

# Type NOVA-TS Triple-Single Recloser and Form 5/Triple-Single Control Technical Specifications

## Introduction

This specification describes the features of the Kyle® Type NOVA™-TS Form 5/Triple-Single Electronically-Controlled Vacuum Recloser. The Type NOVA-TS recloser system consists of three separate single-phase reclosers suitable for pole or substation mounting, utilizing shatter-resistant outdoor cycloaliphatic epoxy encapsulated axial-field vacuum interrupters.

The Kyle Form 5/Triple-Single electronic control coupled with the NOVA-TS reclosers constitute the NOVA-TS recloser system. The control is equipped with a dc-to-dc converter, interface circuit, and a fully shielded 19-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 capacitors in the NOVA-TS mechanism.

## Standards

The Type NOVA-TS Triple-Single Recloser and Form 5/Triple-Single control have been designed and tested in accordance with the following standards as applicable:

*C37.60.1-1981* American National Standard Requirements for Overhead Pad-Mounted, Dry Vault and Submersible Automatic Circuit Reclosers and Fault Interrupters for Alternating Current Systems.

*C37.61-1973/Std. 321-1973 (IEEE)*. IEEE Standard Guide for the Application, Operation and Maintenance of Automatic Circuit Reclosers.

*C37.85 -1989* American National Standard Safety Requirements for X-Radiation Limits for AC High-Voltage Power Switchgear.

*C37.90 -1989 (ANSI/IEEE)* American National Standard Guide for Surge Withstand Capability (SWC) tests.

*C37.90.2 -1993 (ANSI/IEEE)* Electro-magnetic Interference Testing.

*Distributed Network Protocol* Basic Four Document Set.

*EIA* Interface between Data Terminal Equipment and Data Circuit-terminating Equipment Employing Serial Binary Data Interchange.

*IEC-68-2-30* International Electrotechnical Commission Standard for Basic Environmental Testing Procedures - Damp Heat, Steady State.

*EIC 801-3* International electrotechnical Commission Standards for RF Immunity.

*Kyle Spec 574* Surge Withstand and Capability Testing of Electronic Controls.

*Random Vibration Specification* per MIL-STD-810E, method 514.4, Curve 514.4-1.

*R280-90-12* per KYLE Protocol 2179 Reference Document.

## Weight

	One Single- Phase Unit	Mounted Triple- Single Cluster with Hanger
	kg (lbs)	kg (lbs)
Recloser		
NOVA-TS-15 . . . . .	48 (105)	188 (413)
NOVA-TS-27 . . . . .	50 (110)	194 (428)
Control . . . . .		52 (115)
Pole Mounting Hanger . . . . .		44 (98)

## Voltage Ratings

Maximum Design Voltage (kV)	
NOVA-TS-15 . . . . .	15.5
NOVA-TS-27 . . . . .	29.2
Nominal Operating Voltage (kV)	
NOVA-TS-15 . . . . .	14.4
NOVA-TS-27 . . . . .	24.9
Basic Insulation Level (kV)	
NOVA-TS-15 . . . . .	110
NOVA-TS-27 . . . . .	125
60 Hertz Withstand Voltage	
Dry, one minute	
NOVA-TS-15 . . . . .	.50
NOVA-TS-27 . . . . .	.60
Wet, ten seconds	
NOVA-TS-15 . . . . .	.45
NOVA-TS-27 . . . . .	.50
Radio Influence Voltage (RIV)	
100 µV Maximum (kV)	
NOVA-TS-15 . . . . .	.9.4
NOVA-TS-27 . . . . .	.16.4

## Current Ratings

Continuous Current Ratings (Amps)	
NOVA-TS-15, NOVA-TS-27 . . . . .	400/800
Symmetric Interrupting Current (Amps)	
NOVA-TS-15, NOVA-TS-27 (400 Amps) . . . .	8,000
NOVA-TS-15, NOVA-TS-27 (800 Amps) . . .	12,500

Overload Capability	
NOVA-TS-15, NOVA-TS-27	
400 Amp	
125% - 4 hours (Amps) . . . . .	500
150% - 2 hours (Amps) . . . . .	600
800 Amp	
No overload rating	
Cable Charging Current	
NOVA-TS-15 (Amps) . . . . .	10
NOVA-TS-27 (Amps) . . . . .	25
Magnetizing Current	
400 Amps . . . . .	14
800 Amps . . . . .	28
Three-Second Current Symmetric (Amps)	
NOVA-TS-15, NOVA-TS-27 (400 Amp) . . .	8,000
NOVA-TS-15, NOVA-TS-27 (800 Amp) . .	12,500

Mechanical Life  
 Minimum Operations . . . . . 2,500

Frequency  
 Rated Frequency (Hz) . . . . . 50/60

Duty Cycle		
Percent of Maximum	Minimum	Number of Unit
Circuit Interrupting	X/R Ratio	Operations
Rating		
15-20	4	88
45-55	8	112
90-100	15	32
		Total 232

**NOVA-TS Creepage Distances**

	15 kV	27 kV
Terminal to	719 mm	719 mm
Terminal	28.25 in	28.25 in
Lower Terminal	630 mm	798 mm
to Ground	24.75 in	31.5 in

**Recloser Features**

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

The recloser shall be mechanically and electrically trip free. Any applied close signal, either mechanically or electrically, shall not inhibit the recloser from tripping on the programmed time-current curve.

Environmentally-friendly cycloaliphatic epoxy shall be used as the dielectric medium. Oil or SF6 gas shall not be used.

There shall be no porcelain on the external portion of the recloser.

A sensing bushing current transformer, 1000:1 ratio, for use with the recloser control, shall be an integral part of the recloser.

A 4-digit mechanical counter shall be provided under the sleethood.

A manual operating handle shall be provided under the sleethood

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.

Returning the yellow operating handle to the CLOSED position shall not close the recloser. The yellow operating handle must be returned to the CLOSED position for the recloser to respond to a close signal from the Form 5/Triple-Single control. All close operations shall be initiated by the control.

A red/green (closed/open) indicator flag shall be visible on the side of the sleethood to provide contact position indication.

Close and trip capacitors shall be used to store the necessary energy for operating the recloser. Only the close capacitor energy shall be used for closing while both capacitors are available for opening; therefore, trip energy shall be available following any electrical close.

**Control Housing**

The control shall include a receptacle to easily connect a control cable to the recloser and can be located remotely from the recloser. The control shall be housed in a weatherproof steel cabinet with a padlockable internally hinged door and shall include a thermostatically-controlled heater.

**Temperature Range**

The operating range of the recloser/control shall be -40° C to +65° C, ambient.

**Modular Construction**

The design of the control shall consist of modular construction to provide maximum flexibility. A standard module configuration shall include a Recloser Interface Module (RIF), CPU Module, Power Supply Module, Communication Interface Module (CIF) and Front Operating Module. Two customizable Discrete Interface Modules (DIF), Fiber-Optic/RS232 communication cards, and a 120 Vac GFI outlet shall be provided as accessories to interface with customer equipment.

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## Operating Power

The operating power shall be supplied from an external 120 Vac or 240 Vac (two-wire or three-wire) 50 Hertz or 60 Hertz source. A 12 Amp-hour battery shall be provided for back-up control operation in the event of loss of primary supply. The battery shall be capable of operating the control for a minimum of 36 hours with no external loads connected and the cabinet door closed (LED's and display turned off). If the primary supply has not been restored within the allowable discharge time of the battery, the control shall automatically shut down.

## Auxiliary Power

An auxiliary 12 Vdc or 24 Vdc supply shall be provided for user loads with a maximum peak load capability of 40 Watts (1 sec) and a continuous average capacity of 3 watts. The feed shall be separately fused, preventing user loads from disabling the control.

## Serial Communications

The control shall be equipped with three serial communication ports, with two of them factory configurable to either 2179 or DNP 3.0 protocol. Two ports shall be located on the Communication Interface Module (CIM) and have the capability to interface with both RS-232 or fiber-optic equipment. The third port shall interface via RS-232 and be mounted on the operator panel to facilitate local integration and operation of the control.

## Protocols

Two serial communications protocols are supported in the Form 5/Triple-Single Control. They are:

- Cooper Power Systems 2179 Protocol  
Reference R280-90-12,  
Serial Communications Protocol  
Reference R280-90-13,  
Communications Point Database
- GE—Harris DNP3.0 Protocol  
Reference R280-90-14,  
Communications Point Database

## Battery Test Panel

A battery test feature shall be incorporated into the control which will monitor and report the state of the battery. Monitored data shall include battery terminal voltage and battery current (charging and/or load). Battery test terminals shall also be provided for external testing.

## Operator Panel Switches

The front operating panel shall include 18 push-button switches: one each for Trip to Lockout and Close (with cold load pickup) plus 16 overlay switches. Nine of these overlay switches shall be customizable to customer-specific configurations. A Hot Line Tag toggle switch shall be mounted on the front panel to disable all closing operations.

## LED Status Indicators

The control's front operating panel shall include 39 LED status indicators of which 16 will be fixed, 12 are associated with overlay switches and up to 11 customizable to customer specifications. The 16 fixed displays shall indicate:

- Control OK
- AC Power
- Above Min Trip
- 1Ø Trip - 1Ø Lockout
- 1Ø Trip - 3Ø Lockout
- 3Ø Trip - 3Ø Lockout
- Closed - AØ
- Open - AØ
- Lockout - AØ
- Closed - BØ
- Open - BØ
- Lockout - BØ
- Closed - CØ
- Open - CØ
- Lockout - CØ
- Hot Line Tag

These three separate mode status LED's shall clarify the configured mode of the NOVA-TS recloser:

- Single-Phase Trip - Single-Phase Lockout
- Single-Phase Trip - Three-Phase Lockout
- Three-Phase Trip - Three-Phase Lockout

These direct LED's shall be used with each individual phase LED's to interpret why one, two, or all three phases are open.

## Operator Panel

The operator panel shall include a 4-line by 20-character backlit LCD display that shall allow customizable displays for viewing operational data of the control, accessed through two push-button overlays. The LCD shall include complete metering information, including all current, voltage, and power values, along with trip values for all profiles. The LCD panel shall be scrollable in both directions.

## Control Security

The control software shall have a customer-programmed security code to limit access of control programming functions to authorized personnel.

## Protection Profiles

Four protection profiles shall be provided, each capable of fully specifying the operation of the control in overcurrent protection. The profiles shall be selected from front push-button overlays, Discrete Interface (DIF) modules or through interface software and serial communication ports.

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## Time-Current Curve

Each profile shall allow 14 independent Time-Current Curve specifications:

- Four Phase Overcurrents
- Four Ground Overcurrents
- One Each for Phase and Ground Fast Trips Disabled
- One Each for Phase and Ground Hot Line Tag
- One Each for Phase and Ground Cold Load Pickup

## Time-Current Curve Selection

The selected Time-Current Curves shall be chosen from a total of 20 curves located in the control at any one time. The 20-curve library shall be user selectable from a database of 41 time-current curves to permit implementation of any standard or modified curve. Time-current curves shall also be available through a TCC editor to allow users to design their own curves.

## Time-Current Curve Modification

The Form 5/Triple-Single control software shall have the ability to permit altering of any of the following TCC modifications:

- TCC Multiplier: Shift the TCC up or down in time by a selected multiplier. The multiplier can be selected from 0.01 to 2.0 times the selected TCC, in increments of 0.01.
- Constant Time Adder: Adds a constant time value to the selected TCC. The time adder can be selected from 0.01 to 0.20 seconds, in increments of 0.01 seconds.
- Minimum Response Time: Provides a fixed minimum response time, 0.013 to 1.0 seconds, in increments of 0.001 seconds.
- High Current Trip: Provides a trip at a selectable current value and a selectable time. The high-current ratio is selectable from 1 to 31.5 in 0.001 increments and the trip time is selectable from 0.016 to 0.15 in increments of 0.001 seconds.
- Custom TCC Design: Provides custom designed TCC's which can be created by data points (time and current) entered by the user.

## Sequence Coordination

A Sequence Coordination feature shall be included which allows the control to step through selected operations in the operating sequence without tripping. The number of Sequence Coordination advances is programmable from 1 to 3 operations to provide trip coordination with a downline recloser. This feature shall be independently selectable for each protection profile.

## Cold Load Pickup

The control shall include a Cold Load Pickup feature to prevent the control from tripping while energizing non-fault system loads. This feature shall have an independently programmable time current curve, reclose interval and number of operations to lockout for each protection profile.

## Hot Line Tag

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. When selected, the control will use the programmed Hot Line Tag TCC for overcurrent protection operating on one shot to lockout. This feature shall be independently selectable for each protection profile.

Hot Line Tag functionality shall provide automatic three-phase trip/three-phase lockout operation independent of the mode selection. For live-line applications, a fault on any phase shall trip all phases on the programmed TCC, avoiding any further reclosing of any phase. By tripping all three phases, even in single-phase trip/single-phase lockout, the circuit shall close when an unexpected fault occurs.

## Fast Trips Disabled

The control shall include a Fast Trips Disabled feature to modify the protection such that all trip operations use the programmed Fast Trips Disabled TCC. This feature shall be independently selectable for each protection profile.

## Reclose Retry

A Reclose Retry feature shall be included that issues multiple reclose attempts in the event closing power is lost. A reclose signal shall be issued at programmable intervals for a programmable number of attempts. This feature shall be independently activated for each protection profile.

## High Current Lockout

A High Current Lockout feature shall be included to automatically lockout the control when current exceeds a programmable level. The active shot numbers for the lockout shall be selectable for both phase and ground and are independently selected for each protection profile.

## Sensitive Ground/Earth Fault Operation

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

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## Metering

The control shall provide instantaneous and demand metering with programmable integration intervals for the following functions:

- Real, Reactive and Apparent Power for each phase and total.
- Power Factor for each phase and total.
- Voltage Magnitude for each phase.
- Current Magnitude for each phase and neutral.
- Positive and Negative Sequence Voltages (Magnitude and Phase).
- Positive, Negative and Zero Sequence Currents (Magnitude and Phase).

## Harmonic Analysis

Comprehensive harmonic information shall be included for three-phase voltages and currents plus neutral current. The analysis shall include total harmonic distortion in percent of the fundamental frequency plus the percent contribution for each of the second through fifteenth harmonics. Graphing capabilities shall also be included.

## Histograms

Histogram data shall be provided which displays statistical information including time tagged Min/Max values. Each record shall have programmable limits and the ability to clear records to start gathering new information. The histogram data shall display the number of occurrences of a metered variable versus the value of the variable.

## Alarms

The Form 5/Triple-Single control shall include a fully configurable alarm system with the ability to select 40 of a possible 100 data and status alarms. Data alarms shall be included that compare metered values to preset limits for a selectable time delay. Status alarms shall operate when user-selected functions change state. Both alarm types shall also have the ability to initiate an event recorder incident and also initiate a data profile sample.

## Data Profiler

The control shall include a programmable data-profiler feature which enables data collection at user-selectable intervals. The profiler shall have the ability to graph the collected data to display a trend and a cyclic representation of the profile.

## Event Recorder

An Event Recorder shall be provided to record and store events in non-volatile memory. The recorder shall include information on the time and date of the event, event type and data pertinent to the occurrence. The events recorded include the following:

- Overcurrent Trip
- Supervisory Trip from Port X
- Supervisory Trip from Discrete I/O
- Supervisory Ground Trip Block
- Supervisory Close from Port X
- Supervisory Close from Discrete I/O
- Successful Reclose
- Overcurrent Lockout
- Supervisory Lockout from Port X
- Non-Reclose Lockout
- High Current Lockout
- Close Retry Lockout
- Yellow Handle Lockout
- Sensitive Ground Fault Lockout
- Sequence Coordination
- Reset
- Local Close (Front Op. Panel)
- Local Trip and Lockout (Front Op. Panel)
- Remote Lockout from Port X
- Remote Lockout from Discrete I/O
- Loss of ac Power (where applicable)
- Restoration of ac Power (where applicable)
- Hot Line Tag Close Attempt
- EPROM Failure
- Check Battery
- Failed to Close from Close Signal
- Communication Port 1 Error
- Communication Port 2 Error
- Communication Port 3 Error

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## Recloser Duty Monitor

The Form 5/Triple-Single control software shall be equipped with a Recloser Interrupting Duty Monitor. The Duty Monitor shall accumulate the summation of  $I^{1.5}$  for all interrupted currents on each interrupter. The feature shall permit programmable entries to preset the duty of an existing recloser.

## Discrete SCADA Communications

Two Discrete Interface Modules shall be available for order as accessories. Each shall be fully customizable to user specifications and contain 12 status-type inputs and 12 control-type outputs. The I/O points shall accept externally-supplied voltage or can supply power to function internally from the control.

## Dynamic Phase Tripping

A new configurable option for Mode C operation shall be available to trip and lockout all three phases in the event of a phase-to-phase or three-phase fault. Normal operation shall occur per the programmed sequence, but protection shall be enhanced by interrupting all three phases, even non-faulted phases. Should a phase to-phase or three-phase fault be detected on the system, all three reclosers shall trip and lockout whenever any one phase sequences to lockout. Three-phase lockout shall occur if a multiple phase fault is present as the recloser advances to lockout. For example, when there is a phase-to-phase fault, the control shall trip and lockout all three reclosers when any one phase sequences to lockout; avoiding any multi-phase energization from one phase.

## Invalid Frequency Measurement Detection

The control shall detect when the frequency measurement is invalid due to low voltage. The control shall then inhibit protection based on frequency. As a result, the LCD display shall show dashes for the present frequency.

## Manual Close Delay

This feature shall provide a delay in between the activation of the operator panel CLOSE button and the actual execution of this operation. This feature shall allow the user to press the close button before the control performs the operation.

## Over-Current Protection Lockout Indication

Over-current protection lockout indication shall provide remote status output for OCP Lockout on Ports 2 and 3.

## DNP Configurable Class 0

DNP configurable Class 0 shall allow a user to configure the components of a DNP Class 0 data poll and processing/readout for Class 1/2/3 Event polls. Configuration shall be performed via the F5 Interface program or another program that is capable of setting the port configuration parameters.

## Power Factor Sign Convention

This feature shall allow a user to configure the sign that is applied to the power factor. The user shall select between the classical book definition of a power factor (cosine of angle between current and voltage), or the alternate convention which defines power factor sign to follow power flow.





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