

Reclosers

Functional Specification Guide

NOVA STS Single-Tank Triple-Single Recloser and Form 6-TS Control

PS280001EN

1. Scope

This specification describes the features of the NOVA STS Electronically Controlled Vacuum Recloser and Form 6 Triple-Single (Form 6-TS) Control. The NOVA STS recloser system shall consist of three separate single-phase reclosers in a single tank suitable for pole or substation mounting, utilizing shatter-resistant outdoor cycloaliphatic epoxy encapsulated axial-field vacuum interrupters. The NOVA STS recloser shall be available with optional internal voltage sensing.

The Form 6-TS electronic control coupled with the NOVA STS recloser constitute the NOVA STS recloser system. The control shall be equipped with a DC-to-DC converter, interface circuit, and a fully shielded 26-pin cable. The DC-to-DC converter board converts the control's 24 Vdc battery supply voltage to 53 Vdc to drive the trip-close capacitor in the NOVA STS mechanism.

2. Applicable Standards

2.1. The Quality Management System shall be ISO 9001 Certified.

The NOVA STS Single-Tank Triple-Single Recloser and Form 6-TS control shall be designed and tested in accordance with the following standards as applicable:

IEEE Std C37.60™-2012 standard – IEEE Standard Requirements for Overhead Pad-mounted, Dry Vault and Submersible Automatic Circuit –Reclosers and Fault Interrupters for Alternating Current Systems

ANSI C37.61-1973/IEEE Std 321™-1973 standards - IEEE Standard Guide for the Application, Operation, and Maintenance of Automatic Circuit Reclosers.

IEEE Std C37.85™-1989 standard - American National Standard Safety Requirements for X-Radiation Limits for AC High-Voltage Power Switchgear.

ANSI/IEEE Std C37.90™-1989 standard – IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

IEEE Std C37.90.1™-2002 standard – American National Standard Guide for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

IEEE Std C37.90.2™-1995 standard – Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

TIA/EIA 232-F – Interface between Data Terminal Equipment and Data Circuit-terminating Equipment Employing Serial Binary Data Interchange

IEC 60068-2-1 – IEC Standard for environmental testing-Part 2-2 tests-Test A: Cold

IEC 60068-2-2 – IEC Standard for environmental testing-Part 2-2 tests-Test B: Dry Heat

IEC 60068-2-30 – IEC Standard for Basic Environmental Testing Procedures-Part 2-30 : Procedures-Damp Heat, Cyclic

IEC 60255-5—Electrical Relays-Part 5: Insulation coordination for measuring relays and protection equipment-requirements and tests

- Impulse voltage tested at 5kV for input/outputs, voltage sensing, and control cable.
- High-Potential input/outputs shall be tested to 3150 VDC.
- Insulation resistance input/outputs shall be tested to 100 Mohms.

IEC 60255-21-1— IEC Standard for Vibration, shock, bump and seismic tests on measuring relays and protection equipment, Section One-Vibration tests (sinusoidal)

IEC 60255-21-2--- IEC Standard for Vibration, shock, bump and seismic tests on measuring relays and protection equipment, Section Two-Shock and bump tests

IEC 60255-22-1-- Measuring relays and protection equipment - Part 22-1: Electrical disturbance tests - 1 MHz burst immunity tests

- a. 2.5 kV common mode
- b. 1.0 kV differential mode

IEC 61000-4-2-- IEC Electromagnetic Compatibility (EMC) Part4-Testing and measurement techniques, Section 2-Electrostatic discharge immunity test

IEC 61000-4-3-- IEC Radiated, radio frequency, electromagnetic field immunity test

IEC 61000-4-4-- IEC Electrical fast transient/burst immunity test

IEC 61000-4-6-- IEC Immunity to conducted disturbance induced by radio frequency fields

IEC 61000-4-11-- Electromagnetic Compatibility (EMC) - Part 4-11: Testing and Measurement Techniques – Voltage dips, short interruptions and voltage variations immunity tests

- a. 0% of voltage for 25 cycles
- b. 40% and 70% of voltage for 50 cycles

IEC 61000-4-12-- Electromagnetic Compatibility (EMC) - Part 4-12: Testing and Measurement Techniques – Ring wave immunity test

- a. 100 kHz ring wave (contact inputs at level 2), all other circuits at level 4
- b. 100 kHz and 1.0 MHz damped oscillatory at level 3 for all circuits

EN 55022 – Information Technology Equipment-Radio with A1: Disturbance Characteristics-Limits and Methods of Measurements

Distributed Network Protocol Basic Four Document Set

R280-90-12 per Eaton Protocol 2179 Reference Document

3. Ratings

- 3.1. The NOVA STS Recloser and Form 6-TS Control shall be designed in accordance with this specification and shall be rated as follows:

3.1.1. Weight

Single-Tank NOVA STS Recloser	kg (lbs)
NOVA STS-15	130 (288)
NOVA STS-27	133 (294)
NOVA STS-38	138 (305)

Control	kg (lbs)
Form 6-TS Control	34 (75)

Pole Mounting Hanger	kg (lbs)
NOVA STS Pole Mounting Hanger	44 (98)

3.1.2. Voltage

Rating	NOVA STS-15	NOVA STS-27	NOVA STS-38
Maximum Design Voltage (kV)	15.5	27.0	38.0
Nominal Operating Voltage (kV)	14.4	24.9	34.5
Basic Insulation Level (kV)	110	125	170
60 Hertz Withstand Voltage (kV)			
Dry, one minute	50	60	70
Wet, ten seconds	45	50	60
Radio Influence Voltage (RIV)			
100 μ V Maximum (kV)	9.4	16.4	23.0

3.1.3. Current

Rating	NOVA STS-15	NOVA STS-27	NOVA STS-38
Continuous Current (A)	630/800	630/800	630/800
Symmetric Interrupting Current (A)	12,500/16,000	12,500/16,000	12,500
Overload Capability (A)			
630A-STs (125% - 8Hrs.)	787	787	787
800A-STs	NO OVERLOAD RATING		
Cable Charging Current (A)	10	25	40
Three-Second Current Symmetric (A)	12,500/16,000	12,500/16,000	12,500

3.1.4. Mechanical Life

Rating	NOVA STS-15	NOVA STS-27	NOVA STS-38
Minimum Operations	10,000	10,000	10,000

3.1.5. Frequency

Rating	NOVA STS-15	NOVA STS-27	NOVA STS-38
Rated Frequency (Hz)	50/60	50/60	50/60

3.1.6. Duty Cycle

Percent of Maximum Circuit Interrupting Rating	Minimum X/R Ratio	Number of Unit Operations at 12.5 kA	Number of Unit Operations at 16.0 kA
15-20	4	88	44
45-55	8	112	56
90-100	17	32	16
		Total 232	Total 116

3.1.7. Creepage

Rating	NOVA STS-15	NOVA STS-27	NOVA STS-38
Creepage Distances	mm (in)	mm (in)	mm (in)
Terminal to Terminal	1052 (41.5)	1052 (41.5)	1052 (41.5)
Lower Terminal to Ground	673 (26.5)	760 (30.0)	950 (37.5)

4. Construction

- 4.1. The recloser manufacturer shall have no less than 10 years experience in the design and fabrication of reclosers.

- 4.2. The Single-Tank Triple-Single recloser system shall consist of one NOVA STS recloser with one Form 6-TS recloser control.
- 4.3. The recloser shall be electrically trip free. Any applied close signal shall not inhibit the recloser from tripping on the programmed time-current curve.
- 4.4. The reclosers shall utilize environmentally friendly cycloaliphatic epoxy as the dielectric insulating medium. The use of SF₆ gas or oil for insulation or interruption is prohibited. Foam or Polyurethane insulation systems are not allowed.
 - 4.4.1. There shall be no porcelain on the external portion of the recloser.
- 4.5. A sensing bushing current transformer, 1000:1 ratio, for use with the recloser control, shall be an integral part of the recloser.
- 4.6. A 4-digit mechanical counter shall be provided under the sleet hood for each phase.
- 4.7. A manual operating handle shall be provided under the sleet hood for each phase.
- 4.8. Pulling the yellow handle down when in the closed position shall result in a manual opening operation. With the handle in the OPEN position, the recloser is in a "lock-out" position and shall not accept an electrical close signal from the control.
- 4.9. Returning the yellow operating handle to the CLOSED (UP) position shall not close the recloser. The yellow operating handle must be returned to the CLOSED (UP) position for the recloser to respond to a close signal from the Form 6-TS control. All close operations shall be initiated by the control.
- 4.10. A red/green (closed/open) indicator flag shall be visible on the side of the sleet hood to provide contact position indication.
- 4.11. The recloser shall include provisions for mounting arresters to the recloser tank (3 source and three load side arresters).
- 4.12. The recloser shall have an operating temperature range of -40 °C to +55 °C.

5. Mechanism

- 5.1. The recloser mechanism shall consist of a dual-coil (bi-stable) magnetic actuator capable of fast opening and closing operations with no recharging delay. Bi-stable means that no operating power is required to hold the unit open or closed.
- 5.2. A capacitor shall be used to store the necessary energy for operating the magnetic actuator.
- 5.3. The design of the reclosers shall permit for 100 open and close operations after loss of primary control voltage for dead line operation.
- 5.4. The reclosers shall contain no high voltage closing coils. The recloser shall be capable of operating fully from either 120 Vac or 240 Vac and 24 Vdc internal control battery.

6. Solid Dielectric Insulation

- 6.1. Cycloaliphatic epoxy shall be utilized as the dielectric insulating medium and be highly resistant to ozone, oxygen, moisture, contamination and ultraviolet light. No coatings or UV protective covers are acceptable.

- 6.1.1. The cycloaliphatic epoxy shall provide a non-brittle, non-flexible and a high resistance to damage dielectric insulating medium.
- 6.1.2. The cycloaliphatic epoxy shall provide complete encapsulation of the internal vacuum interrupter. The encapsulation shall also be completely bonded to the source and load side bushing terminals.
- 6.2. The recloser bushings shall be designed utilizing alternating minor and major skirts to increase creepage distance.

7. Vacuum Interrupters

- 7.1. The recloser shall make use of Eaton's Axial-Magnetic vacuum interrupters to ensure high fault-interrupting capability, provide fast low energy arc interruption and minimize heat generation.
 - 7.1.1. Current interruption shall occur in vacuum interrupters, providing minimum and even contact wear, long life and maximum reliability and quality.

8. Current Transformers (CT's)

- 8.1. The current transformers shall be an integral part of the cycloaliphatic epoxy bushings. The CTs shall be a 1000:1 sensing CT used for all overcurrent protection, general metering and event history.
- 8.2. The current transformers shall be protected by a CT clamping circuit internal to the recloser to minimize the possibility of hazardous voltage entering the control compartment or exposed due to the control cable being disconnected.

9. Mounting Frame

- 9.1. The recloser shall be provided with a single pole-mount frame for pole mounting.
 - 9.1.1. When specified, the recloser shall be provided with a substation mounting frame.

10. Triple-Single Recloser Control

- 10.1. The single-tank triple-single recloser system shall be controlled by a single microprocessor-based recloser control equivalent to Eaton's Form 6-TS recloser control.
- 10.2. The triple-single recloser control shall be capable of being programmed for three operating modes:
 - Mode A - Three-phase trip, three-phase lockout
 - Mode B - Single-phase trip, three-phase lockout
 - Mode C - Single-phase trip, single-phase lockout
 - 10.2.1. In Mode A, all phases shall trip and close simultaneously, for single-phase or multiple-phase faults.
 - 10.2.2. In triple-single operation (modes B and C), each phase shall operate on a separate four operation sequence and the protection parameters shall be the same for all phases.
 - 10.2.2.1. In Mode B, when one phase fault sequences to lockout, the other two phases shall also trip to lockout to prevent single-phasing.
 - 10.2.2.2. In Mode C, each phase shall trip and lockout independently.
 - 10.2.2.3. In Modes B and C, each phase shall trip and close independently from the front panel or via communications.

- 10.2.2.4. In Modes A and B, pulling the yellow handle for any recloser shall result in opening the other two reclosers in the NOVA-STS system.
- 10.2.2.5. In Modes B and C, the front panel RECLOSER CLOSED and CONTROL LOCKOUT LED indicators shall blink in a pattern versus the RECLOSER OPEN indicator during a sequence and after a single recloser has gone to lockout in Mode C. This shall be due to the fact that the three reclosers in the NOVA-STS system are not at the same state.
- 10.3. The Minimum Trip, Reclose Times, TCCs, Sensitive Earth Fault, Voltage, Frequency, Non-Reclose, Hot Line Tag, Cold Load Pickup Block, and Fast Trips Disabled settings shall apply to all three phases simultaneously.
- 10.4. The recloser control shall include extensive system protection functionality, including phase, ground and negative sequence overcurrent protection, over/underfrequency, over/undervoltage, sensitive ground fault, directionality, and sync check.
- 10.5. Analysis tools shall include fault locating, event recording, and oscillography functions.
- 10.6. Metering functions shall include demand and instantaneous current on a per phase basis, instantaneous voltage and power factor on a per phase basis, and power (real, reactive, apparent) on a per-phase or total basis.
 - 10.6.1. Harmonics shall be provided on a per phase basis.
 - 10.6.2. Symmetrical components for both voltage and current shall be displayed along with kilowatt-hours for energy metering.
 - 10.6.3. All the above values shall be recordable in a Data Profiler that contains user-selectable inputs and sampling rates.
- 10.7. The triple-single recloser control shall include a front panel Human/Machine Interface (HMI) used to configure the operating settings for the recloser control. It shall also be used to display metering, counter information, control parameters, reset alarms, and provide diagnostic information including the ability to view at a minimum the 25 most recent event files.
 - 10.7.1. Control parameters shall also have the ability to be programmed via a personal computer (PC) connected to the control through a front panel RS-232 port.
 - 10.7.1.1. The control programming, interrogation, and operations shall be accomplished using a triple-single recloser control application software residing on a PC.
- 10.8. The triple-single recloser control application software provided with the control shall include additional functions used to create and graphically display Time-Current Curves and provide a comprehensive environment for configuring user-selected inputs and outputs, configurable event and alarm data, and selectable communication points for serial communication. The user shall be able to connect to the control via the application software and open a scheme from file or device or open a saved event with a single menu command.
- 10.9. The control shall operate on 50 and 60 Hz systems, but must be programmed to the correct frequency to obtain proper current and voltage measurements.

11. Control Housing

- 11.1. The control shall be housed in a weatherproof outdoor cabinet with accessible dual-entry (front and rear) through two doors.
 - 11.1.1. Each door shall include gasketing to assure a weather-tight seal and include locking provisions.
 - 11.1.2. A minimum of two latch points shall be required for each door.
 - 11.1.3. A nameplate shall be attached to the front door.
 - 11.1.4. Front door entry shall allow access to the operating panel, thermostatically controlled heater, and battery without exposure to the exposed AC sensing power supply.
 - 11.1.5. Rear door entry shall allow direct access to all control wiring including voltage connections and to serial communications/hardwired inputs and outputs.
 - 11.1.6. As part of the housing, a factory-mounted and pre-wired control cable receptacle shall allow the user a quick-disconnect from the recloser.
 - 11.1.7. The control housing shall also have a provision for standard conduit or cable entry.
 - 11.1.8. Four vent holes shall be included to maintain proper ventilation.
 - 11.1.9. The control shall have a standard 15 W thermostatically controlled heater (ON 70 °F, OFF 85 °F) for humidity control. The heater shall be powered from the power supply board.

12. Configuration Firmware/Interface Software

- 12.1.1. The recloser control shall use a Microsoft® Windows® operating system-based interface software. The software shall be separate from the recloser control. The executable configuration interface software shall allow the user the ability to save and edit files based upon user requirements independent of connectivity to the control. All settings, metering, and analysis tools shall use standard dialog boxes, including available minimum and maximum values, for each setting.
- 12.1.2. Firmware upgrades shall be available through direct connection to the dedicated RS-232 port on the control front panel without any additional equipment required.

13. Temperature Range

- 13.1.1. The operating temperature range of the control shall be -40 °C to +70 °C ambient.
 - 13.1.1.1. To prolong battery life the maximum storage temperature of the battery shall be +47 °C.

14. Front Operating Panel

- 14.1.1. The Front Operating Panel shall be intuitively designed to minimize training costs and avoid potential misoperation.
- 14.1.2. The operating panel shall be separated into two sections clearly identified by color-coding or another acceptable user-approved method.
 - 14.1.2.1. The top portion of the control shall be used for programming the control.
 - 14.1.2.2. The lower portion of the control shall be used for operation.

14.1.3. The recloser control shall be integrated as a system to include proper status of the recloser on the front operating panel.

15. Programming/Status

15.1.1. The control programming section shall provide the user LED status indication.

15.1.1.1. Each LED shall be rated for visibility in bright sunlight.

15.1.1.2. The control shall have a minimum of 31 LEDs available for direct control and recloser status information.

15.1.1.3. As a minimum, dedicated LEDs shall include status indication as follows:

- Control OK
- Control Power
- Control Lockout
- Recloser Open
- Recloser Closed
- A-Phase Fault
- B-Phase Fault
- C-Phase Fault
- Ground Fault
- Sensitive Ground
- Alarm
- Above Minimum Trip
- Indicator 1
- Indicator 2
- Indicator 3
- A-Phase Voltage
- B-Phase Voltage
- C-Phase Voltage
- Frequency Trip
- Voltage Trip
- Indicator 4
- Indicator 5
- Indicator 6
- Indicator 7
- Indicator 8

15.2. The user shall be enabled to remove all front panel insert labels (a total of 31 relabeled LEDs) to customize the LEDs as required.

15.2.1. Removable inserts shall be available to customize LEDs for all 9 Option LEDs and all Target Indicators except CONTROL OK, CONTROL POWER, and ALARM.

15.2.2. Removable inserts and labels shall be designed to enable the user to change inserts without the use of adhesives, label makers, or temporary labels.

15.3. The user shall have the ability to access critical operation functions through the use of eight Analysis One-Touch Keypads.

- Metering
- Reset Targets
- Events
- Lamp Test

- Settings
- Operations Counter
- Alarms
- Change

15.4. A sharp, backlit 4-line x 20-character display shall be included in the programming section.

15.4.1. The LCD panel contrast shall be field-adjusted to allow for various mounting heights and applications.

15.4.2. The LCD shall provide extensive status information regarding the distribution system, recloser, and control using a minimum of eight navigational keypads in an organized menu structure.

15.4.3. The navigational keypads shall include accelerated plus and minus keypads for quick setting changes; direct scroll up, down, left, and right keypads; along with immediate enter and menu keypads for direct operation.

15.4.4. The LCD shall also use four clearly identified function keys for setting and operation instructions.

15.5. The programming section shall also include a DB-9 RS-232 connector for direct connection to a personal computer (PC).

15.5.1. The interface shall be designated DCE to directly connect to the serial port of the PC without any special cables or connectors.

16. Operating Section

16.1. The operating section shall allow the user direct open and close operation of the recloser along with pre-defined and customized operating functions.

16.1.1. The TRIP and CLOSE buttons shall have a protective guard around the perimeter of each button to prevent incidental trip or close.

16.1.1.1. The TRIP button shall be green and the CLOSE button shall be red.

16.1.1.2. The TRIP button shall work independent of the microprocessor. All trip commands from the TRIP button shall trip the recloser, even in the event of microprocessor failure.

16.1.1.3. The CLOSE button functionality is controlled by the state of the microprocessor which shall allow the activation of temporary features such as Cold Load Pickup.

16.2. The front operating panel shall include the following push-button keypads with LED Indicators:

- Ground Trip Blocked
- Non-Reclosing
- Supervisory Off
- A Phase Selected
- B Phase Selected
- C Phase Selected
- Option #1
- Option #2
- Option #3

16.2.1. The front operating panel shall also include the following:

- Hot Line Tag On/Off Toggle Switch
- Hot Line Tag LED Indicator
- RS-232 Port

17. Operating Power

- 17.1. Incoming AC power shall be routed to the Power Supply/Battery Charger Board from either 120 Vac or 240 Vac.
- 17.2. The battery charger shall include a temperature-compensated design to optimally charge the control battery.
- 17.3. The power supply/battery charger board shall also include an auxiliary power supply for connection to communication equipment (radios, modems, etc.).
 - 17.3.1. The auxiliary power supply shall be rated 28 Vdc, 65 W peak.
- 17.4. A separate 28 Vdc to 13.8 Vdc power supply accessory shall be available for communication equipment rated for 12 Vdc.
- 17.5. Some additional features shall be included as follows:
 - 17.5.1. The power supply shall have two LED indicators: the first LED located in the middle is illuminated when AC power is present; the second LED located on the right side of the power supply is illuminated when the battery is shorted to the chassis.
 - 17.5.2. The power supply shall include a selectable 120/240 Vac switch for adapting to multiple transformer connections. The selector switch shall be factory-set based upon each customer order.
 - 17.5.3. The power supply shall include a self-protective fuse (5 A, 250 Vac).
- 17.6. The control shall have a standard 15 W thermostatically controlled heater (ON 70°F, OFF 85°F) for humidity control and voltage input independent.
 - 17.6.1. The heater shall be powered from the power supply board.
- 17.7. The control shall be equipped with a 13 Ah 24 Vdc lead acid battery for operation upon loss of AC power.
 - 17.7.1. The battery shall have a minimum life expectancy of four years.
 - 17.7.2. The control shall maintain full operation from the battery for the following period of time:
 - 17.7.2.1. 13 Ah – 25 hour maximum (20 °C)
 - 17.7.3. Although given a particular control and a particular mechanism one could operate without the battery, it should be noted and emphasized that the battery is expected to be present at all times for proper operation. In the event that the AC power has not returned within the time listed above, the control shall disconnect the battery from the circuit.
 - 17.7.4. The control shall continuously monitor the battery voltage.
 - 17.7.4.1. To prevent battery damage, the control shall shut down automatically upon detection of low battery voltage (below 22 Vdc) for 60 seconds.
- 17.8. Control programming settings and parameters—including event recorder—shall be stored in non-volatile memory and retained upon loss of control power.
- 17.9. The time/date clock shall continue to operate for approximately 30 days after loss of control power.
- 17.10. Phase B shall be the factory default phase when the internal voltage sensing option is not ordered.

17.10.1. Unless changed by the user, the B PHASE VOLTAGE red LED shall illuminate indicating AC is the operating power.

17.10.2. If B phase (or the user-indicated phase) loses AC power, the ALARM red indicator LED shall illuminate. The ALARM log on the LCD Display shall indicate NO AC PRESENT.

18. Terminal Blocks

18.1. Two terminal blocks shall be provided for connection to the recloser control.

18.1.1. Both terminal blocks shall be fit for a #6 screw which shall allow a maximum ring size for a #10 AWG wire.

19. Power Connections

19.1. The transformer required for power shall have a minimum rating of 1 kVA for recloser/control operation.

20. Protocols

20.1. Four serial communications protocol options shall be supported in the control.

- Modbus
- DNP3
- 2179
- IEC 870-5-101

20.2. The control protocol ports shall be configured as follows:

20.2.1. Front Panel Port—This port shall be used exclusively with the ProView interface software supplied with the control.

20.2.2. Rear Panel Ports (2—Standard supplied RS-232 and one that is user-selectable at time of order) — The rear port selection options shall include:

- 20.2.2.1. RS-485 (Isolated)
- 20.2.2.2. Serial Fiber Optic
- 20.2.2.3. Ethernet (Wire or Fiber)

20.2.3. The user shall have the ability to configure which back port shall have the communication protocol.

20.2.3.1. The other port shall automatically be assigned ProView protocol.

20.3. The RS-485 or serial fiber-optic communications cards shall not support ProView protocol.

21. Control Security

21.1. The control shall have a customer-programmable security code to limit access of control programming and viewing functions to authorized personnel.

21.2. There shall be a connection password when communicating between the control and a computer.

22. Protection Profiles

22.1. Four protection profiles shall be provided, each capable of fully specifying the operation of the control.

22.1.1. The profiles shall be selected from front panel programming or through interface software and serial communication ports.

22.1.2. Each protection profile shall include the following as a minimum:

- Overcurrent Protection
- Over and Undervoltage Protection
- Over and Underfrequency Protection
- Directional Protection
- Sync Check
- Sensitive Ground Fault Protection
- Operation Settings

23. Time-Current Curve

23.1. The control shall have time-current curves available for fast and delayed operations.

23.1.1. Each time-current curve shall be selected from a defined fifty curves which can be further customized by the user.

23.1.2. The time-current curves shall also be selected from a graphical TCC editor to visualize any modifications prior to configuring the control.

23.1.3. The time-current curves shall include the following modifications for phase, ground, and negative sequence protection:

23.1.3.1. Time Multiplier with a range of .1 to 25 in .1 increments.

23.1.3.2. Time Adder with a range of 0 to 30 seconds in .01 second increments.

23.1.3.3. Minimum Response Time with a range of 0 to 1 seconds in .001 second increments.

23.1.3.4. High Current Trip with a range of 1 to 32 multiples of minimum trip.

23.1.3.5. HCT Time Delay with a range of .01 to .150 second in .001 second increments.

24. Sequence Coordination

24.1. The control shall include a Sequence Coordination feature which allows the control to step through selected operations in the operating sequence without tripping.

24.1.1. The number of Sequence Coordination advances shall be programmable from one to three operations to provide trip coordination with a downline recloser.

24.1.2. This feature shall be independently selectable for each protection profile.

25. Cold Load Pickup

25.1. The control shall include a Cold Load Pickup feature to prevent the control from tripping due to inrush current.

25.1.1. This feature shall have an independently programmable minimum trip value, time-current curve, reclose interval, and number of operations to lockout for each protection profile.

26. Hot Line Tag

- 26.1. A Hot Line Tag feature to block all closing operations for live-line work shall be included in the design of the control as a standard feature.
- 26.1.1. When selected, the control shall trip on one operation to lockout on the composite curve of the Hot Line Tag definite time and the TCC1 curve (whichever is faster).
- 26.1.2. Hot Line Tag time delay shall be independently selectable for each protection profile.

27. Fast Trips Disabled

- 27.1. The control shall include a Fast Trips Disabled feature to modify the protection, so the recloser and control only operate for trip operations programmed for TCC2.
- 27.1.1. This feature shall be independently selectable for each protection profile.
- 27.1.2. The total trip operations shall change to only trip operations programmed for TCC2. As an example, the control shall change its sequence from two fast (TCC1) and two delayed (TCC2) operations to two delayed (TCC2) operations only when Fast Trips Disabled is active.

28. High Current Lockout

- 28.1. The control shall include a High Current Lockout feature that will automatically lockout the control when current exceeds a programmable level.
- 28.1.1. The active shot numbers for the lockout shall be selectable for phase, ground, and negative sequence. Also, direct values, not multiples of minimum trip, shall be provided.
- 28.1.2. This feature shall be independently selectable for each protection profile.

29. Sensitive Ground/Earth Fault Operation

- 29.1. The control shall include a Sensitive Ground/Earth Fault Trip feature that will provide tripping of the recloser for ground currents below normal ground minimum trip levels.
- 29.2. The feature shall have programmable operations to lockout and reclose intervals independent of the ground settings.
- 29.3. This feature shall be independently selectable for each protection profile.

30. Metering

- 30.1. The control shall provide instantaneous and/or demand metering with programmable integration intervals for the following functions:
- Real and reactive power for each phase and total, including directional, on an individual phase basis.
 - Demand currents on a per phase basis.
 - Instantaneous currents, including ground current.
 - Instantaneous voltage on a per phase basis.
 - Instantaneous frequency.
 - Positive, negative, and zero sequence voltages and currents.
 - Harmonics on a per phase basis for voltage and current.
 - Instantaneous power factor on a per phase basis.
 - Metering settings to include power factor alarm, alarm time delay, demand

interval, and alarm thresholds for current, single-phase kW, three-phase kW, single-phase kVAR, and three-phase kVAR.

31. Data Profiler

- 31.1. The Data Profiler shall record configurable analog data for a specific period of time.
- 31.2. The Data Profiler shall be configured to allow periodic recording with ranges from 1 minute to 24 hours for all selected parameters.
- 31.3. The Data Profiler shall be capable of selecting up to 150 analog data points along with 8 user-customized analog data points.
- 31.4. The data profiler shall present the data in table form and allow exporting to external spreadsheet application software.
- 31.5. Depending on the number of variables selected to record, the Data Profile shall be able to record a minimum of 30 days worth of data.

32. Event Recorder

- 32.1. The recloser control shall contain capabilities to perform Sequence of Events for up to 69 event types.
- 32.2. The event recorder shall include the date and time of the event and appropriate metering analogs based upon event type.
- 32.3. Sixteen additional event types are user-defined through the Idea Workbench software functionality.

32.3.1. Some factory-defined event types shall be as follows:

- Overcurrent Protection Trip
- External Trip
- Non-Reclose Trip
- External Close
- Lockout
- Reset

- 32.4. The Event Recorder shall maintain a minimum of 90 events.

33. Recloser Duty Monitor

- 33.1. The recloser control software shall be equipped with a Recloser Interrupting Duty Monitor.
- 33.2. The Duty Monitor shall accumulate the summation of $I^{1.5}$ for all interrupted currents on each interrupter.
- 33.3. This feature shall permit programmable entries to preset the duty of an existing recloser.

34. Discrete SCADA Communications

- 34.1. The control shall provide a minimum of five configurable output status contacts.
 - 34.1.1. Each status contact shall be configurable using graphical interface software to combine status functionality along with Boolean algebra.
 - 34.1.2. Default output status shall be: Control OK, Lockout, Open/Close, Ground Trip Block, and Hot Line Tag.

- 34.1.3. One output status contact shall be a solid state output with a pickup time no longer than two milliseconds.
- 34.2. The control shall also provide a minimum of three configurable control input contacts.
 - 34.2.1. Each control contact shall be configurable using a graphical interface software.
 - 34.2.2. Each contact shall accept a voltage range of 12-240 Vac, 12-250 Vdc as the wetting voltage.
 - 34.2.3. Each control input shall be configured for either a momentary, latched, or latched with precedence contact.
 - 34.2.4. The default configurations are Three-Phase Remote Trip and Lockout, Three-Phase Supervisory Close, and Three-Phase Supervisory Trip and Lockout.
- 34.3. A Discrete Interface Board shall also be available as an accessory to provide an additional eight output status contacts and eight control input contacts.
 - 34.3.1. The Discrete Interface Board shall be user-configurable via the Idea Workbench.
 - 34.3.1.1. The default output status configurations are: Non-Reclosing, Control or System Alarm, Normal Profile Selected, Alt Profile 1 Selected, Alt Profile 2 Selected, Alt Profile 3 Selected, Under or Over Frequency Alarm, and Under or Over Voltage Alarm.
 - 34.3.1.2. The default control input status shall be: Non-Reclosing, Ground Trip Block, Reset Targets, Normal Profile, Alternate Profile 1, Alternate Profile 2, and Alternate Profile 3.

35. Time Current Curve Editor

- 35.1. Coordination and actual time current modifications shall be available with a graphic interactive Time Current Curve Editor or similar graphical software.
- 35.2. The Time Current Curve Editor shall include a complete database of standard industry recloser time current curves (TCC), both ANSI and IEC types, along with the ability to customize the TCCs with multipliers, constant time adders, or minimum response time adders.
- 35.3. The user shall be able to derive their own specific TCC through data point entry.
 - 35.3.1. Each modified time current curve shall be able to be identified with a user-customized name and shall be selectable for configuring the control.
- 35.4. The grid and format for presenting the TCCs shall have a user-adjustable scale, including the option of presenting multiple TCCs in various user-configured colors.

36. Oscillography

- 36.1. Oscillography shall be provided to present current and voltage waveforms, along with protection function and recloser response status changes.
- 36.2. The recorded values shall be super-imposed on the protection scheme, and the state or value at any point in the scheme shall be displayed.
- 36.3. The user shall have the capability to move through the event and watch the response of all available functions.
- 36.4. All analog signals, digital inputs, and contact outputs shall be monitored.

- 36.5. The oscillography sampling rate shall be a minimum of 16 samples per cycle.
- 36.6. The oscillography data on the analog signals shall be post-filtered values.
- 36.7. Event size shall be user selectable from 2 to 30 cycles with the capability of recording a maximum of twelve 8 cycle events.

37. Idea Workbench

- 37.1. The Idea Workbench application included with the control interface software shall allow the user to program the control using simple graphical logic characters, internal alarms, status, and target.
- 37.2. The user shall have the ability to perform logical functions with a combination of these variables using drag and drop functionality supported by the control.
- 37.3. The Idea Workbench shall provide a true graphical programming environment.
 - 37.3.1. Logical equation programming shall not be acceptable.

38. Over/Undervoltage Protection

- 38.1. The control shall include single-phase and three-phase undervoltage tripping.
- 38.2. The control shall also include single-phase and three-phase overvoltage tripping.
- 38.3. Both over and under voltage functions shall include a phase pickup, a phase time delay, a three-phase pick-up, and a time delay.
- 38.4. Voltage protection shall be included as part of each protection profile.
- 38.5. Auto-Restoration shall be included.

39. Over/Underfrequency Protection

- 39.1. The control shall include two-stage operation for both Underfrequency and Overfrequency protection.
- 39.2. Frequency protection shall have the ability to enable either over or under frequency protection or both functions simultaneously.
- 39.3. A fixed time delay ranging from 0 to 100 seconds in .001 second increments shall be available for both over and underfrequency.
- 39.4. A frequency voltage supervision threshold with a range from 0 to 200 kV in 0.1 kV increments shall be included to prevent spurious frequency trip operations.
- 39.5. A frequency restoration function, enabled or disabled by the user, shall be provided to allow the recloser to automatically close should frequency return to within configured settings for a user-settable time.
- 39.6. Over/Under Frequency Protection shall be included as part of each protection profile.

40. Directional

- 40.1. Directional functionality shall be included to maintain system coordination from multiple sources, as well as circuit reconfiguration for each profile.
- 40.2. Directional shall apply to phase, ground, and negative sequence protection, selected independently.

40.3. A maximum torque angle shall have a range of 0–90 degrees in 1 degree increments.

41. Fault Location

41.1. The control shall include an impedance-based fault locator based upon the Takagi algorithm.

41.2. A load-compensated impedance calculation shall be used for calculating the distance.

41.3. The user shall be able to configure the positive and zero sequence in ohms, and the fault locator line length in kilometers and/or miles.

42. Sync Check

42.1. Sync Check functionality shall include the following applications:

- Hot Line/Hot Bus Closing
- Dead Line/Hot Bus Closing
- Hot Line/Dead Bus Closing
- Dead Line/Dead Bus Closing

42.2. Sync Check Parameters shall include the following configurable settings:

- Voltage Angle
- Mechanism Operating Delay
- Static Angle Delay
- Dead Threshold
- Live Threshold
- Upper Voltage Limit
- Lower Voltage Limit
- Lower Frequency Limit
- Upper Frequency Limit
- Fail to Close Timer

43. Optional Features

43.1. Internal Voltage Sensors

43.1.1. When specified, each NOVA STS recloser shall include an internal voltage sensor to provide source side voltage sensing.

43.1.2. The internal voltage sensors shall utilize a high-voltage resistor within each interrupter module with source-side connections.

43.1.3. The internal voltage sensors and recloser control shall support a magnitude accuracy of 2% or better and a phase degree accuracy of $\pm 1.5^\circ$.

43.1.4. The internal voltage sensing option shall be compatible with Form 6 Triple-Single controls.

43.2. Optional Recloser Accessories

43.2.1. When specified, items checked below shall be included in the proposal:

- Internal voltage sensing
- Bushing terminals, selectable from the following:

- Eye-bolt bushing terminals
- NEMA 2-hole flat pad bushing terminals
- NEMA 4-hole flat pad bushing terminals
- Pole-mounting hanger to include the following:
 - Source side arrester mounting provisions
 - Load side arrester mounting provisions
 - Source side potential transformer mounting provision
 - Load side potential transformer mounting provision
 - Load side external voltage sensor mounting provisions
 - NOVA STS recloser factory-installed in pole mounting hanger
- Substation mounting frame
- Three-stage auxiliary switch
- Bushing terminal animal guards

43.3. Optional Recloser Control Accessories

43.3.1. When specified, items checked below shall be included in the proposal:

- Cable locking sleeves
- Fused 120 Vac, 3-wire polarized GFI convenience outlet
- Full automation accessory (includes radio mounting provisions, 12 Vdc radio power provisions, antenna cable and Polyphaser)
- Basic automation accessory (includes radio mounting provisions and 12 Vdc radio power provisions)
- 120 Vac battery charger for spare batteries
- 240 Vac battery charger for spare batteries

44. Finish Performance Requirements

- 44.1. The recloser tank shall be painted Munsell Notation 5BG7.0/0.4, ANSI 70 Gray.
- 44.2. The coating system shall meet or exceed IEEE Std C57.12.31™ 2010 standard coating system requirements for pole-mount equipment.
- 44.3. Certified test data shall be furnished upon request.

45. Recloser Production Testing

- 45.1. The recloser shall be subjected to the following production tests:

- 45.1.1. Functional test to assure unit is operating.
- 45.1.2. Electrical TCC trip test.
- 45.1.3. High-potential withstand test to determine dielectric strength of the unit.

46. Recloser Control Production Testing

- 46.1. The recloser control shall be subjected to the following production tests:
 - 46.1.1. Continuity test to assure correct internal connections.
 - 46.1.2. Cycle testing of the module.
 - 46.1.3. Electrical TCC trip test.

47. Certified Test Data

- 47.1. Certified test data shall be available upon request for the following:
 - 47.1.1. Interrupter ratings per IEEE Std C37.60TM-2012 standard
 - 47.1.2. Load current, line charging and cable charging interruptions per IEEE Std C37.60TM-2012 standard
 - 47.1.3. Dielectric ratings (BIL, Dry and Wet withstand, and Partial Discharge) per IEEE Std C37.60TM-2012 standard
 - 47.1.4. Continuous current heat run per IEEE Std C37.60TM-2012 standard
 - 47.1.5. Mechanical Life per IEEE Std C37.60TM-2012 standard

48. Approved Recloser Manufacturers

- 48.1. Eaton's NOVA STS Recloser.

49. Approved Recloser Control Manufacturers

- 49.1. Eaton's Form 6-TS Recloser Control.

50. Service

- 50.1. The manufacturer of the recloser and control shall have regional service centers located within two hours flight time of all contiguous 48 states.
- 50.2. Service personnel shall be factory trained in commissioning and routine service of quoted reclosers and controls.