Engineering Data

Description

The Remote Control Circuit Breakers (RCCB) concept, as load controllers in distributed-load applications, provides for a more efficient power distribution system with less line loss at a lower cost and with less weight than the conventional relay-flight deck circuit protector method.

Designed to meet the requirements of MIL-PRF-83383, the RCCB's capability and advantages include:

- Fusible link fail safe
- Remote on/off operation from the flight deck
- Visual indicators for open (green) and closed (red) on top surface
- Substantial reduction in weight and size
- Most direct route from power source to load
- Single wire control line from I/CU to RCCB
- Double-break power contact assembly
- Indication of trip or set by position of the ½ ampere circuit breaker on the flight deck
- Elimination of long runs of heavy and costly cables
- Magnetically latched coils (low power consumption)
- Use as a relay or circuit breaker or both
- Flanges mate for in-line or side-by-side mounting
- 1PST for DC or single phase AC
- 3PST for three phase AC only

Application

The Remote Control Circuit Breaker (RCCB) is a combination relay and circuit breaker which can be released or set by applying a release or set coil current electronically controlled by a command from the Indicator/Control Unit (I/CU) (a ½ ampere fast trip, thermal circuit breaker).

With power available to terminal #4 and/or terminal A1 (28 Vdc or 115 V 400 Hz) on 1PST RCCB: to terminal #4 (28 Vdc) and/or both terminals B1 and C1 (115 V 400 Hz) on 3PST RCCB, the RCCB will assume the state requested/indicated by the I/CU. If power is removed from terminal #4 and A1 on 1PST or from terminal #4 and both B1 and C1 on 3PST, the RCCB will remain in the state it was in prior to power removal. When power is reapplied to the terminals, the RCCB will assume the state indicated by the I/CU.

With the RCCB closed, an overload or fault current on any line or lines will cause the RCCB to trip and in turn will cause a controlled overload of the I/CU, causing it to trip also. A fault or overload on any power contact will cause the RCCB to trip open within the time limits specified regardless of the availability of coil power. To reclose the RCCB, the I/CU line (line 3 to ground) must be opened by the I/CU or series switch and reconnected to ground.

Other Performance Parameters For MIL-PRF-83383

- Coordination. An overload applied to two devices in series with a 2 to 1 current rating will result in only the lower rated device opening.
- Rupture capability to 3600A (115 Vac rms or 28 Vdc for SM600BA and 115 Vac rms for SM601BA series)
- Dielectric. 1500 V, 60 Hz, MIL-STD-202, Test Method 301, 0.5 MA maximum

- Explosion-proof. MIL-STD-202, Test Method 109
- Thermal Temperature Range. -54°C to 71°C (-65°F to 160°F). MIL-STD-202, Test Method 107
- Insulation Resistance. MIL-STD-202, Test Method 302, 100 Megohms minimum
- Aircraft Electrical Power. MIL-STD-704
- Vibration. 10 g's to 2000 Hz. MIL-STD-202, Test Method 204. Condition C (-54°C, 25°C, and 71°C). Maximum duration of contact transfer to uncommanded state: $10x10^{-6}$ seconds.
- Shock. 25 g's. MIL-TD-202, Test Method 213. Maximum duration of contact transfer to uncommanded state: $10x10^{-6}$ seconds.
- Altitude. 50,000 feet
- EMI, MIL-STD-461, Class 1D
- Moisture Resistance. MIL-STD-202, Test Method 106
- Fungus Resistance. MIL-STD-454, Guideline 4
- Sand and Dust Resistance. MIL-STD-202, Test Method 110, Test Condition A
- Salt Spray Resistance. MIL-STD-202, Test Method 101, Test Condition B

Single Pole

- 28 VDC
- 115/200 VAC 400 Hz

Three Phase

- 115/200 VAC 400 Hz
- Three Phase Only

Qualified

Meets MIL-PRF-83383

Weight and Cost Savings

Saves fuel by eliminating long runs of heavy, costly cables

Space Savings

Keeps larger breakers out of cockpit

RCCB System for Remote Operation

To form an RCCB system enabling remote On/Off operation from the flight deck, combine the Safran Electrical & Power RCCB with Indicator Control Unit (ICU) model #1500-053-05 on pg. 13.

Single Wire from Flight Deck

Control of the RCCB requires only one #22 AWG control wire from the ICU on the flight deck to the RCCB.

Use as a Relay, Circuit Breaker, or Both

Combines the best attributes of a circuit breaker and a relay. Automatically protects the wires and the load device during circuit/load breakdown, but allows the flight deck control of the load during normal operation.

Design Concept

Introduction

Part of the weight of the modern jet aircraft comes from the electrical wires and power control systems needed to distribute the electrical energy. As these aircraft increase their passenger carrying capability, the electrical power management system becomes more complex and could become heavier. Wire runs of more than 300 feet from the flight deck circuit breakers to the load become common.

Utilization of SafranElectrical& Power'sRemote Controlled Circuit Breakers (RCCB) close to the load or power source will eliminate much of these long, heavy, and expensive wire/cable. Control of the RCCB requires only one #22 AWG control wire from the flight deck to the RCCB.

Weight reduction, directly from wire use and indirectly from (generator) line heat loss, and installation and maintenance cost reductions becomes significant.

The RCCB combines the best attributes of a circuit breaker and a relay. The RCCB automatically protects the wires and the load device during circuit/load breakdown, but allows flight deck control of the load during normal operation.

Operation

The RCCB is basically a relay and a circuit breaker and allows the utilization of each identity singularly or in combination, depending upon the application. All of the RCCB's capabilities apply in either application.

It can be employed as a relay located adjacent to its load and remotely operated much like relays are today through control wiring and a switching device in the flight deck.

It can also be utilized as a circuit breaker and mounted adjacent to the load, the power source, or even the flight deck.

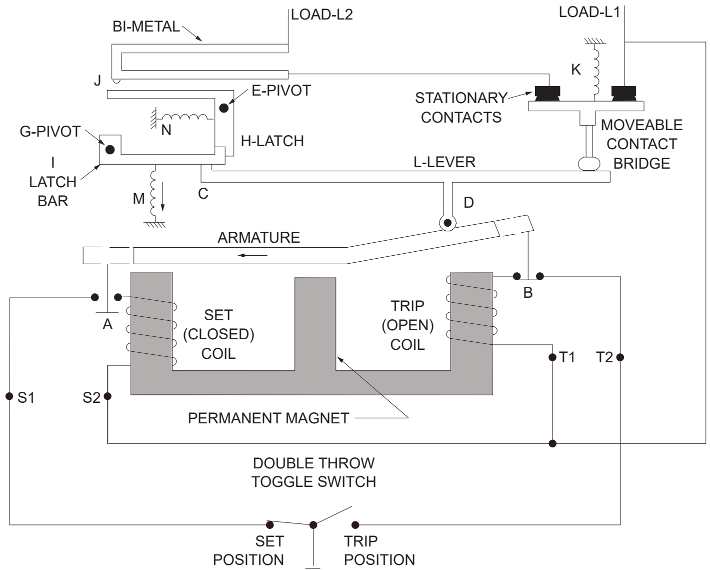

Figure 1

Single Pole RCCB

Motor Operation

Figure 1 depicts a simplified presentation of the RCCB.

Figure 2 describes the "motor", which when "energized", will result in typical armature transfer operation.

The magnetic circuit utilizes a permanent magnet as a fulcrum and latch for the rocking armature and uses electro-magnets (coils) at each end of the armature stroke for transfer purpose. In the set position **(Figure 2)**, the flux generated by the permanent magnet follows a patch from the top of the permanent magnet through the armature, through the left leg of the electro-magnet and back to the permanent magnet.

When the coil T1 -T2 is energized, the flux generated is such that it "flows" through the permanent magnet in the same direction as the flux generated by the permanent magnet itself. Its path now, however, is through the right leg of the electro-magnet. The flux generated by the electro-magnet increases in magnitude as power is applied, and as the flux builds up in the path through the right leg of the electro-magnet, the flux tending to latch the armature in the left leg of the electro-magnet becomes very small in comparison. The armature then "transfers" and seals at the pole face of the right leg of the electro-magnet.

The cutthroat contact B in series with coil T1 -T2 is opened by mechanical actuation due to the armature movement. In Figure 2, a "dotted extension" of the armature represents the mechanical actuator of the cutthroat contacts. In actual design, this is accomplished more conveniently through only one armature extension and an appropriate actuator which drives both contacts B and A.

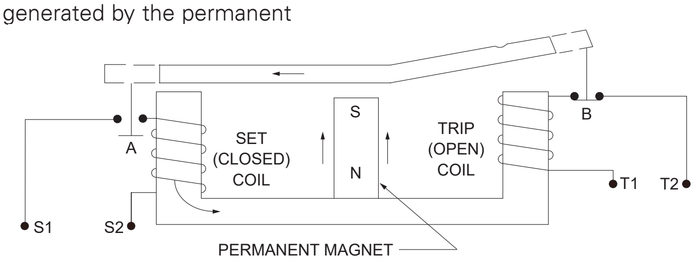

Figure 2

The opening of contact B occurs in the last several thousandths of an inch travel of the armature movement. After coil opening, the armature movement continues (until it seats i.e. seals), due in some degree to the inertia of the armature, but mostly due to the magneto-motive force of the permanent magnet in conjunction with the decreasing air gap at the right pole face.

The device now is again in a stable position, but the armature has transferred and the following conditions exist:

Contact A is closed and contact B is open, and the armature is sealed and latched at the right leg of the electro-magnet. To transfer the armature to its original position, energizing the coil S1-S 2 allows the process described above to occur in the opposite direction.

There are a number of advantages to this design approach of the "motor."

1. The coils open upon transfer of the armature; hence, the actual "on time" or duty cycle approximately equals the operate time of the relay. Accordingly, the coil can be driven hard without fear of burnout. The "hot coil" with the low timer constant results, in turn, in fast operate times.
2. Using intermittent duty coils (smaller coils with less copper) results in less weight and smaller sizes.
3. Power is conserved. This is important for two reasons. If a relay is to use power, it must be available. In some of the present day and future vehicles, power remains an expensive commodity, and elimination of coil power drawing (10-35 watts) in power devices can add up especially when vehicles sophistication requires use of a significant number of these devices. Also, it must be remembered that power utilized by relay coils generate heat which must be dissipated. The necessary elimination of this heat, in turn, requires the use of additional energy from the main power source.
4. As indicated, the cutthroat contacts are opened by the armature mechanically during the last several thousandths of an inch travel of armature movement. Note: In actual RCCB, the cutthroat contacts function is replaced by electronic control of coil on time.

RCCB Operation As A Relay

To examine the RCCB operation as a relay, refer to **Figure 3 and 4**. The device is shown in the set position in **Figure 3** and in the tripped position in **Figure 4**. The circuit path is from L2, through the bimetal to one of the stationary contacts. L1 is connected directly to the other stationary contact.

The movable bridge closes the circuit by bridging between the two stationary contacts.

As can be seen, movement of the armature about its fulcrum will determine the position of the contacts. When coil S1-S 2 has been energized such that the armature seals on the left-hand pole face **(Figure 3)**, the mechanical linkage system closes the contacts. Conversely, when coil T1-T 2 has been energized, such that the armature seals on the right-hand pole face **(Figure 4)**, the relay contacts will open due to the spring forces exerted by compression spring K.

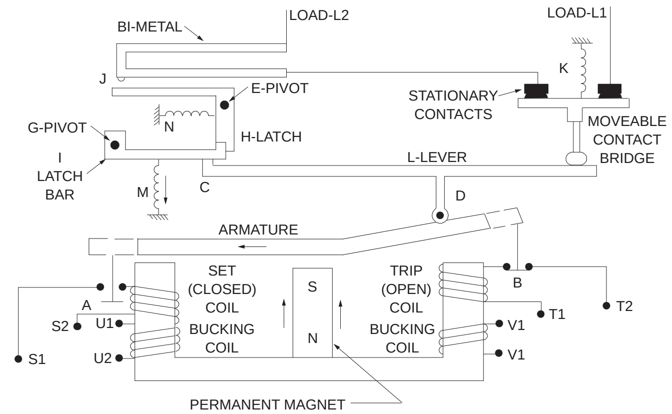

Figure 3

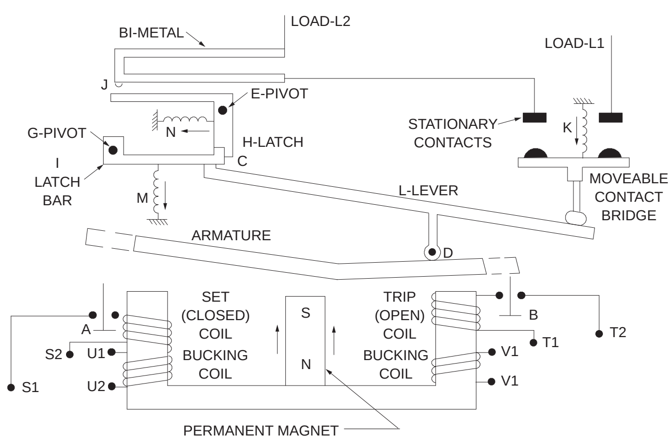

Figure 4

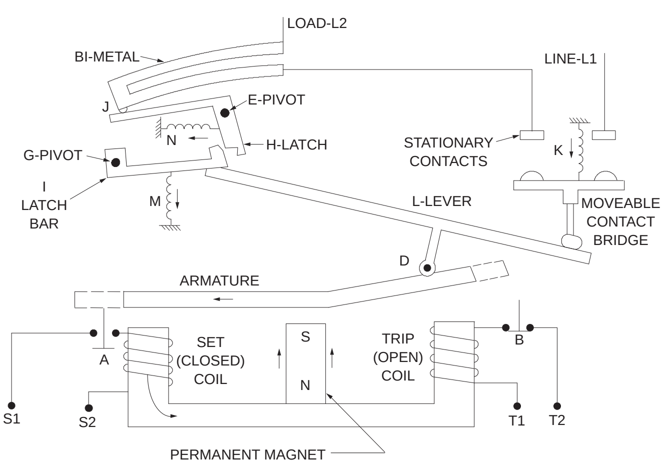

Figure 5

Note: there is an "upward force" directed on the lever L through the linkage tying into the armature at point D. During operation as a relay, point C (interface between lever L and latch bar I) is "fixed" in place, and the lever L actually rotates about point C when moving the contact structure from the opening to the closed, and from the closed to the open position.

Note that the coil U1-U2 is connected in parallel with T1-T2. It is wound on the left-hand core of the electro-magnet such that when energized along with T1-T2, the force it generates will be in a direction opposing the latching force generated in that core by the permanent magnet.

The utilization of a permanent magnet and intermittent duty coils, in conjunction with cutthroat contacts, allows a considerable reduction in copper and iron from that normally required in electro-magnets for continuous duty operation.

RCCB Operation as a Circuit Breaker

To examine the operation of the device as a breaker, refer to **Figures 3, 4, and 5**.

In **Figure 3**, the device is shown in the closed contact position (presumably) carrying rated current. Should an overload occur, currents greater than rated currents now "flow" through the device "entering" through L2, passing through the bimetal, through the connection of the bimetal to one stationary contact, through the bridging moveable contact structure, to the other stationary contact, and "out" through L1.

Depending upon the size of the overload, the bimetal will begin to deflect as shown in **Figure 5** until the actuating end of the bimetal engages latch H at point J.

Motion and force due to the deflection of the bimetal moves latch H such that it rotates in a counter-clockwise direction around its pivot point E.

When latch H has moved an adequate distance, the upward force of lever L, applied at point C to latch bar I, will rotate latch bar I counter-clockwise around its pivot point G. This allows the main lever L to rotate clockwise around point D (where it is engaged with the armature) due to the "contact return" spring (compression spring) force K acting upon the moveable contact bridge.

Note that when this overload occurs, the armature is not transferred to the "off" (tripped) position, but instead remains in the latched position normally associated with the "on" (set) position of the device.

To "reset" the device after the fault or overload clears could be readily accomplished by energizing the "trip" coil (T1-T2) through a toggle or push-button switch **(see Figure 1)** located in the flight deck. The armature would then transfer and seal on the right-hand core of the electro-magnet, which is the "open" position shown in **Figure 4**. At that time, springs M and N (tension springs) would reposition latch bar I and latch H to the position shown in **Figure 4**, providing that the bimetal has now cooled sufficiently and returned to its original position as shown in **Figure 4**. At this stage, the RCCB is still in an "open position" i.e. (the contacts are open), but as outlined above, the fault or overload has been cleared through action and operation of the device through bimetallic activity, i.e. "Circuit Breaker" operation.

To re-close the contacts, it is now only necessary to energize coils S1-S2 and re-establish a mechanism position similar to that shown in **Figure 3**. If the fault of overload condition is still in existence, the device would again trip through bimetallic activity as just described.

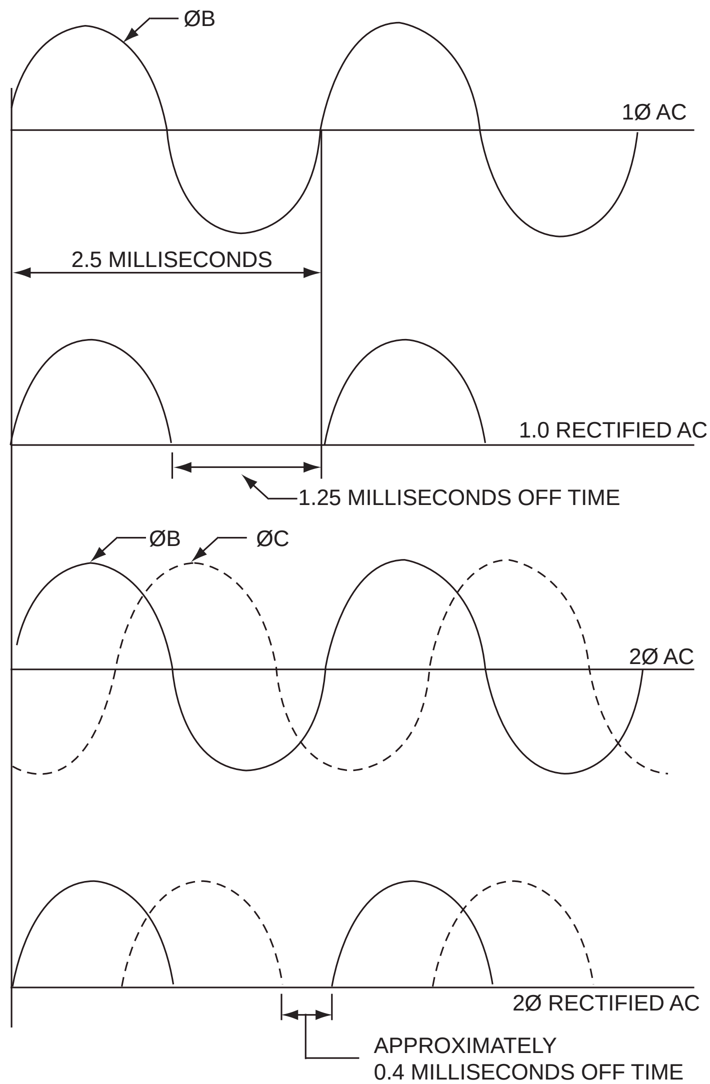

Figure 6

Three Pole RCCB

The design principles employed in the 3-pole RCCB have followed many of the same paths utilized in the 1-pole RCCB. Differences other than the obvious, such as size, weight, shape, etc., are explained below.

Motor Operation

The principles of motor operation and construction of the three pole devices are similar to those employed in the single pole RCCB. In the 3-pole device, the AC operating power is drawn from two of the three phases. The "off" time between current pulses during coil energization is approximately 0.4 milliseconds. In comparison, the "off" time for single-phase power is approximately 1.25 milliseconds. See **Figure 6**.

The timing circuit establishes a coil "on" time longer than the actual transfer time of the armature. The operation of the 3-pole RCCB is identical to the 1-pole.

Control Circuit

Refer to **Figure 7**. There is one minor difference in operating principles and parameters from the single pole devices.

The difference is the addition of a power junction area in the electronics. (**see Figure 7**). The 3-pole RCCB is designed for use in 3-phase circuits and is a 400 Hz AC load controller. The power junction is designed to use AC power only. DC operate (coil) power may be used even though AC loads are to be controlled. This connection is made at terminal 4 of the IWTS connector. In **Figure 7**, two separate power junctions are shown: one for AC and one for DC. In the event both AC and DC are connected to the RCCB, only AC would be utilized by the logic circuit. Should AC power be lost, the DC connection would automatically take over the control function.

The other differences between 1-phase and 3-phase control circuitry, i.e. timer addition, is directly related as described in the above Motor Operation section.

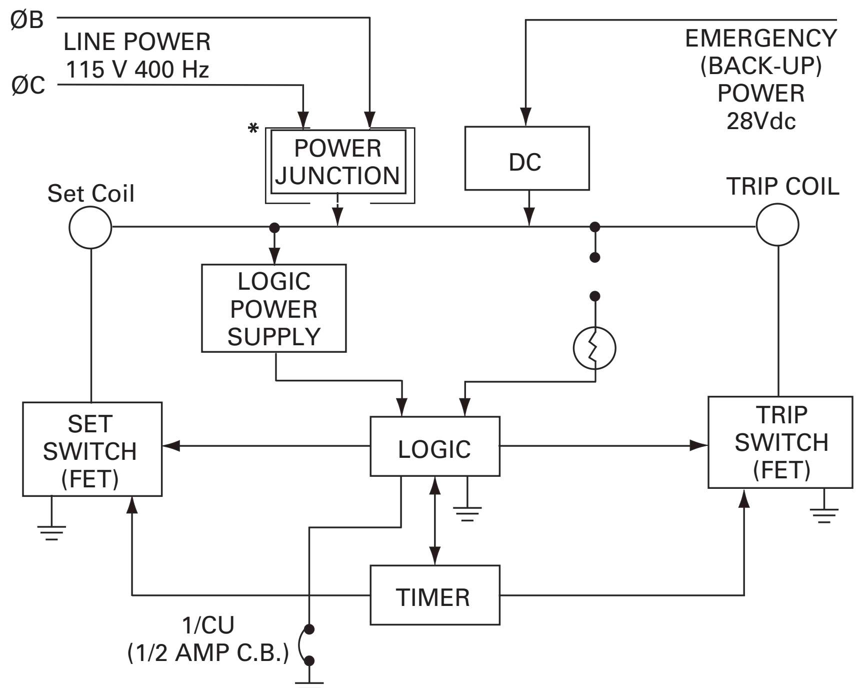

Figure 7

*Indicates In 3 Phase Electronics