MOV Backseat Relay for AC & DC Motors
User's Manual

1 INTRODUCTION

This device is used to backseat motor operated valves (MOV) to stop packing leaks while minimizing stress on the valve. It is connected at the motor control center to bypass the open limit switch. Clamp-on current sensors are used to measure current to the valve motor. By sensing an increase in current, it detects the valve at the backseat and opens a contact to remove power from the valve motor.

The Model 201602-ACDC contains internal switched current shunts to allow operation using either transformer type AC probes or Hall Effect AC/DC probes, thereby supporting both AC and DC motor operated valves.

This manual is applicable to firmware version 4.0.

2 SPECIFICATIONS

Inputs:	-1 to +1 Volts or -1 to +1 Amps through an internal 1 ohm shunt.
Input Impedance:	1 megohm (AC/DC probe) or 1 ohm (AC probe) with internal shunt enabled, with TVS overvoltage protection
Accuracy:	5% of scale, 12 bit resolution
Output:	MOSFET opto-isolated solid state relays rated for 400 volts AC/DC, 2 amps continuous duty. Dual MOSFET relays are used in series for the output contact, along with an independent permit logic circuit controlled by the panel buttons, to reduce the possibility of a single failure keeping the motor running.
Logging:	Text file to Micro SD memory card (up to 32 GB)
Connectors:	4mm safety banana jacks
Response Time:	< 9 milliseconds trip current sensing on step change
Display:	2 lines x 20 characters LCD, backlit
Indications:	LEDs, green (contact open) and red (contact closed)
Controls:	POWER turn on or turn off the unit OPERATE MOV close contact and begin a test sequence STOP stop a test sequence and open contact SETUP view and step through settings [+], [-] change a setting
Power:	6 volts DC from four AA alkaline (supplied) or lithium batteries, good for up to 16 hours of operation.
Auto Shutoff:	After 30 minutes with no key press
Size:	195mm x 101mm x 44mm
Weight:	0.5 kg

3 CURRENT PROBES

The following probes made by AEMC Instruments have been evaluated as suitable for this application. Other models and manufacturers may also be used.

AC current probes are passive clip-on transformer types having a sensitivity of 1 mA/A, or current ratio of 1000:1.

AEMC Model SR601 has a nominal current range of 1000 Amps RMS. It is supplied with banana jacks for use with longer leads (10 foot leads are included standard with the backseat relay) to give a safe distance from an open MCC. It is suitable for the full range of the MOV relay, though the more sensitive AC/DC probe (below) is recommended for small motors. The model SR600 is equivalent to the SR601 but without open circuit diode protection (not needed in this application).

Probes with jack connections allow use of longer test leads for a safer distance from 600V motor control centers.

Where MCC cabinet wiring is tight, the MN185 AC probe with a 120A range and 1 mA/A sensitivity is suitable.

For DC motors and small AC motors, AC/DC clip-on current probes use Hall Effect to measure DC and a transformer to measure AC. Sensitivity is 10 mV/A. The AEMC SL206 and SL261 have been evaluated for this application.

For motor operating current of less than 2 amps, the AC/DC probe is recommended to give better noise margin and resolution due to its higher sensitivity.

While the backseat relay has input jacks for three probes for a 3-phase AC motor, it will perform its function with just one probe on any of the three inputs. Two or three probes may be used for increased noise margin or redundancy if desired.

Current readouts are scaled for AC probes having sensitivity of 1 mA/A and AC/DC probes with sensitivity of 10 mV/A. Other probe sensitivities may be used though the displayed and logged current will be in proportional error. The trip function is based on percent of current change and is independent of probe sensitivity.

Refer to AEMC Instruments web site https://www.aemc.com/ for specifications and other probes.

4 DESCRIPTION OF OPERATION

4.1 The purpose of the relay is to sense the increased current drawn by the valve motor when the load increases as the valve backseats against the packing. The relay contact is connected into the Motor Control Center (MCC) and is closed to start operation of the motor. Upon sensing increased current, the relay contact is opened, thereby removing power from the valve motor.

4.2 Probe type must be specified. When an AC probe is specified, an internal 1 ohm shunt is connected to develop voltage based on current input. When an AC/DC probe is specified, the shunt is disconnected because that type of probe has a voltage output.

4.3 Connected probes are automatically detected by applying a voltage to the input while in the stopped state. A connected probe will pull down this voltage, thus revealing its presence. The one ohm shunts are temporarily disconnected during this test when AC probes are specified.

4.4 Probe inputs are sampled at a rate of 3600 samples per second. A moving RMS calculation is performed on the most recent 60 samples (one cycle).

4.5 When the relay contact is closed, there will be a current inrush surge as the motor starts up. An inrush delay is specified to prevent tripping during this surge.

4.6 The input amplifiers have three ranges. Gain is reduced automatically to keep the inrush surge in range of the analog to digital converter. This improves resolution for smaller motors.

4.7 At the end of the inrush delay, current is measured and a trip setpoint is established as a percentage of this current. The motor will continue to run at a constant current until the backseat is reached and motor current increases. When the current increases above the setpoint, the relay opens to stop the motor.

4.8 A second maximum current setpoint is specified as a safety backup in case the valve is already against the backseat; i.e., motor rotor stalled. It is established as a percentage of the maximum current detected during the inrush surge. If the current exceeds this setpoint after the inrush delay, the relay opens to stop the motor.

4.9 A failed probe trip is implemented with three tests.

- If current is not detected within the specified inrush delay time from when Operate MOV is pressed, a failed probe trip will occur. This test is disabled if the Motor Start From option is set to B- Control Panel since the relay has no way of knowing when current is supposed to start.
- At the end of the delay state, a probe failure trip setpoint will be established at 20% of the operating current. If the current drops below this setpoint during the operate state, the failed probe trip will occur.
- If no probes are detected when Operate MOV is pressed, an immediate probe failure trip will occur.

4.10 Since all setpoints are expressed as percentages, accurate calibration of the relay or probes is not relevant to trip functioning.

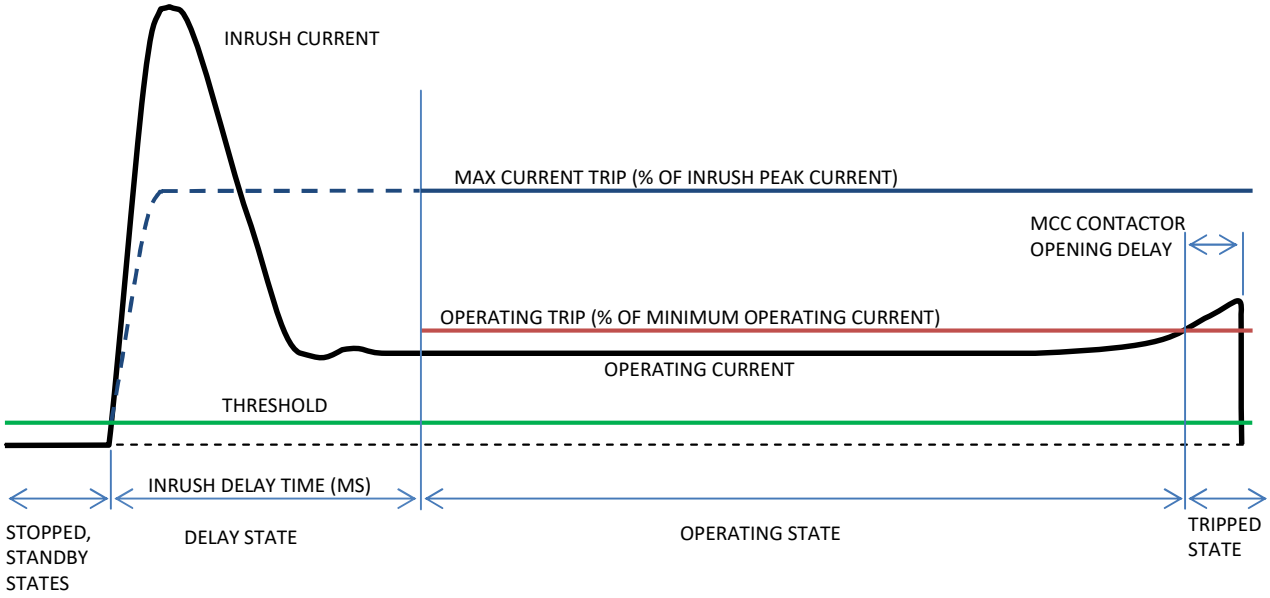

Figure 1: Typical Test Sequence

4.11 Figure 1 shows a hypothetical current trace (not to scale) for a run. The relay progresses through various states according to the sensed current.

4.12 In the STOPPED state, the relay contact is open and the current is expected to be zero. A probe detection function scans each phase input and displays A, B, and/or C for detected probes. If the probe display is incorrect or intermittent, there may be current detected by the probe.

4.13 When OPERATE MOV is pressed, the STANDBY state is entered. The relay contact is closed and the inputs are compared to a threshold setting. When input exceeds threshold, the DELAY state is entered.

4.14 The maximum current trip setpoint is initialized and continuously recalculated as the specified percentage of the measured current during the delay. It begins lower than the current during the delay state and follows the current, but only increasing.

4.15 The operating and maximum current trips are not enabled during the delay state.

4.16 OPERATING state is entered when the inrush delay time ends.

4.17 The initial operating current trip setpoint is determined by multiplying the measured current at start of operating state by the specified setpoint percentage.

4.18 The actual inrush surge time is determined by scanning the readings taken during the delay and determining the time at which the current dropped to a level close to the operating current.

4.19 The operating current trip setpoint will continue to follow the current down, but not up.

4.20 In the operating state the operating trip and maximum trip will be enabled.

4.21 If the motor is stalled or if the delay is specified too small, current may be above the maximum current setpoint when operating state is entered. The MAX CURRENT TRIP will result.

4.22 Soft start or variable frequency motor controllers are used to reduce the strain put on the motor during the typical power-up phase of a motor. The voltage waveform is likely to differ considerably from the desired 60 Hz sine wave. Due to motor inductance, the motor current will be somewhat smoothed. Since the

reduced start current may reduce or eliminate the current inrush surge, the maximum current trip setting has an option to disable that trip.

4.23 When the valve reaches the backseat, current will increase until the operating trip setpoint is reached. The OPER CURRENT TRIP will occur.

4.24 After the relay contact opens, current will continue to increase until the motor controller mechanical contacts have physically opened. This is normally a few milliseconds. This is recorded as post trip current.

4.25 When any trip occurs, the relay contact opens and the display shows *Review Results* and the cause of trip. The [+] or [-] buttons may be pressed to show recorded readings of inrush peak current, inrush time, operating current, run time, trip current, and post trip current. Data points at 1 millisecond intervals are also shown for the first two seconds and last second of the run. These results and data points are retained until the next run or until the device is turned off.

4.26 If a memory card is inserted prior to start of the run, all data points and results will be logged to file (Section 6).

5 OPERATING PROCEDURE

5.1 If the batteries were replaced and an SD card will be used to record results, turn on the device and step through the SETUP options to set the date and time.

5.2 If a recorded log of the test and results is desired, insert a Micro-SD memory card into the small slot on the right side of the case, near the [+] button. Insert with SD card contacts facing front and label facing rear.

5.3 Connect test leads from the yellow relay contact jacks to parallel with the limit switches in the motor control cabinet. Typical connection points are shown in Figures 2 and 3. Option A gives full control to the relay. With option B, the relay just bypasses the limit switches.

5.4 Clip the current probe(s) across the motor wiring. For 3-phase AC, one, two or three probes may be connected. Only one probe is necessary. Phase sequence and sensor orientation do not matter for operability. If using less than three probes, it does not matter which phase jacks they connect to.

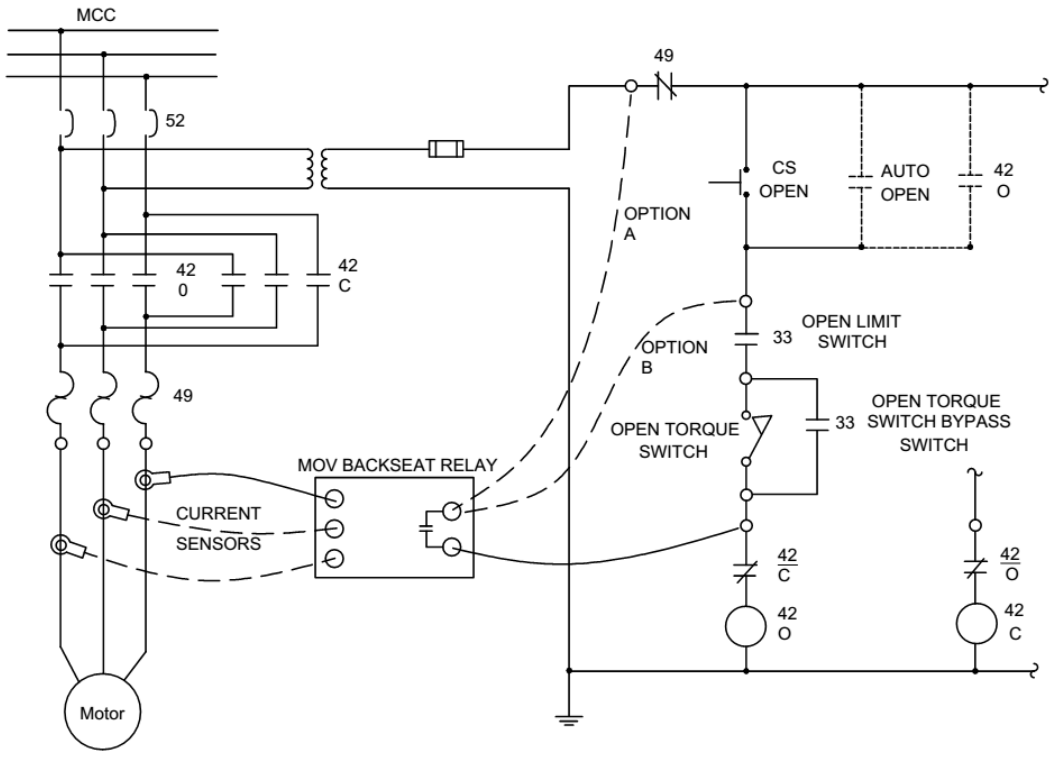

Figure 2 Typical connection diagram for 3-phase AC

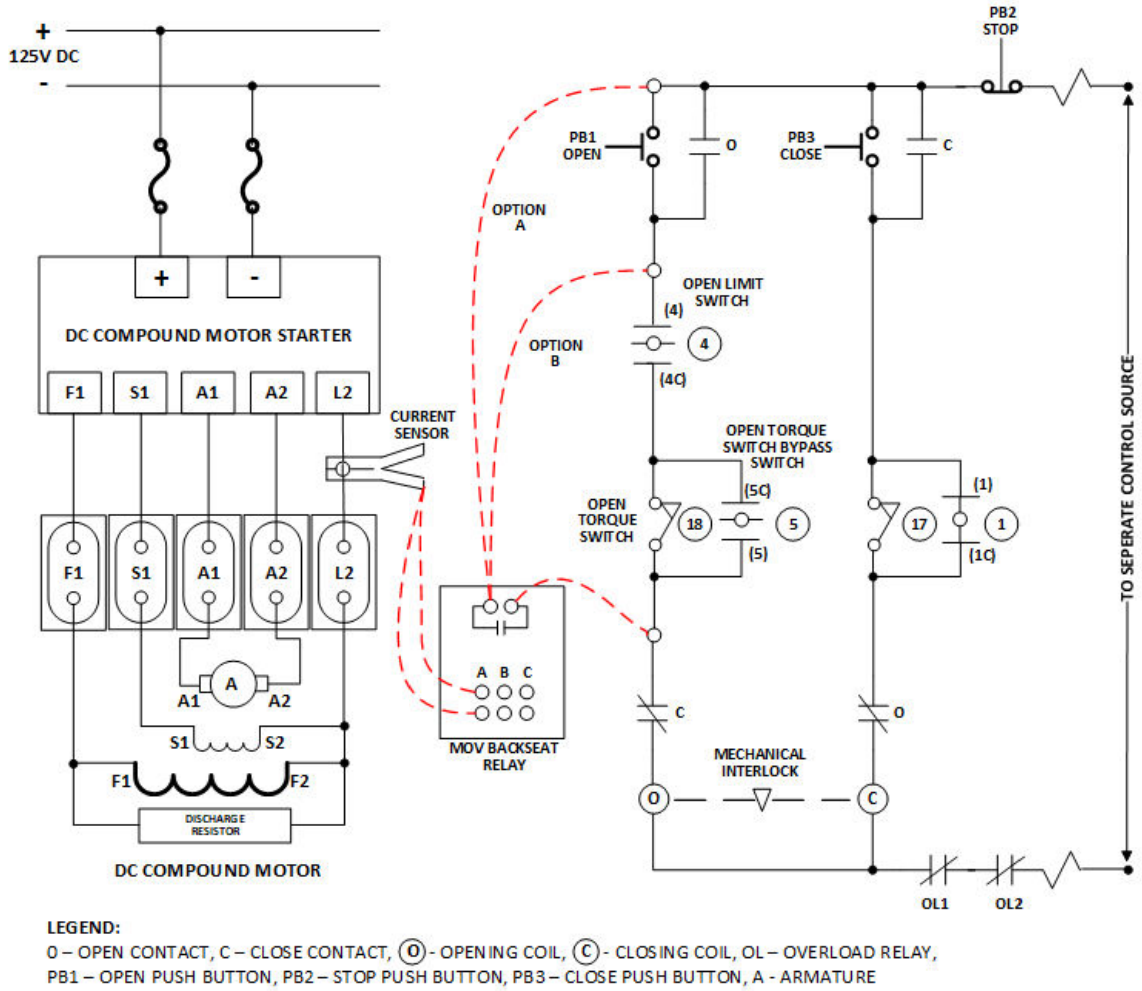

Figure 3: Typical connection diagram for DC

5.5 If an independent secondary protective device is desired, its contact may be wired in series with the relay.

5.6 Press the power button ⏻ to turn on device. After the startup identification, the display will show *PREREQ: Press SETUP to verify settings*.

5.7 Repeatedly press SETUP to cycle through the settings. Press the [+] or [-] button to make changes.

- *Probe Type* – Select the type of probe being used. AC/DC is for AC/DC probes that combine hall effect and transformer, such as the SL206/SL261. AC is for AC only transformer probes such as the SR600/SR601. Default is AC. Detected probes will display as *A, B*, and/or *C*.
- *Phase A[B,C] Probe Zero* - (only shown for detected AC/DC probes) AC/DC probes generally have a zero adjust knob on the probe. Adjust the probe zero knob to obtain a reading of 0 (-9 to +9).
- *Operating Trip* - the operating trip setpoint is set as a percent of the operating current, with 100% being the minimum steady state motor operating current. Thus, a 150% setting for a 10 amp current will give a trip at 15 amps. Default value is 110%. Range is 101% to 500%.

- *Inrush Delay Time* - this time, in milliseconds, is the delay to allow for the inrush current spike to settle out before determining the operating current. Recommended is at least 50 ms longer than the measured inrush time. Default is 250ms. Range is 40 to 2000 milliseconds.
- *Max Current Trip* – the maximum trip setpoint is set as a percentage of the inrush current during the delay. Range is 10% to 95%. Setting above 95% will disable the maximum current trip. This is intended for soft start motor controllers that may not produce an inrush surge.
- *Motor Start From* – Select the connection option as described in Figure 2 or 3. When B-Control Panel is selected, the probe failure detection at end of inrush time for the start of run will be disabled.
- *PREREQ Complete* – A scrolling message that important prerequisites have been reviewed is displayed. You may press STOP and go to step 5.8, or continue pressing SETUP to set the date/time and review additional settings.
- *Current Meter* – This screen can be used as a general purpose current meter. Probe(s) must have been detected to obtain a valid reading.
- *Year, Month, Day, Hour, Minute* – update if not previously set. These are only used for logging purposes and may be ignored if no SD memory card is used.
- *Noise Filter* - This numerical value defines a noise filter applied to the calculated RMS current. It computes a running average, with older readings fading in importance. A larger value will give additional noise filtering at the expense of slower response. This is in addition to the inherent filtering of RMS computed over one cycle so is not normally needed. A soft start motor controller may need significantly more filtering. Default value is 1 (no filtering). Range is 1 and above.
- *Threshold* – A number proportional to the input at which the inrush surge is detected to begin the *DELAY* state. Default value is 40 with 10 to 400 allowed. It should not need to be changed unless there is a high level of background electrical noise. 40 corresponds to approximately 0.5 amps with a 1 mA/A AC probe or 0.1 amps with a 10 mV/A ACDC probe.
- *Log File Contents – Standard* setting will log the test setup, results, and current and state at one millisecond intervals. *Diagnostic* setting provides additional details that can be used by the factory for troubleshooting. These details are probably not meaningful to the user. Default value is *Standard*.
- *Line Frequency* – Select AC line frequency, 60 or 50 Hz, based on country of location. This establishes the sampling rate. Default is 60 Hz.
- *Restore Defaults?* – This item only appears if any item other than line frequency differs from the default value. Press [+] to restore or [-], SETUP, or STOP to keep your existing settings.

  Any changes except date/time are stored in non-volatile memory and retained when power is turned off or batteries removed. Battery removal will require date/time reset. Logged results data are not saved.

5.8 After the setup pages have been reviewed, press STOP to enter the *STOPPED* state if not already there.

5.9 If the battery icon is flashing to indicate the batteries are nearly discharged, replace batteries and restart procedure.

5.10 Press OPERATE MOV to start the run and close the relay contacts. The red LED will come on.

- If an SD memory card is inserted, there may be a notice and momentary delay (the delay gets longer with many files on the SD) while a new log file is opened.
- After the file is opened (if applicable), the red LED will illuminate and the relay contact will close to start the MOV.
- STOP may be pressed at any time to halt the run and open the relay contact.

5.11 If connection option B is used, initiate valve operation using the control panel OPEN switch.

5.12 Display may show *STANDBY* until current is detected, then *DELAY* and then *OPERATING*.

5.13 When the motor current reaches a trip condition, the relay contact will open and the display will show *Review Results (+,-)* and the cause of trip:

- *OPER CURRENT TRIP* will occur when current exceeds the operating trip setpoint.
- *MAX CURRENT TRIP* will occur if current exceeds the maximum trip, possibly caused by valve already against backseat or insufficient inrush delay time.
- *FAILED PROBE TRIP* will occur if the probe became disconnected during the operate phase or if no current was detected at motor start from this device (Figures 2 and 3 option A).
- *MANUAL STOP* if you pressed the STOP button to end run.

5.14 With *Review Results (+,-)* displayed, press [+] or [-] to review various measurements taken during the test. These are useful for establishing setup values for a valve without having to log to an SD memory card.

- Cause of trip
- Inrush peak current
- Standby time includes up to 20 ms for the MOSFET relay in the device to turn on plus time for the motor starter to engage. With motor start option B, it will also include time until motor start from the control panel. This measurement may be used to identify slow motor starters.
- Inrush time (peak width)
- Operating current
- Run time (standby + inrush + operating)
- Trip current
- Post trip current (maximum current following motor contactor delay)
- Log file name (if logging to SD card)
- Data points, at 1 millisecond intervals, showing time (ms), current, and state (delay, operating, or tripped). Up to 1000 points at the start of the run (1 seconds worth) and up to 1800 additional points at the end of the run will be available. Hold down the [+] or [-] key to accelerate the scan of points.

5.15 The run results will be retained until the relay is turned off or until another run is made. Review Results will now be available in the SETUP menus.

5.16 Press STOP to reset to the home state.

5.17 The SD memory card may be removed to transfer the log file to a computer for analysis.

6 LOG FILE

Data logging of MOV runs can be recorded to a Micro SD card. The card is inserted into a small slot on the right side of the case. Orient the card with contacts towards the front, label facing rear. After insertion, a portion of the card will extend about ¼" outside the case. Remove by gripping and pulling.

When OPERATE MOV is pressed to start a test, a new log file will be opened. The file name will contain the serial number and date/time of the test. For example,

```
MOV Backseat 042 Log 2023-08-22_1907.txt
```

Contents start with an identification of relay and date/time, followed by various settings. Next, current readings are recorded from the start of the inrush current until current drops after the contact is opened. Finally, results are recorded.

```
MOV Backseat Relay S/N 042
08/22/2023 19:17:01
Firmware Version 4.0
Operating Trip Setting = 110 %
Inrush Delay Time Setting = 250 ms
Max Current Trip Setting = 50 %
Probe Type = AC
Probe Sensitivity (assumed) =  1 mA/A
Probes connected = ABC
Motor Start From = This Device
Noise Filter = 1
Threshold = 40 ADC Units
Line Frequency = 60 Hz

time(ms)     amps   state
--------   ------   -----
     0       0.00   OPERATE MOV pressed
    15       0.41   Current detected
    16       0.76   Delay
    17       2.91   Delay
    18       5.52   Delay
    19       7.99   Delay
    20      12.14   Delay
    21      15.64   Delay
    22      20.37   Delay
    23      25.75   Delay
    24      30.11   Delay
    25      36.08   Delay
    26      40.74   Delay
    27      46.81   Delay
    28      52.10   Delay
    29      55.70   Delay
    30      60.09   Delay
    31      63.07   Delay
    32      66.74   Delay
    33      70.07   Delay
    34      72.33   Delay
    35      75.01   Delay
    39      81.18   Delay
   .
   .
   .
  1164       9.38   Operate
  1165       9.40   Operate
  1166       9.41   Operate
  1167       9.42   Operate
  1168       9.43   Operate
  1168       9.43   Tripped
  1169       9.45   Tripped
  1170       9.47   Tripped
  1171       9.24   Tripped
  1172       8.92   Tripped
  1173       8.66   Tripped
  1174       8.30   Tripped
  1175       7.92   Tripped
  1176       7.63   Tripped
  1177       7.22   Tripped
  1178       6.90   Tripped
  1179       6.44   Tripped
  1180       5.94   Tripped
  1181       5.53   Tripped
  1182       4.91   Tripped
  1183       4.37   Tripped
  1184       3.60   Tripped
  1185       2.81   Tripped
  1185       2.32   Tripped

Operating Current Trip
```

```
Standby Time = 15 ms
Inrush Peak Current =  81.9A
Inrush Time =   78 ms
Operating Current =   8.58A
Trip Current =   9.44A
Post Trip Current =   9.47A
Run Time to Trip =   1.168 sec
```

The logged current readings are tab delineated text, making the file suitable to opening in Excel for plotting and analysis.

No provisions are made for SD card formatting, file renaming, or file deletion. This must be done on an external computer. Card format is FAT32 and cards partitioned up to 32GB (but not larger) can be used. Micro-SD to USB adapters are commercially available if needed for downloading.

7 TROUBLESHOOTING

The operating current trip is proportional to the minimum current measured during the valve stroke. If shaft friction varies the current, this could affect the trip point.

If premature operating trip occurs, try raising the operating trip setpoint.

With an AC probe and current below 1 amp, resolution may become insufficient. Increasing operating trip setpoint will help. The higher sensitivity AC/DC probe should be considered for small motors.

Apparent continued operation of the relay (red LED on but zero current) could be caused if the MOV limit switches were not correctly bypassed in option B (start from control panel).

If current is present while displaying the *STOPPED* or *Probe Type* screens, this can interfere with probe detection. Turn off current source or unclamp probe from wire.

If MicroSD card does not work, verify orientation. Label faces the rear of the relay.

A MicroSD card greater than 32 GB will not work with this relay unless it is partitioned to 32 GB or less and formatted to FAT32.

8 MAINTENANCE

Calibration of the device or probes may be performed but is not required. Trip setpoints are specified as a percentage of current and calibration of current readout has no effect on the backseat trip functionality. Refer to functional test and calibration procedure TP201602-03.

A battery icon displays on the *STOPPED* screen. *Replace Batteries* will display when battery drops below 4.3 volts. No operations are possible under low battery condition. The icon is scaled for alkaline batteries. Lithium batteries give longer life and may be used but the icon will not accurately show battery state.

To replace batteries, remove panel at top rear of case. For long term storage, alkaline batteries should be removed to prevent damage from leakage.

For version information, including user's manual, functional test/calibration procedure, and download of the latest firmware version, see http://campcreektech.com/mov.html.

Firmware may be easily updated in the field using this procedure.

NOTE: Calibration is retained when firmware is updated

8.1 Download and unzip the update file. It will contain these instructions and an image2.hex file.

8.2 Copy the image2.hex file to a micro-SD card. The card used for logging may be used for this purpose. CAUTION: image.hex from versions 3.x and before is not compatible with this model.

8.3 Turn relay off.

8.4 Insert SD card into the slot on the side of the relay, contact side facing front and label facing rear.

8.5 Press the [-] key. While holding it down, press the power key.

8.6 The screen will show "*Bootloader v2.0, Press SETUP to pgm.*"

8.7 The [-] key may be released once the bootloader screen displays.

8.8 If you wish to cancel the update, press the STOP or power key.

8.9 Press SETUP. The screen will show *Erasing* for about 3 seconds followed by *Programming* for about 3 seconds.

8.10 Once complete, the normal relay startup screen will appear, identifying the version number.

8.11 The SD card may now be removed.

9 CONTACT INFORMATION

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support@campcreektech.com

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10 WARRANTY

Camp Creek Technologies warrants that the product is free from defects in materials and workmanship for a period of one year from date of purchase. If product proves defective during this warranty period, Camp Creek Technologies, at its option, will either repair the defective product without charge for parts or labor, or will provide a replacement in exchange for the defective product.

Revisions

Rev 0, 4/8/2023
Initial issue of manual for model 200602-ACDC
Applies to firmware version 4.0
Changes from firmware version 3.1 for AC and DC models

- Revised hardware supports both AC and DC motors
- Add menu item to select AC or AC/DC probe
- Automatic detection of which phases have probe connected
- Delete probe sensitivity options menu. Standard sensitivity is 1 mA/A (AC) and 10 mV/A (AC/DC)
- Delete key codes to select advanced menu display.

Rev 1, 10/18/2023
Additional firmware version 4.0 changes

- Provisions for soft start or VFD motor starter
- Add option to disable maximum current trip
- Extend failed probe test timeout to specified inrush time
- Additional details in log file

Rev 2, 5/8/2025

- Update for available probe models