

# Battery Management System HIL Testing

## Speedgoat BMS HIL

### Performance real-time target machine

**CPU:** Intel Core 3.1 GHz, 4-core  
**Memory:** 64 GB  
**Real-Time OS:** Simulink® Real-Time™

### Battery Cell Emulator (BCE12-0505): 12 channels

**Voltage range:** 0.1 V to 5 V with 18-bit resolution  
**Cell-to-cell isolation:** 60 V  
**Voltage accuracy:**  $\pm 0.5$  mV  
**Current range sink:** Up to  $\pm 5$  A with 18-bit resolution  
**Current accuracy:**  $< \pm 2$  mA  
**Cell power:** 25 W max. (sink/source)  
**Cell Update rate:** Up to 1 kHz

### Temperature Sensor Emulator With Fault Insertion Unit (FIU24-1/TSE12-1000-1): 24/12 channels (FIU/TSE)

**Resistor range:** 10  $\Omega$  to 4 M $\Omega$   
**Resolution:** 1  $\Omega$   
**Accuracy:**  $\pm 0.1\% \pm 0.5$   $\Omega$   
**Power:** Max. 100 mW per channel  
**Current:** Max. 10 mA  
**Voltage:** Max. 20 V  
**Settling time:** Max. 10 ms  
**Integrated fault insertion:** Emulation of open circuits and short circuits (50 m $\Omega$ ), reverse polarity, broken wire.

### CAN I/O module (IO603-4-T-Performance)

**CAN:** Intelligent CAN I/O module with four independent galvanic isolated ports. Each port is software configurable to either support CAN FD or CAN HS.  
**Bit rates:** CAN FD: from 10 kbit/s up to 8 Mbit/s  
 CAN HS: from 10 kbit/s up to 1 Mbit/s  
**LIN:** 2 x LIN Master/Slave channels and 4 digital input and output lines.

## BMS Development Platform: foxBMS 2

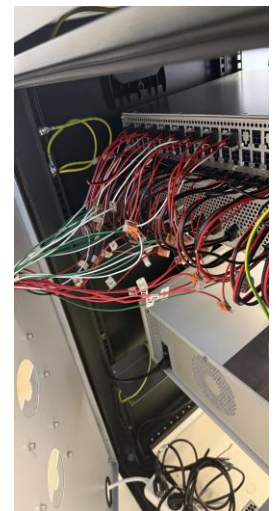
- Second generation open-source BMS development platform
- foxBMS BMS-Master and BMS-Slave

## Key Benefits

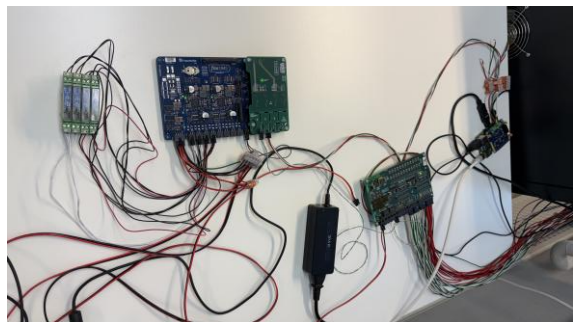
- Automate HIL testing of BMS with cell-level emulation of electric and thermal behavior to any application.
- Expand cell emulation to include the ability to introduce failures (short circuits, disconnected wires, and reversed polarity).
- Emulate batteries' thermal behavior, to extend control design to cope better with long-term effects such as aging.
- Validate algorithms for cell balancing (active/passive), as well as state of charge and health estimation.
- foxBMS2 development platform for battery management system algorithm development and system integration.
- Simulate battery chemistries with cell voltages ranging from 0.01V to 5V and currents from -5 up to 5A.



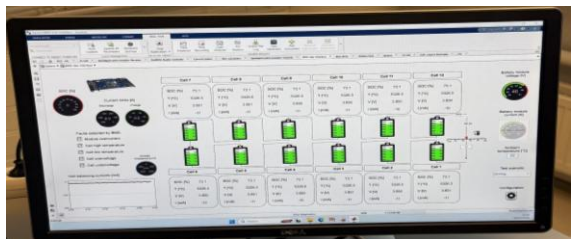
BMS HIL lab



Speedgoat P3 Machine with BCE and FIU/TSE emulator (front end and back end)



foxBMS2 BMS Master and BMS Slave



BMS Graphical User Interface (GUI)