

PLC CONTROL PHILOSOPHY FOR POWER GRID SUBSTATIONS

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(1) DATA NETWORK

(1.1) Serial RS-485 will be used to convey data between the substation PLCs and the HMI in this SCADA system.

(1.1.1) The serial network parameters will be 9600 bits per second, with 8 data bits, an odd parity bit, and 1 stop bit.

(1.2) One PLC per five circuit breakers will be used in each substation as RTUs (Remote Terminal Units) to convey breaker status to the HMI (touch-screen panel) and allow for remote breaker operation from the HMI.

(1.2.1) Substation PLC Modbus addresses:

Modbus address 101 = "Nooksack" substation, PLC for breakers 1 through 5

Modbus address 201 = "Stevens" substation, PLC for breakers 1 through 5

(1.3) The HMI touch-screen panel is located in the Stevens (south) substation. The Nooksack (north) substation has no HMI at this time.

(2) PLC I/O

(2.1) DISCRETE INPUTS -- each substation PLC will be equipped with one combination input/output card per circuit breaker. Input channels will be wired such that the card "sources" current, with external switches "sinking" current from the PLC to the negative terminal of the 24 VDC station DC power supply.

(2.1.1) Each I/O card will monitor the status of a Local/SCADA selector switch, on discrete input channel 1. This selector switch contact will be open in the "Local" position and closed in the "SCADA" position.

(2.1.2) Each I/O card will monitor the status of the circuit breaker via auxiliary contact 52b, on discrete input channel 2. This contact will be closed when the breaker is tripped (open) and open when the breaker is closed.

(2.1.3) Blue-colored wire will identify PLC input signals.

(2.2) DISCRETE OUTPUTS -- each substation PLC will be equipped with one combination input/output card per circuit breaker. Output channels will be wired such that the card "sources" current to external loads from the positive terminal of the 24 VDC station power supply.

(2.2.1) Each I/O card will energize the circuit breaker's "trip" coil via discrete output channel 1.

(2.2.2) Each I/O card will energize the circuit breaker's "close" coil via discrete output channel 2.

(2.2.3) Yellow-colored wire will identify PLC output signals.

(2.3) I/O POWER -- each I/O card will be supplied +24 VDC station power from terminal "n"0 of TB1 (where "n" is the ten's place of the terminal number corresponding to the circuit breaker number; e.g. for circuit breaker #4 this would be TB1-40).

(2.3.1) Red-colored wire will identify +24 VDC station power to the PLC I/O card.

(3) INTERLOCKS AND CONTROLS:

(3.1) The PLC program will contain interlocking logic to prevent simultaneous "trip" and a "close" output signals from being sent to the circuit breaker.

(3.2) The PLC program will contain timing functions to ensure all "trip" and "close" signals will exist for a minimum time duration specified in milliseconds, with 1000 milliseconds being the default setting. This ensures the breaker will receive "trip" and "close" commands for a long enough time to ensure proper operation even if an operator presses the HMI button control for just a fraction of a second.

(3.3) The discrete input bit from the "Local/SCADA" selector switch dedicated to each circuit breaker will enable remote breaker control from the HMI touch-screen panel. When this switch is in the "local" position, the PLC will be prohibited from tripping or closing the breaker. When this switch is in the "SCADA" position, the PLC will be able to act on "trip" or "close" commands sent from the HMI over the RS-485 serial network.

(4) COMPUTATION:

(4.1) The PLC will count the number of times the circuit breaker has been tripped, regardless of the initiating event (e.g. PLC trip versus manual trip or protective relay trip). The initiating bit must come from the sensed breaker status (52b contact). This counter function may only be reset by manipulating the PLC using a computer with ladder-logic editing software.

(5) TAGNAMES:

(5.1) Each circuit breaker will have its own unique tagnames ("nicknames"), identical to the respective data points for all other breakers except for the "CBn" designation, where "n" is the circuit breaker number within that substation (e.g. CB1, CB2, CB3, etc.). I/O tagnames for direct I/O and for network-shared data are listed here, and may also be found in the respective input/output wiring diagrams. Tagnames should only include numbers, letters, and underscore characters. No spaces, hyphens, or other ASCII characters will be allowed in tagnames.

(5.2) Discrete input tagnames

Channel 1 (Xn01) = "CBn_local_scada" (0 = Local ; 1 = SCADA)
Channel 2 (Xn02) = "CBn_breaker_52b" (0 = Closed ; 1 = Tripped)

(5.2) Discrete output tagnames

Channel 1 (Yn01) = "CBn_breaker_trip" (1 = command breaker to trip)
Channel 2 (Yn02) = "CBn_breaker_close" (1 = command breaker to close)

(5.3) Discrete internal tagnames

(Cn01) = "HMI_CBn_trip" (1 = remote HMI signal commanding breaker to trip)
(Cn02) = "HMI_CBn_close" (1 = remote HMI signal commanding breaker to close)

(5.4) Integer internal tagnames

"CBn_breaker_trips" (based solely on 52b contact status)
"CBn_assert_time" (sets how long each trip or close output assertion will last; default = 1000 ms)