

Automating the Sandia Advanced Interoperability Test Protocols

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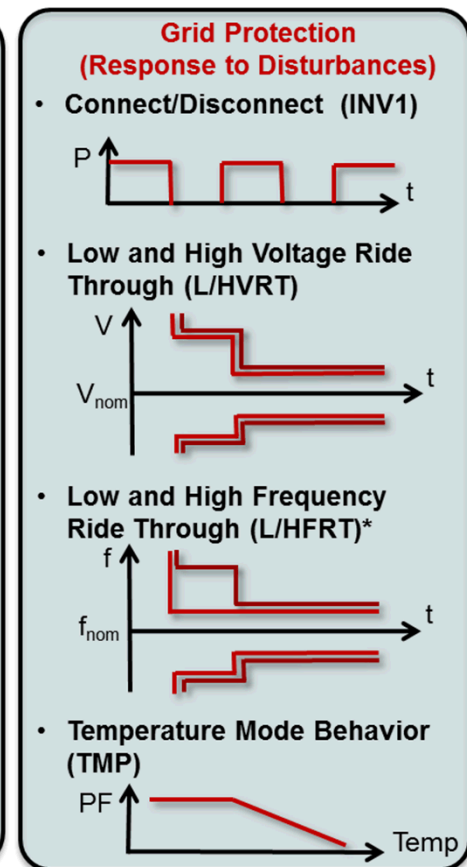
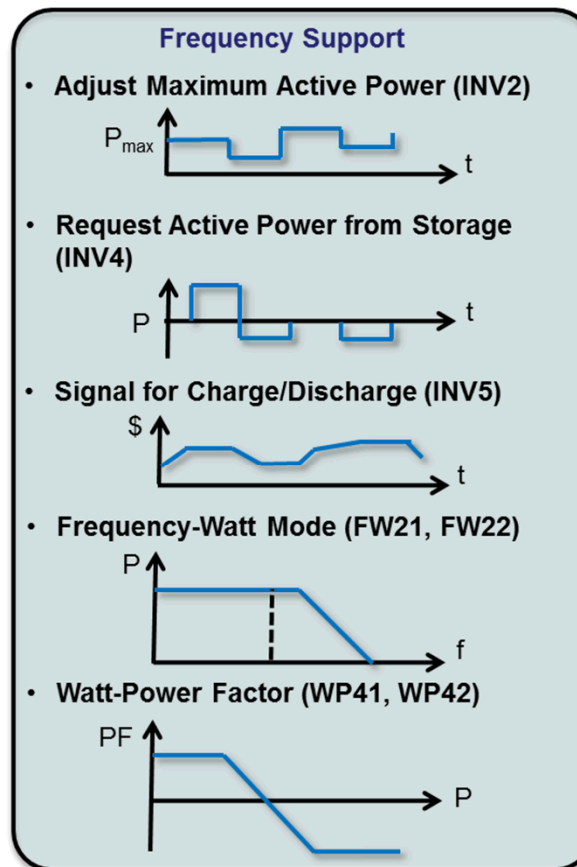
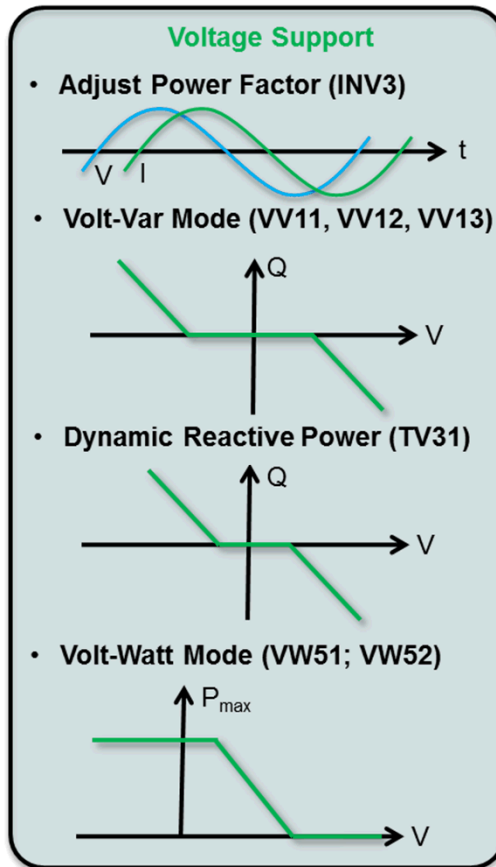
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- California Public Utilities Commission (CPUC) is considering updating Electric Rule 21 to require advanced functions on all newly interconnected PV inverters for Investor Owned Utilities (IOUs).
- Must certify these devices before deploying them.
 - UL 1741 is being updated to add advanced inverter function tests
 - Requires many parameter sets for each of the functions
 - Takes a long time
 - Operator must 'baby sit' the testing system to run hardware
- Sandia is creating a method of automating the test procedure.
 - Designed for testing laboratories, inverter manufacturers, and NRTLs

Advanced Inverter Functions

- Many different functions to verify.
- Many mandatory and optional parameters for each of the functions.

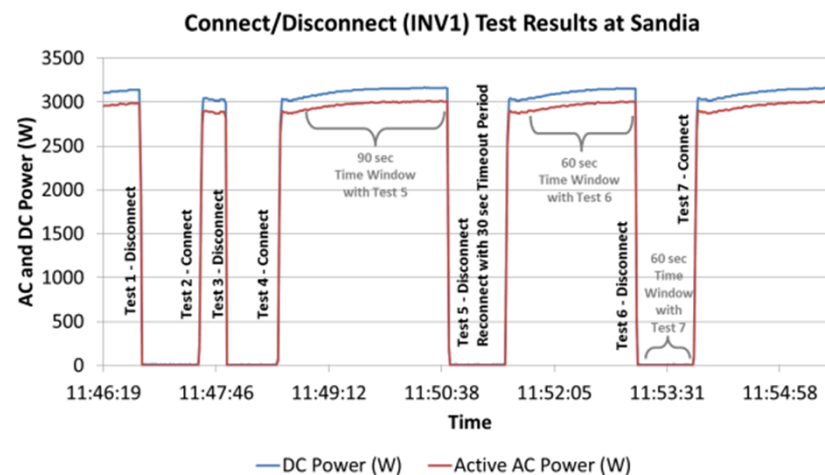


*FRT not included in IEC 61850-90-7, but is included in Sandia Test Protocols.

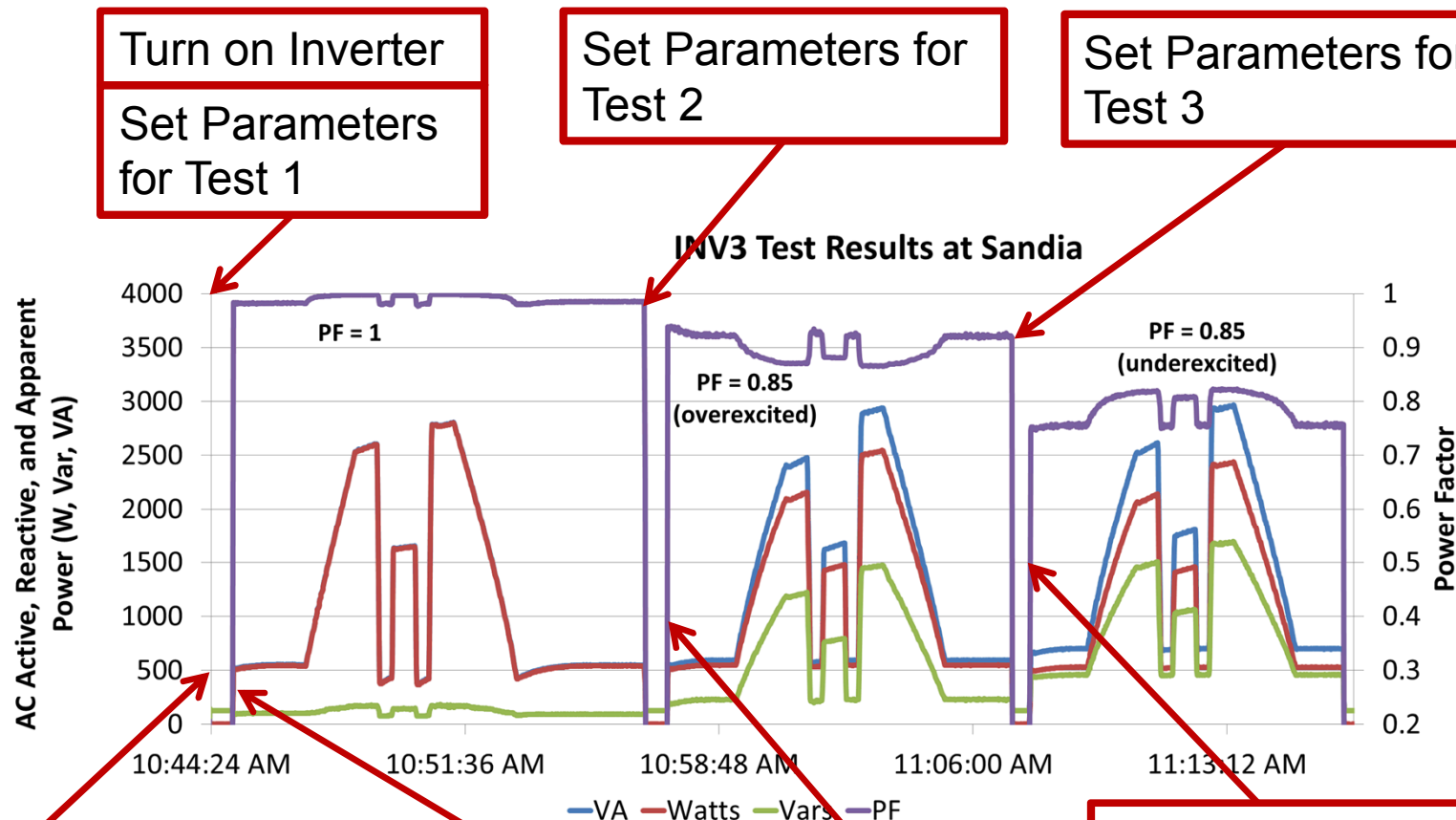
Example Test Matrix

- The Sandia Test Protocols test matrix for the connect/disconnect command.
- 7 tests with different operating points and parameters.

Test	EUT Initial Operating State	Command	Time Window (sec)	Timeout Period (sec)
1	>50% rated power, unity power factor	Disconnect 1	Default (e.g., 0)	Default (e.g., 0)
2	Inverter off	Connect 1	Default (e.g., 0)	Default (e.g., 0)
3	>50% rated power, unity power factor	Disconnect 2	0	Default (e.g., 0)
4	Inverter off	Connect 2	0	Default (e.g., 0)
5	>50% rated power, unity power factor	Disconnect 3	90	30
6	>50% rated power, unity power factor	Disconnect 4	60	0 (No Timeout)
7	Inverter off	Connect 4	60	0 (No Timeout)



Operator Actions for Fixed PF Testing



Turn on Inverter
Set Parameters for Test 1

Set Parameters for Test 2

Set Parameters for Test 3

Turn on and configure the grid simulator

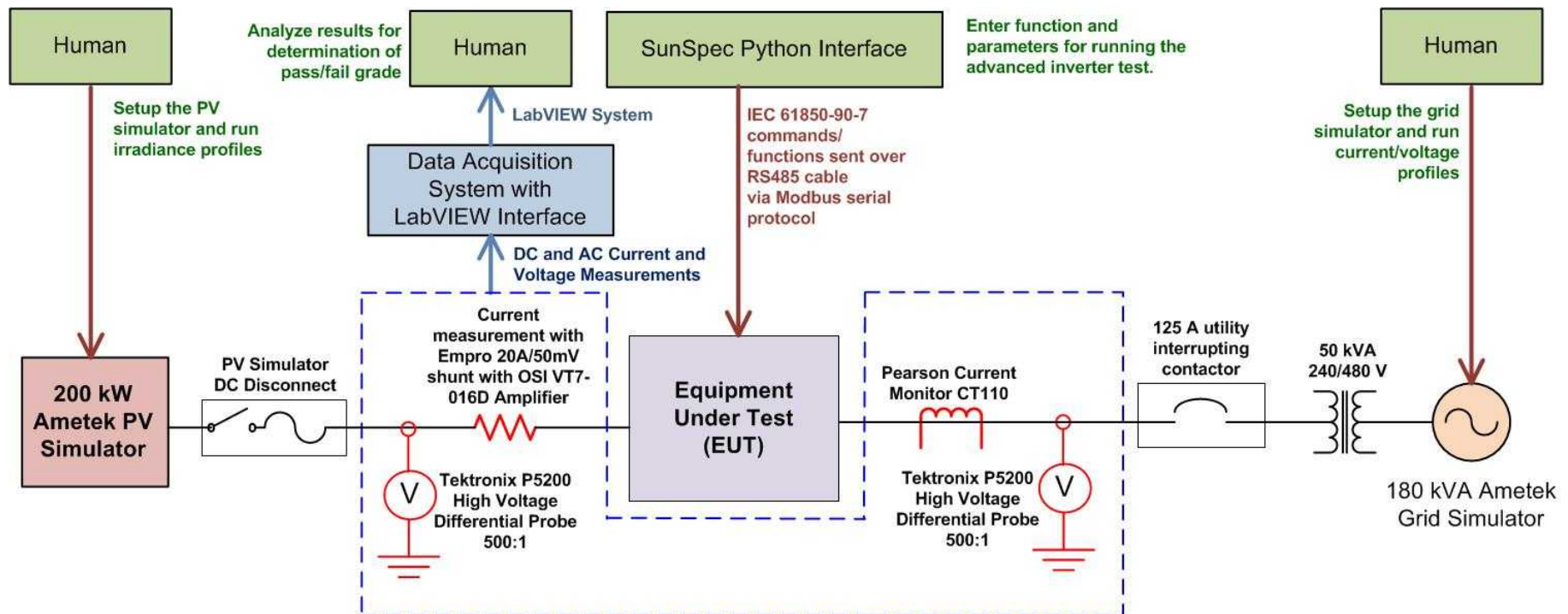
Turn on PV Simulator
Start Irradiance Profile

Run Irradiance Profile

Run Irradiance Profile

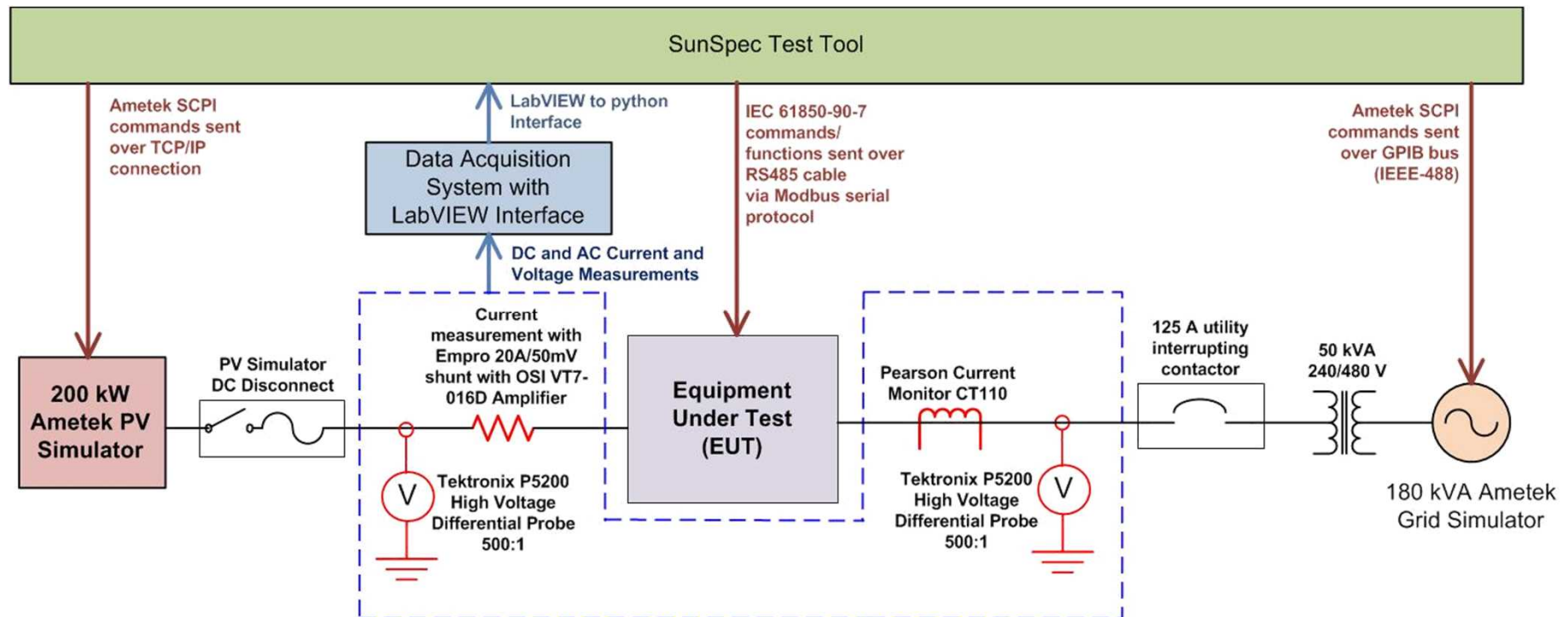
Current Operation

- Requires **human interaction** with each device.

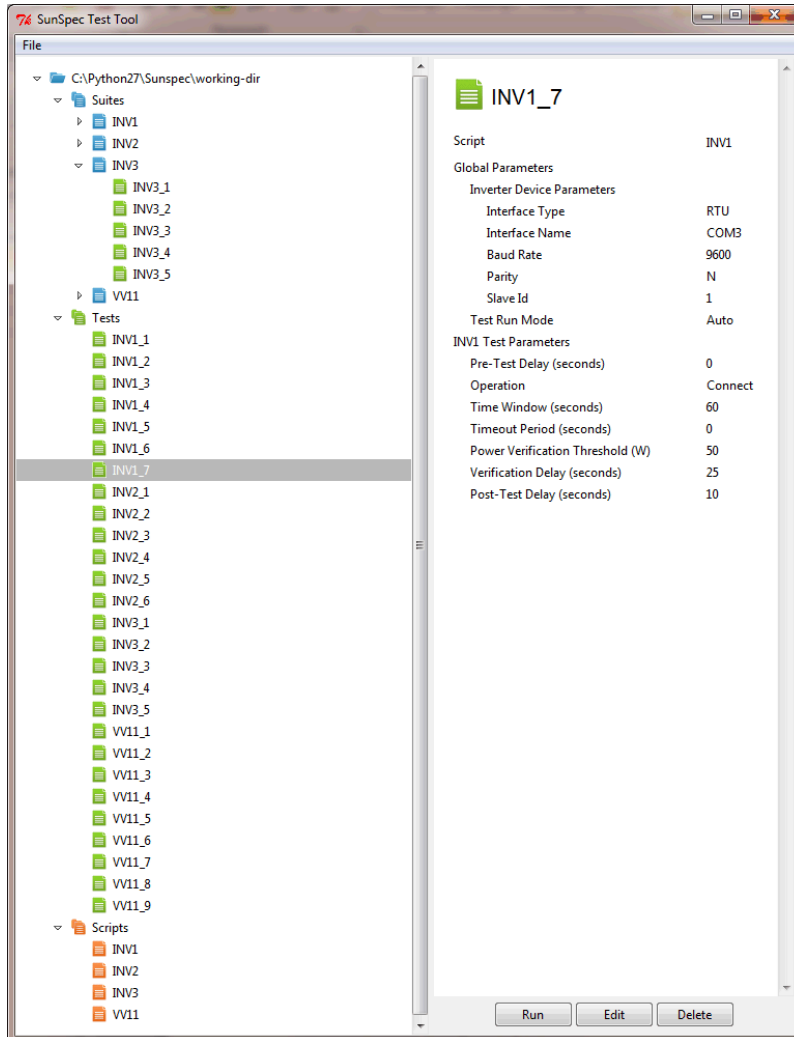


Sandia/SunSpec Test Tool

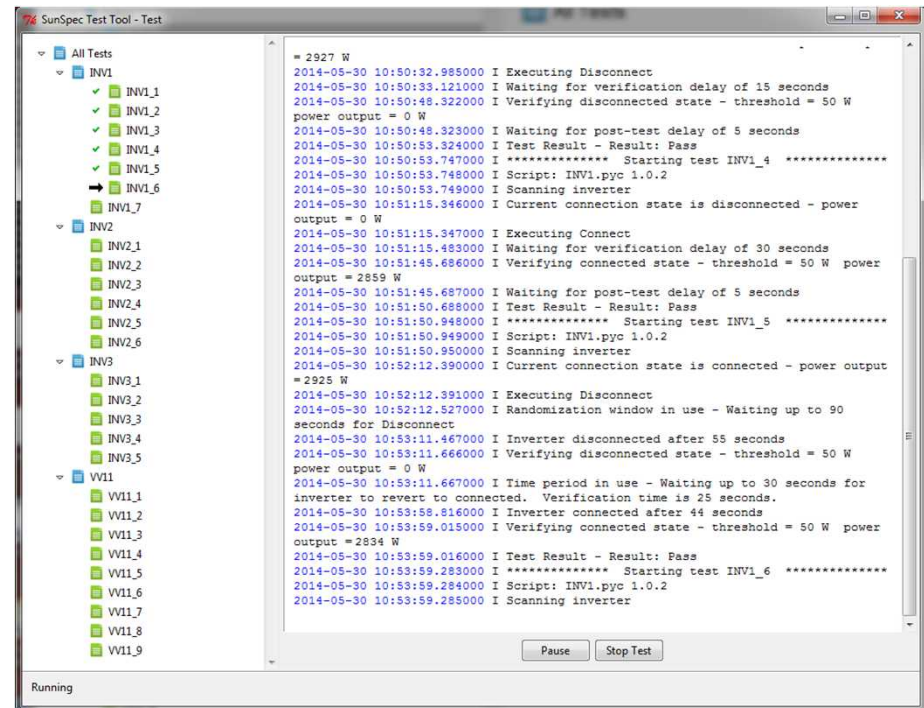
- Provides a means to automate the testing process.



SunSpec Test Tool Graphical User Interface



- Configures the advanced functions into *python scripts*.
- *Tests* are parameter sets associated with scripts.
- *Suites* are collections of multiple tests.



Conclusions

- Grid codes in the US and Europe are requiring new functionality from distributed energy resources.
 - These devices must be certified for proper behavior.
- To assess the devices, a number of parameters for each function must be tested.
 - Long and onerous on the operator.
- Automating the test procedure will assist manufacturers and NRTLs quickly assess the functionality of devices.
 - SunSpec and Sandia are creating a computer system to autonomously test multiple functions with limited human interaction.

Questions?