

### Lab Exercise for INST232 course – introduction

Your team's task is to complete wiring for the circuit breaker controls, and also program the substation PLC to control your circuit breakers from the central HMI touch-screen panel located at the Stevens substation.

All documentation will be provided to you – including tagnames to be used in the PLCs and HMI – to ensure consistency throughout the whole SCADA system. Any modifications to this plan will be edited in the final documentation version by your instructor.

Objective completion table:

Performance objective	Grading	1	2	3	4	Team
PLC program running on personal PLC as per PLC philosophy document	mastery					-----
Breaker CT cable terminated on CT test switch	mastery	–	–	–	–	
Manual control switch wiring test and inspection	mastery	–	–	–	–	
Substation PLC program functional test as per PLC philosophy document	mastery	–	–	–	–	
Final substation PLC program inspection	mastery	–	–	–	–	
Final HMI database and display inspection as per HMI/SCADA philosophy document	mastery	–	–	–	–	
Troubleshooting	mastery					-----
Circuit design challenge (diagram sketch)	mastery					-----
Lab question: Wiring connections	proportional					-----
Lab question: Commissioning	proportional					-----
Lab question: Mental math	proportional					-----
Lab question: Diagnostics	proportional					-----
Lab clean-up	mastery	–	–	–	–	
Team tool locker inspection	mastery	–	–	–	–	

The only “proportional” scoring in this activity are the lab questions, which are answered by each student individually. A listing of potential lab questions are shown at the end of this worksheet question. The lab questions are intended to guide your labwork as much as they are intended to measure your comprehension, and as such the instructor may ask these questions of your team day by day, rather than all at once (on a single day).

**It is essential that your team plans ahead what to accomplish each day. A short (10 minute) team meeting at the beginning of each lab session is a good way to do this, reviewing what's already been done, what's left to do, and what assessments you should be ready for. There is a lot of work involved with building, documenting, and troubleshooting these working instrument systems!**

## Lab Exercise – wiring standards

Wiring for this lab exercise (INST232) consists of connecting all the TB1 terminals where the breaker control cable was landed during the last lab exercise (INST231) to the PLC and also to panel-mounted breaker control and Local/SCADA switches. The breaker CT cables will remain untouched during INST232, and will be completed during INST233 (the Protective Relays course).

Wire-tie anchors will be located inside the ducts to allow the conductors to be bound together for neatness. All wires entering a terminal block will be terminated with a *ferrule*. All wires connecting to a device screw will be terminated by either a *fork terminal* or a *ring terminal*. These compression-style ferrules and terminals bind all the loose wire strands together and makes for more reliable electrical connections. Where a wiring diagram shows a wire “daisy-chained” between different terminals, these wires will be inserted into a common compression-style ferrule or terminal.

The control wiring diagram document will be followed as closely as possible, to ensure every circuit breaker’s controls are wired identically. If multiple circuit breakers are wired differently from each other, it confuses the task of troubleshooting a malfunctioning circuit breaker later.

Professional fit and finish is important for this project, because it will not be disassembled as is the case with so many of our other projects. This project will become a permanent fixture of the Instrumentation lab, with future graduating classes using it to learn PLC programming and power system operation. Those students taking the elective INST233 (“Protective Relays”) course this summer will use what you have built.