



ENGINEERING SPECIFICATION
SYMCOM MODEL 777-P1 Solid State Overload Relay

PART 1 GENERAL

1.1 REFERENCES

- A. UL 508 Industrial Control Equipment – Underwriters Laboratories
- B. IEC 60947 Low Voltage Switchgear and Controlgear – International Electrotechnical Commission
- C. CSA C22.2 No. 14 Industrial Control Equipment – Canadian Standards Association
- D. ANSI/IEEE C62.41 – American National Standards Institute/Institute of Electrical & Electronics Engineers
- E. MODBUS over Serial Line Specification and Implementation Guide V1.02
- F. UL 1053 Ground-Fault Sensing and Relaying Equipment – Underwriters Laboratories

Relays shall be installed according to the latest version of the National Electrical code.

1.2 WARRANTY

- A. Manufacturer Warranty: The manufacturer shall guarantee the overload relay to be free from material and workmanship defects for a period of five years from the date of manufacture when installed and operated according to the manufacturer's requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

The equipment specified shall be the Model 777-P1, manufactured by SymCom, Inc.

2.2 DESCRIPTION

- A. Regulatory Requirements:
 1. The equipment shall be UL Listed as type NKCR—Industrial Control Equipment-Motor Controllers-Auxiliary Devices.
 2. The equipment shall be cUL Listed as type NKCR7—Industrial Control Equipment-Motor Controllers-Auxiliary Devices Certified for Canada.
 3. The equipment shall be CE marked for use in the European Union and evaluated against IEC 60947 Low Voltage Switchgear and Controlgear.
 4. The equipment shall be CSA certified as class 3211-03—Industrial Control Equipment-Motor Controllers-Auxiliary Devices.

2.3 PERFORMANCE/DESIGN CRITERIA: 777-P1 3-PHASE SOLID STATE OVERLOAD RELAY

- A. Protective Relay Functions
 1. The equipment shall provide protection against the following conditions:
 - a. voltage single-phase/phase loss
 - b. phase reversal
 - c. low voltage
 - d. high voltage
 - e. voltage unbalance
 - f. rapid cycling to prevent on-off cycling of the motor multiple times in rapid succession
 - g. under current
 - h. over current
 - i. current unbalance
 - j. current single-phase/phase loss
 - k. low control voltage, to trip the motor if the average voltage falls below the low voltage setpoint X the low control voltage percentage, for the duration of the low control voltage trip delay
 - l. ground fault
 - m. contact failure, to trip the motor, if the motor starter is damaged which causes a current single-phase.
- B. Communication Capabilities
 1. The equipment shall include a Modbus interface when used with the SymCom Model RS485MS-2W or a DeviceNet™ interface when used with a SymCom Model COM-DN-P or CIO-DN-P, or a Profibus interface when used with SymCom Model CIO-777-PR.
 2. The equipment interface shall have the capability of connecting to the following systems:
 - a. MMI (Man Machine Interface)
 - b. SCADA (Supervisory Control and Data Acquisition) programs.
 - c. DCS (Distributed Control System)
 - d. PLC (Programmable Logic Controllers)
 3. The equipment shall support the following communication parameters:
 - a. 9600 baud, Even parity, and 1 stop bit
 - b. 9600 baud, Odd parity, and 1 stop bit



- c. 9600 baud, No parity, and 1 stop bit
- d. 19200 baud, Even parity, and 1 stop bit
- e. 19200 baud, Odd parity, and 1 stop bit
- f. 19200 baud, No parity, and 1 stop bit
4. The equipment shall provide setpoints that are readable and writable via the Modbus/DeviceNet™ interface.
5. The equipment shall provide the ability to energize and de-energize the motor via the Modbus/DeviceNet™ interface.
6. The equipment shall provide a 10-second Modbus network watchdog to trip the relay when Modbus communication is lost.
7. The equipment shall provide two programmable Modbus assemblies for reading large blocks of data.
8. The equipment shall provide configurable communications front and back porches, to increase communication robustness.

C. Network Capabilities

1. The equipment shall provide registers to read the following real-time values:
 - a. L1-L2 line voltage
 - b. L2-L3 line voltage
 - c. L3-L1 line voltage
 - d. Average line voltage
 - e. Phase A current
 - f. Phase B current
 - g. Phase C current
 - h. Average phase current
 - i. Voltage unbalance
 - j. Current unbalance
 - k. Current scale factor
 - l. Power factor
 - m. Ground fault current
 - n. Restart Delay 1 (RD1) Time Remaining
 - o. Restart Delay 2 (RD2) Time Remaining
 - p. Restart Delay 3 (RD3) Time Remaining
 - q. Power in KW
 - r. Trip status of the following:
 - 1) Manual reset status
 - 2) Network off command status
 - 3) Contact failure
 - 4) Under current
 - 5) Over current
 - 6) Ground fault
 - 7) Current unbalance
 - 8) Current single-phase
 - 9) Positive Temperature Coefficient (PTC) off command
 - 10) Low control voltage
 - s. Status of the following:
 - 1) Low voltage pending
 - 2) High voltage pending
 - 3) Voltage unbalance pending
 - 4) Under current pending
 - 5) Reverse phase pending
 - 6) Current unbalance pending
 - 7) Voltage single-phase pending
 - 8) Current single-phase pending
 - 9) Over current pending
 - 10) Ground fault pending
 - 11) Low control voltage pending
 - 12) ABC/ACB phase rotation
 - 13) Global Warning
 - 14) Relay status
 - t. Last fault 1
 - u. Last fault 2
 - v. Last fault 3
 - w. Last fault 4
 - x. Unit ID
 - y. Model code
 - z. Software revision
 - aa. Thermal capacity remaining
 - bb. Start count
 - cc. Start duration 1
 - dd. Start duration 2
 - ee. Start duration 3
 - ff. Start duration 4

- gg. Warning status of the following:
 - 1) Low voltage warning
 - 2) High voltage warning
 - 3) Voltage unbalance warning
 - 4) Over current warning
 - 5) Under current warning
 - 6) Current unbalance warning
 - 7) Ground fault warning
 - 8) Low frequency warning
 - 9) High frequency warning
- hh. Line frequency
- 2. The equipment shall provide the following readable/writable setpoints:
 - a. Low voltage trip point
 - b. High voltage trip point
 - c. Voltage unbalance trip point
 - d. Current multiplier, used to scale the current reading properly when Current Transformers (CTs) are used.
 - e. Current divisor, used to scale the current reading properly when amp turns are used.
 - f. Over current trip point
 - g. Under current trip point
 - h. Current unbalance trip point
 - i. Trip class setpoint
 - j. Restart delay 1 setpoint
 - k. Restart delay 2 setpoint
 - l. Restart delay 3 setpoint
 - m. Number of restarts after an under current fault (#RU) setpoint
 - n. Number of restarts after a fault (#RF) setpoint
 - o. Under current trip delay setpoint
 - p. Ground fault trip point
 - q. Modbus address setpoint
 - r. Network status setpoint to enable the following features:
 - 1) Network watchdog
 - 2) Network program disable
 - 3) Front panel lock
 - s. Communication parameters setpoint to set the following:
 - 1) 9600 baud, Even parity, and 1 stop bit
 - 2) 9600 baud, Odd parity, and 1 stop bit
 - 3) 9600 baud, No parity, and 1 stop bit
 - 4) 19200 baud, Even parity, and 1 stop bit
 - 5) 19200 baud, Odd parity, and 1 stop bit
 - 6) 19200 baud, No parity, and 1 stop bit
 - 7) Enable/disable front porch
 - 8) Enable/disable back porch
 - t. Trip enable setpoint to enable the following:
 - 1) Ground Fault trip
 - 2) Voltage Unbalance trip
 - 3) Current Unbalance trip
 - 4) Under Current trip
 - 5) Over current trip enable
 - u. Motor run hours
 - v. Low control voltage trip delay
 - w. Low control voltage trip percentage
 - x. Configuration control setpoint to set the following options:
 - 1) Under Current Trip Delay in minutes or seconds
 - 2) Restart delay 1 in minutes or seconds
 - 3) Restart delay 2 in minutes or seconds
 - 4) Restart delay 3 in minutes or seconds
 - 5) Zero L2 and L3 voltage readings
 - 6) Single-phase voltage monitoring
 - 7) Single-phase current monitoring
 - 8) Disabled Reverse-Phase Protection
 - 9) Enable low control voltage trips
 - 10) Enable stall 1
 - 11) Enable stall 2
 - 12) ACB phase rotation is not a fault
 - 13) RD1 is loaded on power-up
 - 14) RD1 is loaded on current loss
 - 15) Enable emergency run
 - y. Linear overcurrent trip delay
 - z. Current unbalance trip delay

- aa. Motor acceleration enable setpoint for the following faults:
 - 1) Contact Failure
 - 2) Under Current
 - 3) Ground Fault
 - 4) Current Unbalance
 - 5) Current Single-Phase
 - 6) Low Control Voltage
- bb. Motor acceleration trip delay
- cc. Hot over current percentage, increases the thermal capacity consumption rate by this percentage, 1 minute after motor start-up.
- dd. Command line to respond to the following commands:
 - 1) Positive Temperature Coefficient (PTC) trip
 - 2) Network program enable
 - 3) Network program disable
 - 4) Clear run hours
 - 5) Clear fault history
 - 6) Enable network watchdog
 - 7) Disable network watchdog
 - 8) Start the motor
 - 9) Stop the motor
- ee. Modbus back door address
- ff. Warn enable setpoint to enable the following warnings:
 - 1) Low voltage warning
 - 2) High voltage warning
 - 3) Voltage unbalance warning
 - 4) Over current warning
 - 5) Under current warning
 - 6) Current unbalance warning
 - 7) Ground fault warning
 - 8) Low frequency warning
 - 9) High frequency warning
- gg. Low voltage warning delay
- hh. High voltage warning delay
- ii. Voltage unbalance warning delay
- jj. Over current warning delay
- kk. Under current warning delay
- ll. Current unbalance warning delay
- mm. Ground fault warning delay
- nn. Low voltage warning level
- oo. High voltage warning level
- pp. Voltage unbalance warning level
- qq. Over current warning level
- rr. Under current warning level
- ss. Current unbalance warning level
- tt. Ground fault warning level
- uu. Stall 1 trip delay
- vv. Stall 1 trip inhibit delay
- ww. Stall 1 trip percentage
- xx. Stall 2 trip delay
- yy. Stall 2 trip inhibit delay
- zz. Stall 2 trip percentage
- aaa. Ground fault trip delay
- bbb. High frequency warning level
- ccc. Low frequency warning level
- ddd. Voltage faults enable setpoint for the following faults:
 - 1) Low voltage enable
 - 2) High voltage enable
 - 3) Voltage unbalance enable
 - 4) Reverse-phase enable
 - 5) Voltage single-phase enable
- eee. Modbus assembly 500 words 1-37
- fff. Modbus assembly 501 words 1-23

D. Capabilities and Features

1. The equipment shall include the following front panel setpoint ranges:
 - a. an adjustable low voltage (LV) setpoint range of 170-524VAC
 - b. an adjustable high voltage (HV) setpoint range of 172-528VAC
 - c. an adjustable voltage unbalance (VUB) setpoint range of 2-25% or 999 (disabled)
 - d. an adjustable multiplier (MULT) setpoint range of 1-10, 100, 150, 200, 300, 400, 500, 600, 700, 800



- e. an adjustable over current (OC) setpoint range of (20-100A) ÷ MULT or 80-140% of CT Primary
 - f. an adjustable under current (UC) setpoint range of (0, 10-98A) ÷ MULT or 40-140% of CT Primary
 - g. an adjustable current unbalance (CUB) setpoint range of 2-50% or 999 (disabled)
 - h. an adjustable trip class (TC) setpoint range of 02-60 and L00-L60, or oFF
 - i. an adjustable rapid cycle timer 1 (RD1) of 0-500 seconds
 - j. an adjustable motor cool down timer (RD2) of 2-500 minutes
 - k. an adjustable under current restart delay timer (RD3) of 2-500 minutes or A (automatic)
 - l. an adjustable number of restarts after undercurrent (#RU) setpoint range of 0-4, A (automatic)
 - m. an adjustable device communication address (ADDR) setpoint range of A01-A99
 - n. an adjustable number of restarts after all other faults (#RF) setpoint range of 0, 1, oc1, 2, oc2, 3, oc3, 4, oc4, A, or ocA, where an oc prefix means that over current trips are included in the restart counts, otherwise over current is not included.
 - o. an adjustable undercurrent trip delay (UCTD) setpoint range of 2-255 seconds
 - p. an adjustable ground fault current (GF) setpoint range of (1-20A) or oFF
2. The equipment shall provide ground fault protection that meets UL1053 requirements.
 3. The equipment shall provide three independent adjustable restart delays, one for power-up and rapid cycle protection, one for all other faults, and another one for undercurrent faults.
 4. The equipment shall provide RD1 to be configured as follows:
 - a. RD1 is rapid cycle and power-up timer
 - b. RD1 is only a power-up timer
 - c. RD1 is only a rapid cycle timer
 - d. RD1 is disabled
 5. The equipment shall provide an undercurrent trip delay.
 6. The equipment shall allow manual or automatic restart after a fault.
 7. The equipment shall have the ability to display the last fault that caused the relay to trip off.
 8. The equipment shall provide two independent jam timers that trip the relay after an adjustable inhibit time, if any phase is greater than the jam percentage X the OC setpoint for the duration of the Jam trip delay.
 9. The equipment shall require no external CT's for motors with full load current ratings between 1 and 90 Amps.
 10. The equipment shall require external CT's for motors with full load current ratings greater than 90 Amps.
 11. The equipment shall provide a motor acceleration delay to prevent tripping on motor startup for the following faults:
 - a. Contact Failure
 - b. Under Current
 - c. Ground Fault
 - d. Current Unbalance
 - e. Current Single-Phase
 - f. Low Control Voltage
 12. The equipment shall provide a motor start counter.
 13. The equipment shall provide four independent start duration timers that record the duration of the motor run time in minutes. This shall be a rolling log of the four most recent motor run times.
 14. The equipment shall provide a linear overcurrent trip delay.
 15. The equipment shall provide a method to enable/disable the following trip conditions
 - a. Ground Fault
 - b. Voltage Unbalance
 - c. Current Unbalance
 - d. Under Current
 - e. Over current
 16. The equipment shall provide a motor run hour meter.
 17. The equipment shall provide a front panel tamper guard, to prevent accidental setpoint changes.
 18. The equipment shall provide the ability to clear the last fault using the front panel.
 19. The equipment shall provide a hot overcurrent percentage, increases the thermal capacity consumption rate by this percentage, 1 minute after motor start-up.
 20. The equipment shall provide automatic restart timing after undercurrent when RD3 is set to A as follows:
 - a. Run time >1 hr the next restart delay will be 6 minutes
 - b. Run time 30-59.99 minutes the next restart delay will be 15 minutes
 - c. Run time 15-29.99 minutes the next restart delay will be 30 minutes
 - d. Run time <15 minutes the next restart delay will be 60 minutes
 21. The equipment shall provide warning indication for the following conditions:
 - a. Low voltage
 - b. High voltage
 - c. Voltage unbalance
 - d. Over current
 - e. Under current

- f. Current unbalance
 - g. Ground fault
 - h. Low frequency
 - i. High frequency
22. The equipment shall provide independent warning levels for the following warnings:
- a. Low voltage warning
 - b. High voltage warning
 - c. Voltage unbalance warning
 - d. Over current warning
 - e. Under current warning
 - f. Current unbalance warning
 - g. Ground fault warning
 - h. Low frequency warning
 - i. High frequency warning
23. The equipment shall provide independent warning delays for the following warnings:
- a. Low voltage warning
 - b. High voltage warning
 - c. Voltage unbalance warning
 - d. Over current warning
 - e. Under current warning
 - f. Current unbalance warning
 - g. Ground fault warning
24. The equipment shall provide line frequency measurements.
25. The equipment shall provide a method to disable the following voltage faults:
- a. Low voltage enable
 - b. High voltage enable
 - c. Voltage unbalance enable
 - d. Reverse-phase enable
 - e. Voltage single-phase enable
26. The equipment shall require a 3-phase input voltage of 200-480 VAC.
27. The equipment shall require a 3-phase 50-60 Hz input voltage.
28. The equipment shall be able to set either ABC or BCA phase rotation as a fault.
29. The equipment shall be able to set the current unbalance trip delay.
30. The equipment shall be able to set the ground fault trip delay.
- E. Timing Requirements
- 1. The equipment shall provide a ground fault trip delay that follows an inverse time curve with a maximum trip time of 8 seconds and a minimum trip time of 2 seconds.
 - 2. The equipment shall provide a current unbalance trip delay that follows an inverse time curve with a maximum trip time of 30 seconds and a minimum trip time of 2 seconds.
 - 3. The equipment shall provide an overload trip time that follows an inverse time trip curve.
- F. Accuracy Requirements
- 1. The equipment shall provide a timing accuracy on all timers of 5% \pm 1 second.
 - 2. The equipment shall provide a current measurement accuracy of \pm 3% for currents <100 amps direct for A, B, C phase currents.
 - 3. The equipment shall provide a ground fault current measurement accuracy of \pm 15% for currents <100 amps direct.
 - 4. The equipment shall provide a voltage measurement accuracy of \pm 1%.
- G. Human Interface Features
- 1. The equipment shall provide an adjustment dial to set the following setpoints:
 - a. Low Voltage (LV)
 - b. High Voltage (HV)
 - c. Voltage Unbalance (VUB)
 - d. Multiplier (MULT)
 - e. Over Current (OC)
 - f. Under Current (UC)
 - g. Current Unbalance (CUB)
 - h. Trip Class (TC)
 - i. Rapid Cycle Timer (RD1)
 - j. Motor Cool Down Timer (RD2)
 - k. Under Current Restart Delay Timer (RD3)
 - l. Number Of Restarts After Under Current (#RU)
 - m. Device Communication Address (ADDR)

- n. Number Of Restarts After Other Faults (#RF)
 - o. Under Current Trip Delay (UCTD)
 - p. Ground Fault (GF)
2. The equipment shall provide an adjustment dial to view the following runtime information:
 - a. L1-L2 line voltage
 - b. L2-L3 line voltage
 - c. L3-L1 line voltage
 - d. Measured voltage unbalance
 - e. A phase current
 - f. B phase current
 - g. C phase current
 - h. Measured current unbalance
 - i. Measured ground fault current
 3. The equipment shall provide a 3-digit 7-segment display for viewing operating parameters of the device.
 4. The equipment shall provide a push button switch for the following functions:
 - a. Programming the device
 - b. Viewing the last fault
 - c. Resetting the device after a fault
 - d. Resetting the device during a restart delay
 - e. Activate emergency run
 5. The equipment shall provide connection to an external remote reset switch.
- H. Relay Ratings
1. The equipment shall include SPDT output relay contacts pilot duty rated 480VA at 240VAC.
 2. The equipment shall include SPDT output relay contacts general purpose rated 10A @ 240VAC.
- I. Electromagnetic Compatibility
1. The equipment shall be immune to electrostatic discharge per IEC 1000-4-2, Level 3, 6 kV contact discharge and 8 kV air discharge.
 2. The equipment shall be immune to electrical fast transient bursts exceeding IEC 1000-4-4, Level 3. Specified limits shall be 3.5 kV input power.
 3. The equipment shall be immune to electrical surges per IEC 1000-4-5, Level 3. Specified limits shall be 2kV line-to-line; Level 4, 4kV line-to-ground.
 4. The equipment shall be immune to surge and ring wave per ANSI/IEEE C62.41. Specified limits shall be 6kV line-to-line.
 5. The equipment shall be immune to radiated radio frequency emissions per IEC 1000-4-3, Level 3. Specified limits shall be 10V/m.
 6. The equipment shall be immune to conducted radio frequency emissions per IEC 1000-4-6, Level 3. Specified limits shall be 10V.
- J. Vibration/Shock Requirements
1. The equipment shall withstand vibrations per IEC 68-2-6. Specified limits shall be 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis.
 2. The equipment shall withstand shocks per IEC 68-2-27. Specified limits shall be 30g, 3 axis, 11ms duration, half-sine pulse.
- K. Dielectric Isolation: The equipment shall provide 2000VAC dielectric withstand between the AC mains and the relay contacts and between the AC mains and enclosure for 1 minute.
- L. Enclosure Class of Protection: The equipment shall provide IEC IP20 (finger safe) protection.
- M. Short Circuit Requirements
1. The equipment shall provide a short circuit rating of 100kA
- N. Environmental Requirements
1. The equipment shall operate continuously without de-rating in ambient temperatures of -20° to 70°C (-4° to 158°F).
 2. The equipment shall operate continuously without de-rating in relative humidity of up to 95% non-condensing per IEC 68-2-3.
 3. The equipment shall operate properly after storage in ambient temperatures of -40° to 80°C (-40° to 176°F).
- O. Dimensions: The equipment dimensions shall not exceed 3.0" in width X 3.6" in length X 5.1" in height.
- P. Mounting:
1. The equipment shall be mountable on standard 35 mm DIN rail.



2. The equipment shall be surface mountable on a backplane using four screws, bolts or similar mounting hardware.
- Q. Conformal coating:
1. The equipment's electronics shall be conformal coated with a silicone resin based coating with an operating temperature of -65°C to 200°C and dielectric breakdown strength of 1100 V/mil.

End of Section

Byram Labs