REQUIRED STUDENT SUPPLIES AND MATERIALS for INST231 and INST232 courses:

The INST231 and INST232 courses (PLC Programming and PLC Systems) require all students to purchase their own personal PLC and HMI units. A "PLC" is an industrial computer built to be programmed to do specific control functions. An "HMI" is a graphic display panel designed to interface with a PLC and provide user access to settings and variables.

These hardware purchases are substantial in magnitude, but are essential for students to have as the coursework requires students to complete individual work programming and configuring these units. PLC/HMI technology is ubiquitous in industry, and the best way to maximize learning is to have your own unit to program and experiment with.

PLCs are so useful, in fact, that students may use theirs in other 200-level INST courses, justifying their purchase at any time during the second year of the Instrumentation program. Some students even end up applying their PLC and HMI units to home projects (e.g. burglar alarms, etc.) after the INST231/232 coursework concludes.

For this reason, multiple options are provided for PLCs. These range in cost from $70 to over $200, depending on functionality. All listed in this document satisfy the requirements of the program, with the higher-priced units having more applicability throughout the rest of the second year (outside the INST231/232 couses).

Software for programming both the PLC and HMI units is absolutely free. With these models you only pay for the hardware!

PLC and HMI panel (Automation Direct option):

* Automation Direct CLICK PLC model **C0-10DD1E-D** (price $129) 8 discrete (DC) inputs, 6 discrete (DC) outputs, with Ethernet and RS-232 communications ports.

* Automation Direct CLICK 24 VDC power supply model **C0-00AC** (price $29) 24 VDC at 0.5 amp maximum output

* Automation Direct C-More Micro HMI panel 3 inch **EA1-S3ML-N** (price $161)
* *or* Automation Direct C-More Micro touch-screen HMI panel 3 inch **EA1-S3ML** (price ~ $205). *Students have generally preferred the touch-screen model because it makes entering numerical values so much easier.*

* Automation Direct USB/serial adapter and cable part **EA-MG-PGM-CBL** (price $43) useful for programming both the CLICK PLC and the C-More Micro HMI panel

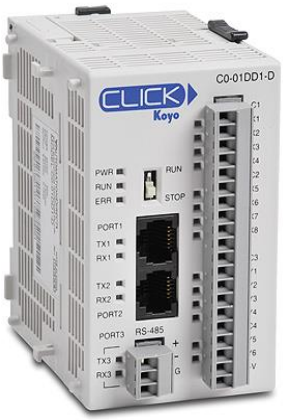

Figure 1 CLICK PLC unit

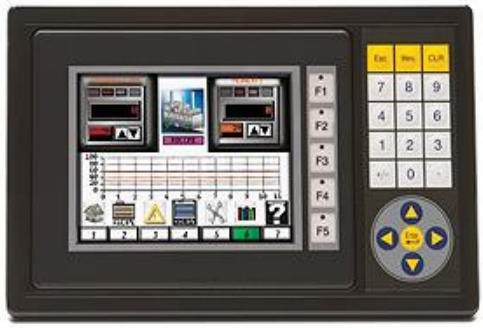

Figure 2 C-More Micro HMI panel

Purchasing one of the PLC units, plus all other items listed on this page, will prepare you for the INST231 and INST232 course requirements. All purchases must be made through Automation Direct's website (http://www.automationdirect.com).

PLC and HMI panel (Allen-Bradley option):

* Rockwell (Allen-Bradley) MicroLogix 1100 PLC model **1763-L16BWA** (price ~ $271+tax with BTC student discount at North Coast Electric) 10 discrete (DC) inputs, 6 discrete (DC) outputs, 2 analog inputs, RS-485 communication port, 10 Mbit/s Ethernet communication port, embedded web server.

* Automation Direct C-More Micro HMI panel 3 inch **EA1-S3ML-N** (price $161)
* *or* Automation Direct C-More Micro touch-screen HMI panel 3 inch **EA1-S3ML** (price $205). *Students have generally preferred the touch-screen model because it makes entering numerical values so much easier.*

* Automation Direct cable part **EA-MLOGIX-CBL** (price $30) and adapter part **EA-MG-SP1** (price $54) necessary for connecting the C-More Micro HMI panel to an Allen-Bradley MicroLogix 1100 PLC

* Automation Direct USB/serial adapter and cable part **EA-MG-PGM-CBL** (price $43) needed to program the C-More Micro HMI panel

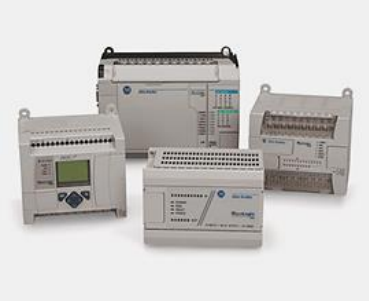

Figure 3 MicroLogix PLC units

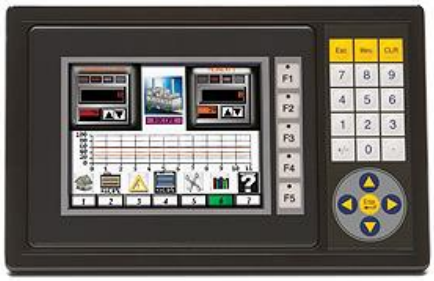

Figure 4 C-More Micro HMI panel

Purchasing one of the PLC units, plus all other items listed on this page, will prepare you for the INST231 and INST232 course requirements. *North Coast Electric in Bellingham sells Allen-Bradley components, but not Automation Direct*. To order Automation Direct components you must go to the Automation Direct website (http://www.automationdirect.com).

Choosing between Allen-Bradley ("MicroLogix") versus AutomationDirect ("CLICK") PLC:

The choice between the Automation Direct ("CLICK") PLC and the Allen-Bradley MicroLogix 1100 PLC is arbitrary from the perspective of course requirements. Either PLC will suffice for the INST231 and INST232 courses.

The main advantage of the Automation Direct ("CLICK") PLC is that it has more features per dollar, and has a gentler learning curve than the Allen-Bradley. Certain advanced functions such as Modbus communications, are much more straightforward with the CLICK than with any Allen-Bradley PLC.

The main advantage of the Allen-Bradley MicroLogix PLCs is that the programming of these units is nearly identical to the programming for the majority of PLCs found in American industry. While the basics of PLC programming are the same for any make or model of PLC, learning to program on the MicroLogix makes it just a bit easier to transition to programming other Allen-Bradley PLC products on the job. However, the words "nearly identical" are worthy of note, as the latest and greatest models of Allen-Bradley PLC (the Logix5000 series) you will see in all new industry installations have programming features and capabilities that are substantially different from those of the MicroLogix series. And then there are places that use Siemens-brand PLCs instead of Allen-Bradley altogether . . .

In summary, these PLC courses teach you the basic principles of programming *any* PLC, and do not delve into the particulars of any one brand or model. In fact, your homework will have you analyze programming examples from Allen-Bradley, Siemens, and AutomationDirect, just to ensure your skills are flexible enough to adapt to the subtle differences. At the level you are going to be learning, a PLC is a PLC is a PLC . . .

If your goal is to use your PLC for a real-world personal control project at home (e.g. aquarium water quality controller, home alarm system, etc.) after you have completed the INST231/232 courses, I strongly recommend the Allen-Bradley Micrologix units. Allen-Bradley hardware is more rugged than AutomationDirect hardware, and will therefore be more reliable in your application than one of the CLICK PLC units. However, you will have to spend more to get that increased reliability. In other words, *quality costs* – no surprises there!

Buying a used PLC:

Re-sale of PLC and HMI hardware is encouraged, as it saves money for both parties. However, it is important for the buyer to know that what they are buying is fully functional. In order to help students tell whether or not they're getting a good deal, I recommend they demand the seller demonstrate the following:

- Connect real switches to the PLC inputs (all of them!) and show that the respective bits in the PLC's memory change states when those switches are actuated. *Do not simply verify that the built-in display LEDs on the PLC turn on and off – the input bits in the PLC's memory must switch states (0 or 1)!* If the PLC has analog inputs, connect a potentiometer and demonstrate that a number in the PLC's memory changes value with potentiometer position.

- Connect real loads (e.g. light bulbs) to the PLC outputs (all of them!) and show that the loads turn on and off when the respective bits in the PLC's memory are forced or toggled by a program. *Do not simply verify that the built-in display LEDs on the PLC turn on and off – the real load connected to each output channel must turn on and off!*

- Demonstrate the HMI communicating with the PLC, either displaying data inside the PLC or controlling data inside the PLC. It doesn't matter what data is being shown, since any communication proves the HMI and PLC are able to communicate.

- Demonstrate the HMI communicating on all serial ports that the PLC offers (e.g. the CLICK PLCs have *two* identical ports, which should both work if the HMI is plugged into each one).

Any seller unwilling or unable to demonstrate these essential functions should not be surprised if the buyer demands a lower price or refuses the deal outright! All these functions will be necessary during the INST231 and INST232 courses.

The most common form of damage in used PLCs is a **defective output channel**. In such cases, the output channel will either not be able to turn on, or not be able to turn off, when the respective bit is toggled in the PLC's memory. This kind of damage occurs when the channel has been improperly connected to a power supply or a load.

The next most common form of damage in used PLCs is a **defective input channel**. In such cases, the respective input bit in the PLC's memory will not change state when the real input is energized and de-energized. Once again, the most common cause of such damage is improper connection to a power source.