
ACT4529M Automotive EMC Performance**Abstract**

This application note shows that the ACT4529M passes third party testing for Automotive SAE-J1752-1 and SAE-J1752-3 EMC testing at EMI level M8A.

Introduction

Automotive applications place stringent EMC restrictions on all electrical components and sub-systems. This ensures electrical compatibility with many different systems in the automobile. Components that do not meet these requirements can radiate high levels of electromagnetic interference, EMI, that adversely affect other circuits.

Because the ACT4529M is an ideal solution for automotive cigarette lighter adapter, CLA, USB charging, Active-Semi is proactively showing that it passes SAE-J1752-1 and SAE-J1752-3 EMC requirements. This application note does not provide detailed test methodology which can be found in published standards. This application note provides PCB schematic, layout, and resulting test data.

Test Board

Active-Semi designed the ACT4529M test board in accordance with SAE J1752-3 requirements. It measures 4x4in and is designed to minimize radiated emissions. The ground plane is maximized on both top and bottom layers. The ACT4529M power stage routing is optimized to minimize loop areas to reduce radiated emissions.

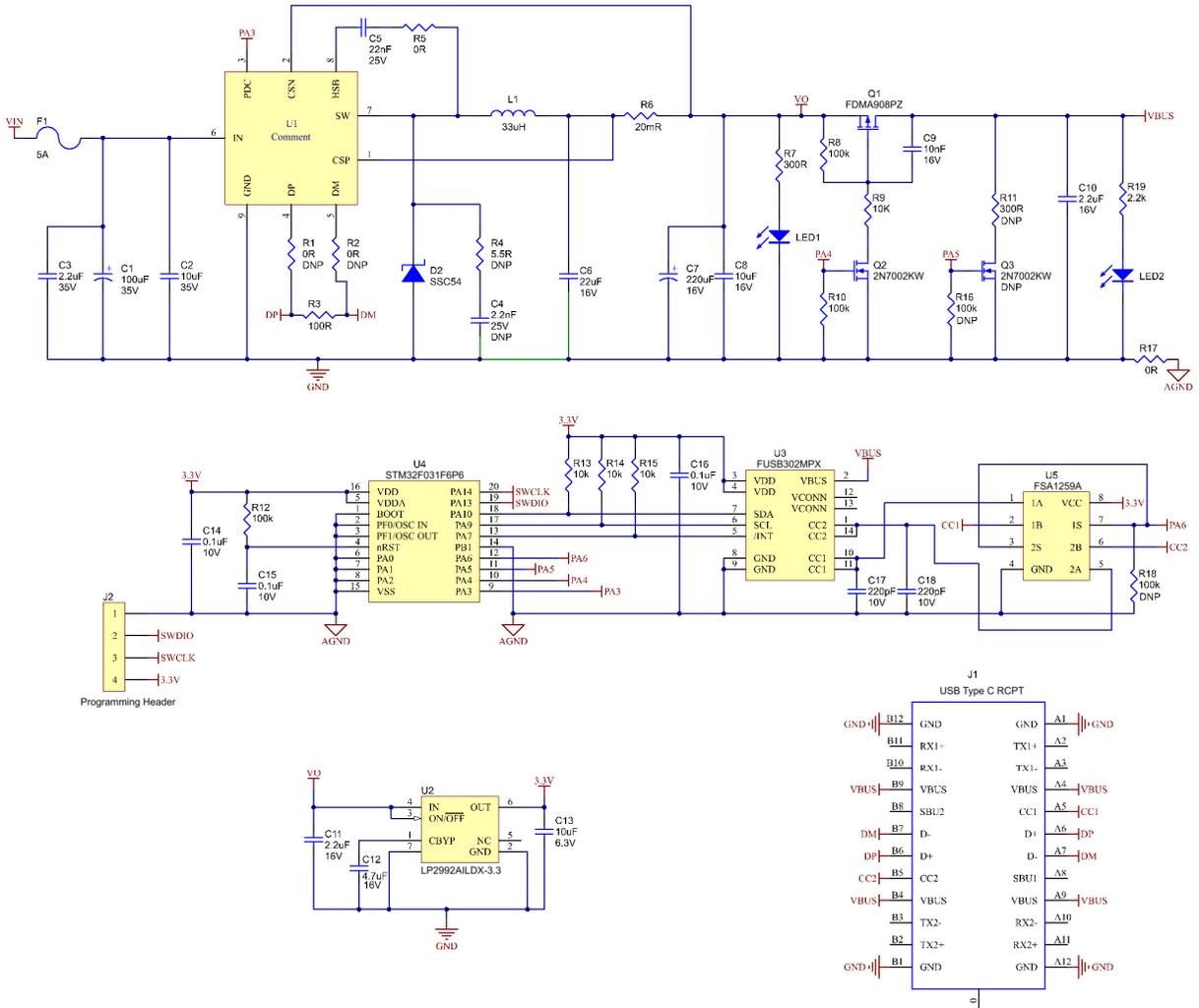


Figure 1. Schematic

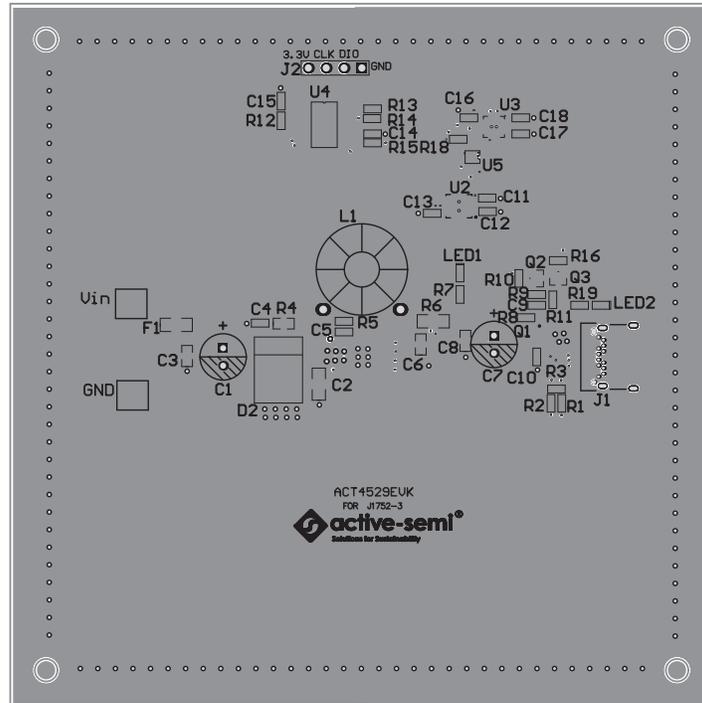


Figure 2. Top Assembly

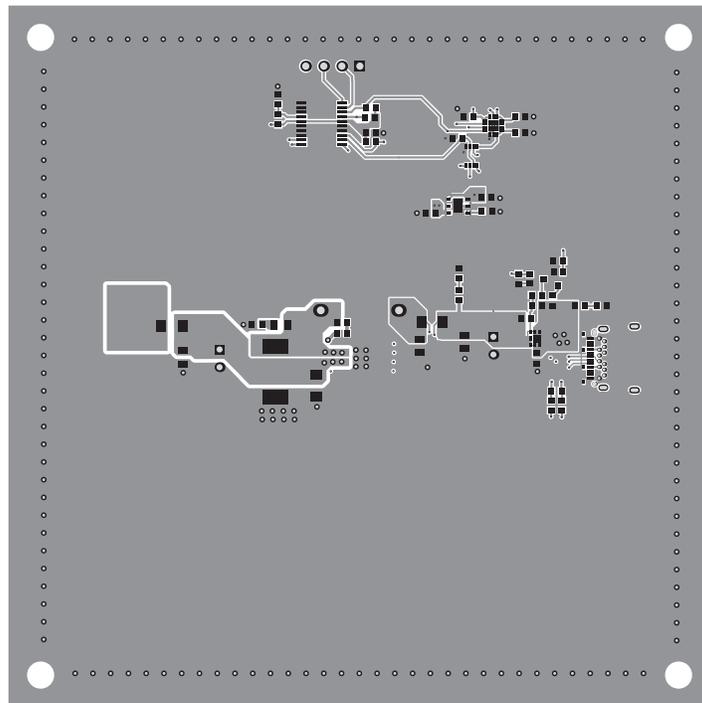


Figure 3. Top Layer

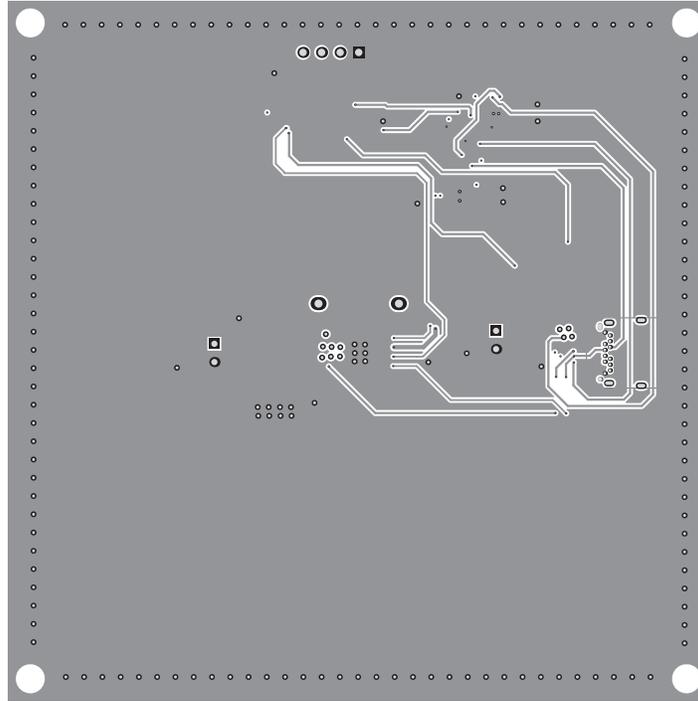


Figure 4. Layer 2

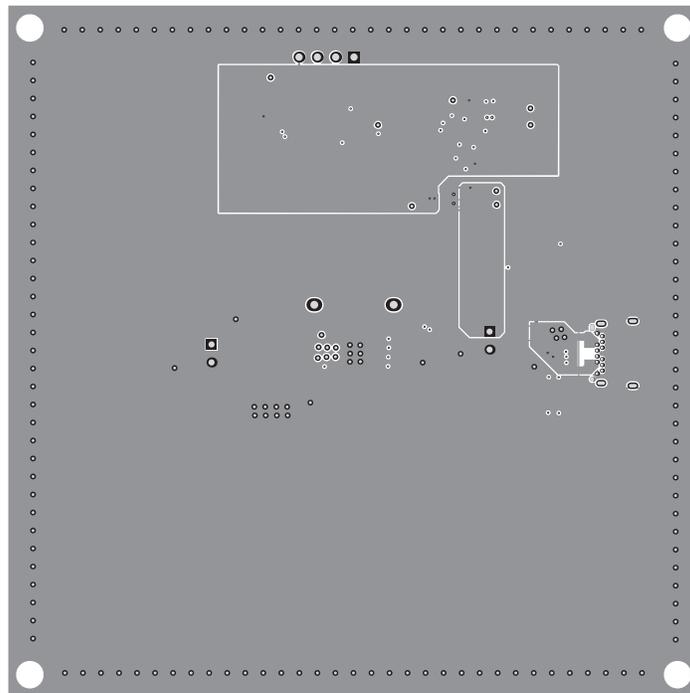


Figure 5. Layer 3

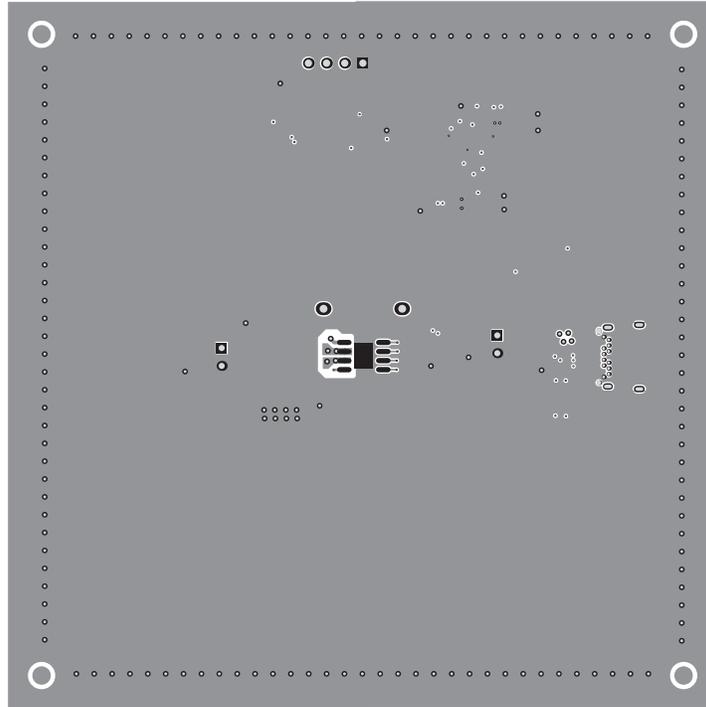


Figure 6. Bottom Layer

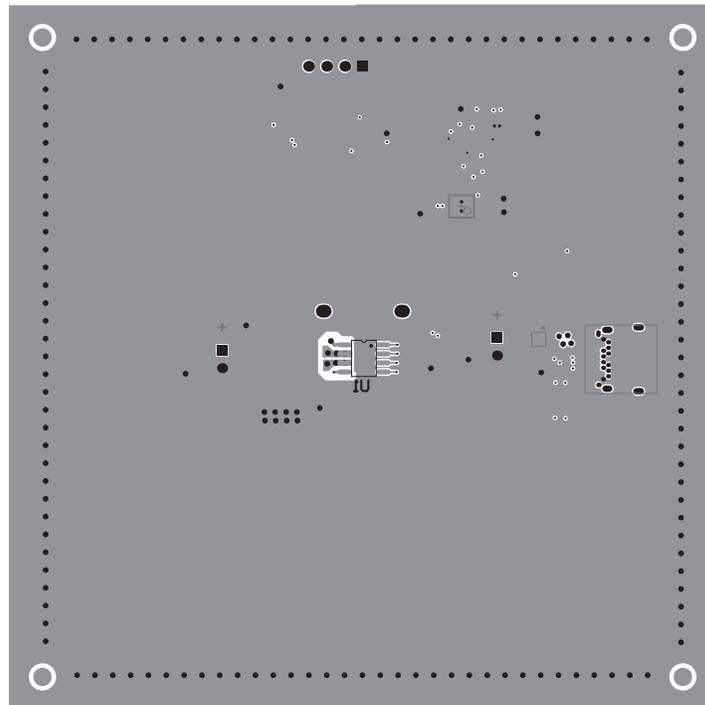


Figure 7. Bottom Assembly

EMC Testing

The PCB was tested at level M8A for radiated emissions accordance with Automotive SAE J1752-1 and SAE J1752-3 requirements “Electromagnetic Compatibility Measurement Procedure for Integrated Circuits”. Testing was performed from 150kHz to 1000kHz in four separate physical orientations. The circuit was operated at Vout = 5V, 9V, and 12V at 3A load for each of the orientations.

Testing Summary

Test Item		IC EMC Level (direction/per)	IC EMC Level (IC/per)	Emissions Margin (dB)
Mode1 5V / 3A	Mode1 0°	M8A	M8A	4.21-7.23
	Mode1 90°	M8A		3.99-7.39
	Mode1 180°	M8A		4.56-7.51
	Mode1 270°	M8A		4.62-7.81
Mode2 9V / 3A	Mode2 0°	M8A		4.14-6.76
	Mode2 90°	M8A		4.66-7.81
	Mode2 180°	M8A		5.37-7.18
	Mode2 270°	M8A		4.41-7.17
Mode3 12V / 3A	Mode3 0°	M8A		4.95-7.34
	Mode3 90°	M8A		4.42-6.87
	Mode3 180°	M8A		4.41-7.30
	Mode3 270°	M8A		5.4-7.24

4. CONTENTS OF TEST

4.1 0° Ambient

Job No.:	Ambient	Polarization:	Ambient
Limit:	NA	Voltage:	NA
Date:	2016/12/20	Time:	上午 10:55:17

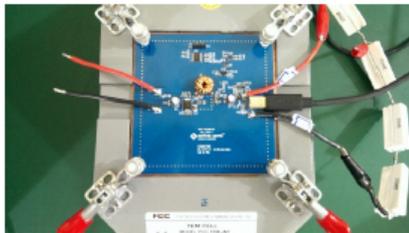
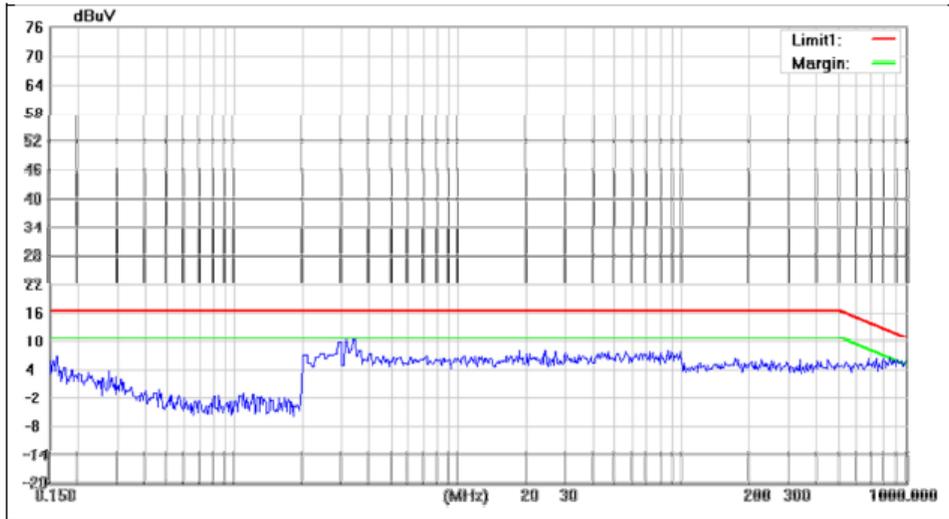
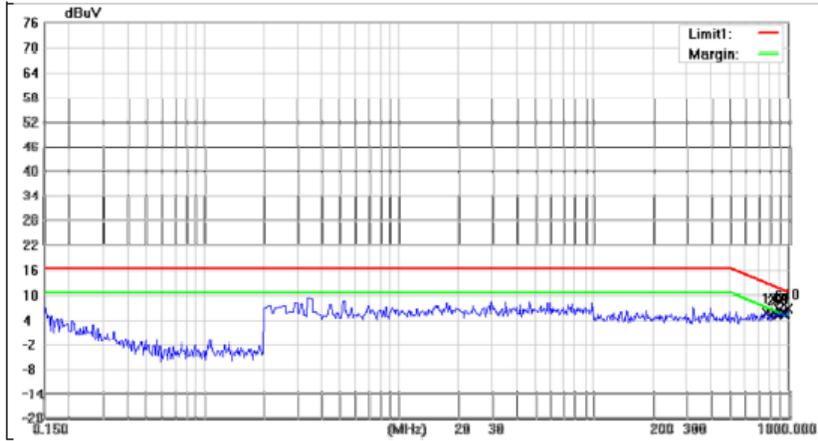


Figure 8. Ambient Radiated Emissions. No Power Applied to PCB

4.2 Mode1 (5V / 3A)
(1) Polarization : 0°

Job No.:	ACT4529 (Mode1)	Polarization:	0°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:19:43



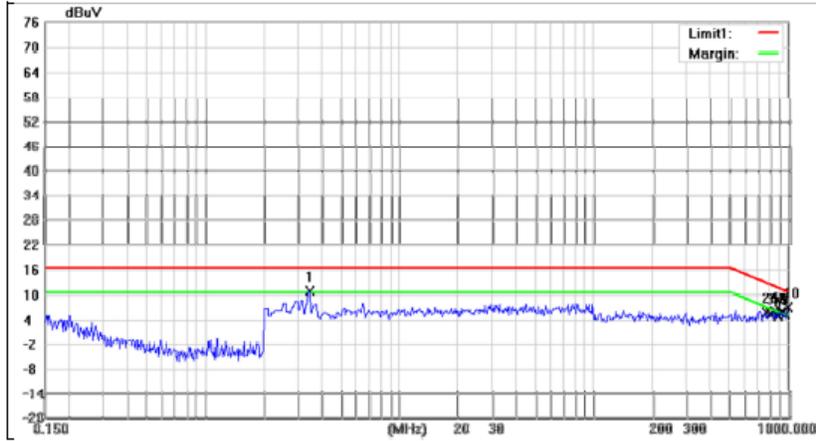
No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	774.6000	6.99	14.22	-7.23	peak
2	822.2000	6.38	13.70	-7.32	peak
3	843.9000	6.96	13.47	-6.51	peak
4	856.5000	6.98	13.35	-6.37	peak
5	879.6000	6.44	13.11	-6.67	peak
6	897.8000	7.72	12.94	-5.22	peak
7	932.1000	6.94	12.61	-5.67	peak
8	951.7000	6.57	12.43	-5.86	peak
9	969.9000	6.61	12.27	-5.66	peak
10	1000.0000	7.79	12.00	-4.21	peak



Figure 9. Mode 1. 5V/3A. 0° Polarization

(2) Polarization : 90°

Job No.:	ACT4529 (Mode1)	Polarization:	90°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:04:28



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	3.4772	12.14	18.00	-5.86	peak
2	774.6520	6.83	14.22	-7.39	peak
3	816.6766	6.73	13.76	-7.03	peak
4	853.4334	7.15	13.38	-6.23	peak
5	876.2769	6.80	13.15	-6.35	peak
6	891.8446	5.83	12.99	-7.16	peak
7	923.8146	6.96	12.69	-5.73	peak
8	948.5420	6.94	12.46	-5.52	peak
9	965.3935	6.50	12.31	-5.81	peak
10	1000.0000	8.01	12.00	-3.99	peak

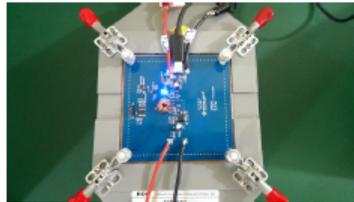
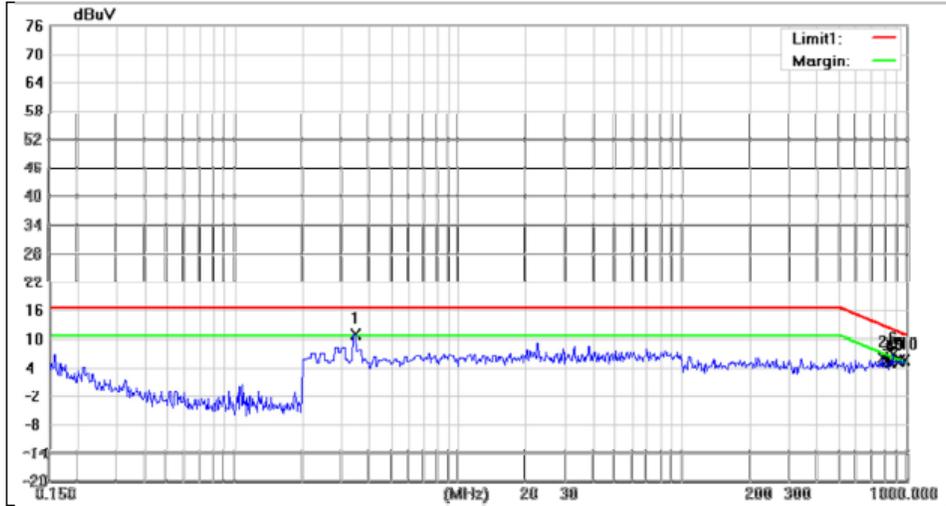


Figure 10. Mode 1. 5V/3A. 90° Polarization

(3) Polarization : 180°

Job No.:	ACT4529 (Mode1)	Polarization:	180°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:10:33



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	3.4772	12.24	18.00	-5.76	peak
2	781.5028	7.17	14.14	-6.97	peak
3	809.5174	6.37	13.84	-7.47	peak
4	838.5362	6.02	13.53	-7.51	peak
5	853.4334	6.18	13.38	-7.20	peak
6	868.5953	7.79	13.22	-5.43	peak
7	907.6889	6.68	12.84	-6.16	peak
8	923.8146	6.47	12.69	-6.22	peak
9	940.2268	6.68	12.54	-5.86	peak
10	982.5444	6.69	12.15	-5.46	peak

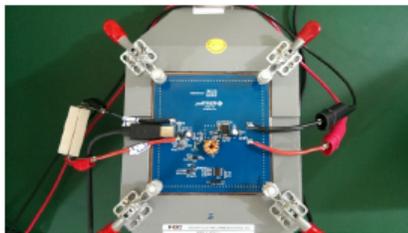
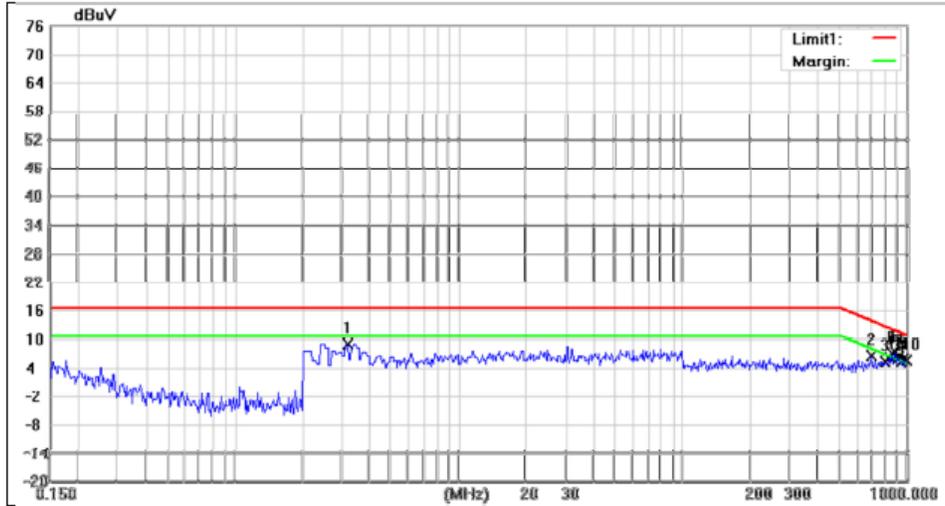


Figure 11. Mode 1. 5V/3A. 180° Polarization

(4) Polarization : 270°

Job No.:	ACT4529 (Mode1)	Polarization:	270°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:14:45



No.	Frequency (MHz)	Result	Limit	Over Limit (dB)	Remark
		26(C)/55%RH	26(C)/55%RH		
1	3.1760	10.19	18.00	-7.81	peak
2	692.7000	7.75	15.19	-7.44	peak
3	799.8000	6.46	13.94	-7.48	peak
4	834.1000	7.21	13.58	-6.37	peak
5	858.6000	8.20	13.32	-5.12	peak
6	888.0000	8.41	13.03	-4.62	peak
7	916.7000	7.41	12.76	-5.35	peak
8	942.6000	6.26	12.51	-6.25	peak
9	969.2000	6.76	12.27	-5.51	peak
10	1000.0000	6.54	12.00	-5.46	peak

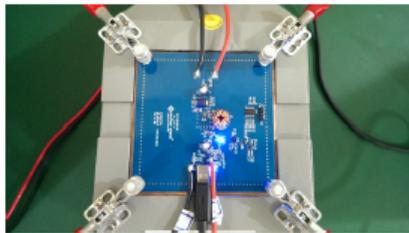
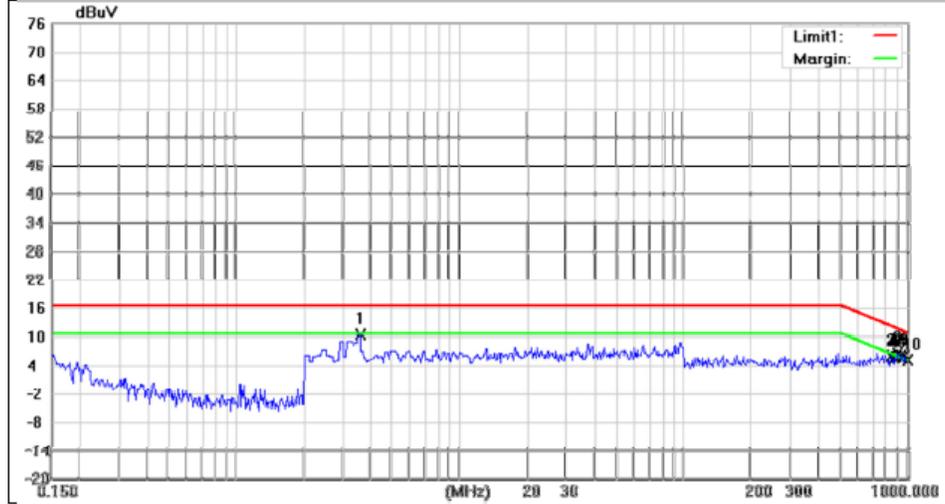


Figure 12. Mode 1. 5V/3A. 270° Polarization

4.3 Mode2 (9V / 3A)
(1) Polarization : 0°

Job No.:	ACT4529 (Mode2)	Polarization:	0°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:24:01



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	3.5680	11.75	18.00	-6.25	peak
2	832.7000	6.83	13.59	-6.76	peak
3	849.5000	7.19	13.42	-6.23	peak
4	865.6000	6.63	13.25	-6.62	peak
5	891.5000	6.95	13.00	-6.05	peak
6	908.3000	7.55	12.84	-5.29	peak
7	930.7000	7.16	12.62	-5.46	peak
8	946.1000	6.59	12.48	-5.89	peak
9	967.1000	7.15	12.29	-5.14	peak
10	1000.0000	6.02	12.00	-5.98	peak

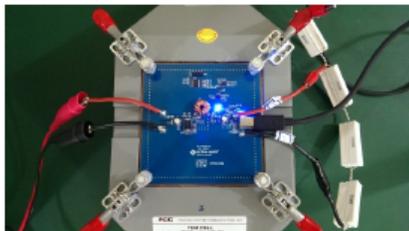
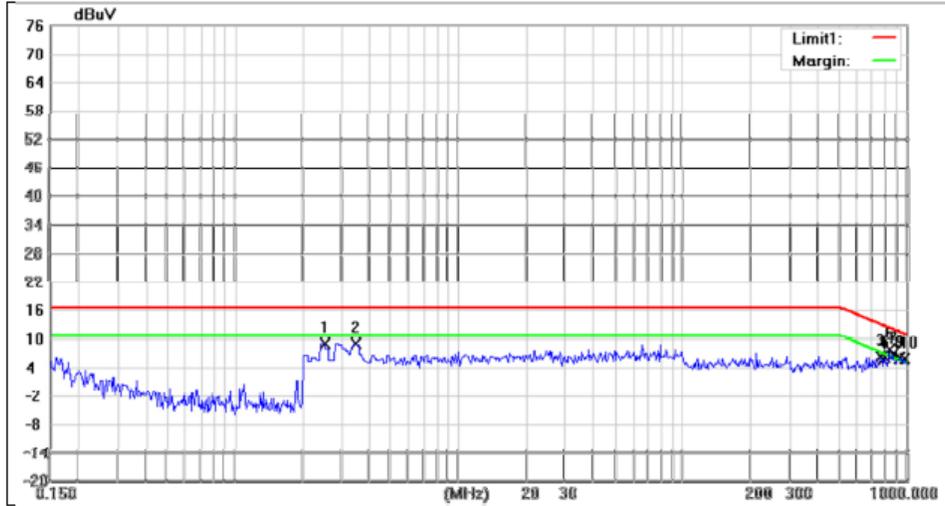


Figure 13. Mode 2. 9V/3A. 0° Polarization

(2) Polarization : 90°

Job No.:	ACT4529 (Mode2)	Polarization:	90°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:28:42



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	2.4900	10.22	18.00	-7.78	peak
2	3.4700	10.19	18.00	-7.81	peak
3	766.9000	7.37	14.31	-6.94	peak
4	778.1000	6.61	14.18	-7.57	peak
5	799.8000	7.07	13.94	-6.87	peak
6	835.5000	8.90	13.56	-4.66	peak
7	864.9000	7.81	13.26	-5.45	peak
8	923.7000	6.96	12.69	-5.73	peak
9	937.7000	7.22	12.56	-5.34	peak
10	979.7000	6.76	12.18	-5.42	peak

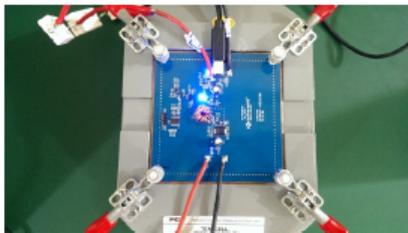
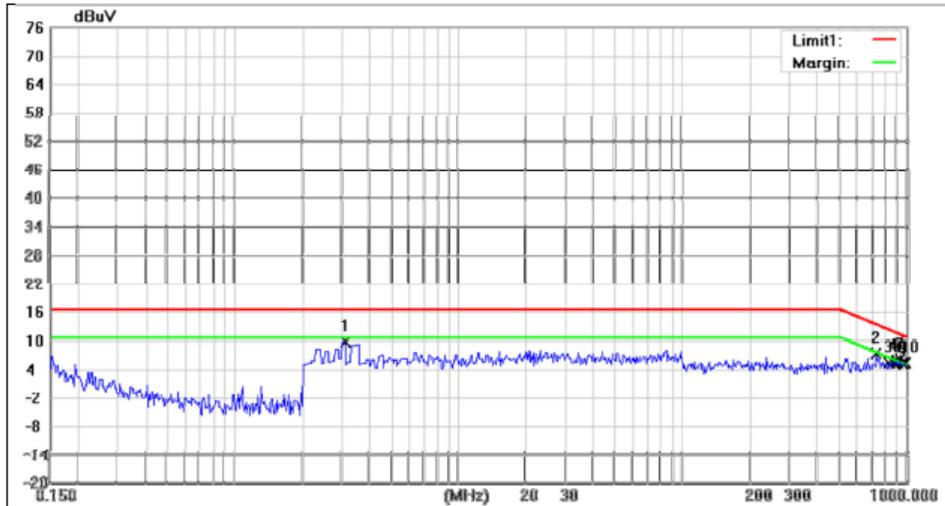


Figure 14. Mode 2. 9V/3A. 90° Polarization

(3) Polarization : 180°

Job No.:	ACT4529 (Mode2)	Polarization:	180°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:32:19



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	3.1011	10.92	18.00	-7.08	peak
2	734.7899	8.41	14.68	-6.27	peak
3	831.1854	6.43	13.61	-7.18	peak
4	868.5953	6.59	13.22	-6.63	peak
5	899.7319	6.76	12.92	-6.16	peak
6	915.7162	6.50	12.76	-6.26	peak
7	931.9846	7.24	12.61	-5.37	peak
8	956.9306	6.50	12.38	-5.88	peak
9	973.9312	6.25	12.23	-5.98	peak
10	991.2338	6.38	12.08	-5.70	peak

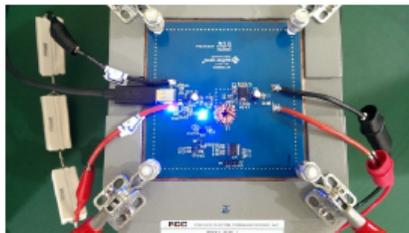
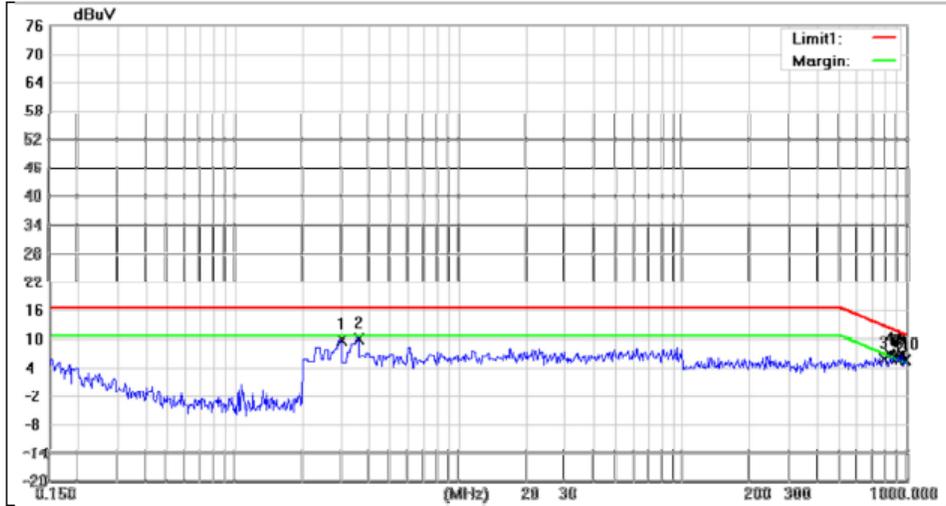


Figure 15. Mode 2. 9V/3A. 180° Polarization

(4) Polarization : 270°

Job No.:	ACT4529 (Mode2)	Polarization:	270°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:36:14



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	2.9800	10.83	18.00	-7.17	peak
2	3.5680	11.05	18.00	-6.95	peak
3	793.5000	6.88	14.01	-7.13	peak
4	841.1000	7.76	13.50	-5.74	peak
5	883.8000	7.28	13.07	-5.79	peak
6	894.3000	7.07	12.97	-5.90	peak
7	923.7000	7.35	12.69	-5.34	peak
8	932.8000	6.76	12.60	-5.84	peak
9	954.5000	7.99	12.40	-4.41	peak
10	985.3000	6.57	12.13	-5.56	peak

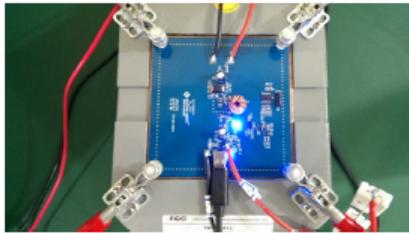
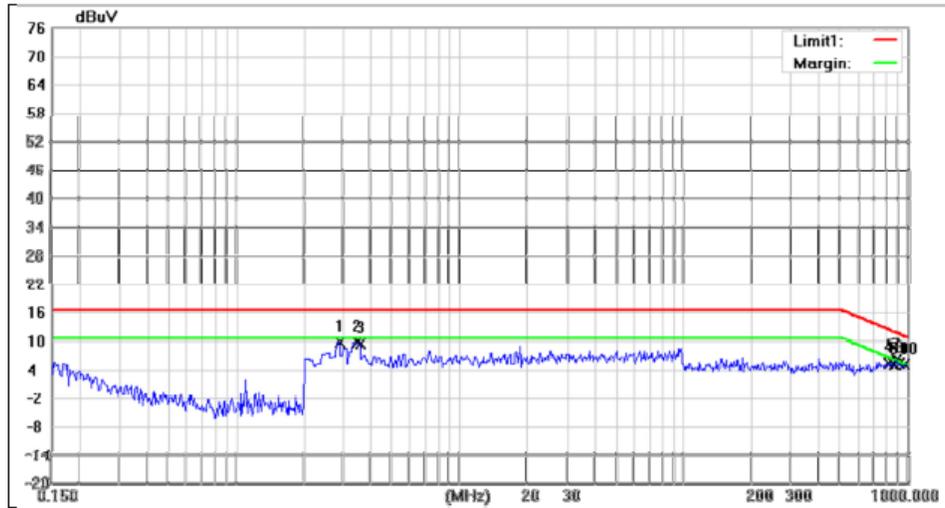


Figure 16. Mode 2. 9V/3A.270° Polarization

4.4 Mode3 (12V / 3A)
(1) Polarization : 0°

Job No.:	ACT4529 (Mode3)	Polarization:	0°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:41:01



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	2.8820	10.83	18.00	-7.17	peak
2	3.4700	10.95	18.00	-7.05	peak
3	3.5680	10.66	18.00	-7.34	peak
4	823.6000	6.35	13.69	-7.34	peak
5	833.4000	6.79	13.58	-6.79	peak
6	866.3000	6.09	13.25	-7.16	peak
7	888.0000	7.08	13.03	-5.95	peak
8	916.7000	6.33	12.76	-6.43	peak
9	962.9000	6.23	12.33	-6.10	peak
10	974.1000	6.14	12.23	-6.09	peak

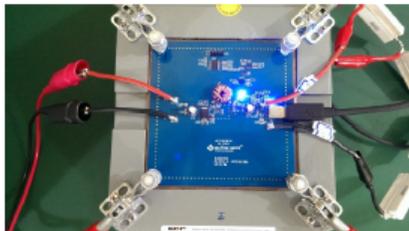
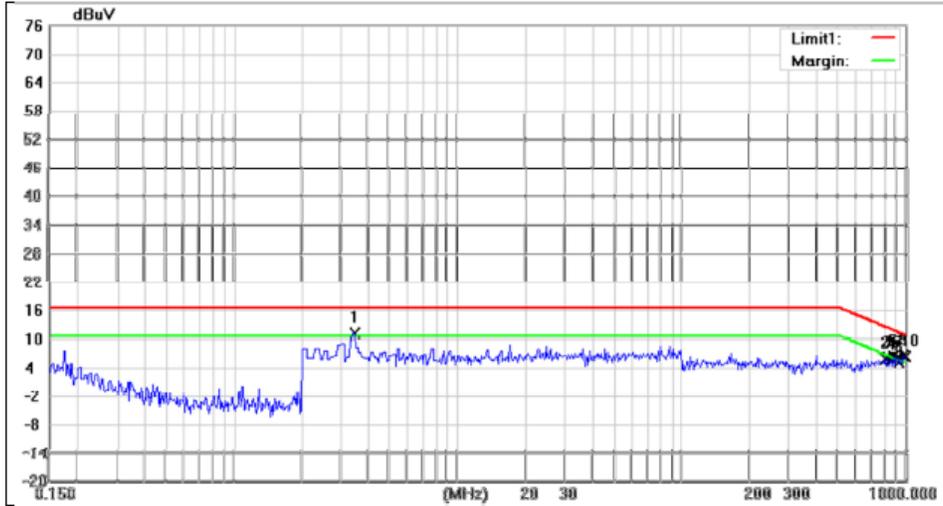


Figure 17. Mode 3. 12V/3A. 0° Polarization

(2) Polarization : 90°

Job No.:	ACT4529 (Mode3)	Polarization:	90°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:44:31



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	3.4700	12.40	18.00	-5.60	peak
2	806.8000	6.99	13.86	-6.87	peak
3	827.1000	7.09	13.65	-6.56	peak
4	855.1000	6.65	13.36	-6.71	peak
5	881.0000	7.28	13.10	-5.82	peak
6	909.7000	7.07	12.82	-5.75	peak
7	934.9000	7.20	12.58	-5.38	peak
8	948.9000	6.13	12.46	-6.33	peak
9	975.5000	7.70	12.22	-4.52	peak
10	1000.0000	7.45	12.00	-4.55	peak

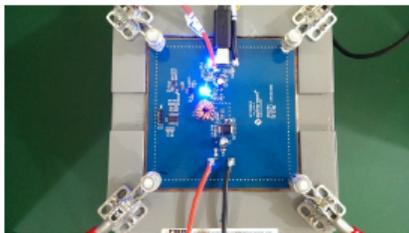
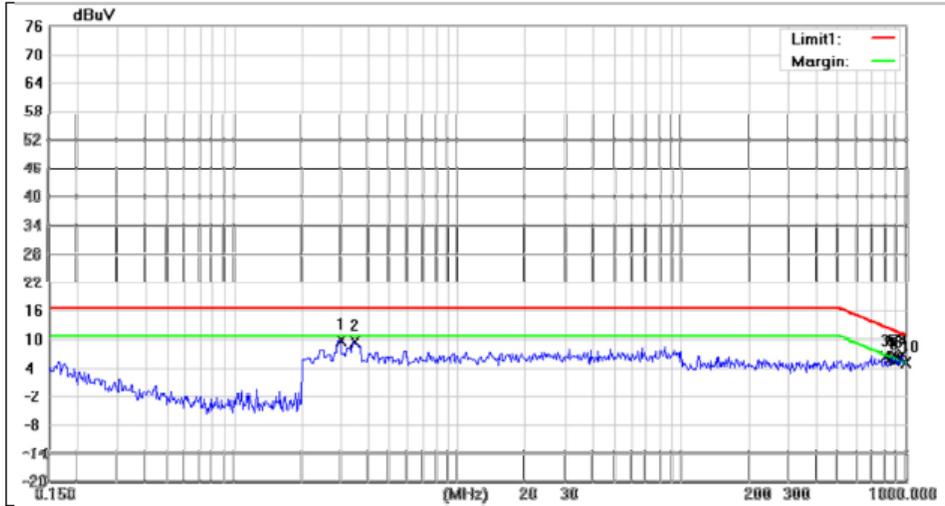


Figure 18. Mode 3. 12V/3A. 90° Polarization

(3) Polarization : 180°

Job No.:	ACT4529 (Mode3)	Polarization:	180°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:48:39



No.	Frequency (MHz)	Result 26(C)/55%RH	Limit 26(C)/55%RH	Over Limit (dB)	Remark
1	2.9800	10.89	18.00	-7.11	peak
2	3.4700	10.70	18.00	-7.30	peak
3	804.7000	7.26	13.89	-6.63	peak
4	849.5000	6.84	13.42	-6.58	peak
5	864.2000	7.31	13.27	-5.96	peak
6	888.7000	6.54	13.02	-6.48	peak
7	905.5000	7.38	12.86	-5.48	peak
8	931.4000	7.19	12.62	-5.43	peak
9	969.9000	7.86	12.27	-4.41	peak
10	1000.0000	6.12	12.00	-5.88	peak

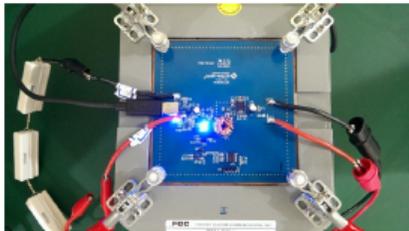
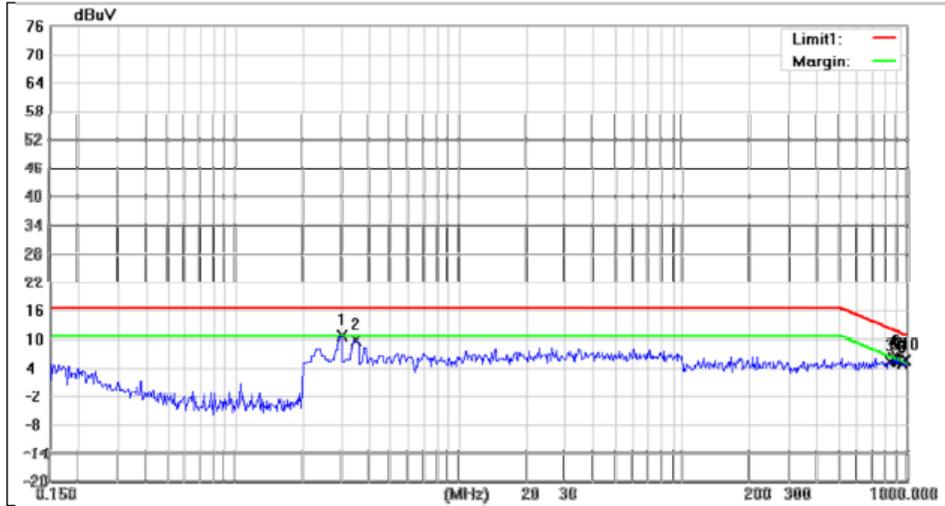


Figure 19. Mode 3. 12V/3A. 180° Polarization

(4) Polarization : 270°

Job No.:	ACT4529 (Mode3)	Polarization:	270°
Limit:	M8A	Voltage:	VCC=12V
Date:	2016/12/20	Time:	上午 10:51:59



No.	Frequency (MHz)	Result	Limit	Over Limit	Remark
		26(C)/55%RH	26(C)/55%RH	(dB)	
1	2.9800	11.85	18.00	-6.15	peak
2	3.4700	10.90	18.00	-7.10	peak
3	839.7000	6.28	13.52	-7.24	peak
4	873.3000	7.19	13.18	-5.99	peak
5	890.8000	6.56	13.00	-6.44	peak
6	907.6000	7.42	12.84	-5.42	peak
7	924.4000	6.54	12.68	-6.14	peak
8	953.8000	6.15	12.41	-6.26	peak
9	965.7000	5.79	12.30	-6.51	peak
10	989.5000	6.69	12.09	-5.40	peak

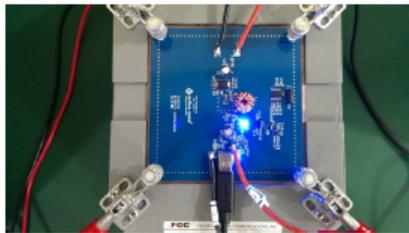


Figure 20. Mode 3. 12V/3A. 270° Polarization

Conclusion

The ACT4529M is an optimal choice for automotive applications. It passes third party Automotive SAE-J1752-1 and SAE-J1752-3 EMC testing at EMI level M8A with margin.