Collaboration in Science and Technology Inc.
CONSULTANTS IN ACOUSTICS, NOISE, AND VIBRATION

SUNGROW USA CORP.
SOLAR INVERTER SKID
NOISE TEST
MODEL NO. SG3600UD
SERIAL NO. A2011215246

CSTI REPORT NO. R-1259-0
CSTI PROJECT NO. 6808

7 SEPTEMBER 2021

Prepared By:
CSTI acoustics

Prepared For:
Sungrow USA Corp.
575 Market Street
San Francisco, CA 94105

Revision History

Rev.	Date	Reason for Issue/Description of Changes	Prepared	Checked	Approved
0	7 Sep 2021	Initial Report Submittal	ASY	ASB	ASB

TABLE OF CONTENTS

TABLES

FIGURES

1. INTRODUCTION

Collaboration in Science and Technology Inc. (CSTI) was retained by Sungrow USA Corp. (Sungrow) to determine the sound levels of a Solar Inverter Skid with Model No. SG3600UD and Serial No. A2011215246 operating close to nominal power or >90% loading. The measurements and calculations were performed according to the ISO 3746:2010 standard.

Information on the test condition and test environment is presented in Section 2. The sound instrumentation is described in Section 3. The sound measurement data is presented in Section 4. Section 5 summarizes the results of the test. Appendix A presents the calibration certificates of the equipment. Appendix B presents one-third octave band sound data and sound power level calculations.

2. TEST CONDITION AND TEST ENVIRONMENT

Sound measurements were made around the field-installed Solar Inverter Skid while it was operating close to nominal power or >90% loading between 2:30 and 3:30 PM on 25 August 2021 at a location near Co. Rd. 322 in El Campo, Texas 77437. Adam Young of CSTI made the measurements.

The Solar Inverter Skid was about 20 ft (6.1 m) long by 8 ft (2.4 m) wide by 9.5 ft (2.9 m) tall. The skid was mounted on a platform that was roughly 3 ft. tall making the total height of the package roughly 12.5 ft. (3.7 m) tall.

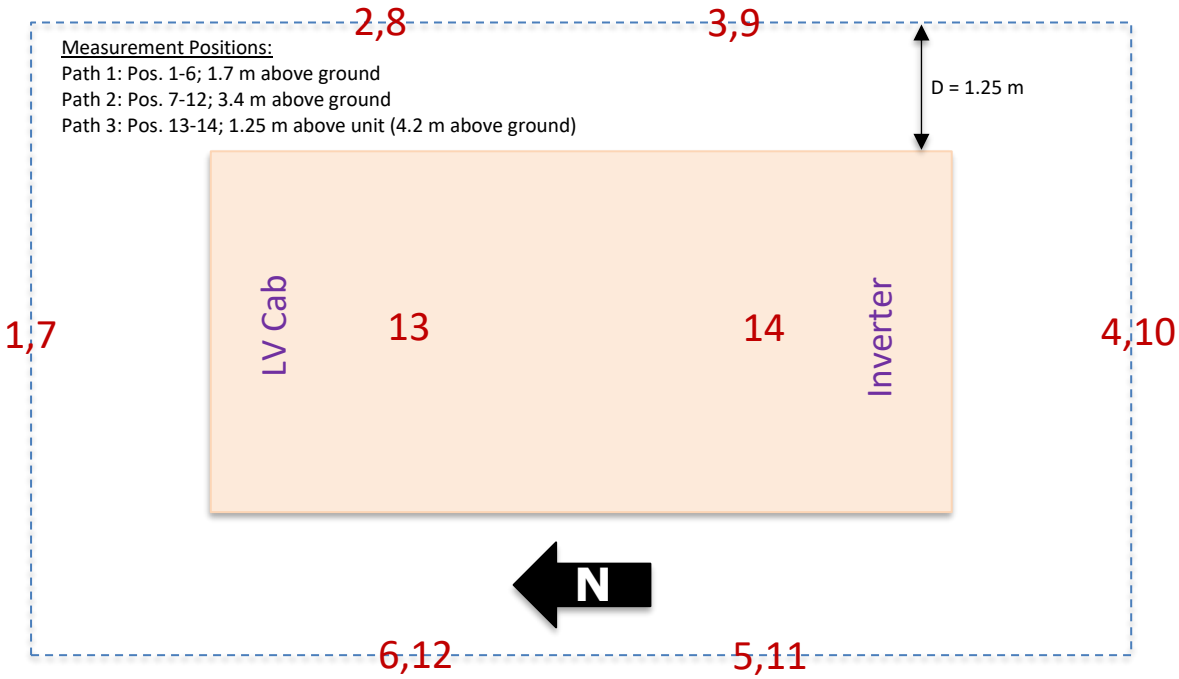
The outdoor test environment was free of significant reflecting surfaces.

Measurements of the background (ambient) sound level were made around the Solar Inverter Skid without the transformer fans running (the dominant sound source). However, it was not possible to shut off power to the transformers, and the associated "hum" was present during the ambient measurements. Therefore, ambient corrections were not made to the presented measured operating sound levels (presented in Table 1). The greatest source of actual ambient sound was insects, though a frequency analysis suggests insects did not significantly affect the operational noise measurements.

Figure 1 shows a photo of the Solar Inverter Skid. Figure 2 shows a drawing of an overhead view with the measurement positions marked. Sound measurements were made at 1.25 m from the equipment skid which is roughly the width of the worker access platform. Three measurement "paths" were made: one at a height of 5.5 ft. (1.7 m) above the ground, one at a height of 11 ft. (3.4 m) above the ground, and one at 1.25 m above the top of the unit (4.2 m above the ground).

Figure 1. Photo of Solar Inverter Skid (Looking East)

Figure 2. Measurement Positions, Overhead View



3. INSTRUMENTATION

Noise measurements were made using the following equipment:

- Rion NL-62 Sound Level Meter, S/N 01030561
- Rion NC-74 Sound Level Calibrator, S/N 34883949

The sound level meter meets the requirements for a Type 1 sound level meter per ANSI S1.4, American National Standard Specification for Sound Level Meters. The sound level meter was calibrated before and after the measurements with the calibrator and showed no significant variation. The calibration certificates for the meter and calibrator are presented in Appendix A.

4. SOUND DATA

Twenty-second samples of one-third octave-band and A-weighted sound pressure levels were measured at positions around the package while in operation as called for in the ISO 3746:2010 standard. The measurement positions are shown in Figure 2.

Ambient measurements were also made at the same locations shown in Figure 2, though we did not correct for the ambient due to the transformer noise present during those measurements.

Octave band, A-weighted, and unweighted (dBZ) data for each measurement position are presented in Table 1. Average sound pressure levels and sound *power* levels (L_W) are also presented. One-third octave band data and sound power level calculations are presented in Appendix B.

Table 1. Sound Measurement Data, dB

Position	Octave Band Center Frequency, Hz									dBA	dBZ
	31.5	63	125	250	500	1000	2000	4000	8000		
1	69	68	68	67	68	63	62	57	52	69.2	75.6
2	66	67	68	67	67	63	63	57	51	68.9	74.6
3	69	68	70	71	75	66	64	62	58	74.3	79.0
4	71	71	74	71	78	71	71	66	64	78.0	81.8
5	69	68	70	71	76	66	63	60	59	74.3	79.2
6	66	67	65	66	69	62	60	56	51	68.7	74.2
7	61	64	64	58	58	54	45	40	35	58.7	69.0
8	65	68	71	65	66	64	59	56	50	68.2	75.2
9	69	69	69	72	75	65	66	61	55	74.0	79.0
10	70	73	74	71	81	71	68	67	62	78.6	83.3
11	69	69	72	72	73	67	65	60	55	73.6	79.0
12	67	68	67	66	70	63	62	58	52	69.9	75.3
13	64	68	68	65	71	60	56	51	47	68.5	74.9
14	69	71	73	71	74	64	63	57	51	72.4	79.2
Average	**68**	**69**	**71**	**69**	**74**	**66**	**64**	**61**	**57**	**73.3**	**78.4**
L_W	**91**	**92**	**93**	**92**	**97**	**88**	**87**	**83**	**80**	**95.9**	**100.9**

The maximum A-weighted sound pressure level measured was 78.6 dBA, at position 10 on the South side of the package near the Inverter. The maximum A-weighted sound pressure level measured at 1.7 m (ear height) above the ground was 78.0 dBA, at position 4 (also near the Inverter.) The average of all fourteen measurements was 73.3 dBA. The A-weighted sound *power* level (L_W) for the package is 95.9 dBA.

5. SUMMARY

The sound levels from a Solar Inverter Skid with Model No. SG3600UD and Serial No. A2011215246 were measured.

The maximum A-weighted sound pressure level measured was 78.6 dBA, at position 10 on the South side of the package near the Inverter. The maximum A-weighted sound pressure level measured at 1.7 m (ear height) above the ground was 78.0 dBA, at position 4 (also near the Inverter.) The average of all fourteen measurements was 73.3 dBA. The A-weighted sound *power* level (L_W) for the package is 95.9 dBA.

APPENDIX A: CALIBRATION CERTIFICATES FOR EQUIPMENT

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP® CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.45457

Instrument: Sound Level Meter
Model: NL62
Manufacturer: Rion
Serial number: 01030561
Tested with: Microphone UC-59L s/n 00638; Preamplifier NH26 s/n 00603
Type (class): 1
Customer: CSTI Acoustics
Tel/Fax: 281-492-2784 / 281-492-1434

Date Calibrated: 10/14/2020 *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: 16155 Park Row Blvd., Suite 150, Houston, TX 77084-6971

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env./ A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Oct 23, 2019	Scantek, Inc./ NVLAP	Oct 23, 2020

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.2	100.00	51.8

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	*[signature]*	Signature	*[signature]*
Date	10/14/2020	Date	10/14/2020

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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Page 1 of 2

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP® CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.45459

Instrument: Acoustical Calibrator
Model: NC-74
Manufacturer: Rion
Serial number: 34889349
Class (IEC 60942): 1
Barometer type:
Barometer s/n:
Customer: CSTI Acoustics
Tel/Fax: 281-492-2784 / 281-492-1434

Date Calibrated: 10/14/2020 *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Address: 16155 Park Row Blvd., Suite 150, Houston, TX 77084-6971

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2019	Scantek, Inc./ NVLAP	Oct 31, 2020
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Oct 22, 2019	ACR Env. / A2LA	Oct 22, 2020
HM30-Thommen	Meteo Station	1040170/39633	Oct 24, 2019	ACR Env./ A2LA	Oct 24, 2020
140-Norsonic	Real Time Analyzer	1406423	Oct 31, 2019	Scantek / NVLAP	Oct 31, 2020
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Oct 23, 2019	Scantek, Inc. / NVLAP	Oct 23, 2020
1203-Norsonic	Preamplifier	14059	March 3, 2020	Scantek, Inc./ NVLAP	March 3, 2021

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	*[signature]*	Signature	*[signature]*
Date	10/14/2020	Date	10/14/2020

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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Page 1 of 2

APPENDIX B: ADDITIONAL SOUND DATA AND CALCULATIONS

Position	One-Third Octave Band Center Frequency, Hz																										dBA	dBZ
	25	32	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.3k	1.6k	2k	2.5k	3.2k	4k	5k	6.3k	8k	10k		
1	65	65	63	62	64	63	58	67	58	59	64	63	65	64	60	58	59	58	55	59	57	53	47	55	48	46	46	69.2	75.6
2	59	62	61	61	62	64	58	67	58	59	63	63	63	63	59	57	59	57	54	61	56	52	47	55	49	45	45	68.9	74.6
3	64	66	63	64	64	63	62	67	66	63	66	68	71	72	65	63	62	58	57	61	60	60	51	58	53	53	53	74.3	79.0
4	67	67	64	65	67	68	69	71	65	63	65	69	76	73	68	69	64	62	63	67	67	62	56	64	59	60	60	78.0	81.8
5	65	65	63	63	64	63	62	68	65	63	66	68	73	72	67	63	60	59	58	58	59	58	51	55	56	53	53	74.3	79.2
6	58	62	61	61	62	63	55	62	60	59	62	63	65	66	58	59	57	57	54	56	53	51	47	53	48	45	44	68.7	74.2
7	55	57	57	57	58	61	55	63	51	51	52	55	57	52	47	48	50	49	41	41	38	36	29	37	31	29	30	58.7	69.0
8	61	61	60	61	65	64	61	70	59	57	58	63	64	60	59	62	56	56	54	55	54	50	45	55	48	43	44	68.2	75.2
9	65	64	64	65	64	64	62	65	65	66	65	69	72	71	65	62	60	60	59	63	61	57	52	57	53	50	48	74.0	79.0
10	65	66	65	66	70	69	69	73	64	63	65	70	79	75	68	69	65	62	62	64	63	64	57	63	59	55	56	78.6	83.3
11	63	65	64	65	65	64	63	71	64	66	66	69	70	69	65	63	63	60	60	62	60	57	52	56	52	49	48	73.6	79.0
12	63	62	60	63	64	62	58	66	60	58	61	63	67	65	62	60	57	58	56	59	55	54	48	56	50	46	45	69.9	75.3
13	58	59	60	64	64	60	61	67	60	59	58	61	68	66	58	55	56	55	51	51	51	48	42	47	44	40	39	68.5	74.9
14	63	65	65	66	67	66	67	70	67	65	64	68	72	68	61	60	60	57	56	60	58	55	48	52	48	46	44	72.4	79.2
Average	**63**	**64**	**63**	**64**	**65**	**65**	**64**	**68**	**63**	**62**	**64**	**67**	**72**	**69**	**64**	**63**	**60**	**59**	**58**	**61**	**60**	**57**	**51**	**57**	**53**	**52**	**51**	**73.3**	**78.4**
L_W	**86**	**86**	**85**	**86**	**87**	**87**	**86**	**91**	**86**	**85**	**86**	**89**	**94**	**92**	**86**	**86**	**83**	**81**	**80**	**83**	**82**	**80**	**73**	**80**	**76**	**74**	**74**	**95.9**	**100.9**

Unit Dimensions	in	m
l1	240	6.1
l2	96	2.4
l3	150	3.8

Meas. Distance, m		1.25
Measurement Surface Area		
a	4.3	m
b	2.5	m
c	5.1	m
S	179.4	m^2
L_W Corr.	22.5	dB