P-HIL Simulation to Easily Control Power Sources for Several Generation Scenarios

Introduction | Real-time control in power sources

The P-HIL (Power Hardware in the Loop) simulation consists of controlling a power device in real-time through analog inputs and outputs. In these systems, the power devices are typically converters or power sources that operate as a power amplifiers. Therefore, the power devices output waveform can be easily controlled according to testing and standards requirements.

In current applications, such as microgrids and electric vehicles, there is interest in verifying the systems operation for different energy generation scenarios, load characteristics and battery charge and discharge profiles. In this context, the use of power supply sources operating in P-HIL mode allows to emulate the most several test scenarios in a simple and practical way through an external low voltage and low current analog reference. Figure 1 shows the P-HIL setup composed by a SUPPLIER Regenerative AC Power Source (model FCAMQ 1100-33-15-PFC55251) + Typhoon HIL 600.

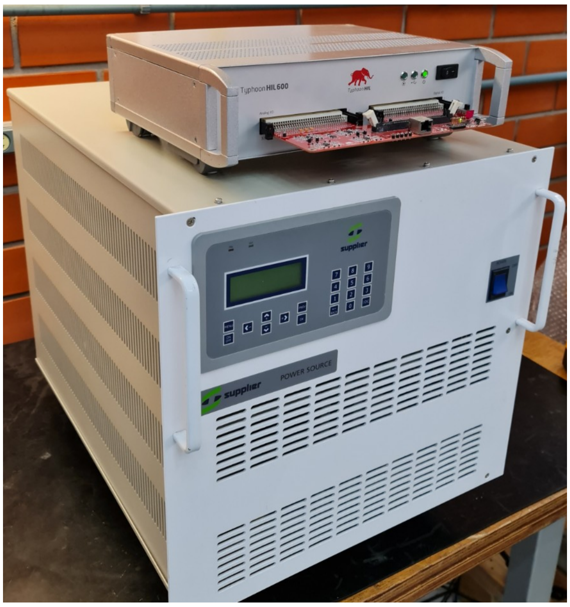

Figure 1 - P-HIL Setup.

Solution | Supplier and Typhoon HIL integration for P-HIL simulation

The Supplier Company develops custom AC and DC voltage or current sources and electronic loads that can be integrated whith any Tyhoon HIL device. All the Supplier’s power sourcers have customizable output power, current, voltage and frequency range for 1, 2 and 4 quadrants operation. It provides versatility for microgid, electric vehicle, power quality and renewable energy application through the P-HIL optional module. Also, this Supplier + Typhoon HIL integration is available as an upgrade for existing Supplier’s source, allowing several new testing possibilities.

Figure 2 presents an example of Supplier’s power source + Typhoon HIL integration for microgrid testing. The power hardware consists of a Supplier’s 4 quadrant power source (FCAMQ 1100-33-15-PFC55251) that can operate as a power amplifier and reproduce the waveform generated in the Typhoon HIL Control Center in real-time. In addition, the source returns the real-time output voltage and current signals from internal sensors. The signals can be sampled by Typhoon HIL interface, processed on HIL SCADA and used to generate new output voltage references. Thus, it can control the amplitude, frequency and harmonics on the uGrid or the device under test (DUT).

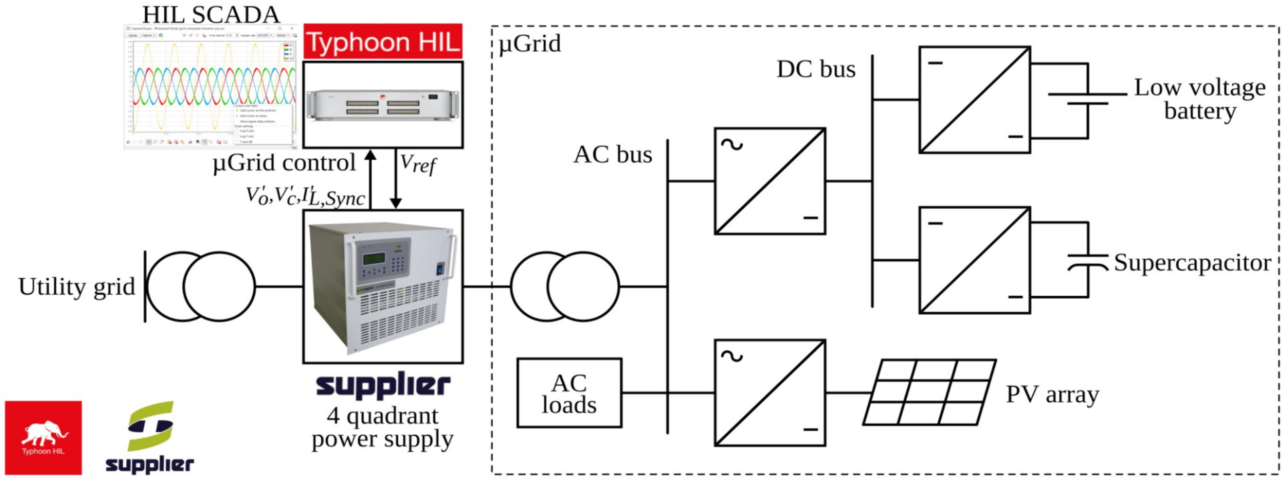

Figure 2 - Example of Typhoon HIL and SUPPLIER integration for microgrids applications.

Setup | Detailed setup and operation

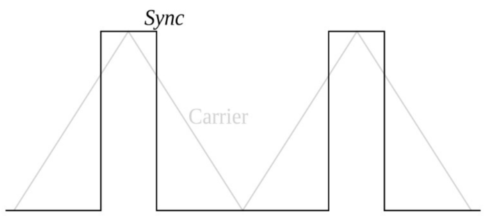

Figure 3 - Syncronization signal.

The power source provides the output voltage measurement (V_O') and the output filter voltage (V_C') and current (I_L') measuriments, all in real time. The sensors signals are isolated, filtered and conditioned to match with the Typhoon HIL analog inputs. In addition, a synchronism signal (*Sync*) from the internal modulator's carrier (on the power source switching frequency) is available for sampling synchronization, as show Figure 3. The reference signal (*Vref*) is connected directly from the HIL Interface Board to the SUPPLIER power source analog input to control V_O instantly as a power amplifier. Figure 4 shows the internal connection diagram. All SUPPLIER's power sources can be customized, so that, other voltages and currents measeuments can be made available and conditioned for others Typhoon HIL devices.

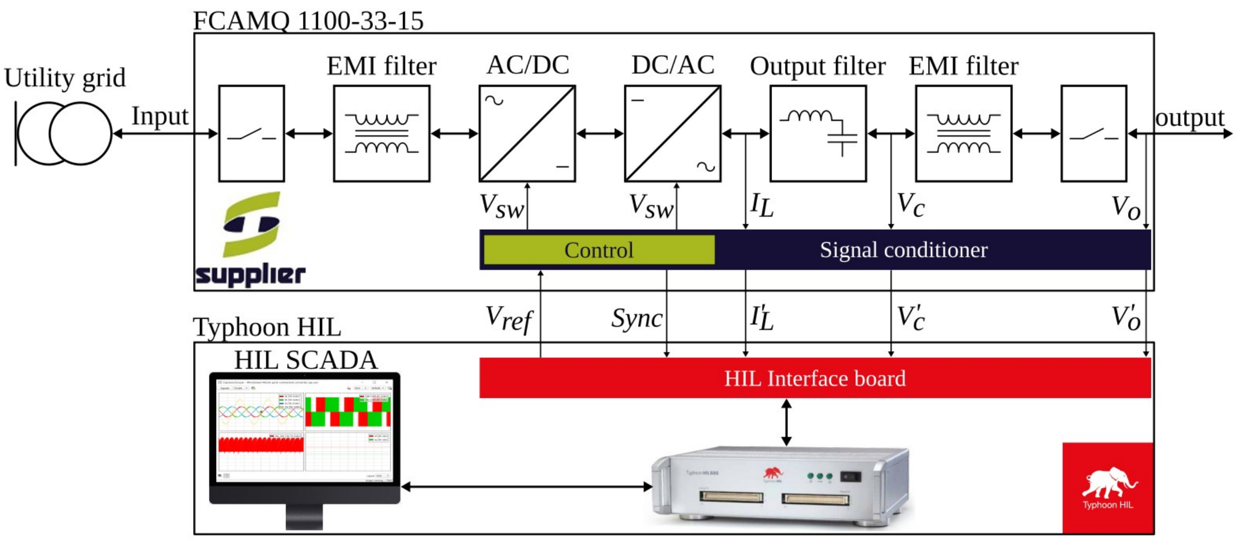

Figure 4 - Detailed integration between the SUPPLIER's source and the Typhoon HIL 600.

To illustrate the system's operation, Figure 5 shows the source output voltage (*V_O – CH1*) controlled by the extra low voltage reference signal (*Vref - CH3*) and the respective voltage measurement (*V_O' - CH2*). Figure 6 illustrates the frequency response of *V_O/Vref*, which can also be customized according to the customer's needs.

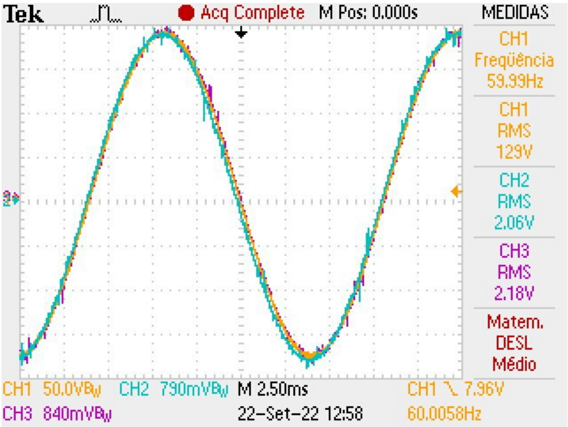

Figure 5 - Waveforms of the output voltage (V_O - CH1), reference voltage (Vref - CH2) and output voltage measurement (V_O' - CH3).

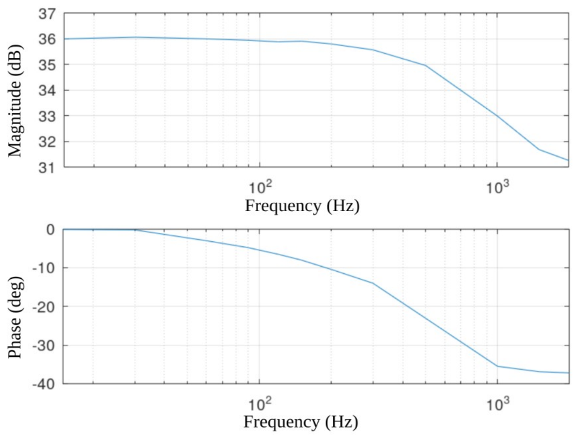

Figure 6 - Frequency response of V_O/Vref.