	ERX-2SJ1R5	RES 1.5 OHM 2W 5% METAL FILM

Capacitor Specifications

Capacitance: 0.47 µF
Tolerance not to exceed a maximum of +/- 10%
DC Voltage rating: 63 V⎓ (minimum)
dV/dt rating: 30 V/µs (minimum)

Table 5. 0.47 µF Capacitor Options

Distributor	Distributor Part Number	Manufacturer	Manufacturer's Part Number	Description
Lutron	LUT-MLC	Lutron	LUT-MLC	MIN LOAD CAP
Mouser Electronics®	667-ECQ-V1474JM	Panasonic®	ECQ-V1474JM	Polyester Film Capacitors .47µF 100V 5%
	80-R82EC3470DQ70J	Kemet™	R82EC3470DQ70J	Polyester Film Capacitors .47µF 100volts 5%
Digi-Key®	P4733-ND	Panasonic®	ECQ-V1474JM	CAP FILM 0.47UF 100 VDC RADIAL
	399-5454-1-ND	Kemet™	R82EC3470DQ70J	CAP FILM 0.47UF 100 VDC

Resistor/Capacitor/Didode Requirements (continued):

Diode Specifications

Average Current Rating: 1 A (minimum)
Surge Current Rating: 30 A (minimum)
Reverse Voltage Rating: 50 V (minimum)

Table 6. Diode Options

Distributor	Distributor Part Number	Manufacturer	Manufacturer's Part Number	Description
Digi-Key®	1N4004GOS-ND	ON Semiconductor™	1N4004G	Diode Std Rec 1 A, 400 V DO-41
	1N4004FSCT-ND	Fairchild Semiconductor™	1N4004	Diode Gen Purpose 400 V, 1 A DO41
	1N4004-E3/54GICT-ND	Vishay® General Semiconductor™	1N4004-E3/54	Diode GP 1 A, 400 V DO41
Mouser Electronics®	512-1N4004	Fairchild Semiconductor™	1N4004	Rectifiers Vr/400 V Io/1 A T/R
	863-1N4004G	ON Semiconductor™	1N4004G	Rectifiers 400 V, 1 A Standard
	625-1N4004-E3/54	Vishay® General Semiconductor™	1N4004-E3/54	Rectifiers Vr/400 V Io/1 A

Typical Bill of Materials (RadioRA 2):

Table 7. 1-pole breaker bill of materials

Description	Model Number	Quantity
Remote Control Breaker	See Eaton® Models above	1 pole
Breaker Wire Harness	See Eaton® Model above	1 per breaker
Contact Closure Device	RR-VCRX-WH	1 for every 2 breakers
24 V⎓ Power Supply	QSPS-P1-1-50-WH	1 per pole
Flyback diodes	1A, 50 V rated	2 per breaker
Shunt Capacitor	0.47 µF film cap	2 per breaker
Resistor	1.5 Ω metal oxide	2 per breaker

Table 8. 2-pole breaker bill of materials

Description	Model Number	Quantity
Remote Control Breaker	See Eaton® Models above	2 pole
Breaker Wire Harness	See Eaton® Model above	1 per breaker
Contact Closure Device	RR-VCRX-WH	1 for every 2 breakers
24 V⎓ Power Supply	QSPS-P1-1-50-WH	2 (1 per pole)
Flyback diodes	1A, 50 V rated	2 per breaker
Shunt Capacitor	0.47 µF film cap	2 per breaker
Resistor	1.5 Ω metal oxide	2 per breaker

Distributor information to purchase the resistors/capacitors/diodes:

Mouser Electronics®
www.mouser.com
1.800.346.6873

Digi-Key®
www.digikey.com
1.800.344.4539

RadioRA® 2 Implementation:

Wiring - Single Pole

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

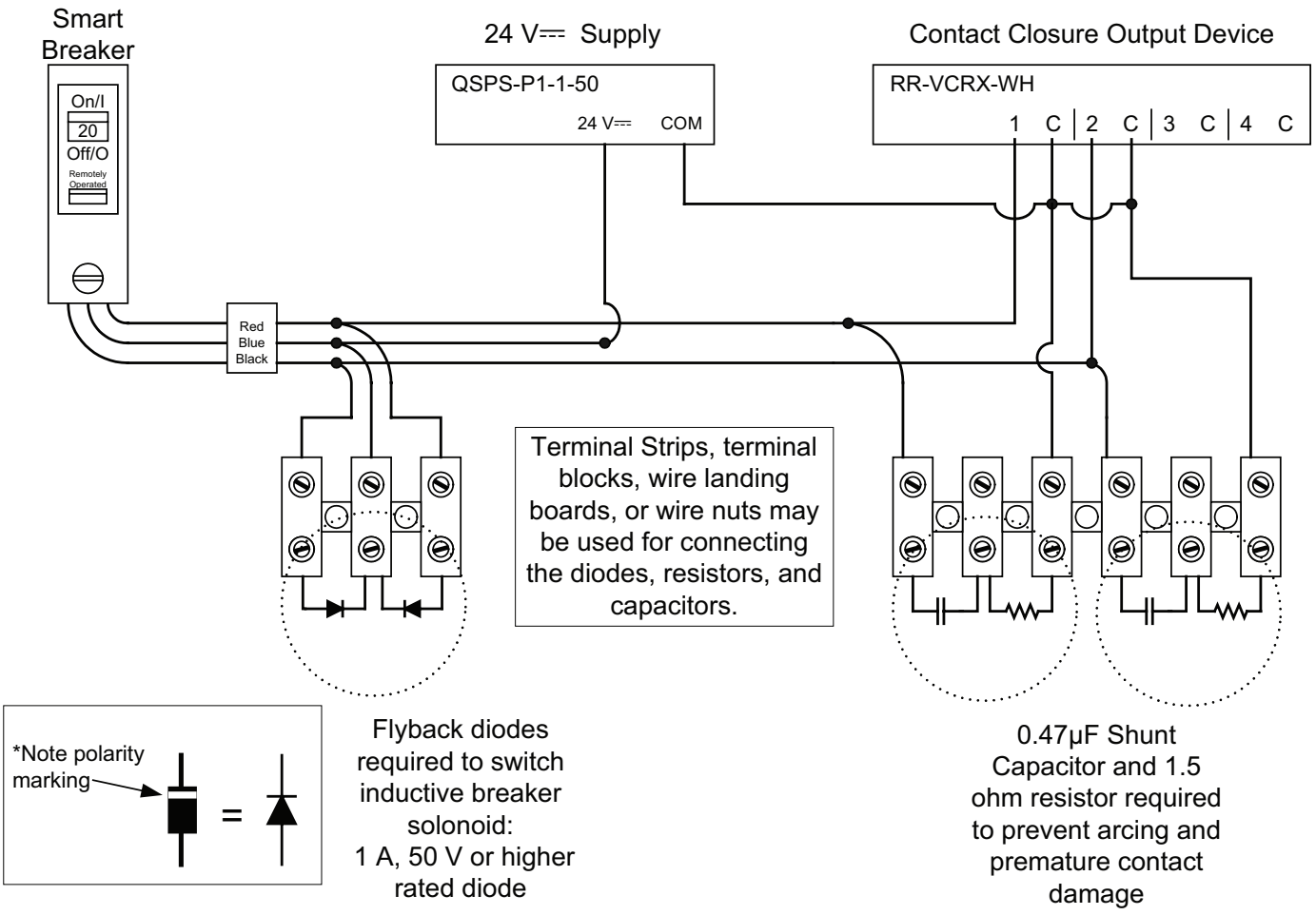


Figure 4. RadioRA® 2 Wiring (1-Pole Breaker)

Programming

Step 1: Add RR-VCRX-WH to RadioRA® 2 database
Step 2: Setup CCO 1 and CCO 2 as pulsed outputs
Step 3: Program keypad buttons/events to pulse the respective CCO to turn on/off the breaker

Breaker ON: CCO 1 = 0.25 s pulse
Breaker OFF: CCO 2 = 0.25 s pulse

RadioRA® 2 Implementation:

Wiring - Double Pole

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

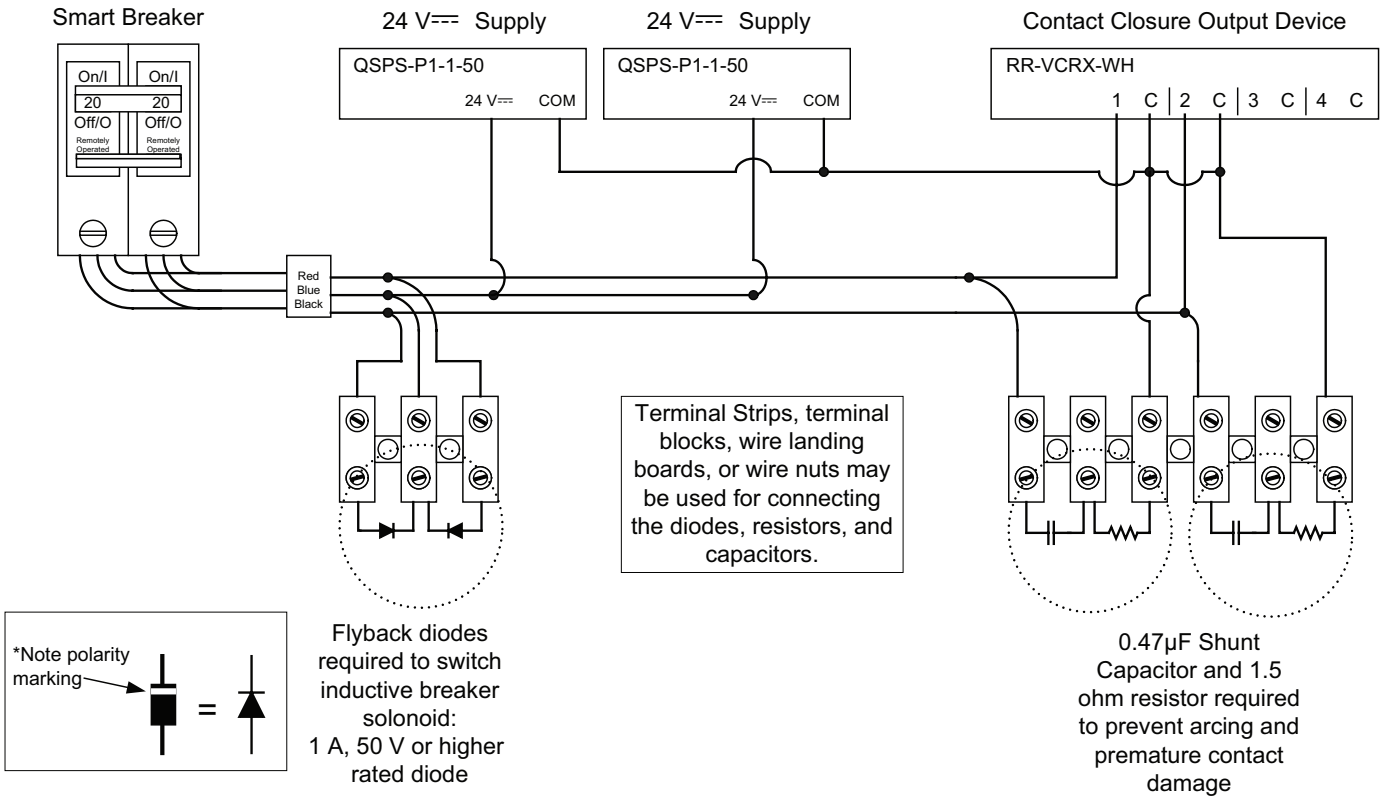


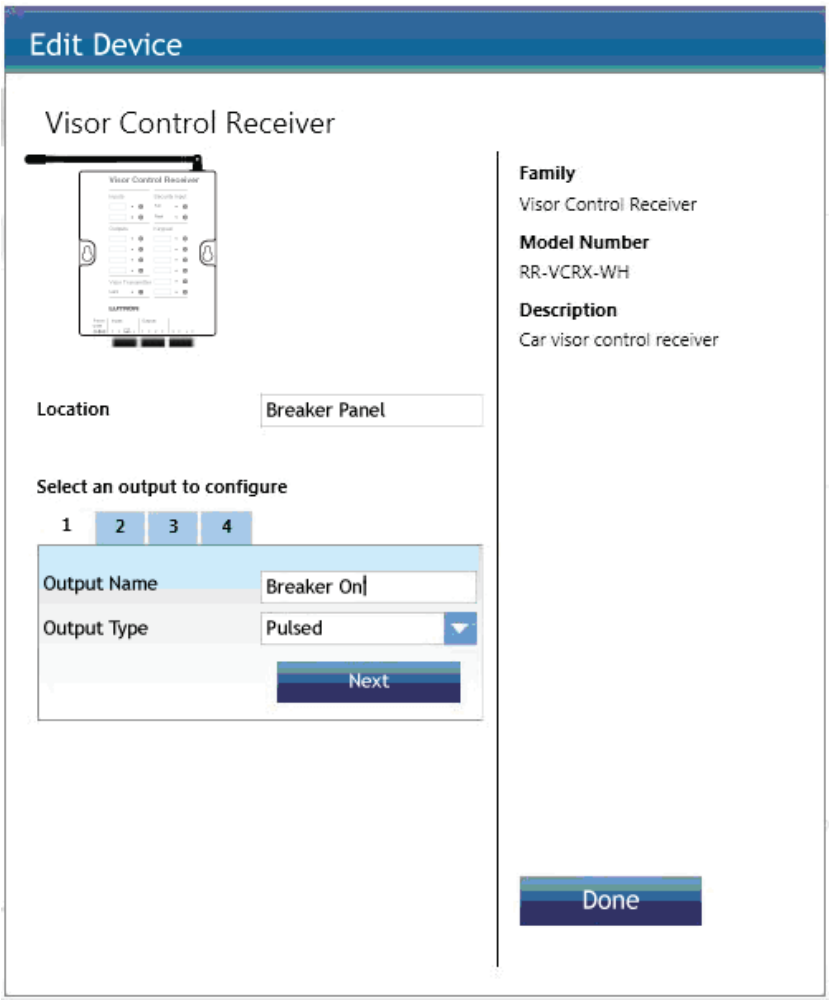
Figure 5. RadioRA® 2 Wiring (2-Pole Breaker)

Programming

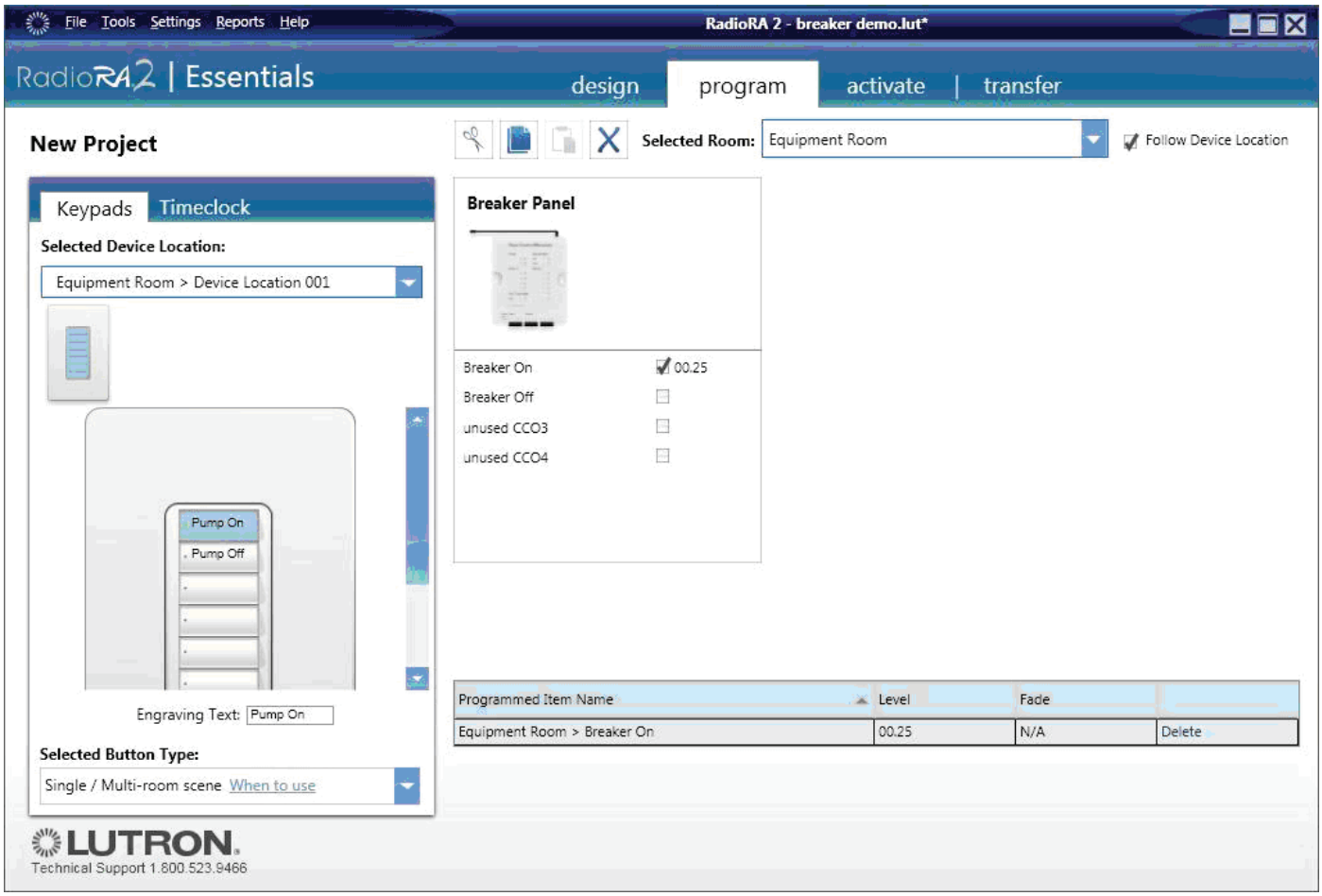
Step 1: Add RR-VCRX-WH to RadioRA® 2 database
Step 2: Setup CCO 1 and CCO 2 as pulsed outputs
Step 3: Program keypad buttons/events to pulse the respective CCO to turn on/off the breaker

Breaker ON: CCO 1 = 0.25 s pulse
Breaker OFF: CCO 2 = 0.25 s pulse

Steps 1 and 2 – Add RR-VCRX-WH and program outputs as pulsed



Step 3 – Program buttons to pulse the CCO outputs for 0.25 s to turn on/off the breakers



Typical Bill of Materials (HomeWorks® QS):

Table 9. 1-pole breaker bill of materials

Description	Model Number	Quantity
Remote Control Breaker	See Eaton® Models above	1 pole
Breaker Wire Harness	See Eaton® Model above	1 per breaker
Contact Closure Device	QS-IO or HQR-VCRX-WH	1 for every 2 breakers
24 V⎓ Power Supply	QSPS-P1-1-50-WH	1 per pole
Flyback diodes	1A, 50 V rated	2 per breaker
Shunt Capacitor	0.47 µF film cap	2 per breaker
Resistor	1.5 Ω metal oxide	2 per breaker

Table 10. 2-pole breaker bill of materials

Description	Model Number	Quantity
Remote Control Breaker	See Eaton® Models above	2 pole
Breaker Wire Harness	See Eaton® Model above	1 per breaker
Contact Closure Device	QS-IO or HQR-VCRX-WH	1 for every 2 breakers
24 V⎓ Power Supply	QSPS-P1-1-50-WH	2 (1 per pole)
Flyback diodes	1A, 50 V rated	2 per breaker
Shunt Capacitor	0.47 µF film cap	2 per breaker
Resistor	1.5 Ω metal oxide	2 per breaker

Distributor information to purchase the resistors/capacitors/diodes:

Mouser Electronics
www.mouser.com
1.800.346.6873

Digi-Key
www.digikey.com
1.800.344.4539

HomeWorks® QS Implementation

Wiring - Single Pole

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

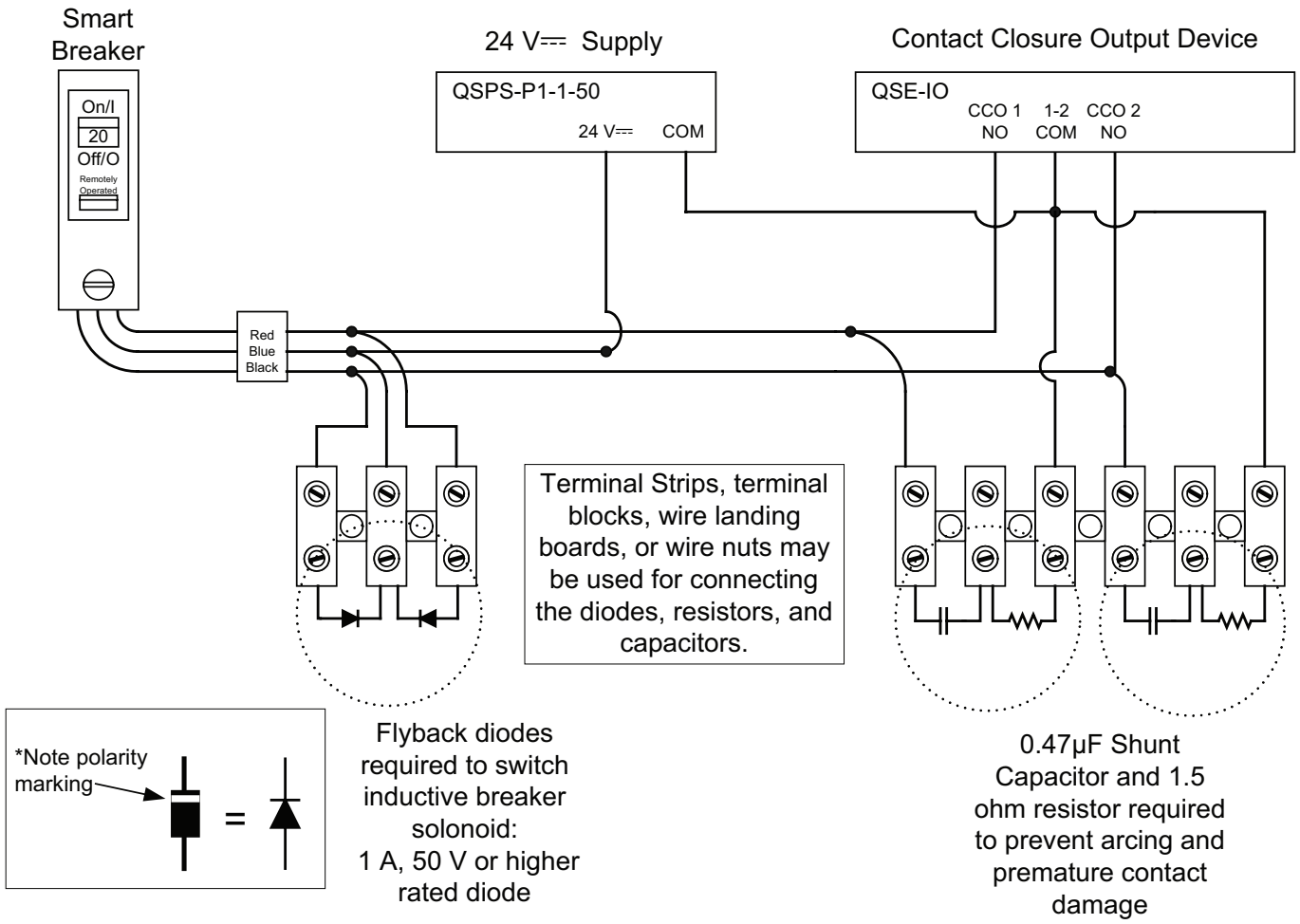


Figure 6. HomeWorks® QS Wiring (1-Pole Breaker)

Programming

Step 1: Defined Pulsed CCO loads for “Breaker On” and “Breaker Off”
Step 2: Add QSE-IO or HQR-VCRX-WH to HomeWorks® QS database
Step 3: Assign “Breaker On” and “Breaker Off” loads to QSE-IO or HQR-VCRX-WH Outputs 1 and 2
Step 4: Program keypad buttons/events to pulse the respective CCO loads to turn on/off the breaker

Breaker ON: CCO1 = 0.25 s pulse
Breaker OFF: CCO2 = 0.25 s pulse

HomeWorks® QS Implementation

Wiring - Double Pole

WARNING - Shock Hazard. May result in serious injury or death. DO NOT WIRE OR INSTALL WHEN LIVE! Switch off power to all power feeds before wiring or installation.

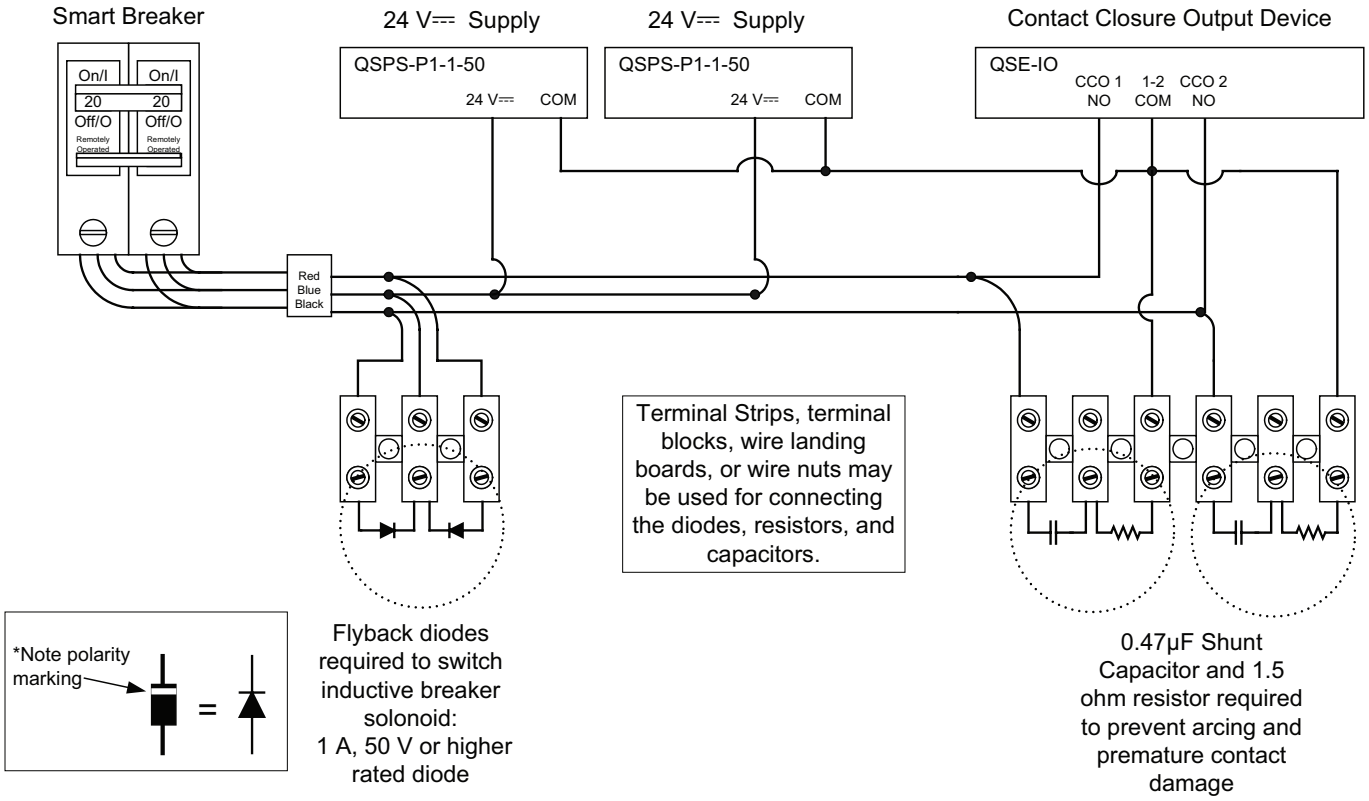


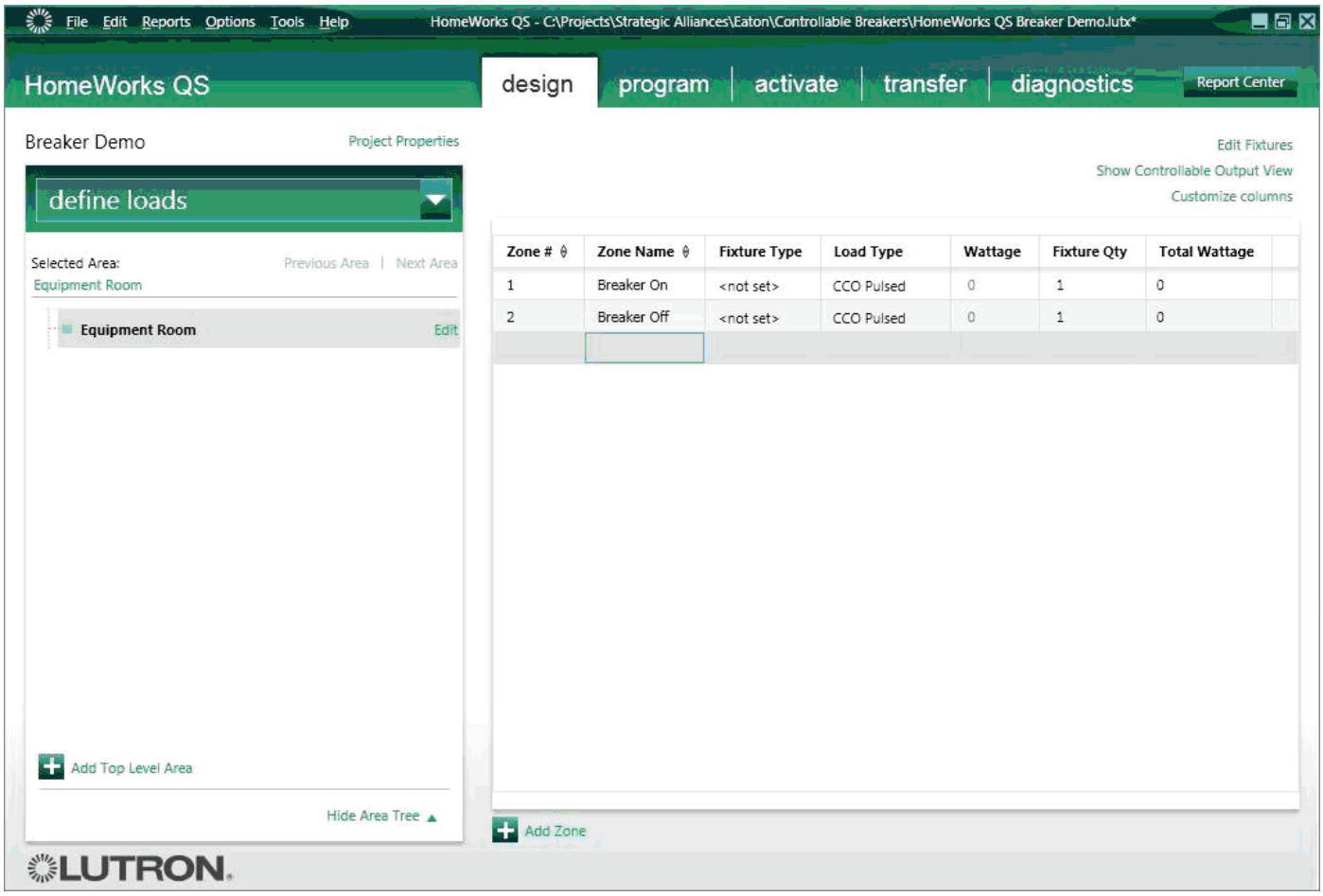
Figure 7. HomeWorks® QS Wiring (2-Pole Breaker)

Programming

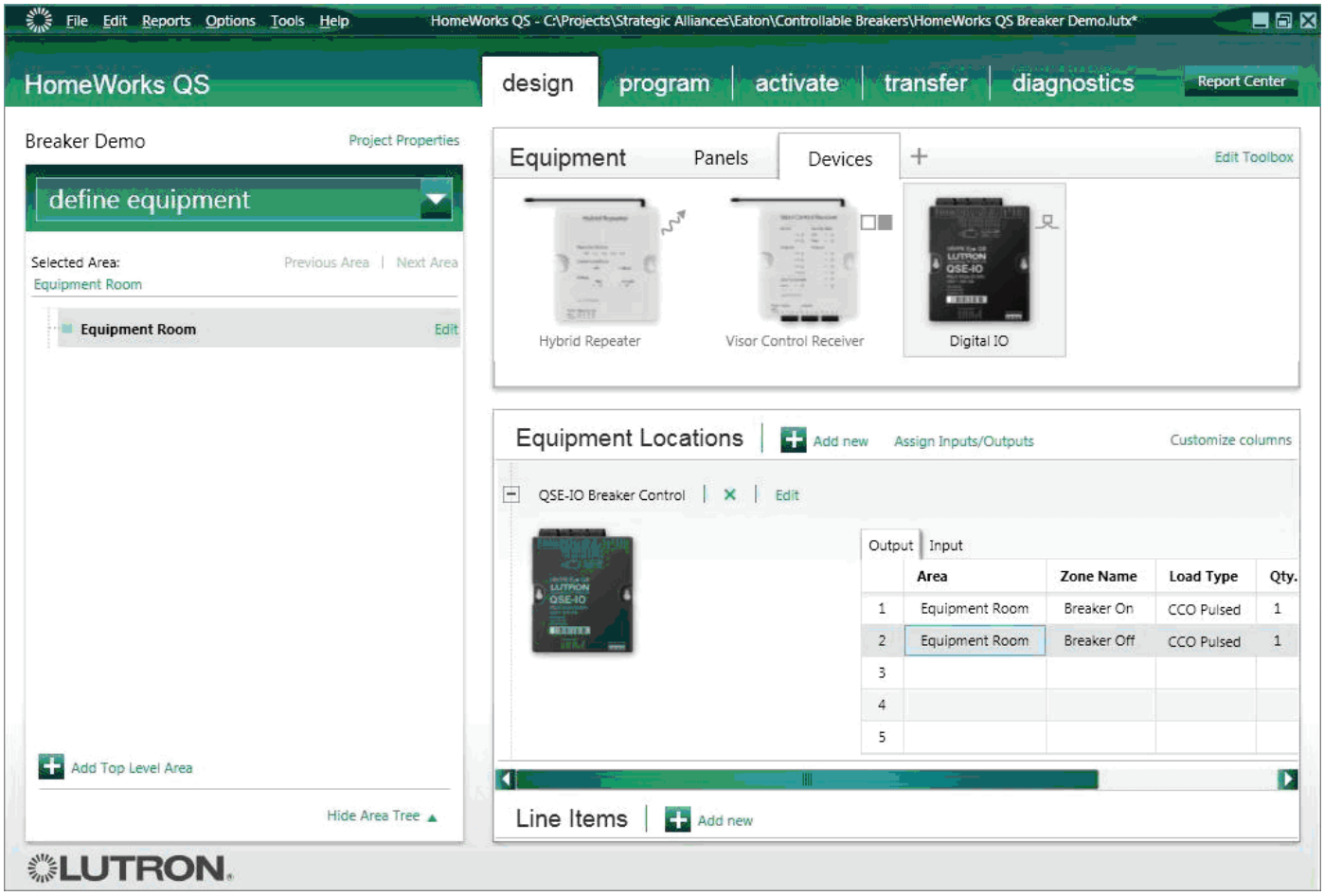
Step 1: Defined Pulsed CCO loads for “Breaker On” and “Breaker Off”
Step 2: Add QSE-IO or HQR-VCRX-WH to HomeWorks® QS database
Step 3: Assign “Breaker On” and “Breaker Off” loads to QSE-IO or HQR-VCRX-WH Outputs 1 and 2
Step 4: Program keypad buttons/events to pulse the respective CCO loads to turn on/off the breaker

Breaker ON: CCO1 = 0.25 s pulse
Breaker OFF: CCO2 = 0.25 s pulse

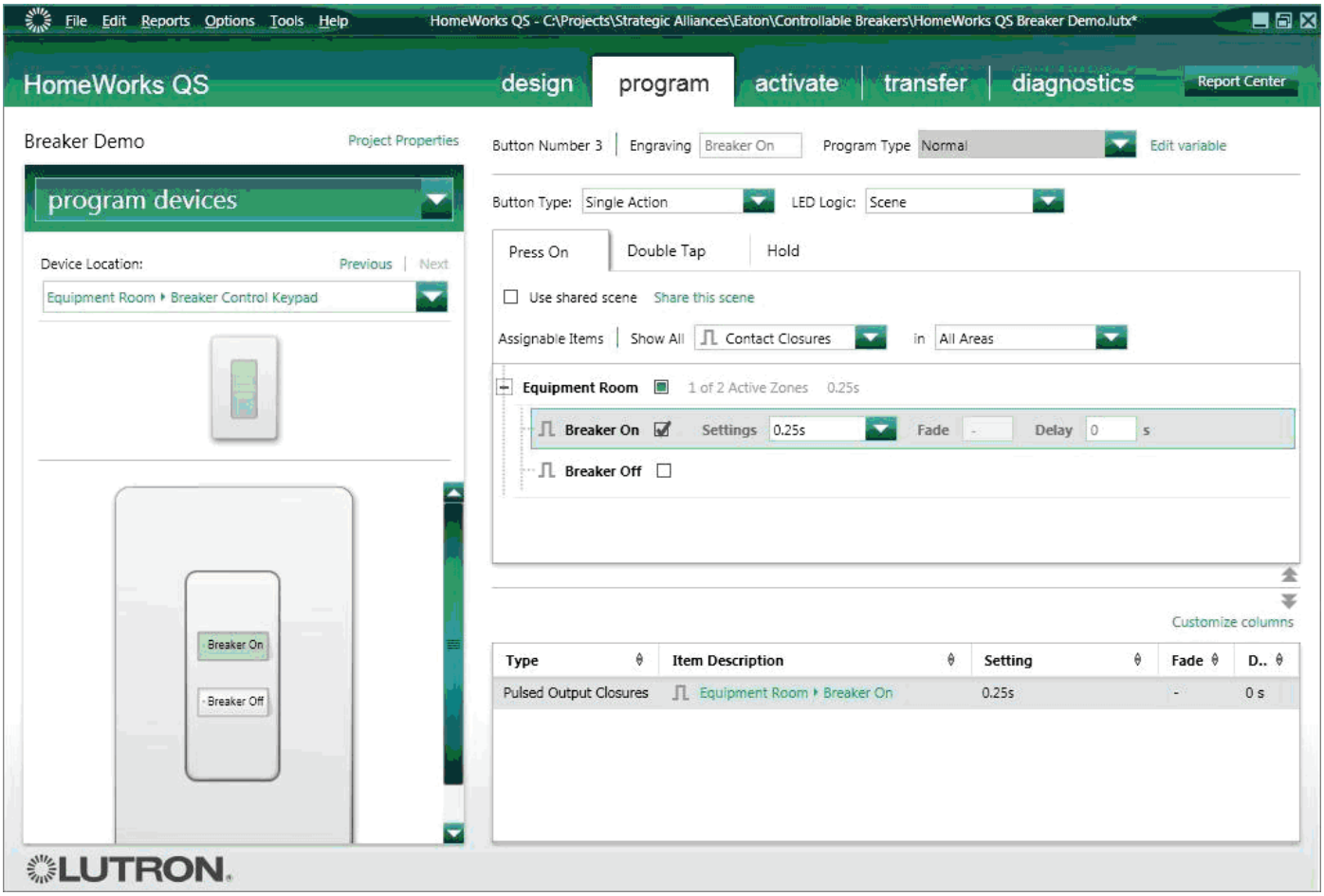
Step 1 – Define pulsed CCO loads



Steps 2 and 3 – Define the QSE-IO and assign the breaker CCO loads



Step 4 – Program buttons to pulse the CCO outputs for 0.25 s to turn on/off the breakers



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