

TPS54xx0-Q1 and TPS57xx0-Q1 Devices EMC Performance Comparison Study

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ABSTRACT

This application report provides the Electromagnetic Compatibility (EMC) performance comparison for radiated and conducted emissions between devices in the same high-frequency buck converter family. TPS54xx0-Q1 and TPS57xx0-Q1 devices have few differences in electrical parameters as listed in [Table 2](#). These electrical parametric changes are achieved by implementing minor changes in metal layers. This report shows that these devices have similar EMC performance as expected.

Contents

1	Introduction	2
2	EMC Tests	3
3	Conclusion	14

List of Figures

1	Setup for Conducted Emission (CE) Measurements.....	3
2	Setup for Radiated Emission (RE) – Monopole Antenna (Rod) for 150 kHz to 30 MHz Range	4
3	Setup for Radiated Emission (RE) – Bi-con Antenna Horizontal for 30 MHz to 200 MHz Range	4
4	Setup for Radiated Emission (RE) – Bi-con Antenna Vertical for 30 MHz to 200 MHz Range.....	5
5	Conducted Emission Line Side: Ambient	6
6	Conducted Emission Return Side: Ambient	6
7	Conducted Emission Line Side: TPS54040-Q1.....	6
8	Conducted Emission Line Side: TPS57040-Q1.....	6
9	Conducted Emission Return Side: TPS54040-Q1.....	6
10	Conducted Emission Return Side: TPS57040-Q1.....	6
11	Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz – Ambient	7
12	Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS54040-Q1	7
13	Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS57040-Q1	7
14	Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: Ambient.....	7
15	Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: Ambient.....	7
16	Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: TPS54040-Q1	7
17	Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: TPS57040-Q1	7
18	Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: TPS54040-Q1	9
19	Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: TPS57040-Q1	9
20	Conducted Emission Line Side: Ambient	10
21	Conducted Emission Return Side: Ambient	10
22	Conducted Emission Line Side: TPS54160-Q1	10
23	Conducted Emission Line Side: TPS57160-Q1	10
24	Conducted Emission Return Side: TPS54160-Q1	10
25	Conducted Emission Return Side: TPS57160-Q1	10

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26 Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: Ambient 11

27 Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS54160-Q1 11

28 Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS57160-Q1 11

29 Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: Ambient 11

30 Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: Ambient 11

31 Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: TPS54160-Q1 11

32 Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: TPS57160-Q1 11

33 Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: TPS54160-Q1 13

34 Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: TPS57160-Q1 13

List of Tables

1 List of Devices Being Phased Out (EOL) and Proposed Replacement Devices 2

2 Key Electrical Specification Differences Among TPS54xx0-Q1 and TPS57xx0-Q1 Devices 2

1 Introduction

The TPS570x0-Q1 and TPS571x0-Q1 devices have been updated to improve the EN threshold tolerance and ESD performance with respect to the TPS540x0-Q1 and TPS541x0-Q1 devices they replace. A PCN was issued in 2015 to notify the customers of End of Life (EOL) for TPS540x0-Q1 and TPS541x0-Q1 devices and replacement devices are proposed according to [Table 1](#). [Table 2](#) shows the key electrical specification differences among these devices.

Pre-certification EMC-radiated emissions tests according to Automotive CISPR25 guidelines show the EMC performance between the original device and its replacement device is similar and comparable. This application report is a comparison study between the devices in this family. These devices can pass emissions requirements by optimizing external components selection, component placement, and board layout.

Table 1. List of Devices Being Phased Out (EOL) and Proposed Replacement Devices

DEVICES BEING PHASED OUT	PROPOSED REPLACEMENT DEVICE
TPS54040-Q1	TPS57040-Q1
TPS54060-Q1	TPS57060-Q1
TPS54140-Q1	TPS57140-Q1
TPS54160-Q1	TPS57160-Q1

Table 2. Key Electrical Specification Differences Among TPS54xx0-Q1 and TPS57xx0-Q1 Devices

DEVICE NAME	MAXIMUM INPUT VOLTAGE (V)	MAXIMUM LOAD CURRENT (A)	ESD RATING(V) – HBM ⁽¹⁾	EN PIN SWITCHING THRESHOLD (V)
TPS54040-Q1	42	0.5	+/-500	Min=0.9 Max=1.55
TPS54060-Q1	60	0.5	+/-500	Min=0.9 Max=1.55
TPS54140-Q1	42	1.5	+/-500	Min=0.9 Max=1.55
TPS54160-Q1	60	1.5	+/-500	Min=0.9 Max=1.55
TPS57040-Q1	42	0.5	+/-2000	Min=1.15 Max=1.36
TPS57060-Q1	60	0.5	+/-2000	Min=1.15 Max=1.36

⁽¹⁾ Human-body model (HBM) per AEC Q100-002

Table 2. Key Electrical Specification Differences Among TPS54xx0-Q1 and TPS57xx0-Q1 Devices (continued)

DEVICE NAME	MAXIMUM INPUT VOLTAGE (V)	MAXIMUM LOAD CURRENT (A)	ESD RATING(V) – HBM ⁽¹⁾	EN PIN SWITCHING THRESHOLD (V)
TPS57140-Q1	42	1.5	+/-2000	Min=1.15 Max=1.36
TPS57160-Q1	60	1.5	+/-2000	Min=1.15 Max=1.36

2 EMC Tests

2.1 EMC Test Setup

Tests are carried out based on CISPR25 test procedures for conducted and radiated emissions at an external laboratory (test house). [Figure 1](#) through [Figure 4](#) shows pictures of each setup.



Figure 1. Setup for Conducted Emission (CE) Measurements



Figure 2. Setup for Radiated Emission (RE) – Monopole Antenna (Rod) for 150 kHz to 30 MHz Range



Figure 3. Setup for Radiated Emission (RE) – Bi-con Antenna Horizontal for 30 MHz to 200 MHz Range

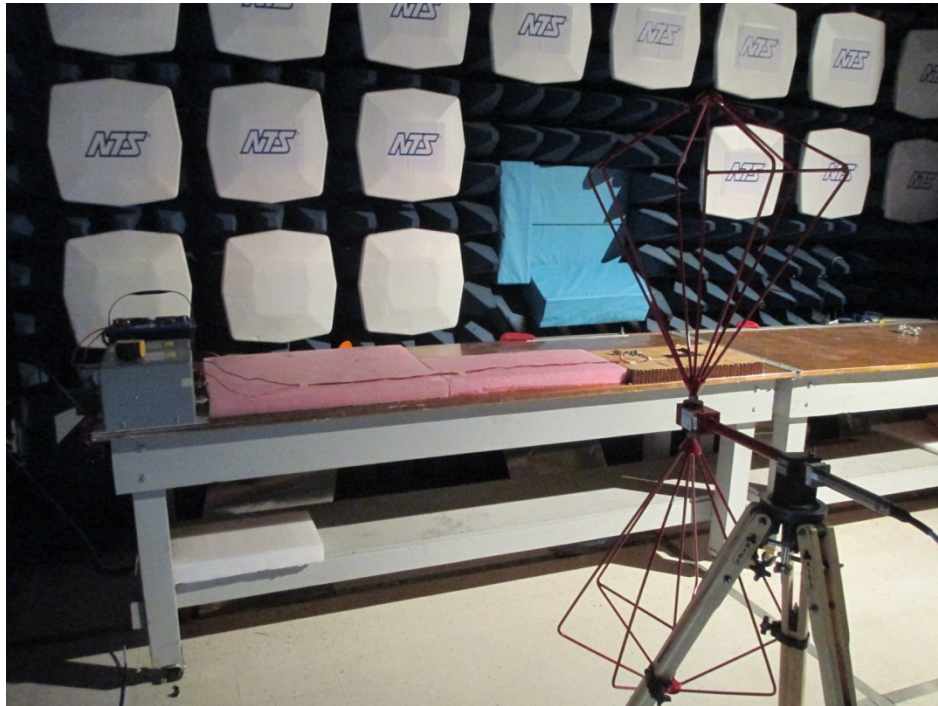


Figure 4. Setup for Radiated Emission (RE) – Bi-con Antenna Vertical for 30 MHz to 200 MHz Range

2.2 Device Setup

- Device under test (DUT) for comparison between TPS54040-Q1 and TPS57040-Q1 devices.
 - The TPS54040-Q1 device was mounted on one TPS57160EVM and TPS57040-Q1 device was mounted on another TPS57160EVM (see EVM schematics in *EVM User Guide* , [SLVUA80](#)).
- Device under test (DUT) for comparison between TPS54160-Q1 and TPS57160-Q1 devices.
 - The TPS54160-Q1 device was mounted on one TPS57160EVM and TPS57160-Q1 device was mounted on another TPS57160EVM (see EVM schematics in *EVM User Guide* , [SLVUA80](#)).
- Input voltage: Car battery
 - BAT+ = 13.5 V
 - BAT– = GND
- Switching frequency: $f_{sw} = 2$ MHz
- Output voltage: $V_o = 5$ V
- Load currents:
 - $I_o = 0.5$ A (10-ohm resistive load) for TPS54040-Q1 and TPS57040-Q1
 - $I_o = 1.0$ A (5-ohm resistive load) for TPS54160-Q1 and TPS57160-Q1
- Wiring harness length and placement: (BAT+ / BAT–) : 1.7 m. Wire harness and DUT are placed on 50 mm of insulation with respect to the test table.
- Line-Impedance Stabilization Networks (LISN): CISPR25 LISN placed between BAT+/BAT– and wire harness.

2.3 Measurement Procedure

Per CISPR25 measurement procedure, an ambient sweep is done without powering up the device.

After the ambient sweep, the device under test is powered up with its full load for the test measurement.

2.3.1 Comparison Between TPS54040-Q1 and TPS57040-Q1

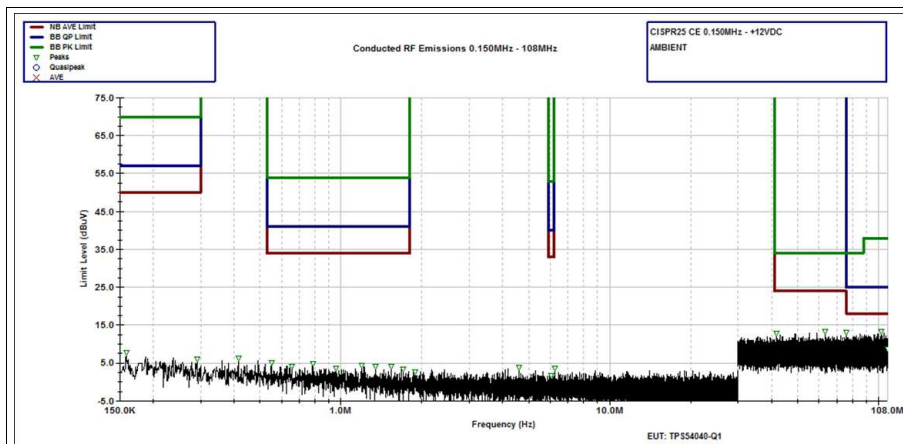


Figure 5. Conducted Emission Line Side: Ambient

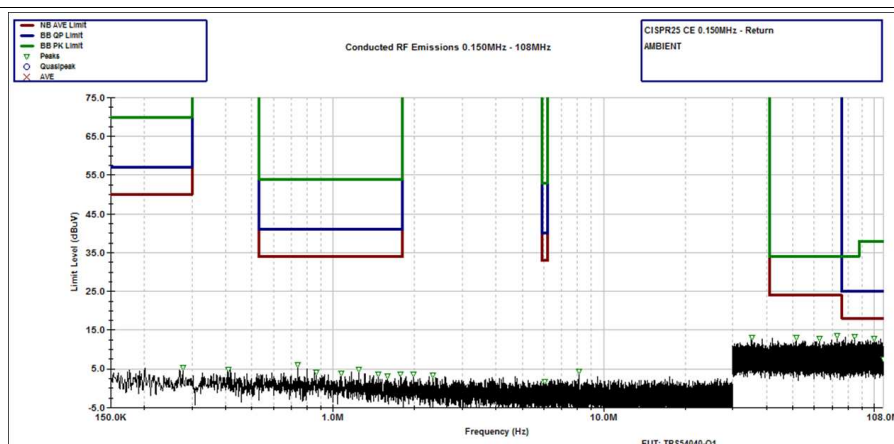


Figure 6. Conducted Emission Return Side: Ambient

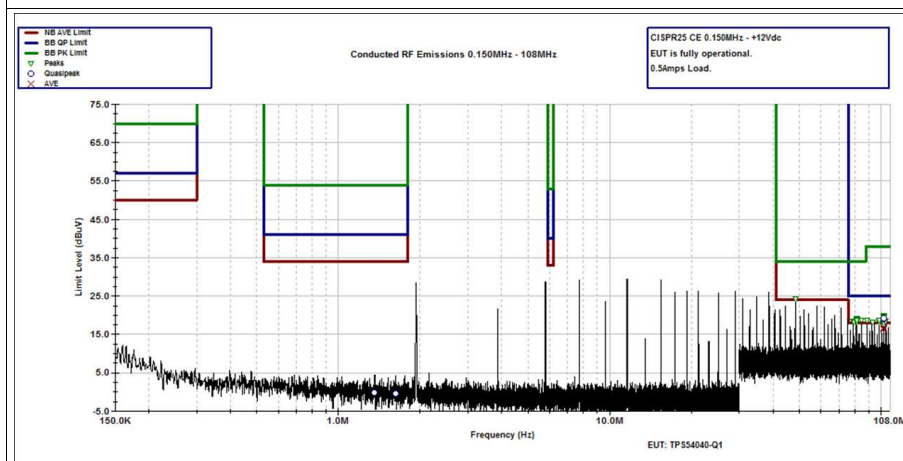


Figure 7. Conducted Emission Line Side: TPS54040-Q1

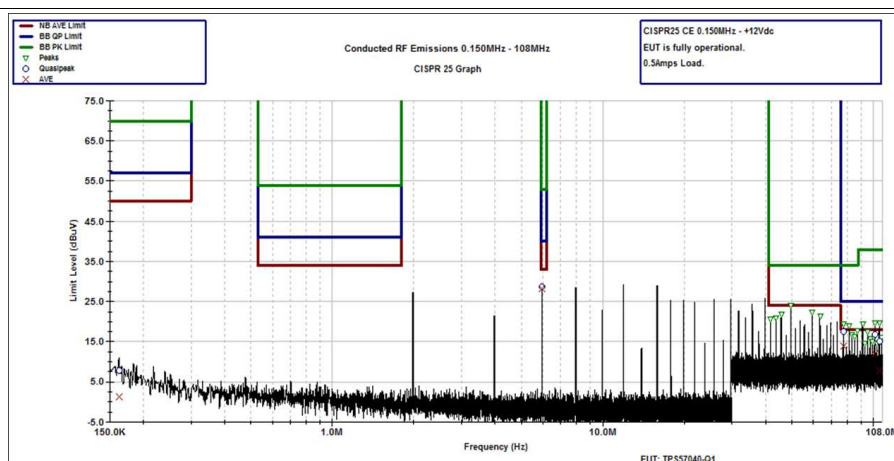


Figure 8. Conducted Emission Line Side: TPS57040-Q1

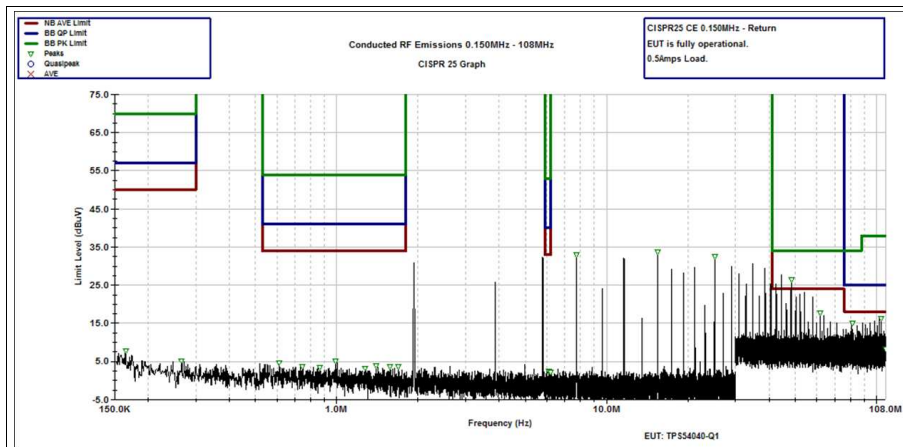


Figure 9. Conducted Emission Return Side: TPS54040-Q1

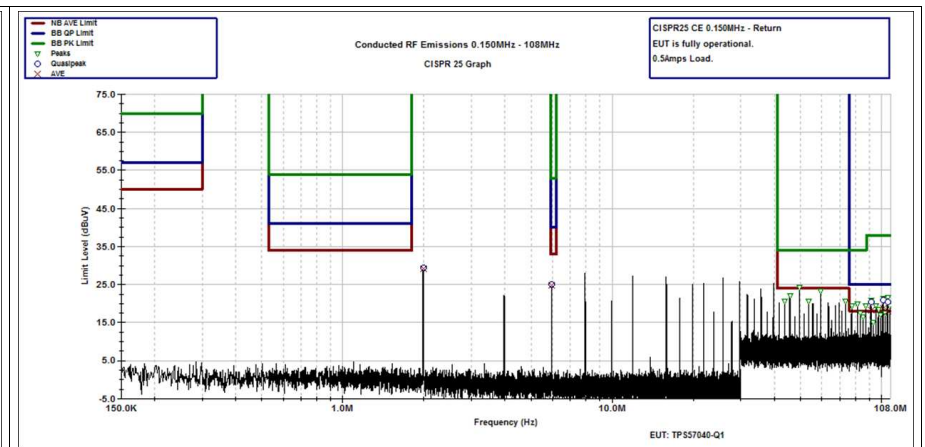


Figure 10. Conducted Emission Return Side: TPS57040-Q1

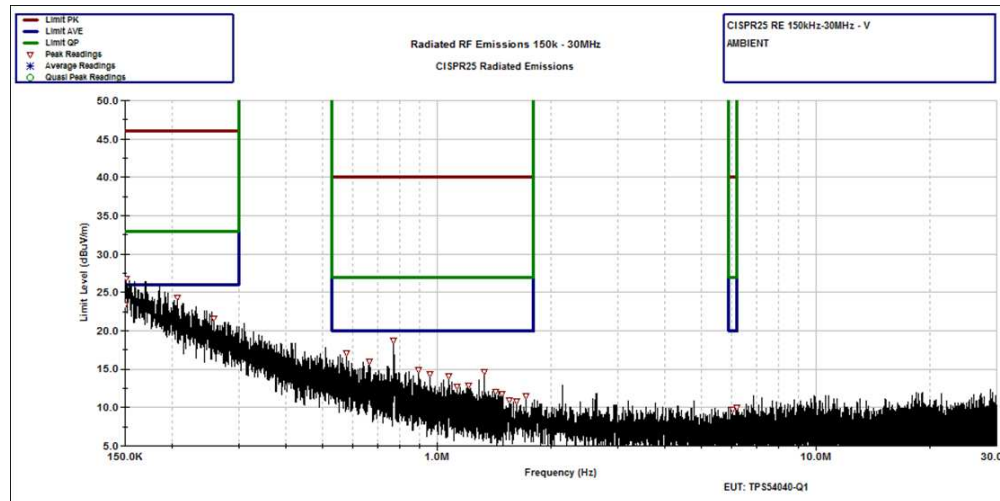


Figure 11. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz – Ambient

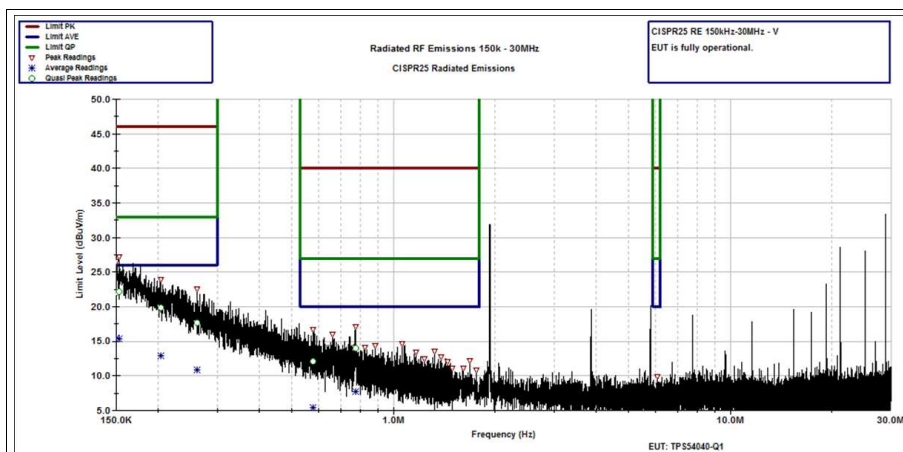


Figure 12. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS54040-Q1

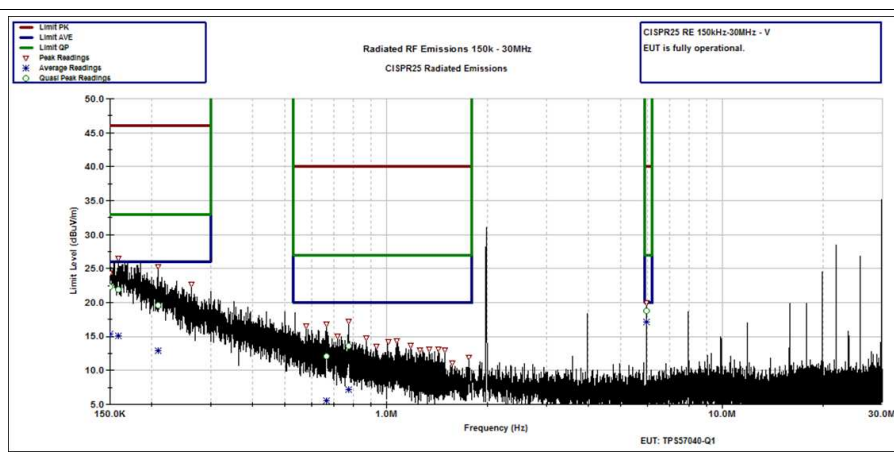


Figure 13. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS57040-Q1

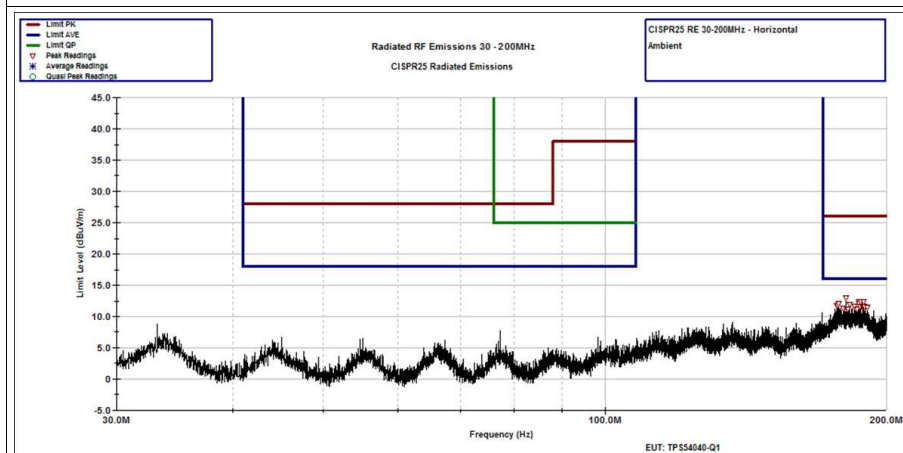


Figure 14. Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: Ambient

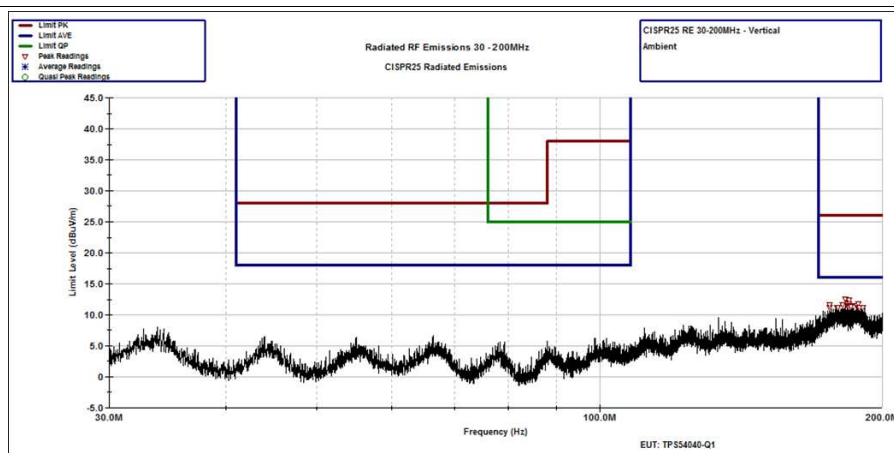


Figure 15. Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: Ambient

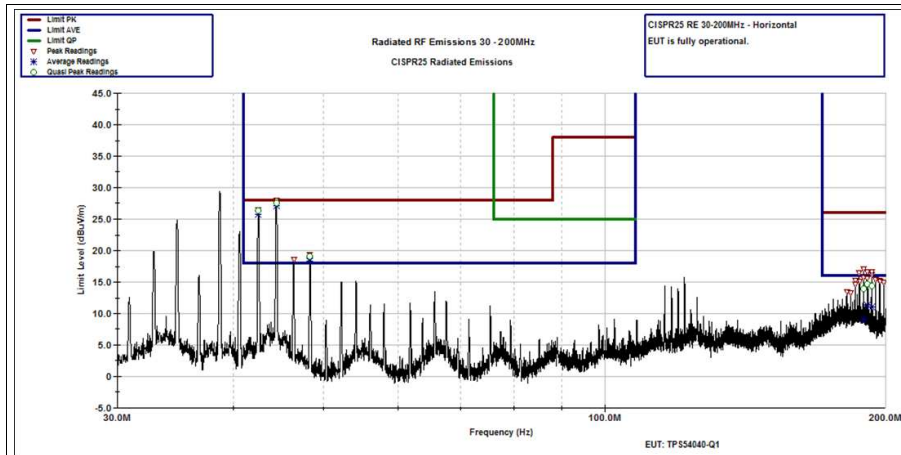


Figure 16. Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: TPS54040-Q1

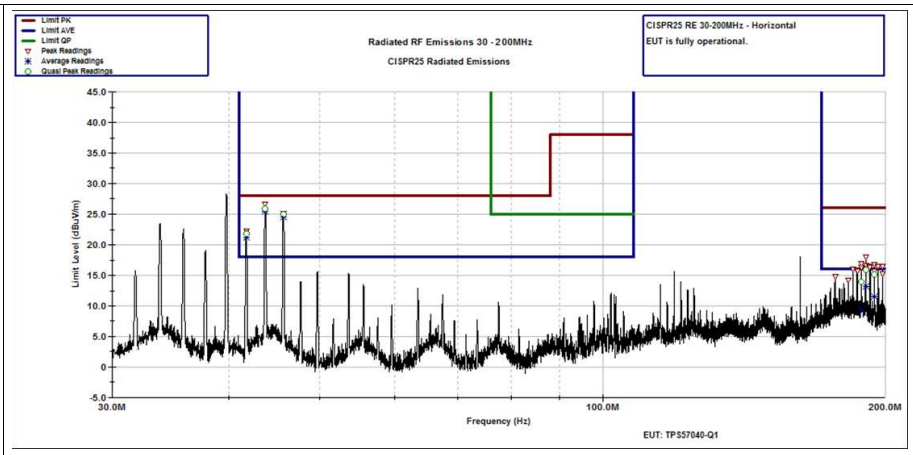


Figure 17. Radiated Emission (Horizontal – Bicon Antenna) – 30 MHz to 200 MHz: TPS57040-Q1

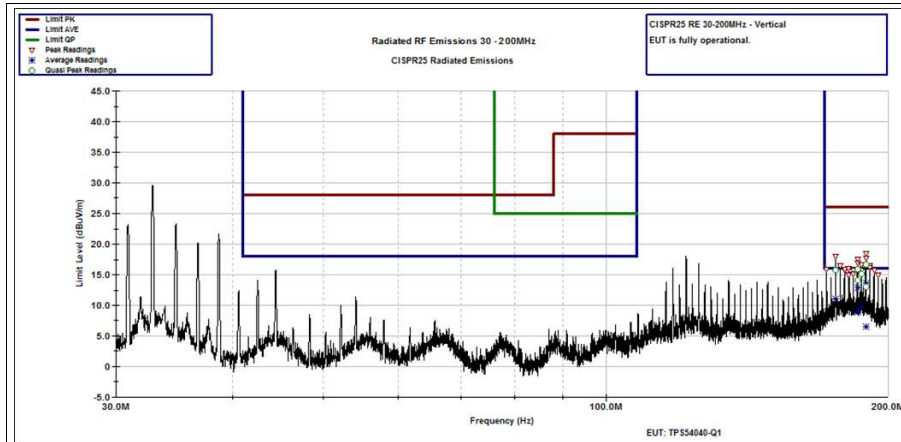


Figure 18. Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: TPS54040-Q1

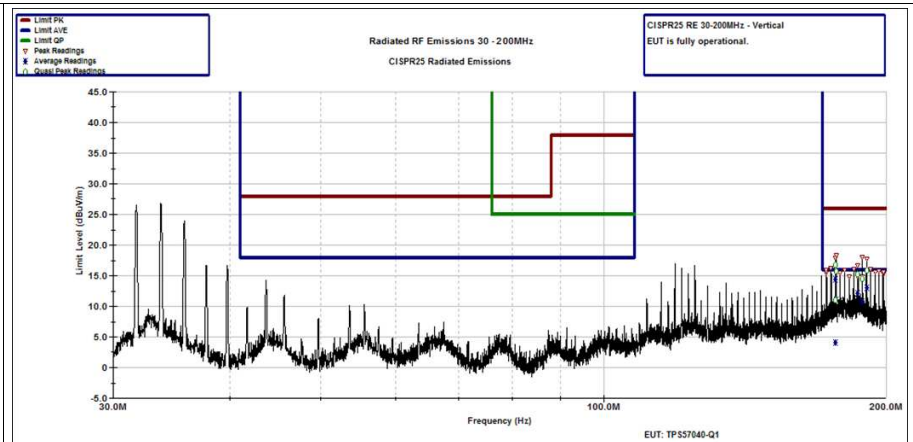


Figure 19. Radiated Emission (Vertical – Bicon Antenna) – 30 MHz to 200 MHz: TPS57040-Q1

2.3.2 Comparison between TPS54160-Q1 and TPS57160-Q1

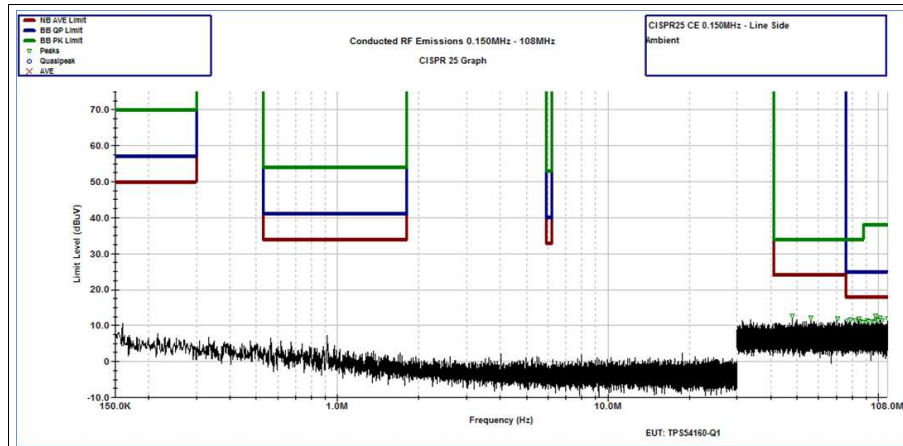


Figure 20. Conducted Emission Line Side: Ambient

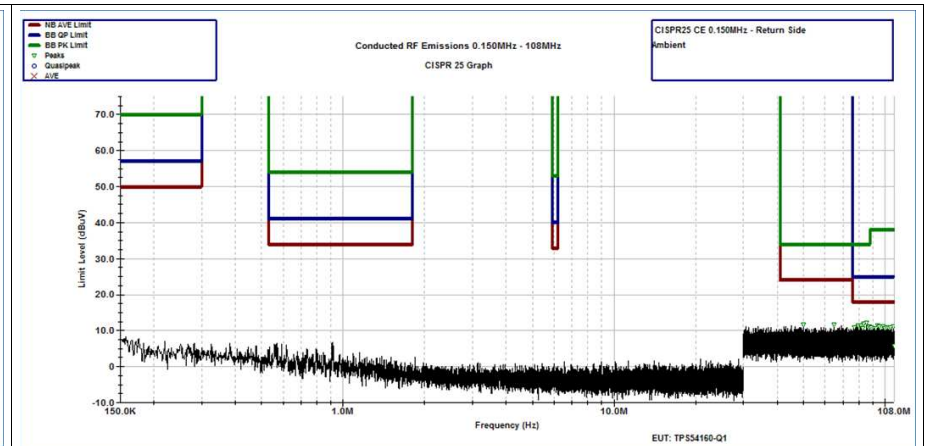


Figure 21. Conducted Emission Return Side: Ambient

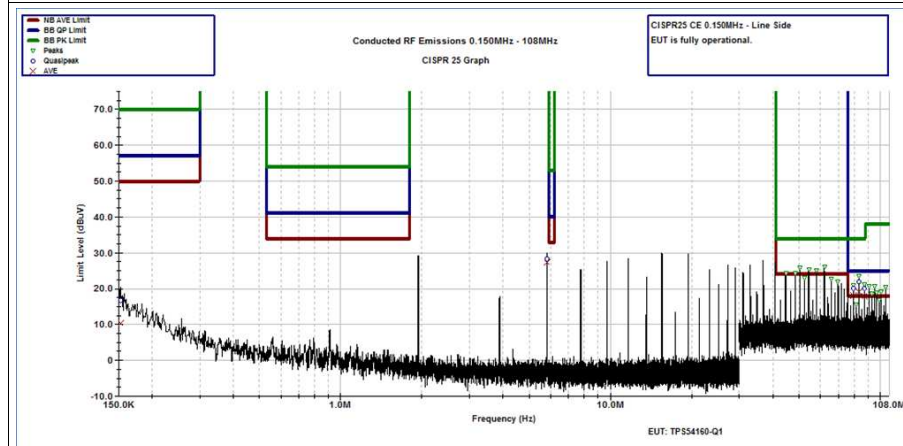


Figure 22. Conducted Emission Line Side: TPS54160-Q1

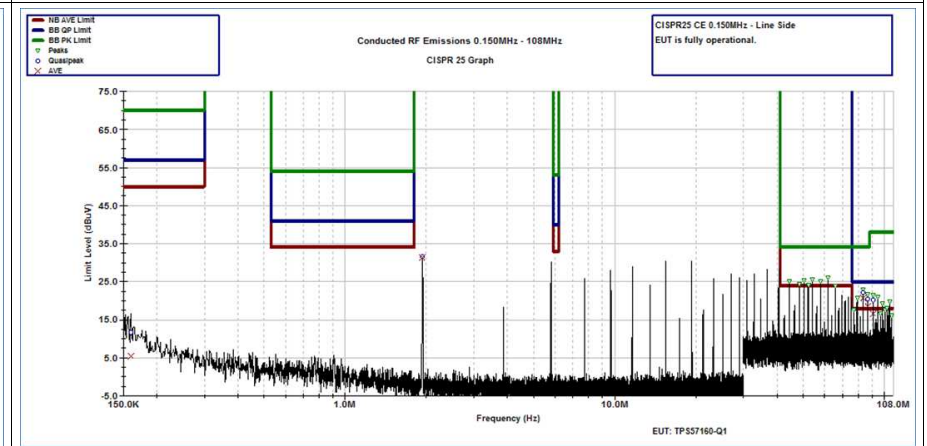


Figure 23. Conducted Emission Line Side: TPS57160-Q1

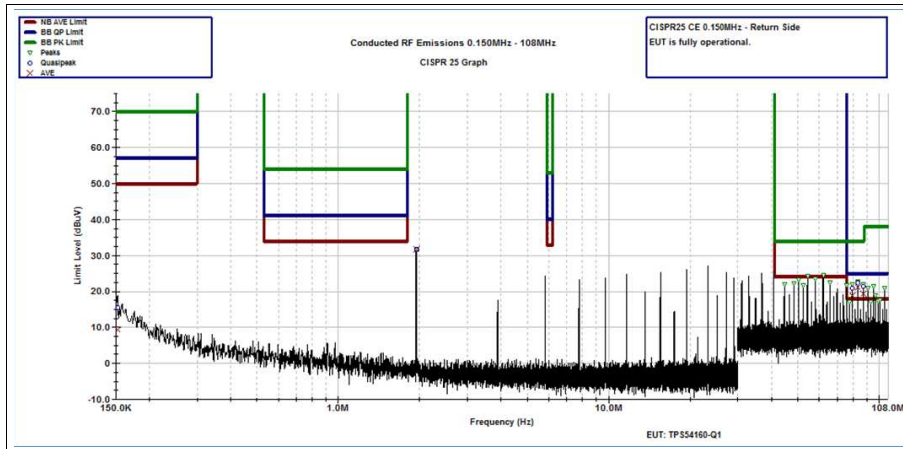


Figure 24. Conducted Emission Return Side: TPS54160-Q1

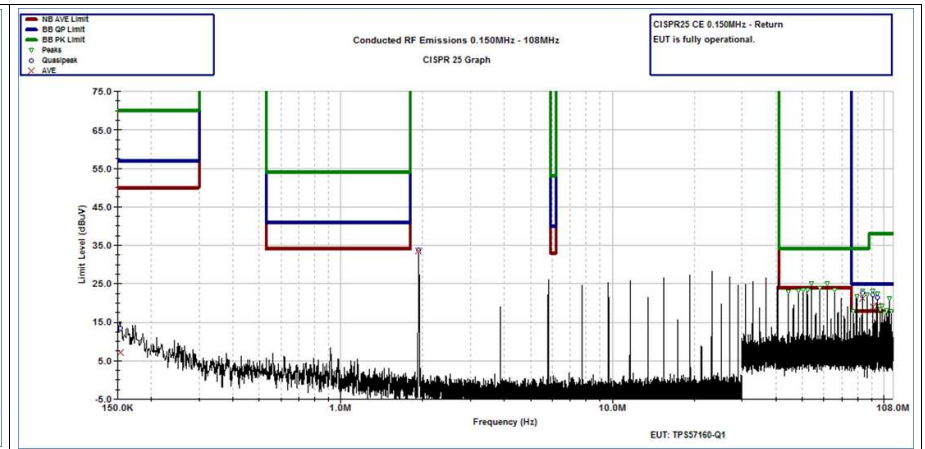


Figure 25. Conducted Emission Return Side: TPS57160-Q1

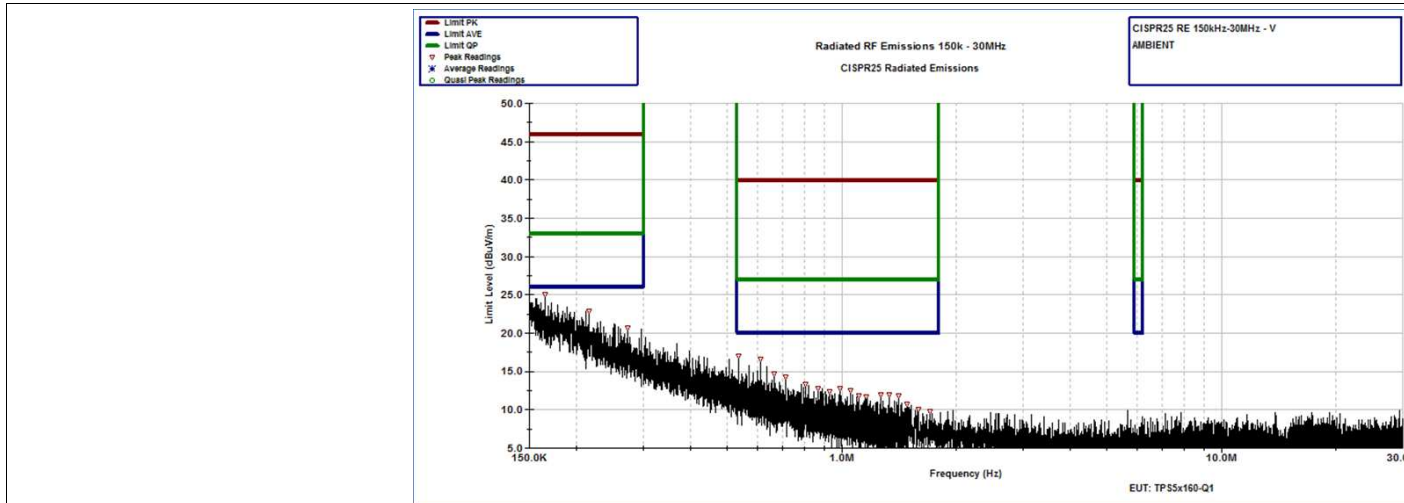


Figure 26. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: Ambient

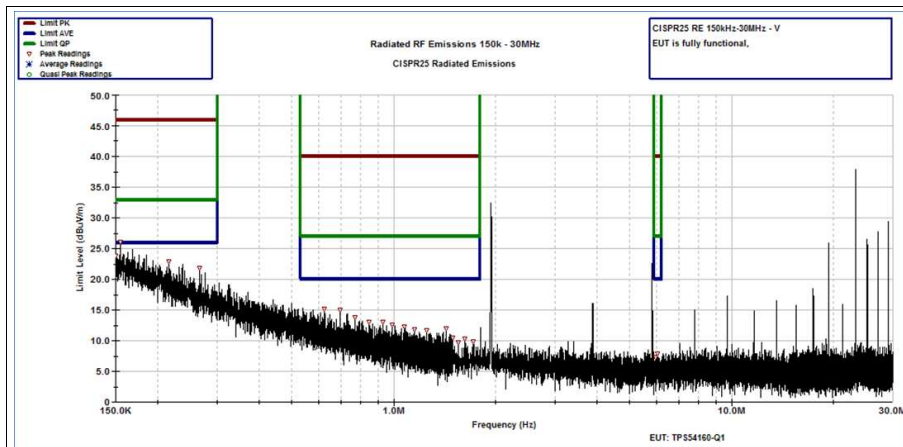


Figure 27. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS54160-Q1

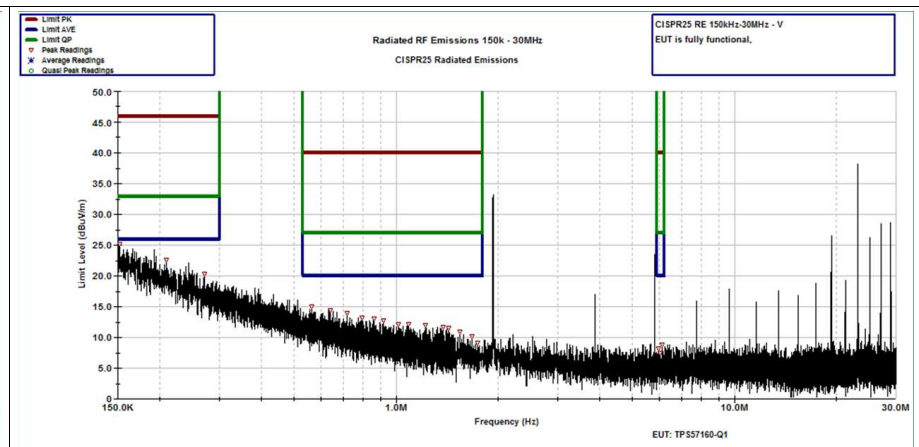


Figure 28. Radiated Emission (Rod Antenna) – 150 kHz to 30 MHz: TPS57160-Q1

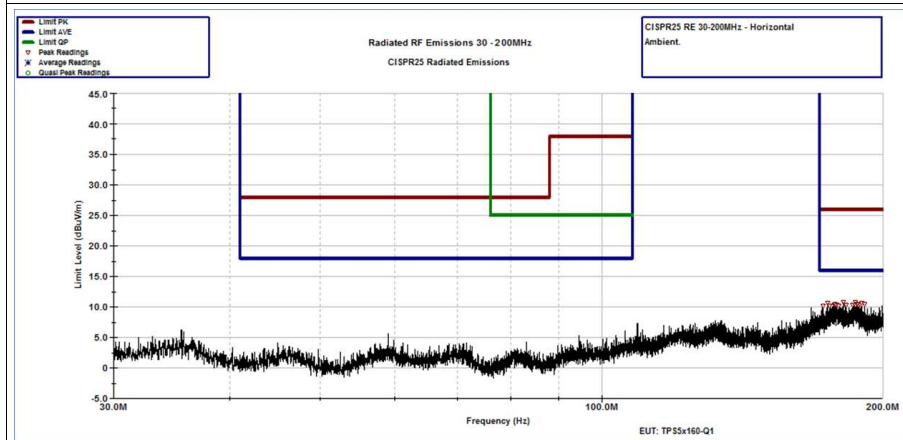


Figure 29. Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: Ambient

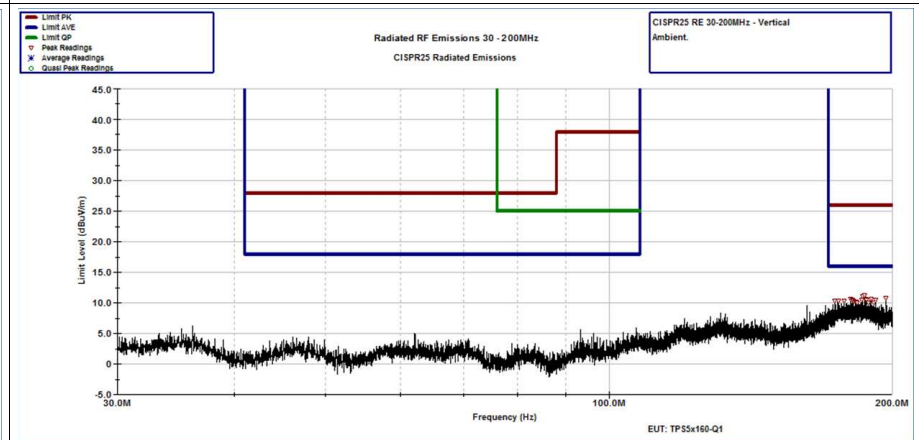


Figure 30. Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: Ambient

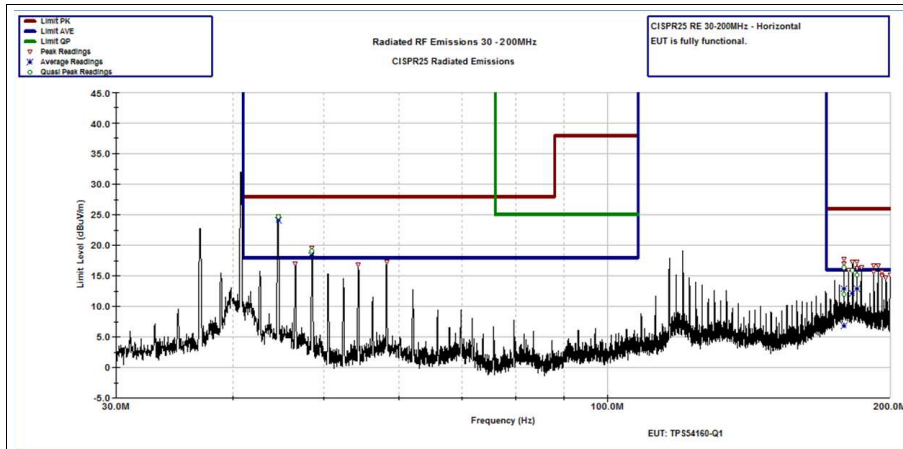


Figure 31. Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: TPS54160-Q1

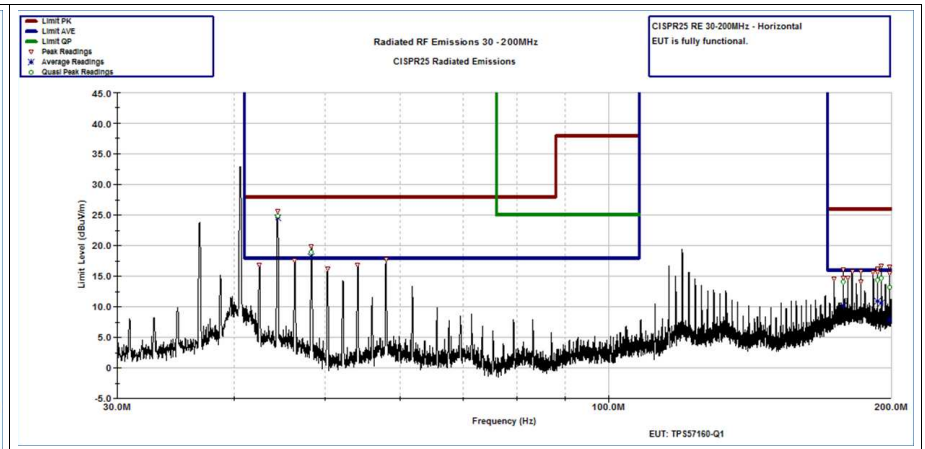


Figure 32. Radiated Emission (Horizontal Bicon Antenna) – 30 MHz to 200 MHz: TPS57160-Q1

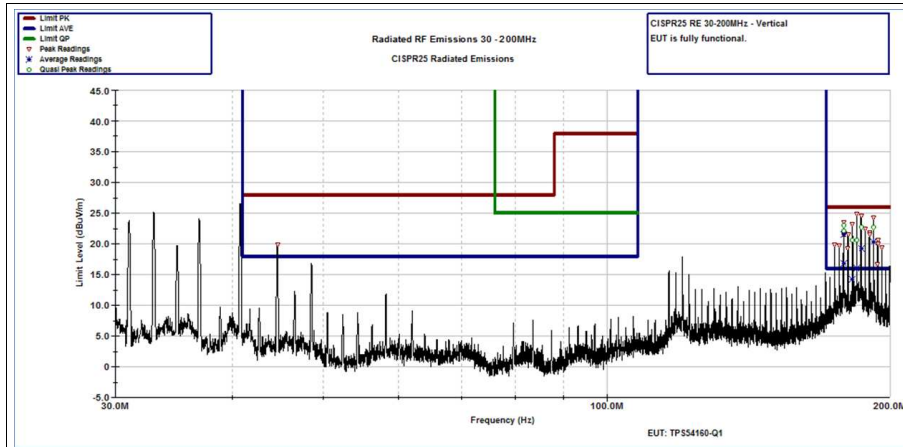


Figure 33. Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: TPS54160-Q1

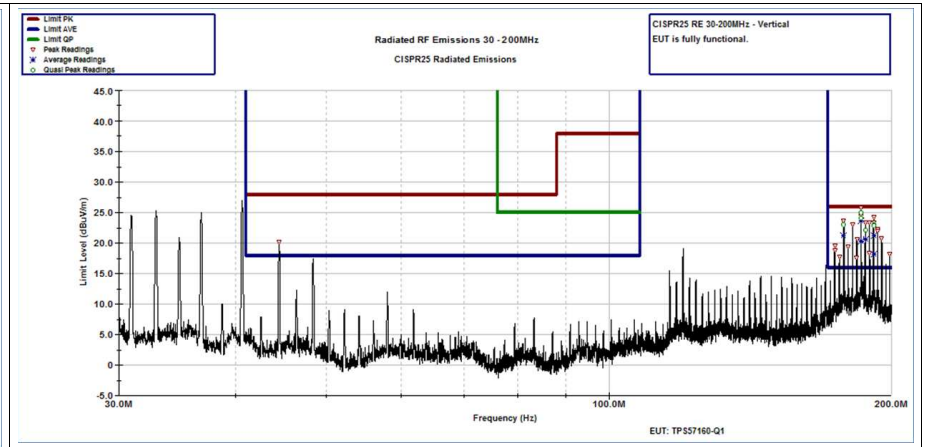


Figure 34. Radiated Emission (Vertical Bicon Antenna) – 30 MHz to 200 MHz: TPS57160-Q1

3 Conclusion

Conducted Emission test and Radiated Emission test results for TPS54040-Q1 and TPS57040-Q1 devices are comparable with no major differences noted. Slight differences could be due to board-to-board (including external component variance) and sweep-to-sweep variations. Similarly, the TPS54160-Q1 and TPS57160-Q1 results are comparable with no significant differences. These results are as expected since the design changes are minor and not in circuits that will contribute to the emissions profile. Also, since these devices are all in the same family, the TPS5x040-Q1 results are comparable to TPS5x160-Q1 results even though the tests are conducted with different load conditions.

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