

EMC TEST REPORT

Product : MEMS Switch Module Series
Trade mark : N/A
Model/Type reference : MEMS OPTICAL SWITCH
Serial Number : N/A
Ratings : DC 5V
Report Number : EED32P819215
Date of issue : Dec. 04, 2023
Regulations : See below

Test Standards	Results
<input checked="" type="checkbox"/> EN 55032:2015+A11:2020	PASS
<input checked="" type="checkbox"/> EN 55035:2017+A11:2020	PASS

Prepared for:

Photonwares Corporation,
15 Presidential Way, Woburn, MA 01801, USA

Prepared by:

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Date of issue: Dec. 04, 2023

Check No.: 8900271123



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(Note: N/A means not applicable)

1. GENERAL INFORMATION

Applicant: Photonwares Corporation,
15 Presidential Way, Woburn, MA 01801, USA

Manufacturer: Photonwares Corporation,
15 Presidential Way, Woburn, MA 01801, USA

Factory: Photonwares Corporation,
15 Presidential Way, Woburn, MA 01801, USA

Product: MEMS Switch Module Series

Trade mark: N/A

Model/Type reference: MEMS OPTICAL SWITCH

Serial Number: N/A

Report Number: EED32P819215

State of Sample(s): Normal

Sample Received Date: Nov. 27, 2023

Sample tested Date: Nov. 27, 2023 to Nov. 29, 2023

Company Name and Address shown on Report, the sample(s) and sample Information was/ were provided by the applicant who should be responsible for the authenticity which CTI hasn't verified.

2. TEST SUMMARY

The Product has been tested according to the following specifications:

EMISSION		
Standard	Test Item	Test
EN 55032	Conducted disturbance	N/A ¹
EN 55032	Radiated disturbance	Yes

IMMUNITY (EN 55035)		
Standard	Test Item	Test
IEC 61000-4-2	Electrostatic discharge (ESD)	Yes
IEC 61000-4-3	Continuous RF electromagnetic radiated field disturbances	Yes
IEC 61000-4-4	Electrical fast transients (EFT)	N/A ¹
IEC 61000-4-5	Surges	N/A ¹
IEC 61000-4-6	Radio-frequency continuous conducted Immunity	N/A ¹
IEC 61000-4-8	Power-frequency magnetic fields Immunity	N/A ²
IEC 61000-4-11	Voltage dips and interruptions	N/A ¹

1. The Product is powered By DC 5V, and DC power cable is not longer than 3 m, the test related DC input is not applicable.

2. The Product doesn't contain any device susceptible to magnetic fields.

3. TEST UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

Test item	Value (dB)
Radiated disturbance (30MHz~1GHz)	4.9
Radiated disturbance (above1GHz)	4.7

4. PRODUCT INFORMATION AND TEST SETUP

4.1 PRODUCT INFORMATION

Ratings: DC 5V

The highest frequency of the internal sources of the EUT is :

- ☐ less than 108 MHz, the measurement shall only be made up to 1 GHz.
- ☐ between 108 MHz and 500 MHz, the measurement shall only be made up to 2 GHz.
- ☐ between 500 MHz and 1 GHz, the measurement shall only be made up to 5 GHz.
- ☒ above 1 GHz, the measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less.

4.2 TEST SETUP CONFIGURATION

See test photographs attached in Appendix 1 for the actual connections between Product and support equipment.

4.3 SUPPORT EQUIPMENT

No.	Device Type	Brand	Model	Series No.	Data Cable	Power Cord
1.	Notebook	HP	C1260	---	---	---

Notes:

- All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
- Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

5. FACILITIES AND ACCREDITATIONS

5.1 TEST FACILITY

All test facilities used to collect the test data are located at Hongwei Industrial Zone, Bao'an 70 District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4, CISPR 16-1-1 and other equivalent standards.

5.2 TEST EQUIPMENT LIST

Instrumentation: The following list contains equipments used at CTI for testing.

The calibrations of the measuring instruments, including any accessories that may effect such calibration, are checked frequently to assure their accuracy. Adjustments are made and correction factors applied in accordance with instructions contained in the manual for the measuring instrument.

Equipment used during the tests:

3M Semi-anechoic Chamber (2)- Radiated emissions Test				
Equipment	Manufacturer	Model	Serial No.	Due Date
3M Chamber & Accessory Equipment	TDK	SAC-3	---	05/21/2025
Receiver	R&S	ESCI7	100938-003	10/13/2024
TRILOG Broadband Antenna	schwarzbeck	VULB 9163	401	10/15/2024
Multi device Controller	matur	NCD/070/10711 112	---	---
Microwave Preamplifier	JS Tonscend	EMC051845SE	980380	12/23/2023
Horn Antenna	Schwarzbeck	BBHA 9120D	9120D-1869	04/16/2024

Shielding Room No. 1 - ESD Test (IEC 61000-4-2)				
Equipment	Manufacturer	Model	Serial No.	Due Date
ESD Simulator	TESEQ	NSG437	1182	06/09/2024

3M Full-anechoic Chamber - Continuous RF electromagnetic radiated field disturbances Test (IEC 61000-4-3)				
Equipment	Manufacturer	Model	Serial No.	Due Date
3M Chamber & Accessory Equipment	ETS-LINDGREN	FACT-3	3510	05/19/2025
Signal Generator	R&S	SMB 100B	103084	05/19/2024
Power Probe	R&S	NRP6A	103342	07/12/2024
Power Probe	R&S	NRP6A	103343	07/13/2024
Power Amplifier	R&S	BBA 150-BC500	104743	06/06/2024
Power Amplifier	BONN	BLMA 1060-100	2113427	08/24/2024
RF switch	R&S	OSP220	102205	---
Directional coupler	BONN	BDC 1060-40/500	2128343-04	12/02/2024
Stacked double Log.-Per. Antenna	schwarzbeck	STLP 9128 E special	9128ES-110	---
Horn Antenna	schwarzbeck	STLP 9149	0776	05/21/2024

5.3 LABORATORY ACCREDITATIONS AND LISTINGS

The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

6. RADIATED DISTURBANCE (RE)

6.1 LIMITS

Requirements for radiated emissions at frequencies up to 1 GHz
for Class B equipment

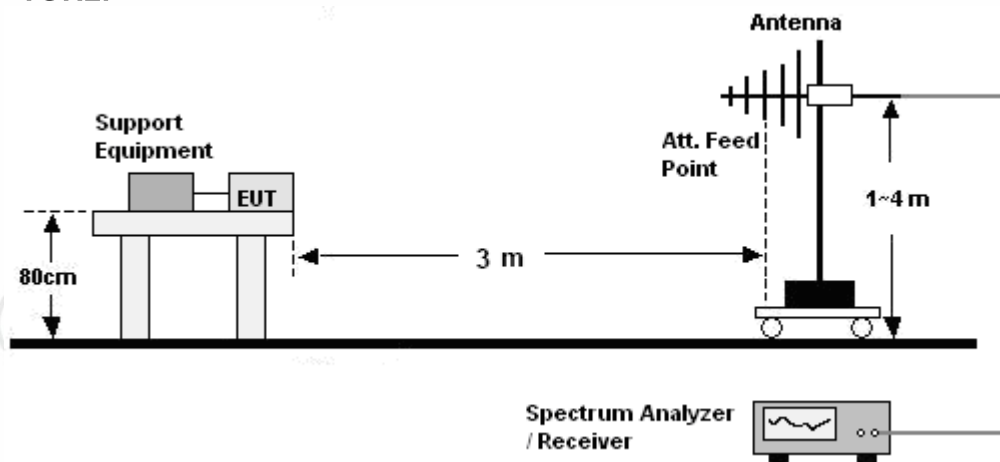
Frequency (MHz)	Quasi-peak limits at 3m dB(μ V/m)
30-230	40
230-1000	47

Frequency (GHz)	limit above 1GHz at 3m dB(μ V/m)	
	Average	peak
1-3	50	70
3-6	54	74

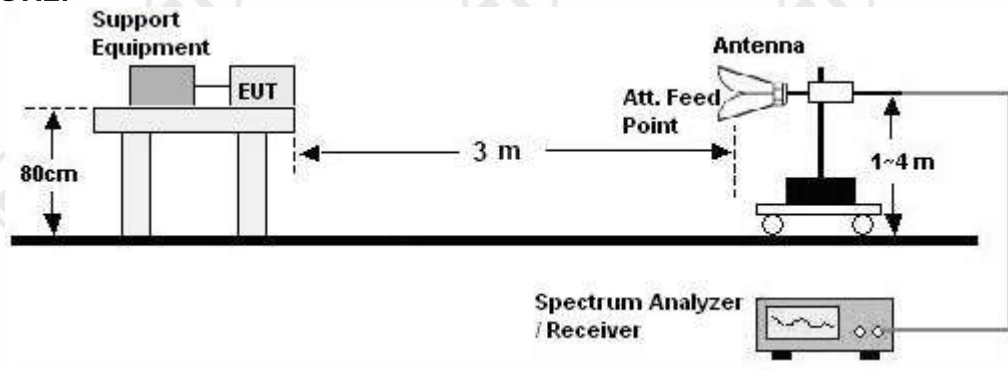
NOTE: The lower limit shall apply at the transition frequencies

6.2 BLOCK DIAGRAM OF TEST SETUP

30MHz ~ 1GHz:



Above 1GHz:



6.3 TEST PROCEDURE

30MHz ~ 1GHz:

- a. The Product was placed on the non-conductive turntable 0.8m above the ground at a chamber.
- b. Set the spectrum analyzer/receiver in Peak detector, Max Hold mode, and 120 kHz RBW. Record the maximum field strength of all the pre-scan process in the full band when the antenna is varied between 1~4 m in both horizontal and vertical, and the turntable is rotated from 0 to 360 degrees.
- c. For each frequency whose maximum record was higher or close to limit, measure its QP value: vary the antenna's height and rotate the turntable from 0 to 360 degrees to find the height and degree where Product radiated the maximum emission, then set the test frequency analyzer/receiver to QP Detector and specified bandwidth with Maximum Hold Mode, and record the maximum value.

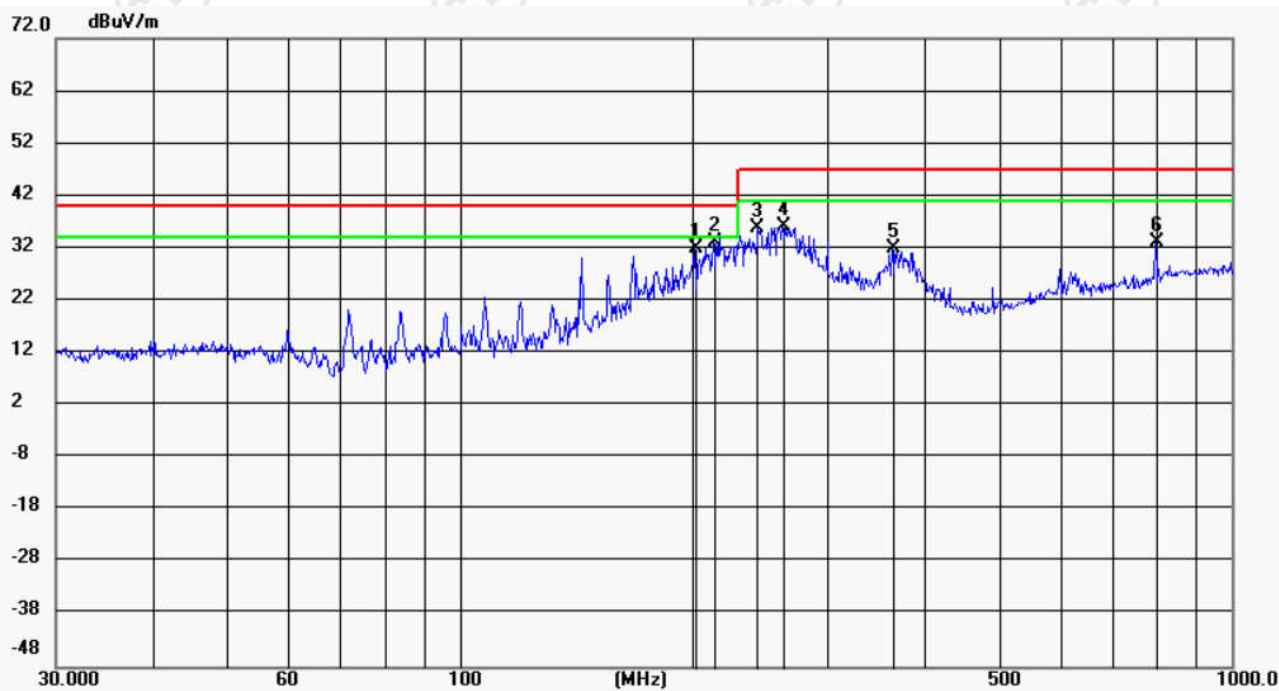
Above 1GHz:

- a. The Product was placed on the non-conductive turntable 0.8m above the ground at a chamber.
- b. Set the spectrum analyzer/receiver in Peak detector, Max Hold mode, and 1MHz RBW. Record the maximum field strength of all the pre-scan process in the full band when the antenna is varied in both horizontal and vertical, and the turntable is rotated from 0 to 360 degrees.
- c. For each frequency whose maximum record was higher or close to limit, measure its AV value: rotate the turntable from 0 to 360 degrees to find the degree where Product radiated the maximum emission, then set the test frequency analyzer/receiver to AV value and specified bandwidth with Maximum Hold Mode, and record the maximum value.

6.4 GRAPHS AND DATA

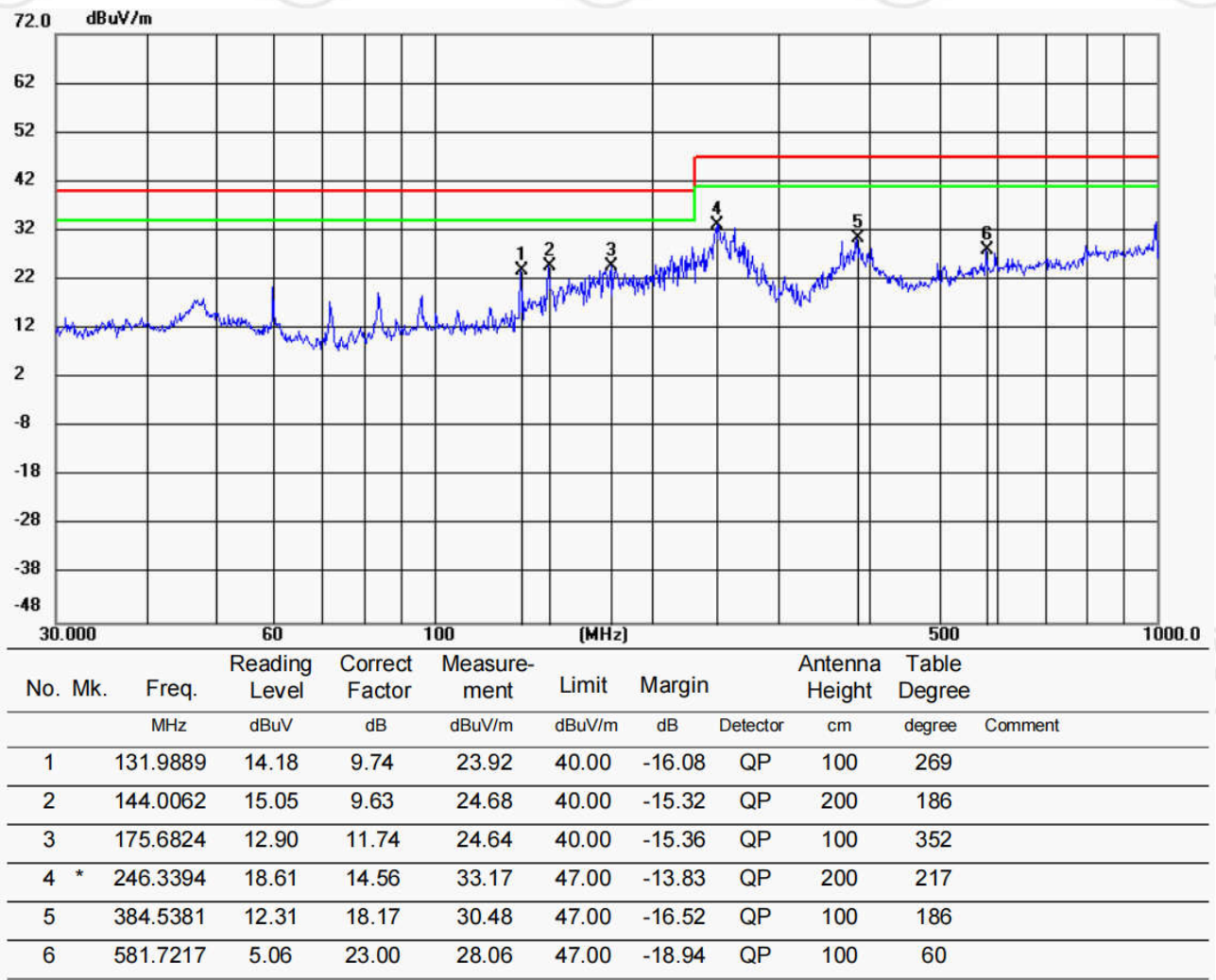
30MHz~1GHz:

Product : MEMS Switch Module Series
Model/Type reference : MEMS OPTICAL SWITCH
Power : DC 5V Temperature : 22℃
Mode : Normal Humidity : 53%
Polarization : Horizontal Press : 101kPa



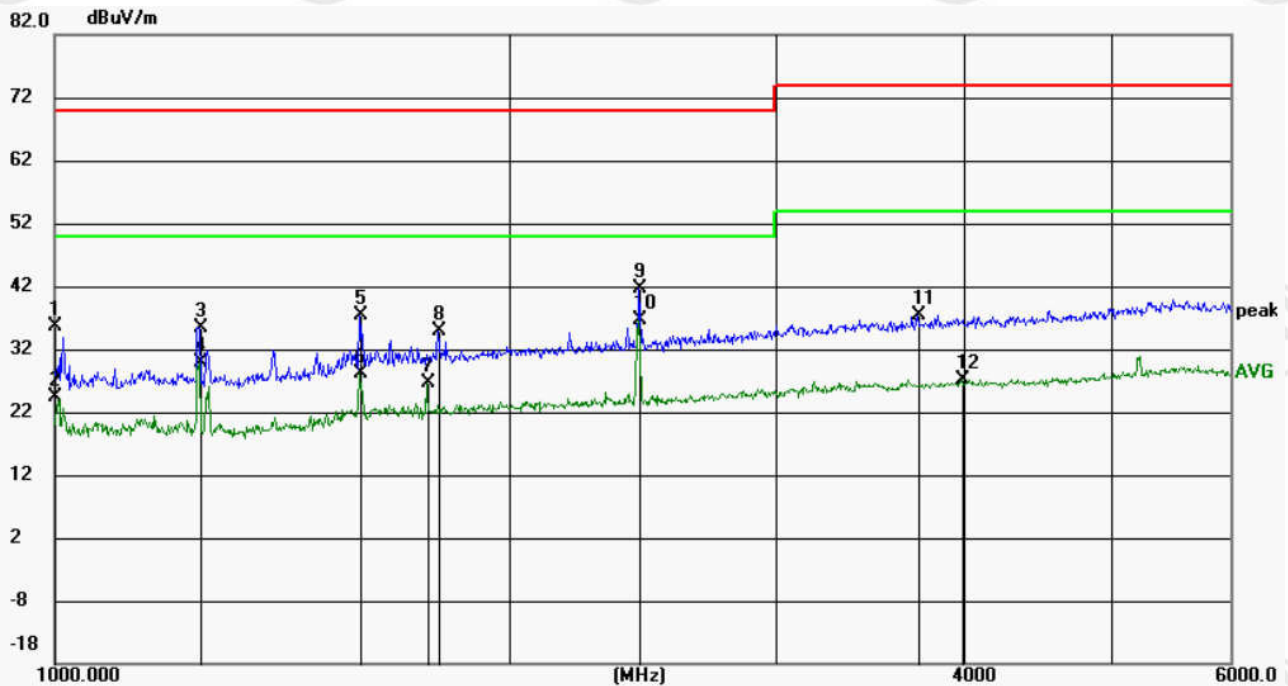
No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		201.7818	19.09	12.88	31.97	40.00	-8.03	QP	100	246
2	*	213.3889	19.71	13.32	33.03	40.00	-6.97	QP	100	257
3		243.3771	21.48	14.44	35.92	47.00	-11.08	QP	200	246
4		262.0212	20.99	15.14	36.13	47.00	-10.87	QP	200	278
5		363.7489	14.04	17.77	31.81	47.00	-15.19	QP	100	267
6		798.8396	7.45	25.80	33.25	47.00	-13.75	QP	100	111

Product : MEMS Switch Module Series
Model/Type reference : MEMS OPTICAL SWITCH
Power : DC 5V
Temperature : 22℃
Mode : Normal
Humidity : 53%
Polarization : Vertical
Press : 101kPa



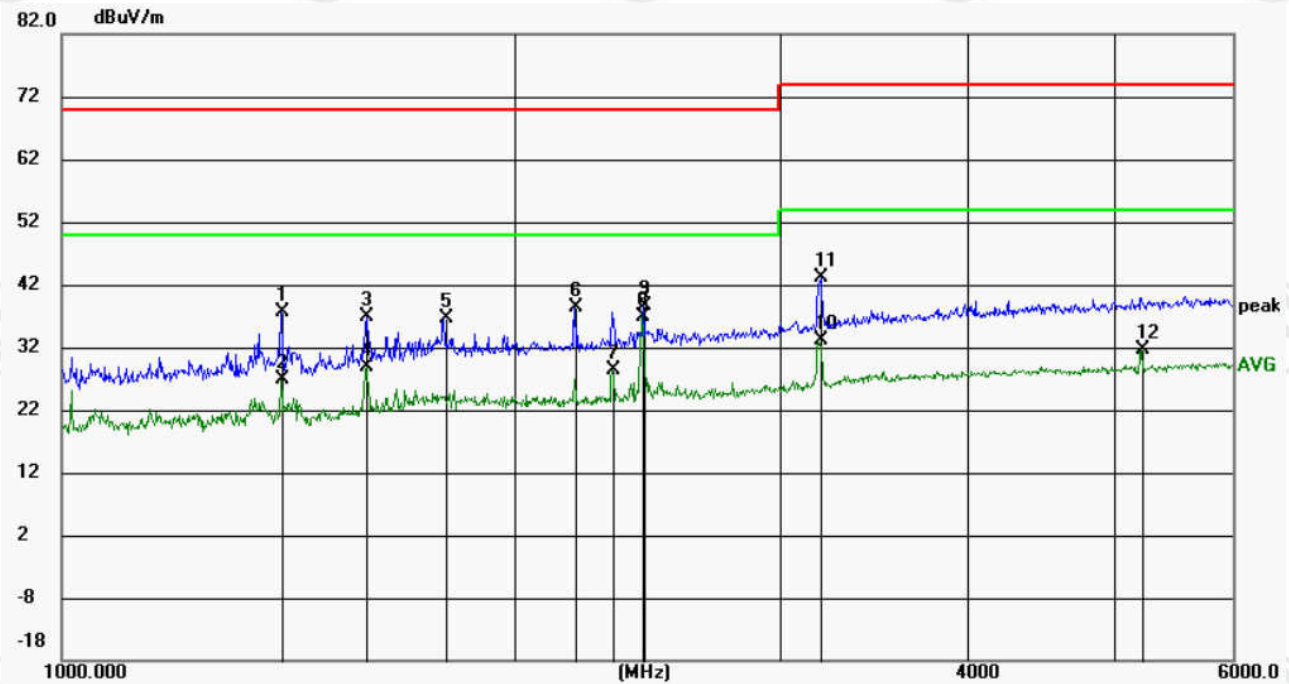
Above 1G:

Product : MEMS Switch Module Series
Model/Type reference : MEMS OPTICAL SWITCH
Power : DC 5V **Temperature** : 22℃
Mode : Normal **Humidity** : 53%
Polarization : Horizontal **Press** : 101kPa



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		1000.0000	54.40	-18.78	35.62	70.00	-34.38	peak	100	328
2		1000.0000	43.10	-18.78	24.32	50.00	-25.68	AVG	200	328
3		1247.005	52.77	-17.31	35.46	70.00	-34.54	peak	100	23
4		1247.005	47.07	-17.31	29.76	50.00	-20.24	AVG	100	23
5		1593.951	52.31	-14.95	37.36	70.00	-32.64	peak	200	76
6		1593.951	43.17	-14.95	28.22	50.00	-21.78	AVG	100	76
7		1765.978	40.10	-13.39	26.71	50.00	-23.29	AVG	100	76
8		1795.973	47.87	-13.11	34.76	70.00	-35.24	peak	100	160
9		2437.887	50.94	-9.31	41.63	70.00	-28.37	peak	200	244
10	*	2437.887	45.99	-9.31	36.68	50.00	-13.32	AVG	100	244
11		3726.316	41.22	-3.89	37.33	74.00	-36.67	peak	100	23
12		3990.653	30.32	-3.12	27.20	54.00	-26.80	AVG	100	59

Product : MEMS Switch Module Series
Model/Type reference : MEMS OPTICAL SWITCH
Power : DC 5V **Temperature** : 22℃
Mode : Normal **Humidity** : 53%
Polarization : Vertical **Press** : 101kPa



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		1398.524	53.63	-16.00	37.63	70.00	-32.37	peak	100	133
2		1398.524	42.84	-16.00	26.84	50.00	-23.16	AVG	100	133
3		1593.951	51.45	-14.50	36.95	70.00	-33.05	peak	100	98
4		1593.951	43.28	-14.50	28.78	50.00	-21.22	AVG	200	98
5		1797.422	49.34	-12.78	36.56	70.00	-33.44	peak	100	116
6		2194.109	48.61	-10.17	38.44	70.00	-31.56	peak	100	81
7		2324.629	37.96	-9.58	28.38	50.00	-21.62	AVG	200	116
8	*	2435.922	46.01	-9.07	36.94	50.00	-13.06	AVG	100	352
9		2437.887	47.80	-9.07	38.73	70.00	-31.27	peak	100	116
10		3190.457	38.24	-5.23	33.01	54.00	-20.99	AVG	100	98
11		3197.325	48.34	-5.19	43.15	74.00	-30.85	peak	200	98
12		5218.818	30.46	1.14	31.60	54.00	-22.40	AVG	100	268

Note:

1. Margin=Measurement-Limit.
2. Measurement=Reading_Level+Correct Factor.
3. Correct Factor=Ant Factor+Cable loss.

7. IMMUNITY TEST

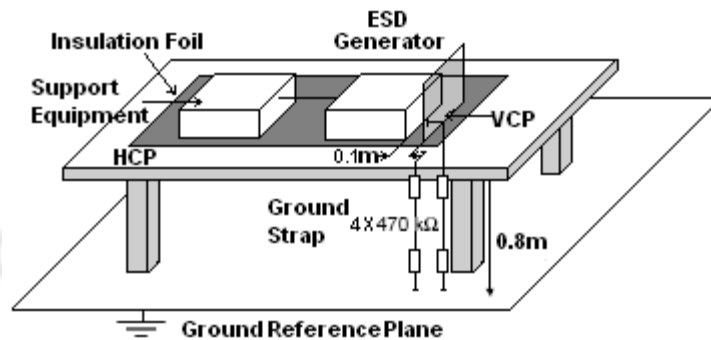
General Performance Criteria	
Product Standard	EN 55035:2017+A11:2020 clause 8
CRITERION A	<p>The equipment shall continue to operate as intended without operator intervention. No degradation of performance, loss of function or change of operating state is allowed below a performance level specified by the manufacturer when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.</p>
CRITERION B	<p>During the application of the disturbance, degradation of performance is allowed. However, no unintended change of actual operating state or stored data is allowed to persist after the test.</p> <p>After the test, the equipment shall continue to operate as intended without operator intervention; no degradation of performance or loss of function is allowed, below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance.</p> <p>If the minimum performance level (or the permissible performance loss), or recovery time, is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.</p>
CRITERION C	<p>Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions. A reboot or re-start operation is allowed.</p> <p>Information stored in non-volatile memory, or protected by a battery backup, shall not be lost.</p>

7.1 ELECTROSTATIC DISCHARGE (ESD)

7.1.1 TEST SPECIFICATION

Basic Standard	: EN 55035 & IEC 61000-4-2
Test Port	: Enclosure port
Discharge Impedance	: 330 ohm / 150 pF
Discharge Mode	: Single Discharge
Discharge Period	: one second between each discharge

7.1.2 BLOCK DIAGRAM OF TEST SETUP



7.1.3 TEST PROCEDURE

- Electrostatic discharges were applied only to those points and surfaces of the Product that are accessible to users during ON operation.
- The test was performed with at least ten single discharges on the pre-selected points in the most sensitive polarity.
- The time interval between two successive single discharges was at least 1 second.
- The ESD generator was held perpendicularly to the surface to which the discharge was applied and the return cable was at least 0.2 meters from the Product.
- Contact discharges were applied to the non-insulating coating, with the pointed tip of the generator penetrating the coating and contacting the conducting substrate.
- Air discharges were applied with the round discharge tip of the discharge electrode approaching the Product as fast as possible (without causing mechanical damage) to touch the Product. After each discharge, the ESD generator was removed from the Product and re-triggered for a new single discharge. The test was repeated until all discharges were complete.
- At least ten single discharges (in the most sensitive polarity) were applied to the Horizontal Coupling Plane at points on each side of the Product. The ESD generator was positioned vertically at a distance of 0.1 meters from the Product with the discharge electrode touching the HCP.
- At least ten single discharges (in the most sensitive polarity) were applied to the center of one vertical edge of the Vertical Coupling Plane in sufficiently different positions that the four faces of the Product were completely illuminated. The VCP (dimensions 0.5m x 0.5m) was placed vertically to and 0.1 meters from the Product.

7.1.4 RESULTS & PERFORMANCE

Product

Model/Type reference

Power

Mode

Press

: MEMS Switch Module Series

: MEMS OPTICAL SWITCH

: DC 5V

: Normal

: 101kPa

Temperature

Humidity

: 24℃

: 52%

Discharge Method	Discharge Position	Voltage (±kV)	Min. No. of Discharge per polarity (Each Point)	Performance Criterion	Test Result
Contact Discharge	Conductive Surfaces	4	10	B	A
	Indirect Discharge HCP	4	10	B	A
	Indirect Discharge VCP	4	10	B	A
Air Discharge	Slots, Apertures, and Insulating Surfaces	8	10	B	A

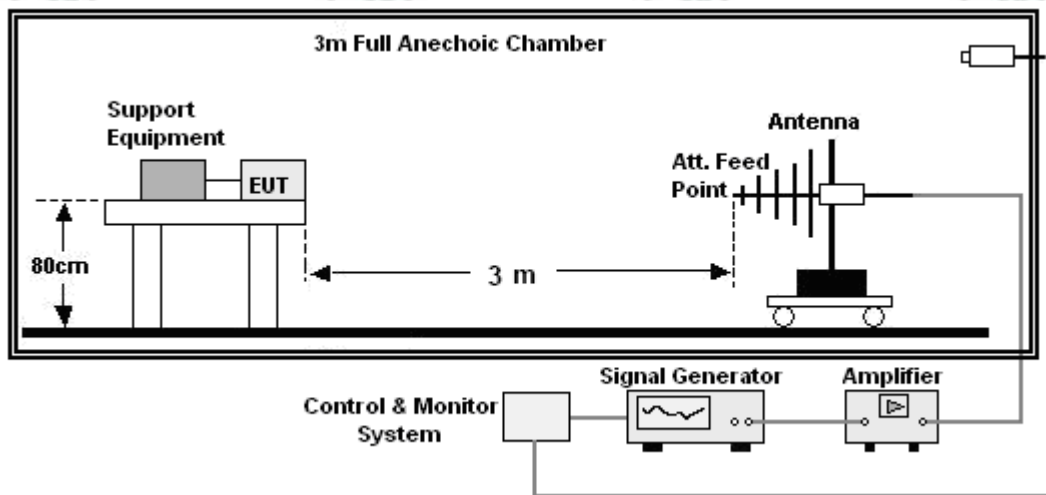
7.2 CONTINUOUS RF ELECTROMAGNETIC RADIATED FIELD DISTURBANCES

7.2.1 TEST SPECIFICATION

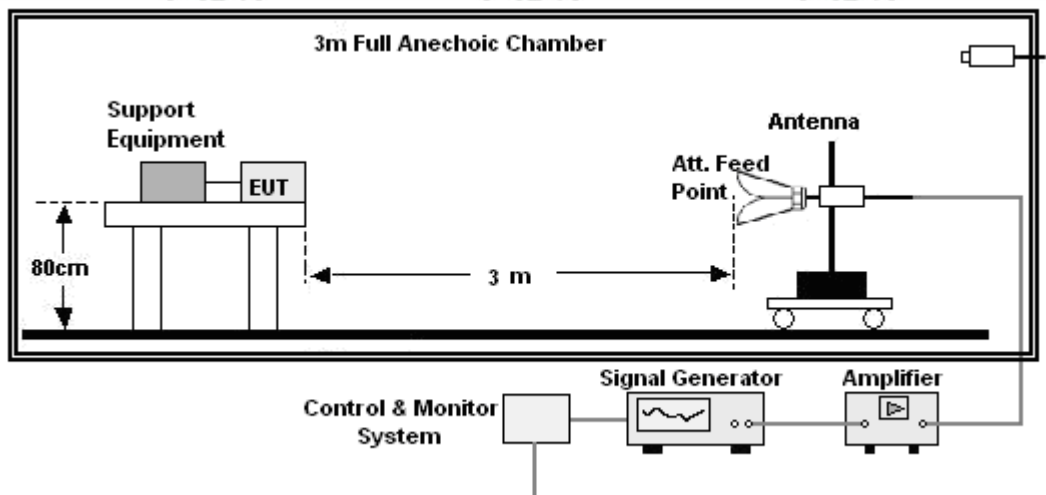
Basic Standard	: EN 55035 & IEC 61000-4-3
Test Port	: Enclosure port
Step Size	: 1%
Modulation	: 1kHz, 80% AM
Dwell Time	: 1 second
Polarization	: Horizontal & Vertical

7.2.2 BLOCK DIAGRAM OF TEST SETUP

80-1000MHz:



1000-6000MHz:



7.2.3 TEST PROCEDURE

- a. The testing was performed in a fully-anechoic chamber. The transmit antenna was located at a distance of 3 meters from the Product.
- b. The frequency range is swept from 80MHz to 1000MHz, 1800MHz, 2600MHz, 3500MHz, 5000MHz with the signal 80% amplitude modulated with a 1 kHz sine wave. The rate of sweep did not exceed 1.5×10^{-3} decade/s. Where the frequency range is swept incrementally, the step size was 1%.
- c. The test was performed with the Product exposed to both vertically and horizontally polarized fields on each of the four sides.

7.2.4 RESULTS & PERFORMANCE

Product : MEMS Switch Module Series

Model/Type reference : MEMS OPTICAL SWITCH

Power : DC 5V

Mode : Normal

Press : 101kPa

Temperature : 24℃

Humidity : 52%

Frequency (MHz)	Position	Field Strength (V/m)	Performance Criterion	Test Result
80 - 1000	Front, Right, Back, Left	3	A	A
1800	Front, Right, Back, Left	3	A	A
2600	Front, Right, Back, Left	3	A	A
3500	Front, Right, Back, Left	3	A	A
5000	Front, Right, Back, Left	3	A	A

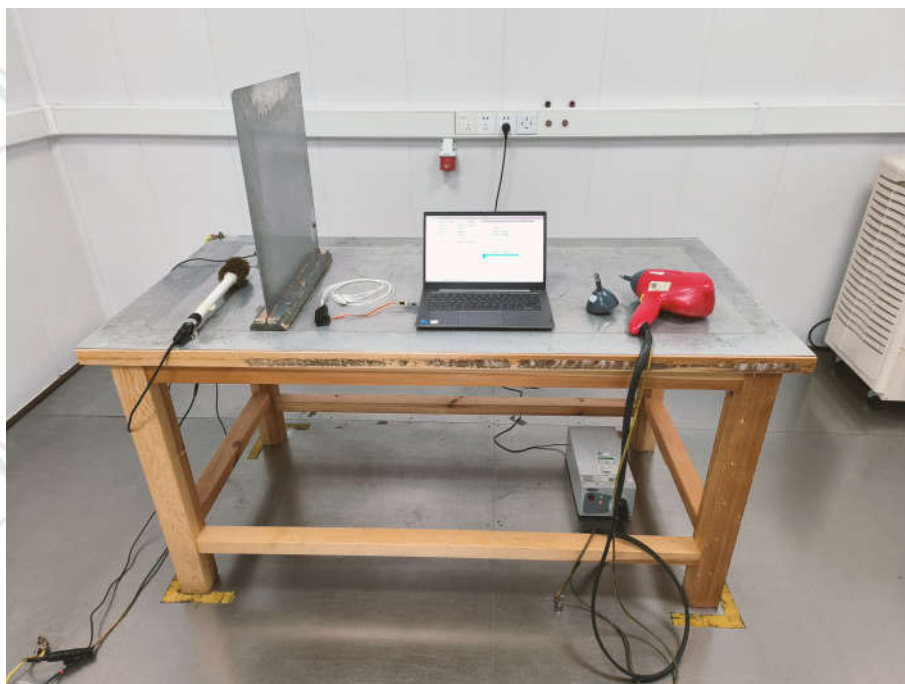
APPENDIX 1 PHOTOGRAPHS OF TEST SETUP



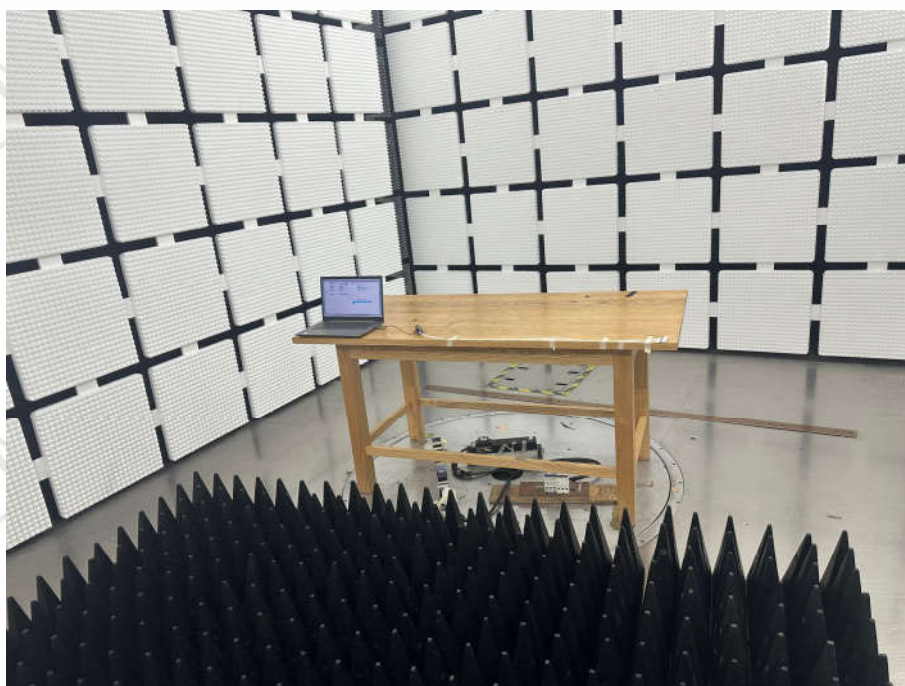
RADIATED EMISSION TEST SETUP-1



RADIATED EMISSION TEST SETUP-2

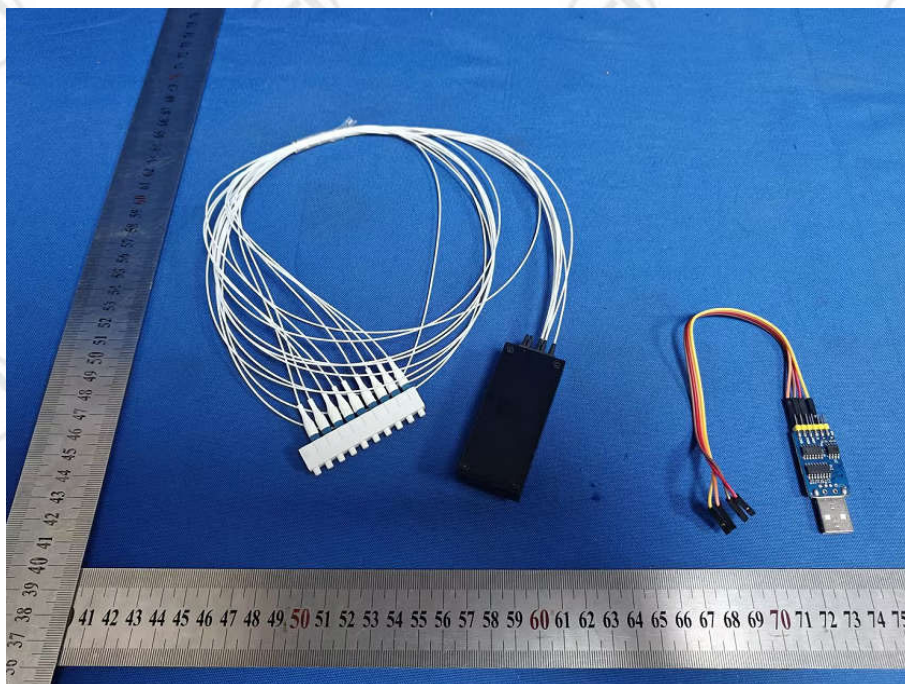


ESD TEST SETUP

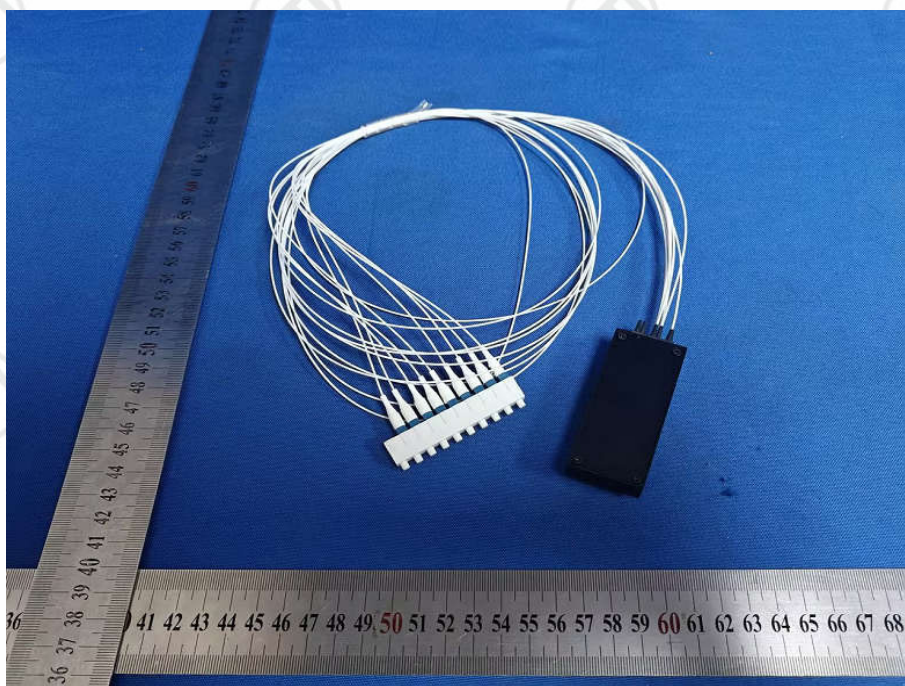


RADIO-FREQUENCY ELECTROMAGNETIC FIELD TEST SETUP

APPENDIX 2 PHOTOGRAPHS OF PRODUCT



View of Product-1



View of Product-2

The test report is effective only with both signature and specialized stamp. The result(s) shown in this report refer only to the sample(s) tested. Without written approval of CTI, this report can't be reproduced except in full.

*** End of Report ***