PERSONAL DEVELOPMENT AND ENHANCEMENT

In addition to standard commissioning skills, I have developed additional methods and devices to complete jobs in difficult scenarios. Professional testing equipment is not always available when needed, so I found it very helpful to always have a set of portable testing equipment for troubleshooting. Portable testing equipment is not meant to replace manufactured and calibrated equipment but serves as a valuable addition.

The rental cost, weight, and shipping cost of professional equipment can be prohibitive when trying to have all possible testing equipment available onsite. I came up with the idea of having a set of small portable devices, wires, and wire jumpers connected with quick connectors to always have with me in my toolbox. The solution was small in size and low in weight.

Most portable devices, like oscilloscopes, variable and floating DC power supplies, DC signal generators, 3-phase AC sources, milliohm meters, etc., I was able to purchase. However, I needed to design and build a portable programmable controller (Fig. 1, 2, 3) and a small breaker test station (Fig. 4, 5).

The programmable controller has 4 inputs (5-170VDC), 4 outputs (10A contacts), and a DC current sensor, weighing only 0.4 kg. It can be powered by a 5V battery bank or a laptop USB port. The controller's inputs and outputs are optically isolated, making it safe to connect to and operate with a laptop. The controller is programmed using a powerful and flexible C/C++ language. I can create or modify C/C++ programs for particular troubleshooting or testing requirements.

The 25 multicolor programmable LEDs provide visual information like I/O statuses or identify certain stages of the running program. Text messages can be sent to a laptop USB port and read by any terminal program. The device can be operated using mini buttons, input statuses, or a laptop keyboard.

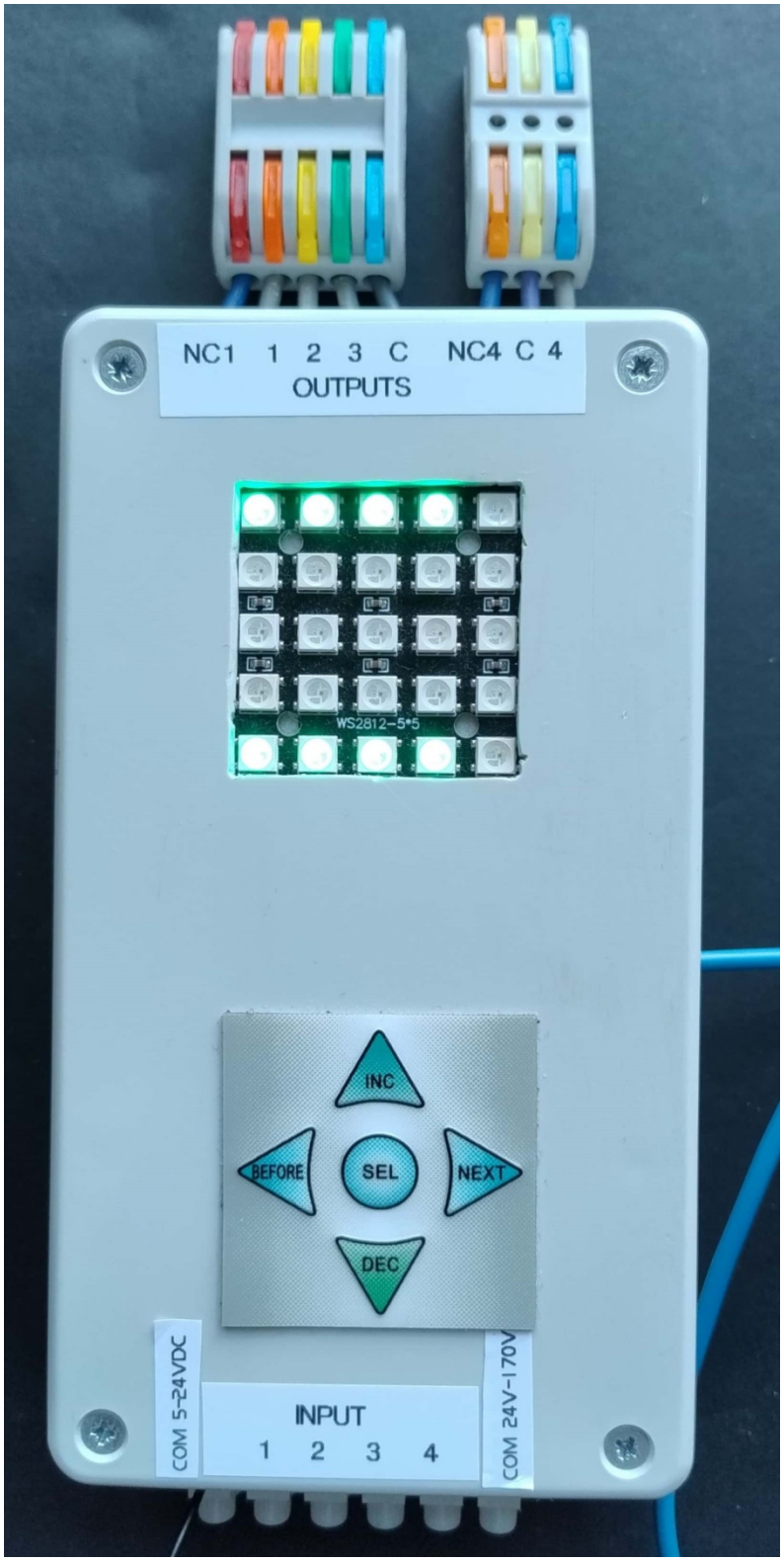

Figure 1: Universal programmable controller

Functional Examples:

- **Breaker Simulator**: Allows preserving the breaker mechanism while testing relays or a transfer scheme with a missing or defective breaker.
- **Multichannel Timer**: Helps identify the operation sequence and event time spacing, aiding in systems troubleshooting and quick timing verification of breakers or relays.
- **Visual Input Sensor**: Enables the operator to visually detect short pulses. The bottom input diodes are green when the input is open or low and red when closed or high. The second row of diodes is programmed to illuminate blue for 1 second when the associated input changes from open to close, or yellow when the input changes from close to open.

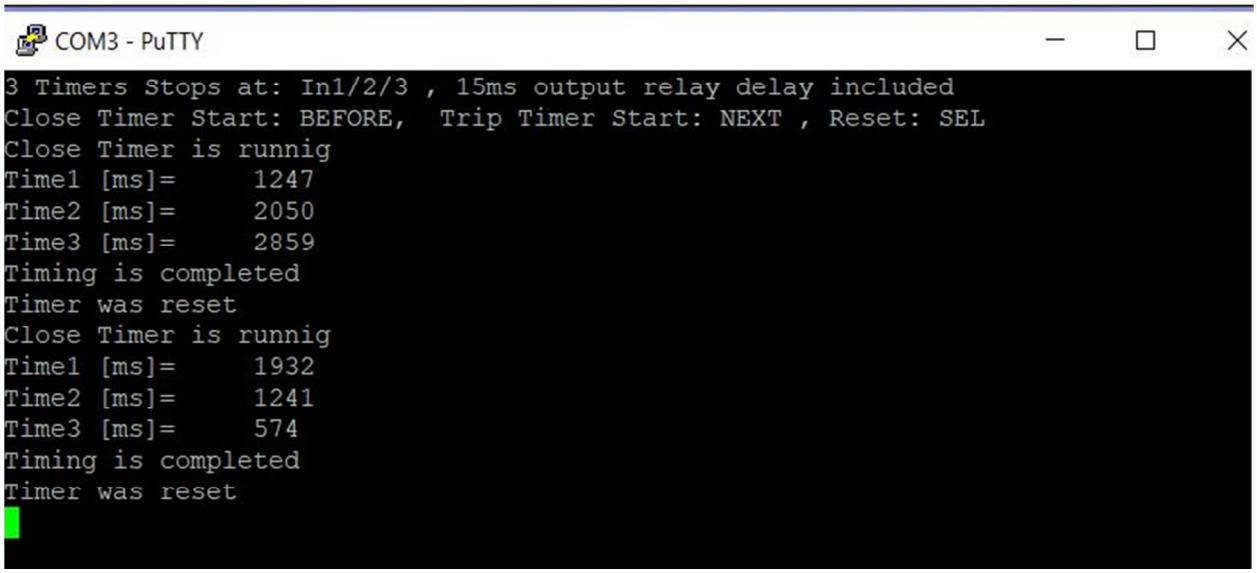

Figure 2: Close (NO) timer operation results from laptop terminal

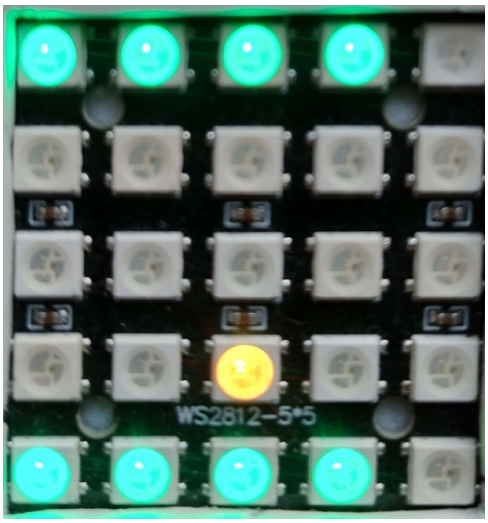

Figure 3: A short pulse on input 3 was identified by a yellow LED, which held for 1 second.

Portable Breaker Test Station

A breaker test station is essential for testing power breakers. Job sites sometimes lack installed or accessible stationary breaker test stations. Additionally, using a stationary test station often requires removing and transporting heavy breakers to the station. A small and lightweight (1 kg) portable station enhances the efficiency of breaker testing. It has the following additional features:

- **AC/DC Power Supply**: Can be powered by either AC or DC sources.
- **Ground Fault Interrupter (GFI)**: Equipped with a 30mA GFI, which is more reliable for testing compared to the 6mA GFI commonly used in North America that can cause false positive trips.
- **Safety Breakers**: Includes a 16A 30mA GFI breaker combo in series with a 10A fast breaker, providing safety and fault indication. In the event of a ground fault, the 16A GFI breaker trips first, while overcurrent and short faults cause the 10A OC breaker to trip.
- **Monitoring Tools**: Features a meter to monitor current and voltage, helping to identify problems within the attached breaker and prevent damage to components.
- **Quick Connections**: The breaker plug is connected using simple wires attached to quick connectors, allowing for easy swapping.

This portable station is versatile and can also be used as a start/stop station for breakers and contactors, making it a valuable tool for various testing scenarios.

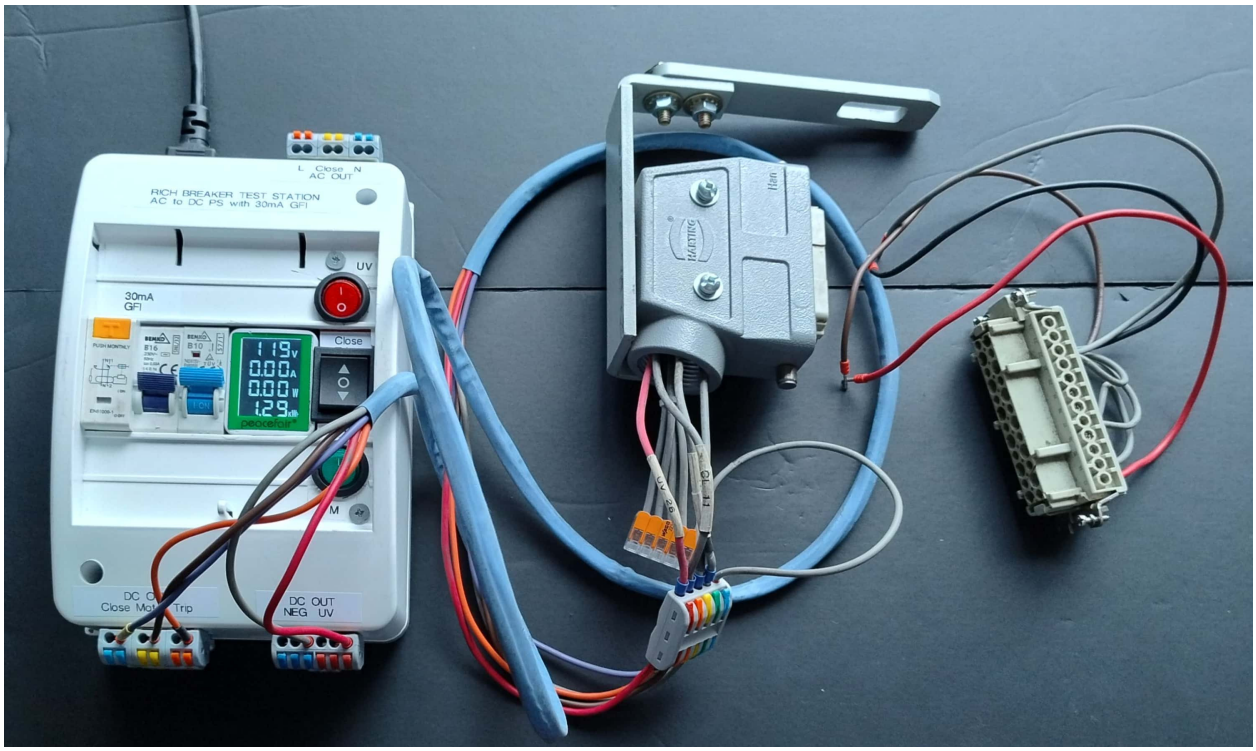

Figure 4: Breaker test station and quick connections

Figure 5: Breaker AC/DC test station

Other Devices and Practical Examples:

- **3 Phase AC Source**: The symmetrical 3-phase AC output follows the single-phase voltage adjusted with a small Variac transformer. I tested protective relays and a transfer scheme with the Omicron CMC356. When the tester was taken away for another site, I used my AC source a few weeks later to simulate SCADA inputs and demonstrate the transfer scheme to the client.
- **DC Signal Generator**: I used the generator with a voltage divider to simulate all functions on DC traction relays.
- **Variable Floating DC Source**: I used it for testing relays when site DC was not available, as rectified AC does not work in control circuits.