Inverter Testing Protocol

1. Overview 🔗

Objective 🔗

Ensure that the characterisation of inverters follows a standardized process and all technical and operational requirements are specified and answered regardless of the inverter brand

Scope 🔗

This protocol covers inverter configurations, Modbus interface monitoring and control compliance testing, functional behaviour verification, specific cases and failure scenario handling.

Test Info 🔗

Testing Entity	Name of organization carrying out the test
Agent of Testing Entity	Agent of the organization carrying out the test
Test Date	
Test Location	City and actual site of test
Load Simulator	Manufacturer, model, version used testing
Load Simulator FW Version	Load Simulator Firmware version
PV Simulator	Manufacturer, model, version used testing
PV Simulator FW Version	PV Simulator Firmware version

2. Device Information 🔗

2.1 Inverter Device Info 🔗

Parameter	Value
Manufacturer	
Model	
Version	
Power Rating	
Firmware Build Version	
Hardware Version	
List of Supported Network interfaces	
List of other Supported physical interfaces	
List of Supported Network Settings	

2.2 Battery Device Info 🔗

Parameter	Value
Manufacturer	
Model	
Version	
Capacity	
Charge Power	
Discharge Power	
End of charge SOC	
End of Discharge SOC	
Efficiency	
Firmware Build Version	
Hardware Version	
List of other Supported physical interfaces	

3. Testing Configuration 🔗

Parameter	Value
Max Grid Power Configured	i.e. Single-Phase at 6.9 kVA
Max PV Power	i.e. String 1 at 3 kW, String 2 at 3 kW
Network Communication Interface Used	i.e. Wifi
Modbus Interface/Method Used	i.e. Ethernet / Modbus TCP

4. Test Cases 🔗

4.1 Inverter App Testing 🔗

Test	Procedure/Expectation
Settings & Updates	☐ There is an Installer app and can configure internet details on it. Comment: "i.e. built-in WiFi", "using specific Dongle Ref. XYZ" ☐ Can update firmware via an Installer app. ☐ Can update grid code via installer app. ☐ Can update meter parameters via an Installer app. Values: {key, value pair} ☐ Can update battery parameters via an Installer app. Values: {key, value pair}

	☐ Can update installation site installation details via an Installer app. Values: {key, value pair}
	☐ Can update grid injection parameters via an Installer app. Comment: "i.e. zero export, kW injection limitation"
	☐ Can update voltage regulation parameters via an Installer app. Comment: "i.e. P-U Curve points, P-Q Curve points setup"
	☐ There is a User app and can configure internet details on it.
	☐ Can update firmware via a user app, if any.
App Error Reporting	☐ Can't detect grid connection. "Text and Value: "
	☐ Meter is disconnected from the inverter. "Text and Value: "
	☐ PV is disconnected from the inverter. "Text and Value: "
	☐ Battery is disconnected from the inverter. "Text and Value: "
	☐ Inverter goes offline. "Text and Value: "
	☐ Inverter detects overvoltage. "Text and Value: "
	☐ Inverter detects under voltage. "Text and Value: "

4.2 Inverter Modbus 🔗

Test	Expectation
Register Map	☐ The inverter has a publicly available register map.
	☐ Generated Inverter Reg. Map according to template. "Y/N"
	📄 Hybrid_Inverter_Registers.xltx
Telemetry Data	☐ The inverter has a Modbus RTU Interface and allows telemetry data readings. Comment: "i.e. using RS485 port A", "using specific dongle Ref. XYZ"
	☐ The inverter has a Modbus TCP Interface and allows telemetry data readings. Comment: "i.e. using ethernet port 1", "using specific dongle Ref. XYZ"
	☐ The inverter supports Sunspec Modbus Protocol. Supported Sunspec Models:
	☐ Minimum time resolution at which the inverter allows reading the Active Power at the grid point. "Value and unit: "
	☐ While obtaining telemetry data over Modbus, is still possible to change configurations on the inverter using the OEM energy management platform; Comment:
	☐ While obtaining telemetry data over Modbus, is still possible to perform firmware updates using the OEM energy management platform; Comment:
	☐ While obtaining telemetry data over Modbus, is still possible to reboot the inverter using the OEM energy management platform; Comment:
	☐ While obtaining telemetry data over Modbus, is still possible to issue forced charge/discharge commands using the OEM energy management platform; Comment:
Battery Control	☐ The inverter allows charge/discharge power for a period commands using the Modbus interface;

- [ ] A forced discharge for a given period is achieved by writing in the following registers: "1. Name / Address, 2. Name Address, etc"
- [ ] A forced charge is achieved by writing in the following registers: "1. Name / Address, 2. Name / Address, 3. etc"
- [ ] A forced idle is achieved by writing in the following registers. "1. Name / Address, 2. Name / Address, 3. etc"
- [ ] The minimum resolution for the power value applicable to the forced charge/discharge is: "Value and unit: "
- [ ] The minimum resolution for the period value applicable for the forced charge/discharge is: "Value and unit: "
- [ ] While charging/discharging the inverter does not surpass the available grid capacity, by reducing the initial power value.
    - [ ] When the load is reduced the inverter resumes to the set power value
- [ ] When a power value is set above the maximum allowable,
    - [ ] the inverter follows the maximum allowed value;
    - [ ] the inverter throws an error; "Value:"
    - [ ] the inverter ignores the command.
- [ ] When a power value is set as empty,
    - [ ] the inverter follows the maximum allowed value;
    - [ ] the inverter throws an error; "Value:"
    - [ ] the inverter ignores the command.
- [ ] After the period resumes, the inverter applies Self-Consumption
- [ ] After the period resumes, the inverter goes to idle
- [ ] The inverter supports forced charge/discharge commands for a given period when a power value is not specified, assuming a default value.
    - [ ] The default value is set by using the sequence of registers: "1. Name / Address, 2. Name / Address, 3. etc"
- [ ] The inverter allows charge/discharge until a target SoC command using the modbus interface;
    - [ ] The charge until a target soc command achieved by writing in the following sequence of registers: "1. Name / Address, 2. Name / Address, 3. etc"
    - [ ] The discharge until a target soc command achieved by writing in the following registers: "1. Name / Address, 2. Name / Address, 3. etc"
    - [ ] The minimum value for the target soc value is: "Value:"
    - [ ] The maximum value for the target soc value is: "Value:"
    - [ ] The minimum resolution value for the target soc value is: "Value"
    - [ ] While charging/discharging to the target the inverter follows the available grid capacity
    - [ ] While charging/discharging to the target the inverter charges/discharges using a static power value of: "Value and unit"
    - [ ] After reaching the target soc the inverter applies Self-Consumption
    - [ ] After reaching the target soc the inverter goes to idle
    - [ ] When a soc is set outside the allowable interval,
        - [ ] the inverter goes to the nearest max/min value;
        - [ ] the inverter throws an error; "Value:"
        - [ ] the inverter ignores the command.

	☐ When a soc value is set as empty,
	
	    ☐ the inverter goes to a default value;
	
	        ☐ The default value is set by using the sequence of registers: "1. Name / Address, 2. Name / Address, 3. etc"
	
	    ☐ the inverter throws an error; "Value:"
	
	    ☐ the inverter ignores the command.
	
	☐ While sending charge/discharge commands over Modbus, is still possible to change configurations on the inverter using the OEM energy management platform; Comment:
	
	☐ While sending charge/discharge commands over Modbus, is still possible to perform firmware updates using the OEM energy management platform; Comment:
	
	☐ While sending charge/discharge commands over Modbus, is still possible to reboot the inverter using the OEM energy management platform; Comment:
	
	☐ While sending charge/discharge commands over Modbus, is still possible to issue forced charge/discharge commands using the OEM energy management platform; Comment:

Inverter Behavior	☐ Inverter enters sleep/idle mode when no DC source is available. "Time until sleep/idle ": ☐ Inverter wakes up when PV source is available. "Time until ready:" , "Minimum Voltage/Power ": ☐ Inverter wakes up when charge command is applied. "Time until ready: "
Errors	☐ Can't detect grid connection. Modbus Alarm: "Name / Address" ☐ Meter is disconnected from the inverter. Modbus Alarm: "Name / Address" ☐ PV is disconnected from the inverter. Modbus Alarm: "Name / Address" ☐ Battery is disconnected from the inverter. Modbus Alarm: "Name / Address" ☐ Inverter goes offline. Modbus Alarm: "Name / Address" ☐ Inverter detects overvoltage. Modbus Alarm: "Name / Address" ☐ Inverter detects under voltage. Modbus Alarm: "Name / Address"

4.3 Inverter/Battery Measured Characterization 🔗

Test	Measurements
Performance	☐ Battery Capacity. "Value: " ☐ Max Charge Power. "Value: " ☐ Max Discharge Power. "Value: " ☐ Depth of Discharge. "Value: " ☐ PV to AC Efficiency. "Table with power vs efficiency" ☐ PV to Battery Efficiency. "Table with power vs efficiency" ☐ Battery to AC Efficiency. "Table with power vs efficiency" ☐ AC to Battery Efficiency. "Table with power vs efficiency" ☐ Battery DC Voltage range vs SOC. "Table with voltage vs SOC" ☐ Battery DC Voltage range vs Output Power. "Table with voltage vs Power"

	☐ Battery DC Voltage range vs Input Power. "Table with voltage vs Power"
	☐ Inverter standby power consumption. "Value: "
	☐ Battery Self-discharge Rate. "Value: "
	☐ Battery temperature vs Output power: "Table with temperature vs power "
	☐ Battery temperature vs Input power: "Table with temperature vs power "
Readings Errors	☐ The reported values of PV power by the inverter have an error. "Error value: "
	☐ The reported values of PV Energy by the inverter have an error. "Error value: "
	☐ The reported values of Battery power by the inverter have an error. "Error value: "
	☐ The reported values of Battery Energy by the inverter have an error. "Error value: "
	☐ The reported values of AC power by inverter have an error. "Error value: "
	☐ The reported values of AC Energy by inverter have an error. "Error value: "

5. Log & Debugging Information 🔗

- **Logging Method:** [Detail how logs are captured]

6. Conclusion 🔗

- **Issues Identified:** [List major concerns]
  - Specific Inverter Behaviour Not Covered
  - General Challenge Encountered During the Test (logistics, equipment)
  - Suggestions to Improve Testing Process and Documentation