



LIGO Laboratory / LIGO Scientific Collaboration

LIGO-E1100032-v1

advanced LIGO

1/12/11

Harmonics Multiplier Test Results

submitted by Daniel Sigg

Distribution of this document:
LIGO Scientific Collaboration

This is an internal working note
of the LIGO Laboratory.

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Abstract:

Test results of the harmonics multiplier modules from Spectrum Microwave. This covers model 96269 and serial numbers 1043-01/S1000796, 1043-02/S1000797, 1043-03/S1000798, 1043-04/S1000799 and 1043-05/S1000800.

Related Documents

LIGO-T1000384: [Spectrum Microwave Harmonics Generator \(96269\)](#)

LIGO-E1000061: [Specifications for the Harmonic Generator](#)

LIGO-E1100020: [RF Harmonics Generator Count](#)

**SPECTRUM MICROWAVE INC
STATE COLLEGE OPERATION**

*1900 West College Avenue
State College, PA 16801-2723
Phone: 814-272-2700
Fax: 814-272-2796*

CERTIFICATE OF COMPLIANCE

DATE: 10/29/2010

We hereby certify that the material covered by this certificate has been tested in accordance with, and has been found to meet the applicable requirements for the material, including any specification forming a part of the description.

The reports are on file subject to examination.

CUSTOMER: Ligo Hanford Observatory
California Institute of Tech

CUSTOMER PO#: 75ADV-S097507

SPECTRUM MODEL #: 96269

CUSTOMER PART #: N/A

SERIAL #: 1043-01 thru -05

SHIPPED VIA: UPS Ground



Arthur M. Ridenour
Senior Technologist

SPECTRUM MICROWAVE INC
STATE COLLEGE OPERATION

1900 West College Avenue
State College, PA 16801-2723

PHONE 814-272-2700 * FAX 814-272-2796

Warranty

Spectrum Microwave, Inc., State College Operation warrants its products for a period of 1 (one) year from the date of shipment to be free from defects caused by faulty materials or poor workmanship, provided warranty seals are unbroken.

- Customer should contact Spectrum at 814-272-2765 to be given an RMA number and approval to return unit(s). **DO NOT SHIP UNITS PRIOR TO RECEIVING AN RMA NUMBER FROM SPECTRUM.**
- Once received, the unit(s) will be examined to insure that the problem is not due to misuse or improper installation.
- An evaluation fee will be charged to the customer to cover inspection costs for any product returned under warranty which is found to be within original specifications or not Spectrum Microwave's responsibility.

If the warranty has expired, units will not be accepted on debit memos. A purchase order will be required prior to evaluation to cover the evaluation charge on units out of warranty and a revision to the purchase order will be required prior to repair.

Returns are shipped standard UPS ground unless customer provides a shipping account to charge against.

Spectrum Microwave reserves the right to make product improvements and/or design changes in any of its products without incurring any obligation or liability to make the same changes in units previously purchased.

REVISIONS				
ECN	REV.	DESCRIPTION	CHNG/DATE	APPVD/DATE
0384	-	New release	CJL/2010-10-07	KLM/2010-10-14

DWG NO. **069-20115**
 SH **1** OF **2**
 REV **-**

Test Data Record

Model 96269

SN 1043-01

UNLESS OTHERWISE SPECIFIED

* INTERPRET DRAWING IAW ASME Y14.100-2004
 * DIMENSIONING AND TOLERANCING IAW ASME Y14.5-1994
 * PARENTHETICAL INFORMATION FOR REFERENCE ONLY
 * DIMENSIONAL LIMITS APPLY BEFORE PROCESSES
 * DIMENSIONS ARE IN INCHES **63**
 * TOLERANCES ARE: ANGLES ±1.0° $\sqrt{\text{2 PLACE DECIMAL } \pm 0.2}$
 * SURFACE FINISH $\sqrt{\text{3 PLACE DECIMAL } \pm 0.005}$
 * REMOVE ALL BURRS AND SHARP EDGES .010 RAD. MAX.
 * CONCENTRICITY MACHINED DIA: .002 FIM
 * MACHINED TOOL MISMATCH: .002 MAX.

DO NOT SCALE DRAWING

		3RD ANGLE PROJECTION		SPECTRUM MICROWAVE, INC 1900 West College Avenue				
		ANSI		Test Data Record Model 96269				
		DRAWN	CJL					DATE
		CHECKED						
		ENGR	CJL	DATE	2010-10-13			
MFG								
QA	KLM	DATE	2010-10-14		SIZE	CAGE CODE	DWG NO.	REV
COMPUTER ASSISTED DRAWING GENERATED USING MICROSOFT WORD					A	52747	069-20115	-
		SCALE:	NTS		SHEET	1 OF 2		

Spectrum Microwave; Model 96269

1.0 Input Frequency (8.68628 / 9.09627904 MHz)

✓ ✓ or X

2.0 Input Power (+10 dBm min.)

✓ ✓ or X

3.0 Output Frequency (8.68628 MHz)

- 3.1 X2
- 3.2 X3
- 3.3 X4
- 3.4 X5
- 3.5 X6
- 3.6 X10
- 3.7 X15

Freq	✓ or X	Power dBm	dBm
<u>✓</u>	✓ or X	<u>11</u>	dBm
<u>✓</u>	✓ or X	<u>17</u>	dBm
<u>✓</u>	✓ or X	<u>11</u>	dBm
<u>✓</u>	✓ or X	<u>10</u>	dBm
<u>✓</u>	✓ or X	<u>16</u>	dBm
<u>✓</u>	✓ or X	<u>13</u>	dBm
<u>✓</u>	✓ or X	<u>11</u>	dBm

4.0 Output Frequency (9.09627904 MHz)

- 4.1 X2
- 4.2 X3
- 4.3 X4
- 4.4 X5
- 4.5 X6
- 4.6 X10
- 4.7 X15

Freq	✓ or X	Power dBm	dBm
<u>✓</u>	✓ or X	<u>12</u>	dBm
<u>✓</u>	✓ or X	<u>16</u>	dBm
<u>✓</u>	✓ or X	<u>14</u>	dBm
<u>✓</u>	✓ or X	<u>11</u>	dBm
<u>✓</u>	✓ or X	<u>15</u>	dBm
<u>✓</u>	✓ or X	<u>13</u>	dBm
<u>✓</u>	✓ or X	<u>11</u>	dBm

5.0 Output Power (10 dBm min. Each)

✓ ✓ or X

6.0 Phase Noise

- 6.1 Reference +20 LOG N + 3dB Up To X6
- 6.2 Reference +20 LOG N + 6dB X10 AND X15

✓ ✓ or X
✓ ✓ or X

7.0 Internally Generated Spurious (-80 dBc MAX.)

✓ ✓ or X

8.0 Harmonics (-60 dBc max.)

✓ ✓ or X

9.0 SUB Harmonics (-60 dBc max.)

✓ ✓ or X

10.0 Temperature (+20 to +30°C)

✓ ✓ or X

Work Order: 6520

Model: 96269 S/N: 1043-01

✓ Pass.

Fail. Note failed parameter(s) _____

Technician: PSB Date: 29 OCT 2010

SIZE A	CAGE CODE 52747	DWG NO. 069-20115	REV -
SCALE: NTS		SHEET 2 OF 3	

REVISIONS				
ECN	REV.	DESCRIPTION	CHNG/DATE	APPVD/DATE
0384	-	New release	CJL/2010-10-07	KLM/2010-10-14

DWG NO. **069-20115**
 SH **1** OF **2**
 REV -

Test Data Record


Model 96269

SN 1043-02

UNLESS OTHERWISE SPECIFIED

* INTERPRET DRAWING IAW ASME Y14.100-2004
 * DIMENSIONING AND TOLERANCING IAW ASME Y14.5-1994
 * PARENTETICAL INFORMATION FOR REFERENCE ONLY
 * DIMENSIONAL LIMITS APPLY BEFORE PROCESSES
 * DIMENSIONS ARE IN INCHES **63**
 * TOLERANCES ARE: ANGLES ±1.0° 2 PLACE DECIMAL ±.02
 * SURFACE FINISH 3 PLACE DECIMAL ±.005
 * REMOVE ALL BURRS AND SHARP EDGES .010 RAD MAX.
 * CONCENTRICITY MACHINED DIA: .002 FIM
 * MACHINED TOOL MISMATCH: .002 MAX.

DO NOT SCALE DRAWING

		SPECTRUM MICROWAVE, INC 1900 West College Avenue			
		DRAWN CJL		DATE 2010-10-07	
		CHECKED		TITLE	
		ENGR CJL		Test Data Record Model 96269	
		MFG		SIZE A	CAGE CODE 52747
QA KLM		DATE 2010-10-14		SHEET 1 OF 2	
COMPUTER ASSISTED DRAWING GENERATED USING MICROSOFT WORD SCALE: NTS					

REV 3
 SH 2 OF
 029-20115
 DWG NO.

Spectrum Microwave; Model 96269

1.0 Input Frequency (8.68628 / 9.09627904 MHz)

✓ √ or X

2.0 Input Power (+10 dBm min.)

✓ √ or X

3.0 Output Frequency (8.68628 MHz)

- 3.1 X2
- 3.2 X3
- 3.3 X4
- 3.4 X5
- 3.5 X6
- 3.6 X10
- 3.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	dBm
<u>11</u>	dBm
<u>15</u>	dBm
<u>13</u>	dBm
<u>12</u>	dBm
<u>15</u>	dBm
<u>13</u>	dBm
<u>11</u>	dBm

4.0 Output Frequency (9.09627904 MHz)

- 4.1 X2
- 4.2 X3
- 4.3 X4
- 4.4 X5
- 4.5 X6
- 4.6 X10
- 4.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	dBm
<u>12</u>	dBm
<u>12</u>	dBm
<u>16</u>	dBm
<u>11</u>	dBm
<u>10</u>	dBm
<u>13</u>	dBm
<u>11</u>	dBm

5.0 Output Power (10 dBm min. Each)

✓ √ or X

6.0 Phase Noise

- 6.1 Reference +20 LOG N + 3dB Up To X6
- 6.2 Reference +20 LOG N + 6dB X10 AND X15

✓ √ or X
✓ √ or X

7.0 Internally Generated Spurious (-80 dBc MAX.)

✓ √ or X

8.0 Harmonics (-60 dBc max.)

✓ √ or X

9.0 SUB Harmonics (-60 dBc max.)

✓ √ or X

10.0 Temperature (+20 to +30°C)

✓ √ or X

Work Order 6520

Model: 96269 S/N: 1043-02

✓ Pass.

Fail. Note failed parameter(s) _____

Technician: PSB Date: 27 OCT 2010

SIZE A	CAGE CODE 52747	DWG NO. 069-20115	REV -
SCALE: NTS		SHEET 2 OF 3	

DWG NO. 069-20115
 SH 1 OF 2
 REV -

REVISIONS				
ECN	REV.	DESCRIPTION	CHNG/DATE	APPVD/DATE
0384	-	New release	CJL/2010-10-07	KLM/2010-10-14

Test Data Record


Model 96269

SN 1043-03

UNLESS OTHERWISE SPECIFIED

* INTERPRET DRAWING IAW ASME Y14.100-2004
 * DIMENSIONING AND TOLERANCING IAW ASME Y14.5-1994
 * PARENTHEICAL INFORMATION FOR REFERENCE ONLY
 * DIMENSIONAL LIMITS APPLY BEFORE PROCESSES
 * DIMENSIONS ARE IN INCHES **63**
 * TOLERANCES ARE: ANGLES ±1.0° 2 PLACE DECIMAL ±.02
 * SURFACE FINISH 3 PLACE DECIMAL ±.005
 * REMOVE ALL BURRS AND SHARP EDGES .010 RAD MAX.
 * CONCENTRICITY MACHINED DIA: .002 FIM
 * MACHINED TOOL MISMATCH: .002 MAX.

DO NOT SCALE DRAWING

ANSI 		SPECTRUM MICROWAVE, INC 1900 West College Avenue		
DRAWN	CJL	DATE	2010-10-07	
CHECKED			TITLE	
ENGR	CJL	DATE	2010-10-13	
MFG			Model 96269	
QA	KLM	DATE	SIZE	CAGE CODE
		2010-10-14	A	52747
			DWG NO.	REV
			069-20115	-
COMPUTER ASSISTED DRAWING GENERATED USING MICROSOFT WORD			SCALE:	SHEET
			NTS	1 OF 2

REV -
 3
 SH 2 OF
 029-20115
 DWG NO.

Spectrum Microwave; Model 96269

1.0 Input Frequency (8.68628 / 9.09627904 MHz)

✓ √ or X

2.0 Input Power (+10 dBm min.)

✓ √ or X

3.0 Output Frequency (8.68628 MHz)

- 3.1 X2
- 3.2 X3
- 3.3 X4
- 3.4 X5
- 3.5 X6
- 3.6 X10
- 3.7 X15

Freq	√ or X	Power dBm	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm
<u>✓</u>	√ or X	<u>13</u>	dBm
<u>✓</u>	√ or X	<u>12</u>	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm
<u>✓</u>	√ or X	<u>14</u>	dBm
<u>✓</u>	√ or X	<u>13</u>	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm

4.0 Output Frequency (9.09627904 MHz)

- 4.1 X2
- 4.2 X3
- 4.3 X4
- 4.4 X5
- 4.5 X6
- 4.6 X10
- 4.7 X15

Freq	√ or X	Power dBm	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm
<u>✓</u>	√ or X	<u>14</u>	dBm
<u>✓</u>	√ or X	<u>10</u>	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm
<u>✓</u>	√ or X	<u>13</u>	dBm
<u>✓</u>	√ or X	<u>11</u>	dBm

5.0 Output Power (10 dBm min. Each)

✓ √ or X

6.0 Phase Noise

- 6.1 Reference +20 LOG N + 3dB Up To X6
- 6.2 Reference +20 LOG N + 6dB X10 AND X15

✓ √ or X
✓ √ or X

7.0 Internally Generated Spurious (-80 dBc MAX.)

✓ √ or X

8.0 Harmonics (-60 dBc max.)

✓ √ or X

9.0 SUB Harmonics (-60 dBc max.)

✓ √ or X

10.0 Temperature (+20 to +30°C)

✓ √ or X

Work Order 6520

Model: 96269 S/N: 1043-03

✓ Pass.

Fail. Note failed parameter(s) _____

Technician: PSB Date: 28 OCT 2010

SIZE A	CAGE CODE 52747	DWG NO. 069-20115	REV -
SCALE: NTS		SHEET 2 OF 3	

DWG NO. 069-20115
 SH 1 OF 2
 REV -

REVISIONS				
ECN	REV.	DESCRIPTION	CHNG/DATE	APPVD/DATE
0384	-	New release	CJL/2010-10-07	KLM/2010-10-14

Test Data Record


Model 96269

SN 1043-04

UNLESS OTHERWISE SPECIFIED

- * INTERPRET DRAWING IAW ASME Y14.100-2004
- * DIMENSIONING AND TOLERANCING IAW ASME Y14.5 1994
- * PARENTHEICAL INFORMATION FOR REFERENCE ONLY
- * DIMENSIONAL LIMITS APPLY BEFORE PROCESSES
- * DIMENSIONS ARE IN INCHES **63**
- * TOLERANCES ARE: ANGLES ±1.0° $\sqrt{2}$ PLACE DECIMAL ±.02
- * SURFACE FINISH $\sqrt{3}$ PLACE DECIMAL ±.005
- * REMOVE ALL BURRS AND SHARP EDGES .010 RAD MAX.
- * CONCENTRICITY MACHINED DIA: .002 FIM
- * MACHINED TOOL MISMATCH: .002 MAX.

DO NOT SCALE DRAWING

	3RD ANGLE PROJECTION		SPECTRUM MICROWAVE, INC 1900 West College Avenue					
	ANSI		Test Data Record Model 96269					
	DRAWN	CJL				DATE	2010-10-07	
	CHECKED							
	ENGR	CJL				DATE	2010-10-13	
MFG				SIZE	CAGE CODE	DWG NO.	REV	
QA	KLM	DATE	2010-10-14	A	52747	069-20115	-	
COMPUTER ASSISTED DRAWING GENERATED USING MICROSOFT WORD				SCALE:	NTS		SHEET	1 OF 2

Spectrum Microwave; Model 96269

1.0 Input Frequency (8.68628 / 9.09627904 MHz)

✓ √ or X

2.0 Input Power (+10 dBm min.)

✓ √ or X

3.0 Output Frequency (8.68628 MHz)

- 3.1 X2
- 3.2 X3
- 3.3 X4
- 3.4 X5
- 3.5 X6
- 3.6 X10
- 3.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	
<u>10</u>	dBm
<u>13</u>	dBm
<u>10</u>	dBm
<u>10</u>	dBm
<u>13</u>	dBm
<u>13</u>	dBm
<u>11</u>	dBm

4.0 Output Frequency (9.09627904 MHz)

- 4.1 X2
- 4.2 X3
- 4.3 X4
- 4.4 X5
- 4.5 X6
- 4.6 X10
- 4.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	
<u>11</u>	dBm
<u>12</u>	dBm
<u>12</u>	dBm
<u>10</u>	dBm
<u>11</u>	dBm
<u>12</u>	dBm
<u>11</u>	dBm

5.0 Output Power (10 dBm min. Each)

✓ √ or X

6.0 Phase Noise

- 6.1 Reference +20 LOG N + 3dB Up To X6
- 6.2 Reference +20 LOG N + 6dB X10 AND X15

✓ √ or X
✓ √ or X

7.0 Internally Generated Spurious (-80 dBc MAX.)

✓ √ or X

8.0 Harmonics (-60 dBc max.)

✓ √ or X

9.0 SUB Harmonics (-60 dBc max.)

✓ √ or X

10.0 Temperature (+20 to +30°C)

✓ √ or X

Work Order 6520

Model: 96269 S/N: 1043-04

✓ Pass.

Fail. Note failed parameter(s) _____

Technician: PSD Date: 27 OCT 2010

SIZE A	CAGE CODE 52747	DWG NO. 069-20115	REV -
SCALE: NTS		SHEET 2 OF 3	

DWG NO. 069-20115
 SH 1 OF 2
 REV -

REVISIONS				
ECN	REV.	DESCRIPTION	CHNG/DATE	APPVD/DATE
0384	-	New release	CJL/2010-10-07	KLM/2010-10-14

Test Data Record


Model 96269

SN 1243-05

UNLESS OTHERWISE SPECIFIED

* INTERPRET DRAWING IAW ASME Y14.100-2004
 * DIMENSIONING AND TOLERANCING IAW ASME Y14.5-1994
 * PARENTY-ETICAL INFORMATION FOR REFERENCE ONLY
 * DIMENSIONAL LIMITS APPLY BEFORE PROCESSES
 * DIMENSIONS ARE IN INCHES **63**
 * TOLERANCES ARE: ANGLES ±1.0° 2 PLACE DECIMAL ±.02
 * SURFACE FINISH 3 PLACE DECIMAL ±.005
 * REMOVE ALL BURRS AND SHARP EDGES .010 RAD MAX.
 * CONCENTRICITY MACHINED DIA: .002 FIM
 * MACHINED TOOL MISMATCH: .002 MAX.

DO NOT SCALE DRAWING

	3rd ANGLE PROJECTION		SPECTRUM MICROWAVE, INC 1900 West College Avenue			
	ANSI		Test Data Record Model 96269			
	DRAWN	CJL				
	CHECKED		ENGR	CJL	2010-10-13	
	MFG		QA	KLM	2010-10-14	
COMPUTER ASSISTED DRAWING GENERATED USING MICROSOFT WORD		SIZE	CAGE CODE	DWG NO.	REV	
		A	52747	069-20115	-	
SCALE: NTS			SHEET 1 OF 2			

Spectrum Microwave; Model 96269

1.0 Input Frequency (8.68628 / 9.09627904 MHz)

✓ √ or X

2.0 Input Power (+10 dBm min.)

✓ √ or X

3.0 Output Frequency (8.68628 MHz)

- 3.1 X2
- 3.2 X3
- 3.3 X4
- 3.4 X5
- 3.5 X6
- 3.6 X10
- 3.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	dBm
<u>10</u>	dBm
<u>14</u>	dBm
<u>10</u>	dBm
<u>12</u>	dBm
<u>14</u>	dBm
<u>13</u>	dBm
<u>12</u>	dBm

4.0 Output Frequency (9.09627904 MHz)

- 4.1 X2
- 4.2 X3
- 4.3 X4
- 4.4 X5
- 4.5 X6
- 4.6 X10
- 4.7 X15

Freq	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X
<u>✓</u>	√ or X

Power dBm	dBm
<u>11</u>	dBm
<u>12</u>	dBm
<u>12</u>	dBm
<u>11</u>	dBm
<u>11</u>	dBm
<u>13</u>	dBm
<u>11</u>	dBm

5.0 Output Power (10 dBm min. Each)

✓ √ or X

6.0 Phase Noise

- 6.1 Reference +20 LOG N + 3dB Up To X6
- 6.2 Reference +20 LOG N + 6dB X10 AND X15

✓ √ or X
✓ √ or X

7.0 Internally Generated Spurious (-80 dBc MAX.)

✓ √ or X

8.0 Harmonics (-60 dBc max.)

✓ √ or X

9.0 SUB Harmonics (-60 dBc max.)

✓ √ or X

10.0 Temperature (+20 to +30°C)

✓ √ or X

Work Order 1043-05

Model: 96269 S/N: 6520

✓ Pass.

Fail. Note failed parameter(s) _____

Technician: [Signature] Date: 28 OCT 2010

SIZE A	CAGE CODE 52747	DWG NO. 069-20115	REV -
SCALE: NTS	SHEET 2 OF 3		