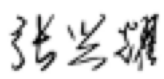
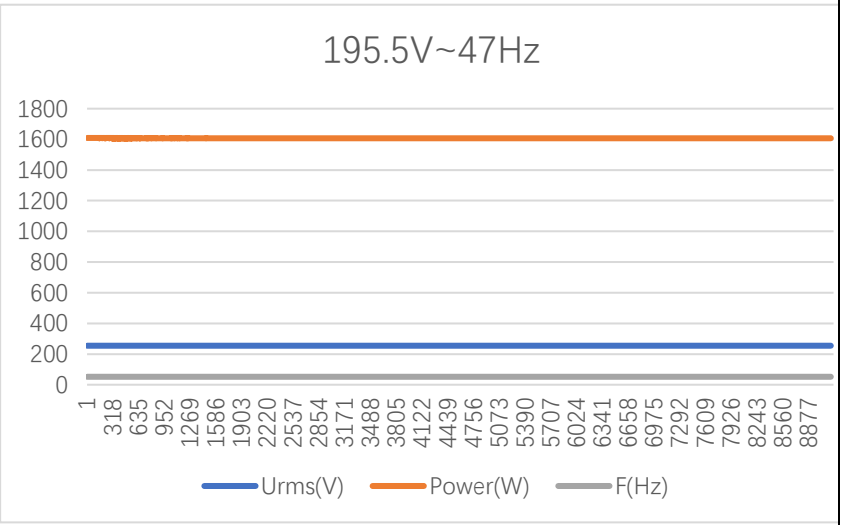
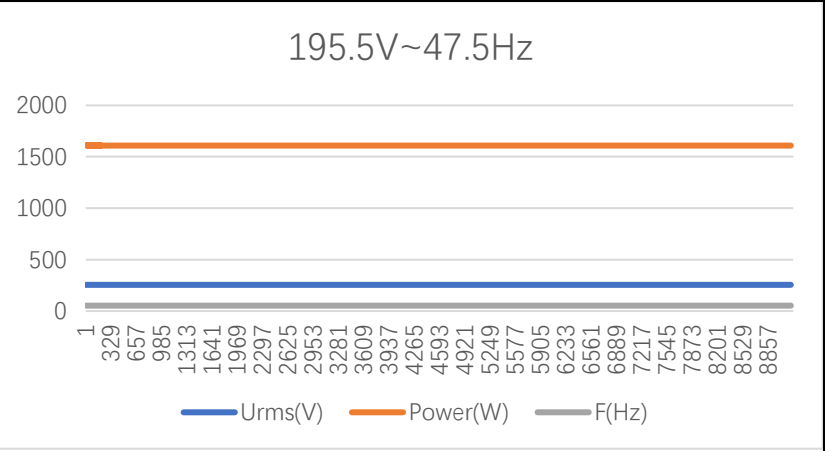
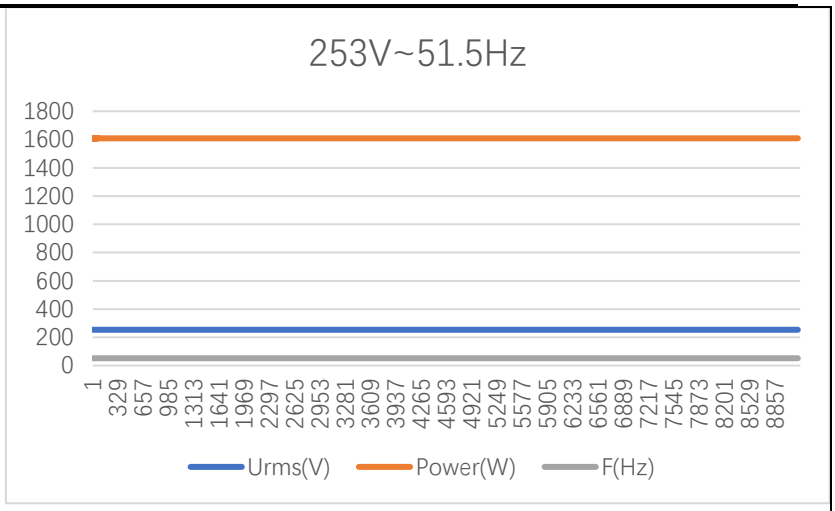
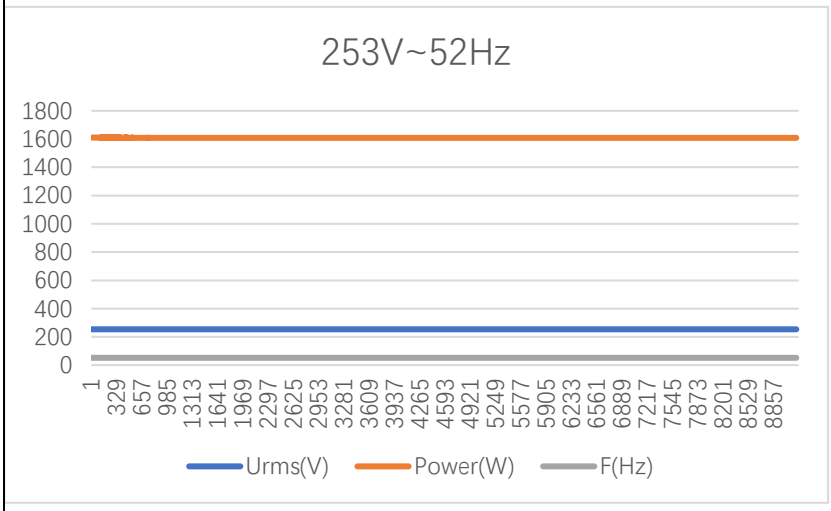
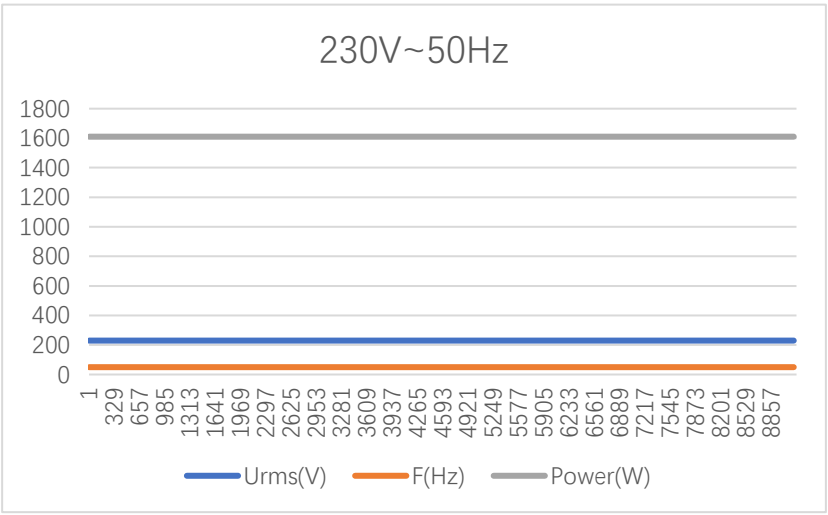
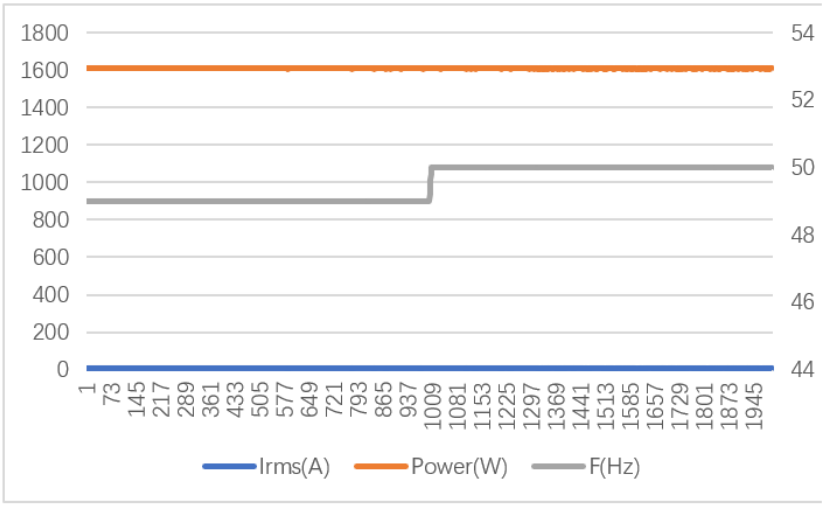
ENA EREC G98/1-4:2019

<table>
<tr><td colspan="5">Type Approval and Manufacturer declaration of compliance with the requirements of G98.
This form should be used when making a Type Test submission to the Energy Networks Association (ENA).
If the Micro-generator is Fully Type Tested and already registered with the ENA Type Test Verification Report Register, the Installation Document should include the Manufacturer’s Reference Number (the Product ID), and this form does not need to be submitted.
Where the Micro-generator is not registered with the ENA Type Test Verification Report Register this form needs to be completed and provided to the DNO, to confirm that the Microgenerator has been tested to satisfy the requirements of this EREC G98.</td></tr>
<tr><td colspan="2">SSEG Type reference number</td><td colspan="3">HMS-1600-4T</td></tr>
<tr><td colspan="2">SSEG Type</td><td colspan="3">Photovoltaic Microinverter</td></tr>
<tr><td colspan="2">System Supplier name</td><td colspan="3">Hoymiles Power Electronics Inc.</td></tr>
<tr><td colspan="2">Address</td><td colspan="3">No.18 Kangjing road, Hangzhou, Zhejiang Province, P.R. China</td></tr>
<tr><td>Tel</td><td colspan="2">+86 571 28056101</td><td>Fax</td><td>+86 571 28056137</td></tr>
<tr><td>E:mail</td><td colspan="2">zhangxingyao@hzconverter.com</td><td>Web site</td><td>www.hoymiles.com</td></tr>
<tr><td rowspan="5">Maximum rated capacity, use separate sheet if more than one connection option.</td><td colspan="4">Connection Option</td></tr>
<tr><td>1.6</td><td colspan="3">kW single phase, single, split or three phase system</td></tr>
<tr><td>NA</td><td colspan="3">kW three phase</td></tr>
<tr><td>NA</td><td colspan="3">kW two phases in three phase system</td></tr>
<tr><td>NA</td><td colspan="3">kW two phases split phase system</td></tr>
<tr><td colspan="5">SSEG manufacturer/supplier declaration</td></tr>
<tr><td colspan="5">Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above Type Tested reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.</td></tr>
<tr><td>Signed</td><td>  </td><td>On behalf of</td><td colspan="2">Hoymiles Power Electronics Inc.</td></tr>
</table>

Note that testing can be done by the Manufacturer of an individual component or by an external test house.
Where parts of the testing are carried out by persons or organizations other than the Manufacturer then that person or organization shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

Operating Range	
	Test 1: 195.5V~47.0Hz, PF=1
HMS-1600-4T	
	Test 2: 195.5V~47.5Hz, PF=1
HMS-1600-4T	
	Test 3: 253V~51.5Hz, PF=1

HMS-1600-4T	
	Test 4: 253V~52Hz, PF=1
HMS-1600-4T	
	Test 5: 230V~50.0Hz, PF=1
HMS-1600-4T	
	Test 6: RoCoF withstand

HMS-1600-4T	

Power Quality-Harmonics: These tests should be carried out as specified in BS EN 61000-3-2.						
SSEG rating per phase (rpp)			1.6	kW	NV=MV*3.68/rpp	
Harmonic	At 45-55% of rated output		100% of rated output			
	Measured Value(MV) in Amps	Normalised Value (NV) In Amps	Measured Value(MV) In Amps	Normalised Value (NV) In Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0194	0.0446	0.04	0.092	1.080	
3	0.0115	0.0265	0.0353	0.0812	2.300	
4	0.0084	0.0193	0.0129	0.0297	0.430	
5	0.0145	0.0334	0.0465	0.107	1.140	
6	0.0054	0.0124	0.0098	0.0225	0.300	
7	0.0206	0.0474	0.0396	0.0911	0.770	
8	0.0049	0.0113	0.0066	0.0152	0.230	
9	0.0152	0.035	0.0398	0.0915	0.400	
10	0.0035	0.0081	0.0054	0.0124	0.184	
11	0.0079	0.0182	0.0435	0.1001	0.450	
12	0.0025	0.0058	0.0045	0.0104	0.153	

13	0.0076	0.0175	0.0342	0.0787	0.210	
14	0.0022	0.0051	0.0095	0.0219	0.131	
15	0.0057	0.0131	0.0258	0.0593	0.150	
16	0.0018	0.0041	0.0078	0.0179	0.115	
17	0.0086	0.0198	0.0187	0.043	0.132	
18	0.0025	0.0058	0.0095	0.0219	0.102	
19	0.0053	0.0122	0.0145	0.0334	0.118	
20	0.0025	0.0058	0.0047	0.0108	0.092	
21	0.0066	0.0152	0.013	0.0299	0.107	
22	0.0015	0.0035	0.0076	0.0175	0.084	
23	0.0087	0.02	0.0152	0.035	0.098	0.147
24	0.0024	0.0055	0.0077	0.0177	0.077	
25	0.0066	0.0152	0.0186	0.0428	0.090	0.135
26	0.0028	0.0064	0.009	0.0207	0.071	
27	0.0044	0.0101	0.018	0.0414	0.083	0.124
28	0.0004	0.0009	0.0072	0.0166	0.066	
29	0.0041	0.0094	0.0142	0.0327	0.078	0.117
30	0.0023	0.0053	0.0108	0.0248	0.061	
31	0.0029	0.0067	0.0126	0.029	0.073	0.109
32	0.0022	0.0051	0.0111	0.0255	0.058	
33	0.0071	0.0163	0.0136	0.0313	0.068	0.102
34	0.0006	0.0014	0.0071	0.0163	0.054	
35	0.0082	0.0189	0.012	0.0276	0.064	0.096
36	0.001	0.0023	0.0076	0.0175	0.051	
37	0.0051	0.0117	0.0083	0.0191	0.061	0.091
38	0.0018	0.0041	0.0099	0.0228	0.048	
39	0.0069	0.0159	0.0085	0.0196	0.058	0.087

40	0.0005	0.0012	0.0098	0.0225	0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

Power Quality-Voltage fluctuations and Flicker

	Starting			Stopping			Running	
	dmax [%]	dc [%]	d(t) [%]	dmax [%]	dc [%]	d(t) [%]	Pst	Plt 2 hours
Measured Values	0.1	0	0	0.1	0	0	0.064	0.064
Normalised to standard impedance and 3.68kW for multiple units	0.3	0	0	0.3	0	0	0.2	0.2
Limits set under BS EN 61000-3-2	4%	3.30%	3.3% 500ms	4%	3.30%	3.3% 500ms	1	0.65

Test start date	2022-01-31	Test end date	2022-01-31
Test location	SHANGHAI TESTING & INSPECTION INSTITUTE FOR ELECTRICAL EQUIPMENT CO., LTD.		

Power quality-DC injection: This test should be carried out in accordance with EN 50438 Annex D.3.10

Test power level	20%	50%	75%	100%	
Recorded value(mA)	3.62	3.74	4.33	2.34	
as % of rated AC	0.0520%	0.0538%	0.0622%	0.0336%	
Limit	0.25%	0.25%	0.25%	0.25%	

Power Quality-Power factor: This test shall be carried out in accordance with EN 50538 Annex D.3.4.1 but with nominal voltage -6% and +10%. Voltage to be maintained within ±1.5% of the stated level during the test.

	216.2V	230V	253V
20% of Registered	0.9935	0.9920	0.9912
50% of Registered	0.9951	0.9958	0.9949
75% of Registered	0.9972	0.9967	0.9956
100% of Registered	0.9983	0.9981	0.9972
Limit	>0.95	>0.95	>0.95

Protection-Frequency tests: These tests should be carried out in accordance with EN 50438 Annex D.2.4 and the notes in EREC G98 Annex A1 A 1.3.2 (Inverter connected) or Annex A2 A.2.2.2 (Synchronous)

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip
U/F stage 1	47.5Hz	20s	47.5Hz	20.1s	47.7Hz/ 30s	Confirmed
U/F stage 2	47Hz	0.5s	47Hz	0.54s	47.2Hz/ 19.5s	Confirmed
					46.8Hz/ 0.45s	Confirmed
O/F stage 2	52Hz	0.5s	52Hz	0.54s	51.8Hz/ 120s	Confirmed
					52.2Hz/ 0.45s	Confirmed

Protection-Voltage tests: These tests should be carried out in accordance with EN 50438 Annex D.2.3 and the notes in EREC G98 Annex A1 A 1.3.1 (Inverter connected) or Annex A2 A.2.2.1 (Synchronous)

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184V	2.5s	183.5V	2.53s	188V/5.0s	Confirmed
					180V/2.45s	Confirmed
O/V stage 1	262.2V	1.0s	263.1V	1.04s	258.2V/5.0s	Confirmed
O/V stage 2	273.7V	0.5s	274.4V	0.52s	269.7V/0.95s	Confirmed

	277.7V/0.45s	Confirmed
Note for Voltage tests the Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.		

Protection-Loss of Mains test: For PV Inverters shall be tested in accordance with BS EN62116. Other Inverters should be tested in accordance with EN 50438 Annex D.2.5 at 10%,55% and 100% of rated power.

Note: Inverter tested according to BS EN 62116.

Test Power and imbalance	33% -5% Q	66% -5% Q	100% -5% P	33% +5% Q	66% +5% Q	100% +5% P
Trip time. Limit is 0.5s	96.4ms	221.2ms	265.2ms	95.1ms	218.7ms	270.3ms

Protection-Frequency change, Stability test: This test should be carried out in accordance with EREC G98 Annex A1 A 1.3.5 (Inverter connected) or Annex A2 A.2.2.5 (Synchronous).

	Start Frequency	Change	End Frequency	Confirm no trip
Positive Vector Shift	49Hz	+50 degrees		Confirmed
Negative Vector Shift	50Hz	- 50degrees		Confirmed

Protection-Frequency change, RoCoF Stability test: The requirement is specified in section 11.3, test procedure in Annex A 1.3.5 (Inverter connected) or Annex A2 A.2.2.5 (Synchronous).

	Ramp range	Test frequency	Test Duration	Confirm no trip
Positive Frequency drift	49Hz to 51Hz	+0.95Hz/sec	2.1s	Confirmed
Negative Frequency drift	51Hz to 49Hz	-0.95Hz/sec	2.1s	Confirmed

Protection-Limited Frequency Sensitive Mode-Overfrequency test: This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over-frequency. The test should be carried out using the specific threshold frequency of 50.4 Hz and dro op of 10%.

Test sequence at Registered Capacity >80%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00	1603.7W	50Hz		-

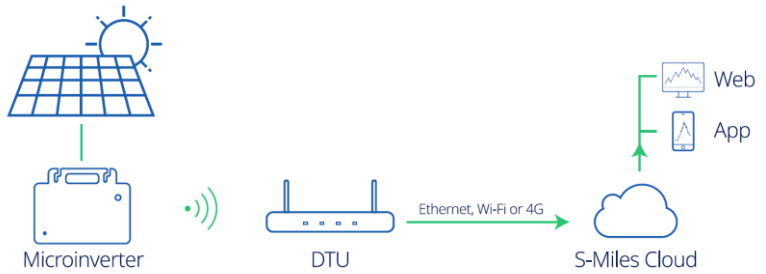
Hz ±0.01Hz				
Step b) 50.45 Hz ±0.05Hz	1585.3W	50.45Hz		-
Step c) 50.70 Hz ±0.10Hz	1506.2W	50.7Hz		-
Step d) 51.15 Hz ±0.05 Hz	1367.0W	51.15Hz		-
Step e) 50.70 Hz ±0.10Hz	1505.9W	50.7Hz		-
Step f) 50.45 Hz ±0.05Hz	1584.8W	50.45Hz		-
Step g) 50.00 Hz ±0.10Hz	1603.3W	50Hz		-
Test sequence at Registered Capacity 40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00 Hz ±0.01Hz	805.2W	50Hz		-
Step b) 50.45 Hz ±0.05Hz	797.9W	50.45Hz		-
Step c) 50.70 Hz ±0.10Hz	759.1W	50.7Hz		-
Step d) 51.15 Hz ±0.05 Hz	688.8W	51.15Hz		-
Step e) 50.70 Hz ±0.10Hz	760.1W	50.7Hz		-
Step f) 50.45 Hz ±0.05Hz	798.2W	50.45Hz		-
Step g) 50.00 Hz ±0.10Hz	804.4W	50Hz		-
Steps as defined in EN 50438				

Protection-Power output with falling frequency test: This test should be carried out in accordance with EN 50438 Annex D.3.2 active power feed -in at under-frequency.			
Test sequence	Measured Active Power Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	1603.2W	50 Hz	DC Supply
Test b) Point between 49.5 Hz and 49.6 Hz	1602.9W	49.55Hz	DC Supply
Test c) Point between 47.5 Hz and 47.6 Hz	1602.6W	47.55Hz	DC Supply
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

Protection-Re-connection timer					
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2.					
Time delay setting	Measured delay	No reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
20.0s	30.0s	At 266.2V	At 180V	At 47.4Hz	At 52.1Hz
Confirmation that the SSEG does not re-connect.		Confirmed	Confirmed	Confirmed	Confirmed

Fault level contribution. The requirement is specified in section 5.7, test procedure in Annex A or B 1.4.6					
For a directly coupled SSEG			For a Inverter SSEG		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	ip	N/A	20ms	16.19V	0.513A
Initial Value of aperiodic	A	N/A	100ms	7.63V	0.202A
Initial symmetrical	Ik	N/A	250ms	6.33V	0.129A
Decaying (aperiodic)	iDC	N/A	500ms	5.70V	0.125A
Reactance/Resistance Ratio	X/R	N/A	Time to trip	0.0042s	(in seconds)

Logic interface (input port)	
Confirm that an input port is provided and can be used to reduce the Active Power output to zero.	Yes
Provide high level description of logic interface, e.g. details in 9.4.3 such as AC or DC signal (the additional comments box below can be used). This inverter does provide a logic interface to cease active power output within 5s. The logic interface works in the way that the end user can send control command from Website or APP to the gateway (DTU) and the gateway will deliver the command to the inverter via Sub-1G signal. Following is the topology of the communication system.	Yes

Self-Monitoring solid state switching :No specified test requirements. Refer to EREC G98 Annex A1 A 1.4.6 (Inverter connected).	Yes/or NA
It has been verified that in the event of the solid state switching device failing to disconnect the Micro-generator, the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s.	N/A

Cyber security	
Confirm that the Manufacturer or Installer of the Micro-generator has provided a statement describing how the Micro-generator has been designed to comply with cyber security requirements, as detailed in 9.7. This inverter and the associated equipment (such as the gateway and the database of the Cloud) are all designed and developed complied with the cyber security requirements of IEEE1547.	Yes

Additional comments