Application Note

CDC6C CISPR-25 EMI Report

Cris Kobierowski, Sandra Saba

Clocks and Timing Solutions

ABSTRACT

This application note aims to reduce the Electromagnetic interference (EMI) concern of the CDC6C and showcase how slew rate affects EMI performance.

Table of Contents

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

EMI is any unwanted interference in an electrical circuit caused by an external source. EMI can be categorized as conducted or radiated. Conducted EMI is a form of conduction coupling caused by parasitic impedance, power, and ground connections. Radiated EMI is the coupling of unwanted signals from radio transmission. This test report focuses on radiated EMI emissions from the CDC6C.

The CDC6C device is a low jitter, low power, fixed-frequency oscillator which incorporates the BAW as the resonator source. The device is factory-programmed per specific frequency and function pin. With a Frequency control logic and output frequency divider, the CDC6C is capable of producing any frequency up to 200MHz, providing a single device family for all frequency needs. Through the use of BAW technology, the CDC6C can provide increased flexibility and clocking stability when compared to a quartz oscillator (Table 1-1).

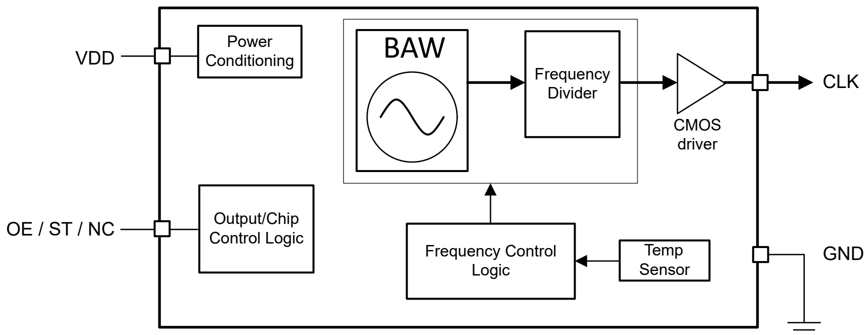

Figure 1-1. CDC6C Block Diagram

Table 1-1. BAW vs. Quartz Oscillator

Parameter	BAW Technology	Quartz Oscillator Technology
Frequency Flexibility	BAW oscillator devices supports multiple frequencies with single die	Frequency limitations. Different frequencies need different crystals.
Temperature Stability	BAW has ±10ppm from -40°C to +105°C	As temperature increases, so does ppm stability.
Vibration Sensitivity	BAW meets MIL_STF_883F Method 2002 Condition (Typical is 1ppb/g)	Typically does not pass MIL-STD Can be as high as >10ppb/g
Mechanical Shock	BAW meets MIL_STD_883F Method 2007 Condition B	Typically does not pass MIL-STD Can fail at 2,000g

This application note aims to reduce the EMI concern of the CDC6C and showcase different device settings to improve EMI performance.

2 Test Setup

This application note focuses on the following test setups:

1. CDC6C oscillator with a 25MHz LVCMOS output
2. CDC6C is powered with 3.3V supply
3. CDC6C is either DLE or DLY package (see Table 2-1)
4. CDC6C is programmed for Slow Mode 2
5. CDC6C is routed with immediate termination (55mil trace length)
6. CDC6C is terminated with C_L = 5pF for Slow Mode 2 (as recommended in the *CDC6Cx Low Power LVCMOS Output BAW Oscillator*, data sheet)

All boards were tested in Texas Instruments' pre-compliant EMI chamber set up for CISPR-25.

2.1 Board Variation Summary Table

Table 2-1. Board Variation Summary Table

Board Variant	Device	Frequency	Package	Slow Mode	Termination
1	CDC6C	25MHz	DLE	2	5pF
2	CDC6C	25MHz	DLY	2	5pF

2.2 Schematics

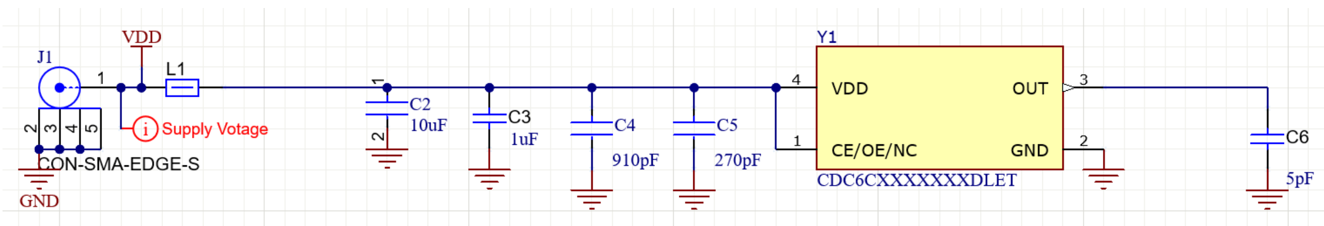

Figure 2-1. CDC6C Board Schematic

2.3 Layout

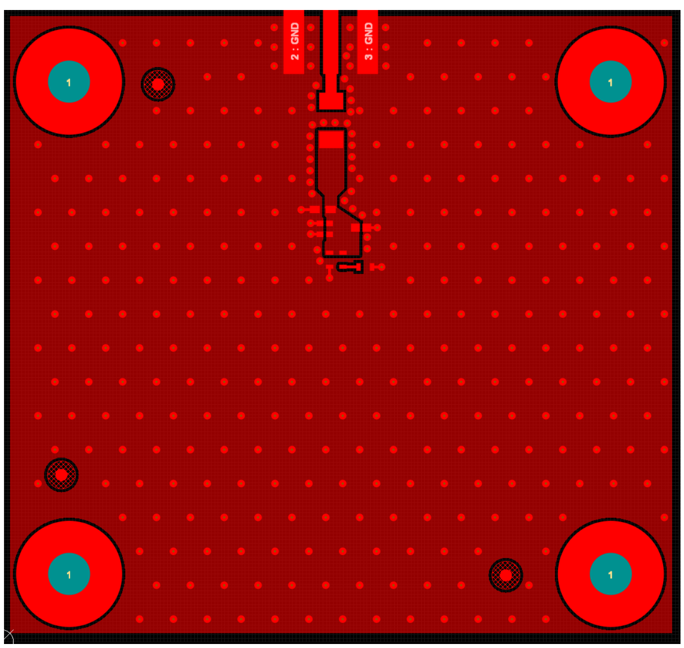

Figure 2-2. CDC6C Top Layer Layout

2.4 Stack-Up

#	Name	Material	Type	Weight	Thickness	Dk
	Top Overlay		Overlay			
	Top Solder	Solder Resist	Solder Mask		0.4mil	3.5
1	Top Layer		Signal	1oz	1.4mil	
	Dielectric 1	FR-4 High Tg	Prepreg		6mil	4.2
2	Signal Layer 1		Signal	1oz	1.4mil	
	Dielectric 2	FR-4 High Tg	Core		42mil	4.2
3	Signal Layer 2		Signal	1oz	1.4mil	
	Dielectric 3	FR-4 High Tg	Prepreg		6mil	4.2
4	Bottom Layer		Signal	1oz	1.4mil	
	Bottom Solder	Solder Resist	Solder Mask		0.4mil	3.5
	Bottom Overlay		Overlay			

Figure 2-3. CDC6C Test Board Stack-Up

3 CISPR-25

CISPR-25 is the Automotive standard for EMI. Four separate antennas are used to cover the 150kHz to 6GHz range.

Table 3-1. CISPR-25 Antenna Frequency Ranges

Antenna	Frequency Range
Monopole	150kHz - 30MHz
Bi-Conical	30MHz - 200MHz
Log-Periodic	200MHz - 1GHz
Horn	1GHz - 6GHz

EMI spurs are measured in dBuV/m, with the antenna set 1m away from the center of the power supply line.

CISPR-25 limits are defined by certification class, with Class 1 being the least stringent, and Class 5 being the most stringent. All limits specified in this test report are Class 5.

Limits for maximum allowed EMI impact are specific to individual frequency bands. For example, TV Band 1 has a Class 5 Max Peak limit of 34dBuV/m, while Analogue UHF has a Class 5 Max Peak limit of 38dBuV/m.

Ground plane is shared between the conductive table and system.

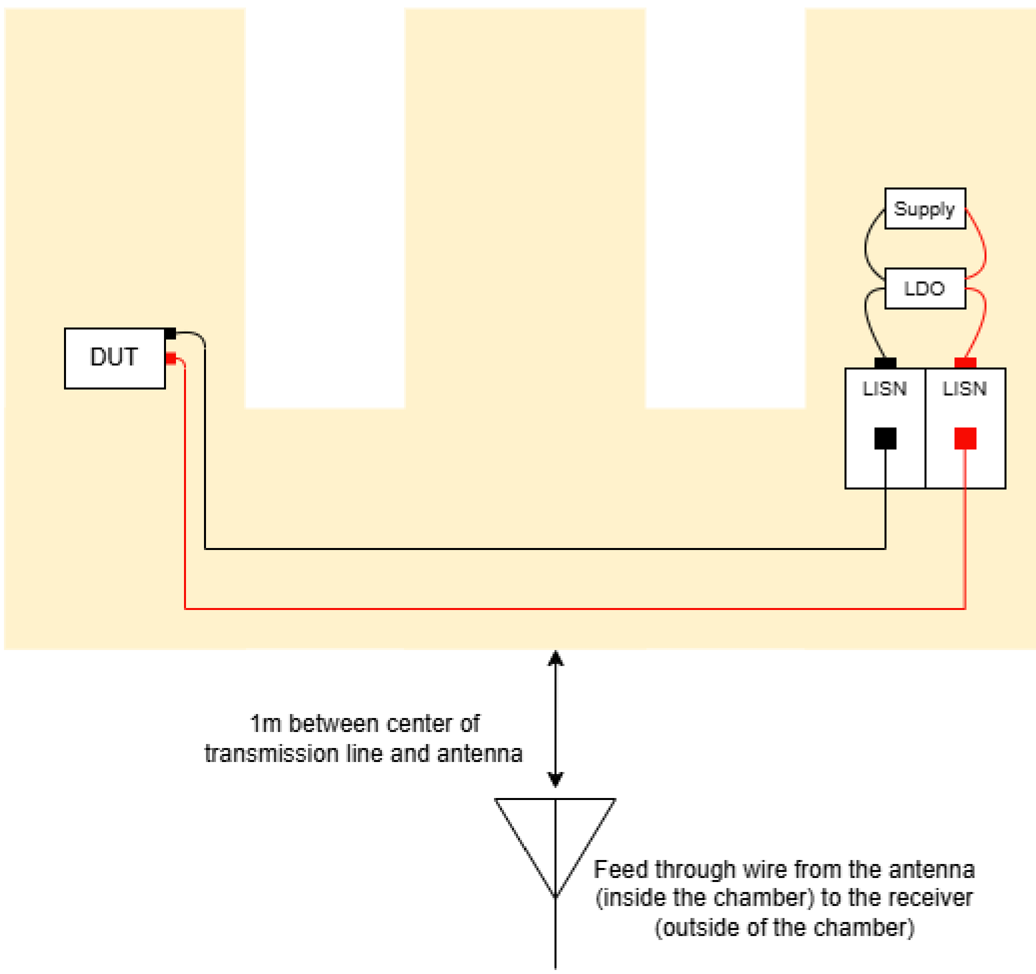

Figure 3-1. CISPR Setup Diagram

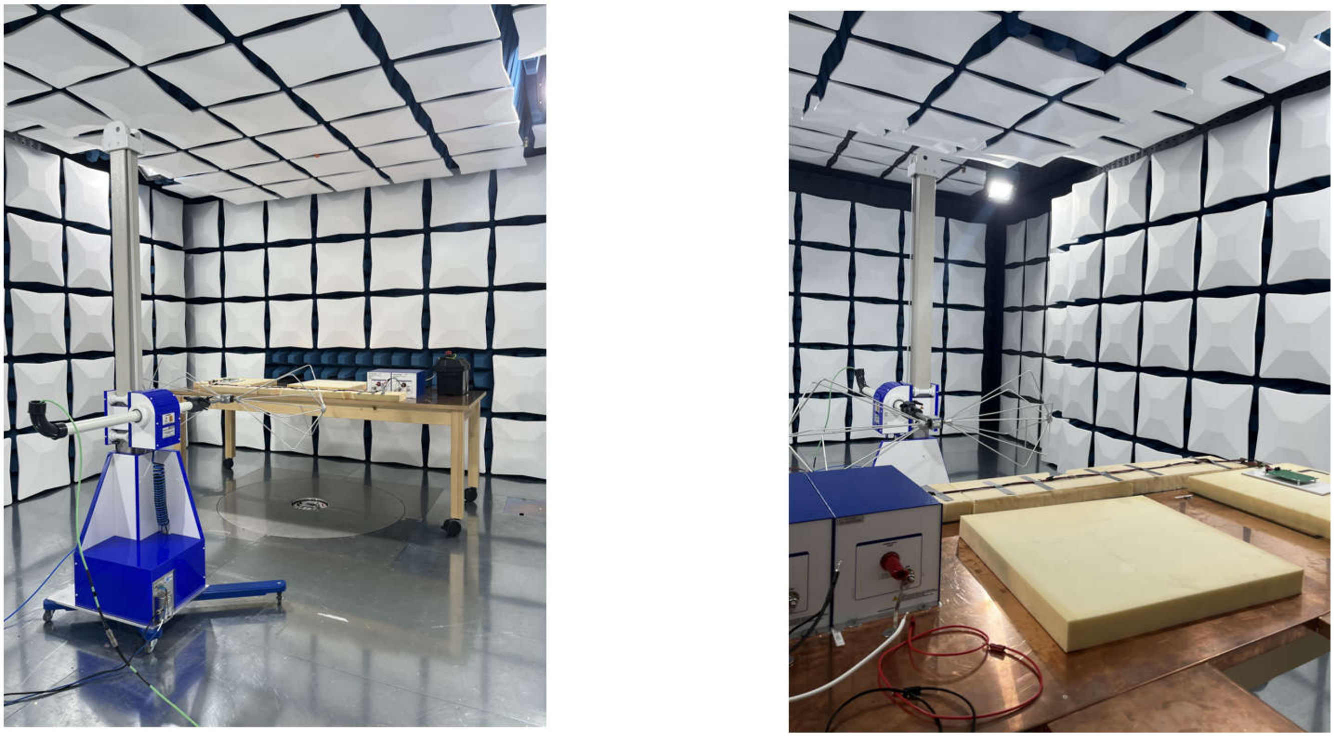

Figure 3-2. CISPR-25 Chamber Setup

3.1 CISPR-25 Summary

At 3.3V, the CDC6C passes CISPR-25 Class 5 for all bands except BDS, GPS L1, and GLONASS L1, where the device passes Class 4. For best performance, the DLY package, use of slew rate control, and lower supply voltage is recommended.

			CISPR-25 Radiation Limits (ALSE method) [dBµV/m]						3.3V			
			Class 5			Class 4			Passing Class for CISPR-25		Significant Spurs [dBµV/m]	
Service/Band	Frequency (MHz)	Antenna	Peak	Quasi-Peak	Average	Peak	Quasi-Peak	Average	Var1 DLE SM2	Var2 DLY SM2	Var1 DLE SM2	Var2 DLY SM2
Analogue broadcast services												
LW	0.15 to 0.3	Monopole	46	33	26	56	43	36	Class 5	Class 5		
MW	0.53 to 1.8	Monopole	40	27	20	48	35	28	Class 5	Class 5		
SW	5.9 to 6.2	Monopole	40	27	20	46	33	26	Class 5	Class 5		
FM	76 to 108	Bi-conical	38	25	18	44	31	24	Class 5	Class 5		
TV Band I	41 to 88	Bi-conical	28	–	18	34	–	24	Class 5	Class 5		
TV Band III	174 to 230	Bi-con/LPA	20	–	10	26	–	16	Class 4	Class 5	**175 MHz:** AVG = 4.45 **225 MHz:** AVG = 12.3	**175 MHz:** AVG = 6.25 **225 MHz:** AVG = 7.4
TV Band IV	470 to 944	Log-Periodic	41	–	31	47	–	37	Class 5	Class 5	**500 MHz:** AVG = 8.93 **550 MHz:** AVG = 13.83	**500 MHz:** AVG = 7.64 **550 MHz:** AVG = 8.13
Digital broadcast services												
DAB III	171 to 245	Bi-con/LPA	30	-	20	36	-	26	Class 5	Class 5	**175 MHz:** AVG = 4.45 **225 MHz:** AVG = 12.3	**175 MHz:** AVG = 6.25 **225 MHz:** AVG = 7.4
TV Band III	174 to 230	Bi-con/LPA	30	-	20	36	-	26	Class 5	Class 5	**175 MHz:** AVG = 4.45 **225 MHz:** AVG = 12.3	**175 MHz:** AVG = 6.25 **225 MHz:** AVG = 7.4
DTTV	470 to 770	Log-Periodic	46	-	36	52	-	42	Class 5	Class 5	**500 MHz:** AVG = 8.93 **550 MHz:** AVG = 13.83	**500 MHz:** AVG = 7.64 **550 MHz:** AVG = 8.13
DAB L Band	447 to 1,494	LPA/Horn	54	-	44	60	-	50	Class 5	Class 5	**450 MHz:** AVG = 13.54 **1475 MHz:** AVG = 10.17	**450 MHz:** AVG = 11.53 **1475 MHz:** AVG = 9.19
SDARS	320 to 2,345	LPA/Horn	58	-	48	64	-	54	Class 5	Class 5	**350 MHz:** AVG = 13.61 **2325 MHz:** AVG = 15.77	**350 MHz:** AVG = 15.54 **2325 MHz:** AVG = 12.98
Mobile services												
CB	26 to 28	Monopole	40	27	20	46	33	26	Class 5	Class 5	**25 MHz:** AVG = 12.26	**25 MHz:** AVG = 5.66
VHF	30 to 54	Bi-conical	40	27	20	46	33	26	Class 5	Class 5		
VHF	68 to 87	Bi-conical	35	22	15	41	28	21	Class 5	Class 5		
VHF	142 to 175	Bi-conical	35	22	15	41	28	21	Class 5	Class 5	**150 MHz:** AVG = 3.74 **175 MHz:** AVG = 4.45	**150 MHz:** AVG = 1.07 **175 MHz:** AVG = 6.25
Analogue UHF	380 to 512	Log-Periodic	38	25	18	44	31	24	Class 5	Class 5	**450 MHz:** AVG = 13.54 **500 MHz:** AVG = 8.93	**450 MHz:** AVG = 11.53 **500 MHz:** AVG = 7.64
RKE & TPMS 1	300 to 330	Log-Periodic	32	–	18	38	–	24	Class 5	Class 5		
RKE & TPMS 2	420 to 450	Log-Periodic	32	–	18	38	–	24	Class 5	Class 5	**450 MHz:** AVG = 13.54	**450 MHz:** AVG = 11.53
Analogue UHF	820 to 960	Log-Periodic	44	31	24	50	37	30	Class 5	Class 5		
GPS L5	1,156.45 to 1,196.45	Horn	-	-	20	-	-	26	Class 5	Class 5	**1175 MHz:** AVG = 7.76	**1175 MHz:** AVG = 6.5
BDS, B1I	1,553.098 to 1,569.098	Horn	-	-	5.5	-	-	11.5	Class 4	Class 4	**1555.8 MHz:** AVG =10.21	**1558.8 MHz:** AVG = 9.3
GPS L1	1,567.42 to 1,583.42	Horn	–	–	10	–	–	16	Class 4-5	Class 4-5	**1575 MHz:** AVG =10.75	**1575 MHz:** AVG = 10.19
GLONASS L1	1,590.781 to 1,616.594	Horn	–	–	10	–	–	16	Class 4-5	Class 4-5	**1615 MHz:** AVG = 10.27	**1600 MHz:** AVG =9.39
Wi-Fi / Bluetooth	2,402 to 2,494	Horn	52	-	32	58	-	38	Class 5	Class 5	**2475 MHz:** AVG = 17.3	**2475 MHz:** AVG =17.66
Wi-Fi	5,150 to 5,350	Horn	59	-	39	65	-	45	Class 5	Class 5	**5335 MHz:** AVG =21.58	**5335 MHz:** AVG =21.64
Wi-Fi	5,470 to 5,725	Horn	59	-	39	65	-	45	Class 5	Class 5	**5475 MHz:** AVG = 21.84	**5475 MHz:** AVG = 21.88
V2X (Wi-Fi)	5,850 to 5,925	Horn	84	-	64	90	-	70	Class 5	Class 5	**5894 MHz:** AVG = 20.37	**5900 MHz:** AVG = 20.66

Figure 3-3. CISPR-25 - 3.3V Supply - Summary Table

3.2 CISPR-25 Results

Note

Spectrum Overview plots represent both horizontal and vertical measurements, unless specified otherwise.

3.2.1 Monopole

Table 3-2. Board Variation Summary Table

Board Variant	Device	Frequency	Package	Slow Mode	Termination
1	CDC6C	25MHz	DLE	2	5pF
2	CDC6C	25MHz	DLY	2	5pF

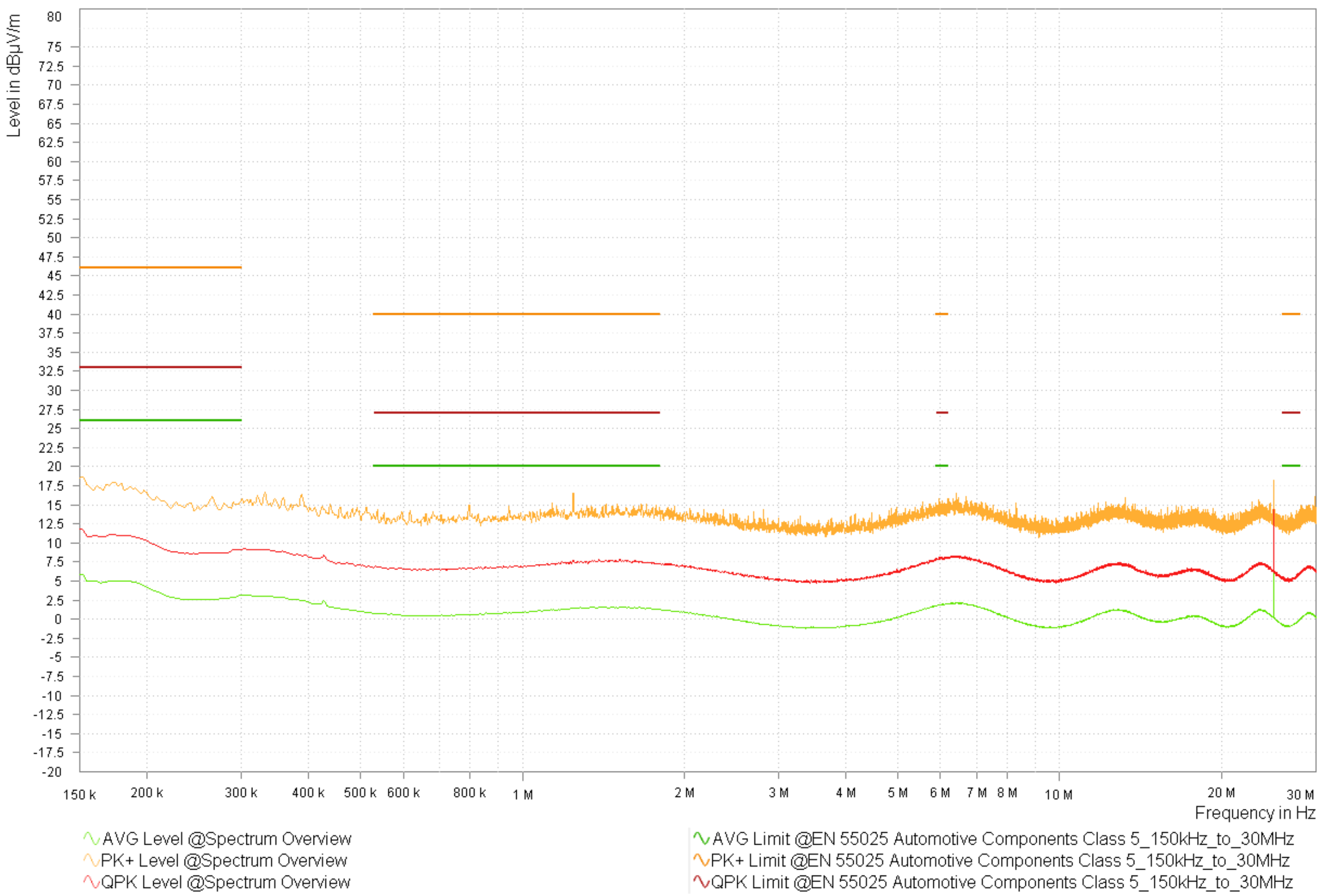

Figure 3-4. Variant 1 DLE - 3.3V - Spectrum Overview - Monopole

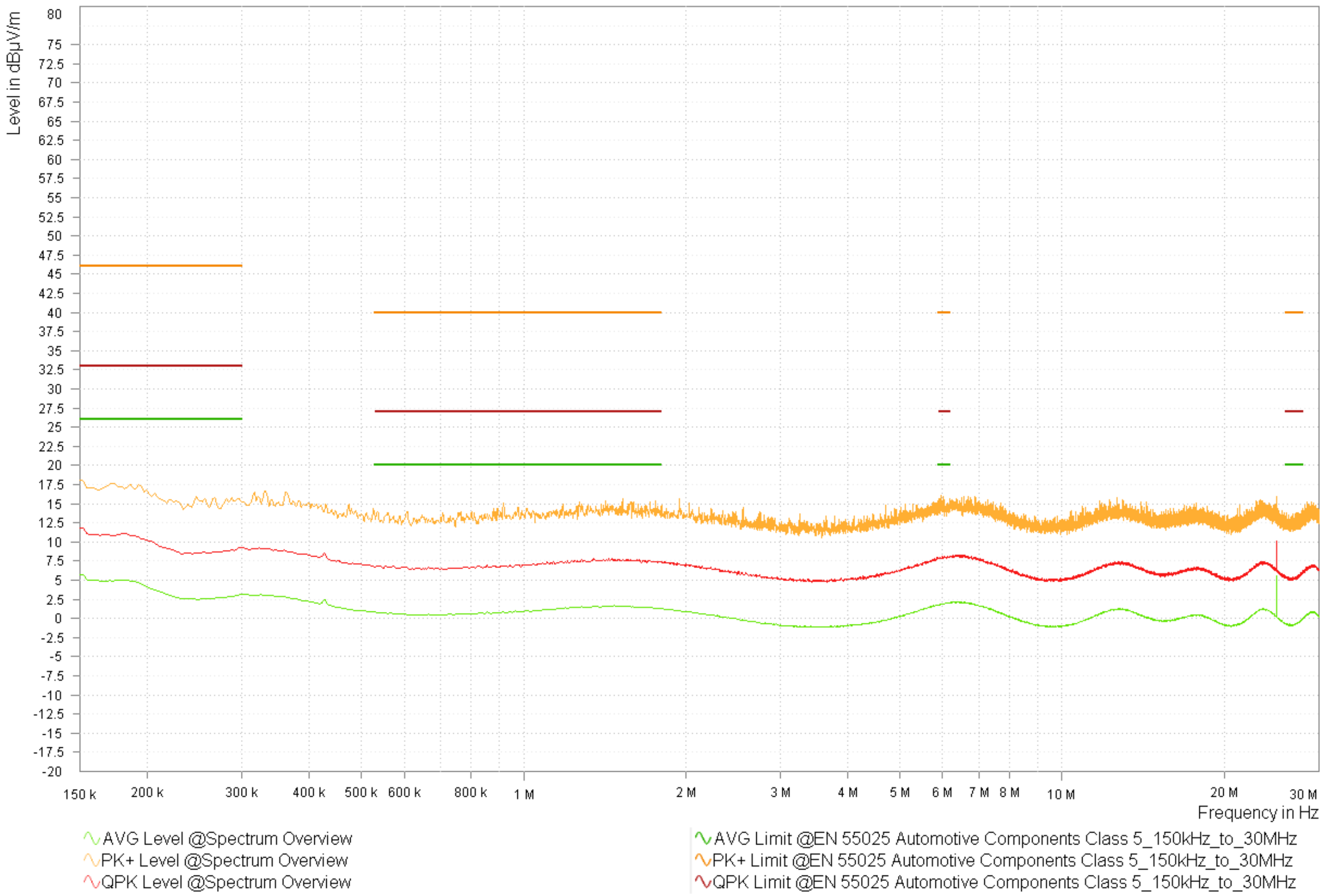

Figure 3-5. Variant 2 DLY - 3.3V - Spectrum Overview - Monopole

3.2.2 Bi-Conical

Table 3-3. Board Variation Summary Table

Board Variant	Device	Frequency	Package	Slow Mode	Termination
1	CDC6C	25MHz	DLE	2	5pF
2	CDC6C	25MHz	DLY	2	5pF

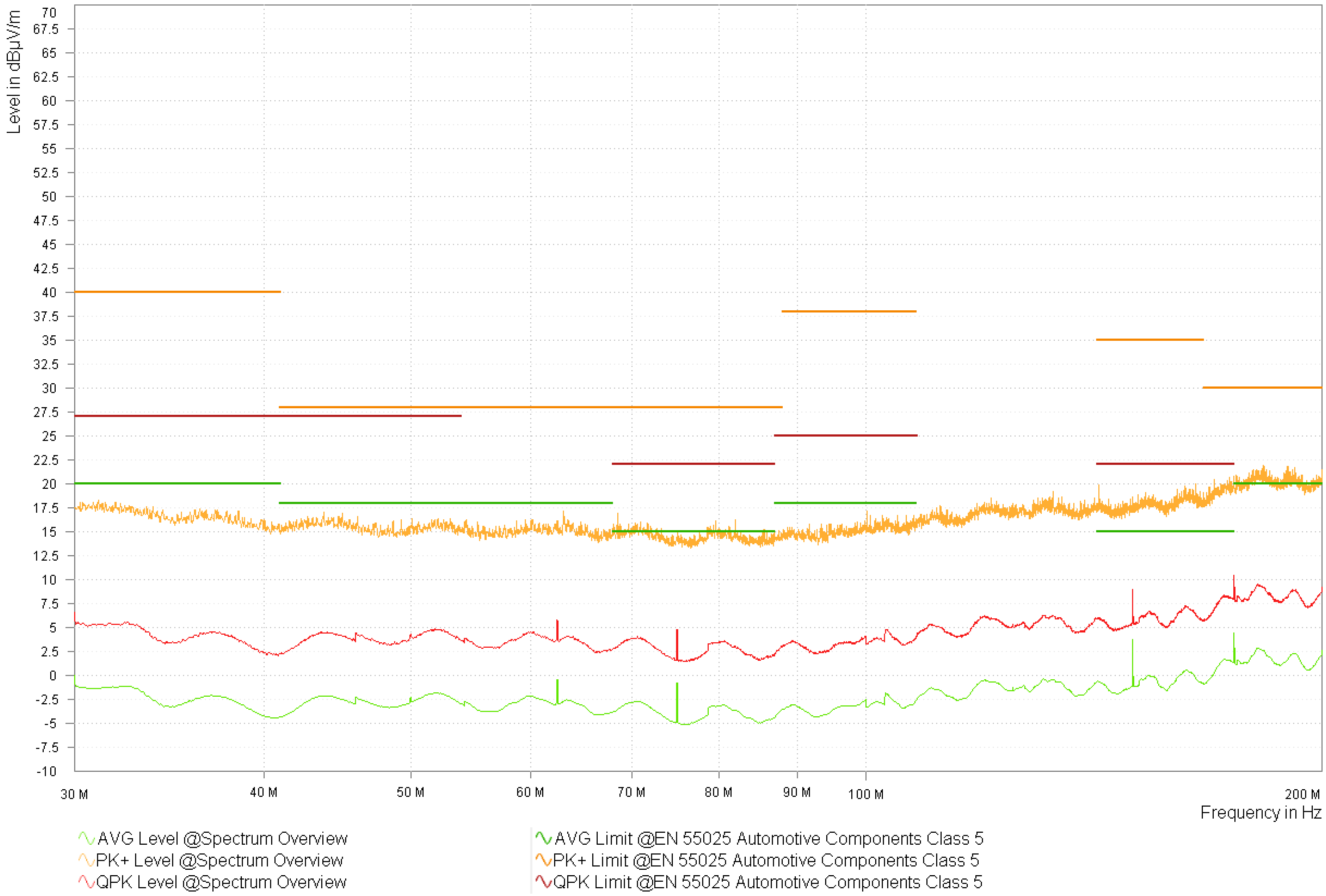

Figure 3-6. Variant 1 DLE - 3.3V - Spectrum Overview - Bi-Conical

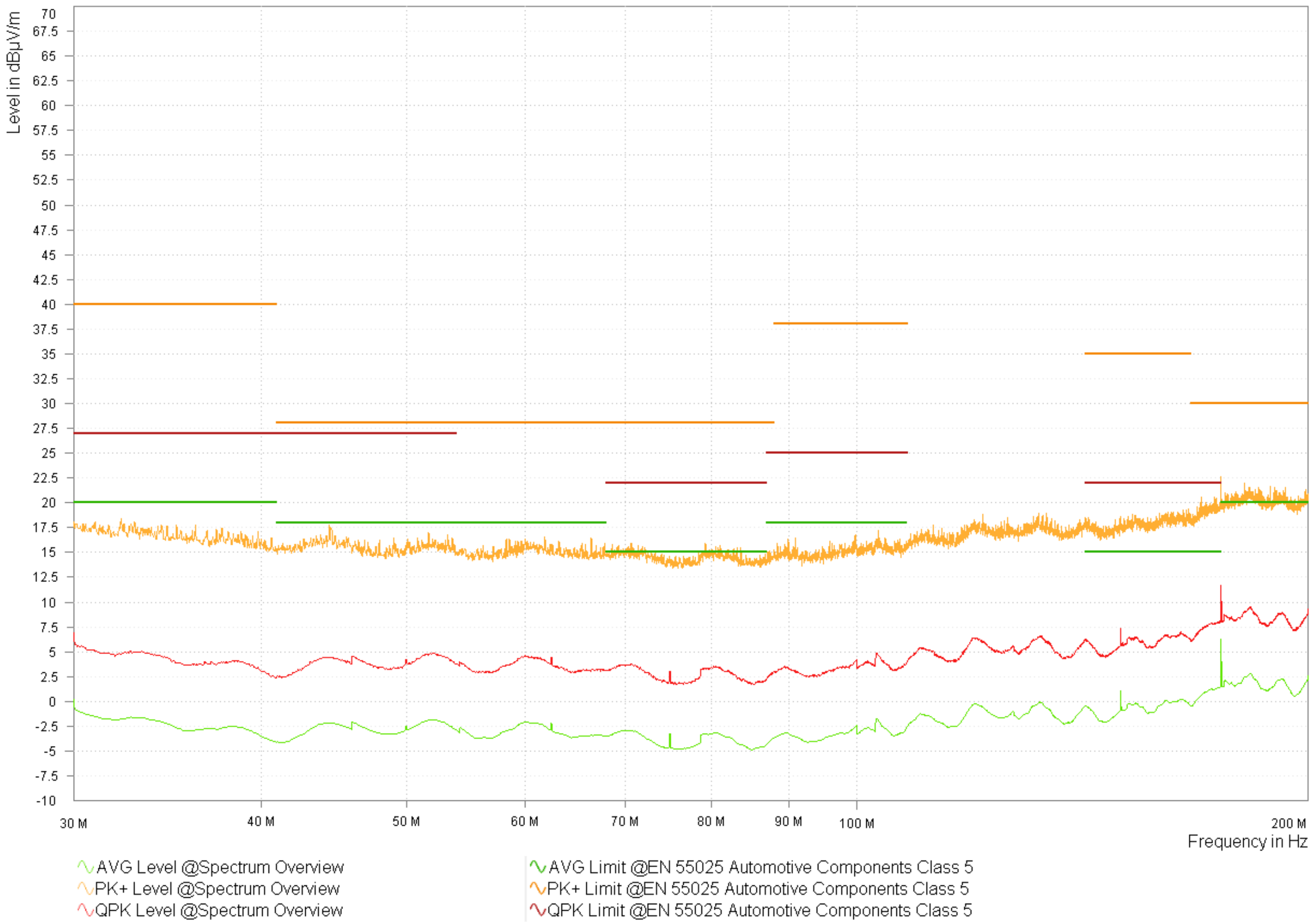

Figure 3-7. Variant 2 DLY - 3.3V - Spectrum Overview - Bi-Conical

3.2.3 Log-Periodic

Table 3-4. Board Variation Summary Table

Board Variant	Device	Frequency	Package	Slow Mode	Termination
1	CDC6C	25MHz	DLE	2	5pF
2	CDC6C	25MHz	DLY	2	5pF

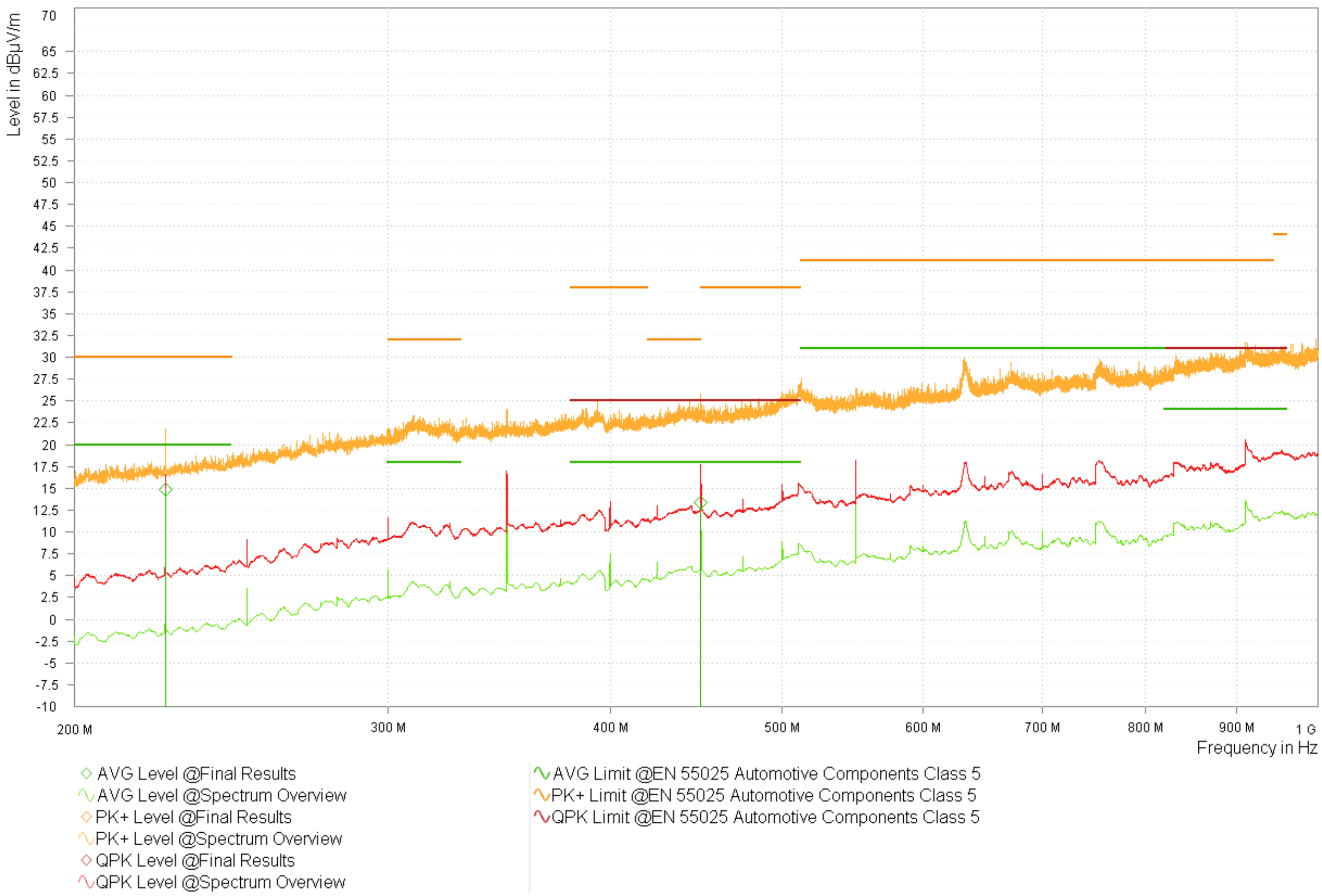

Figure 3-8. Variant 1 DLE - 3.3V - Spectrum Overview - Log-Periodic

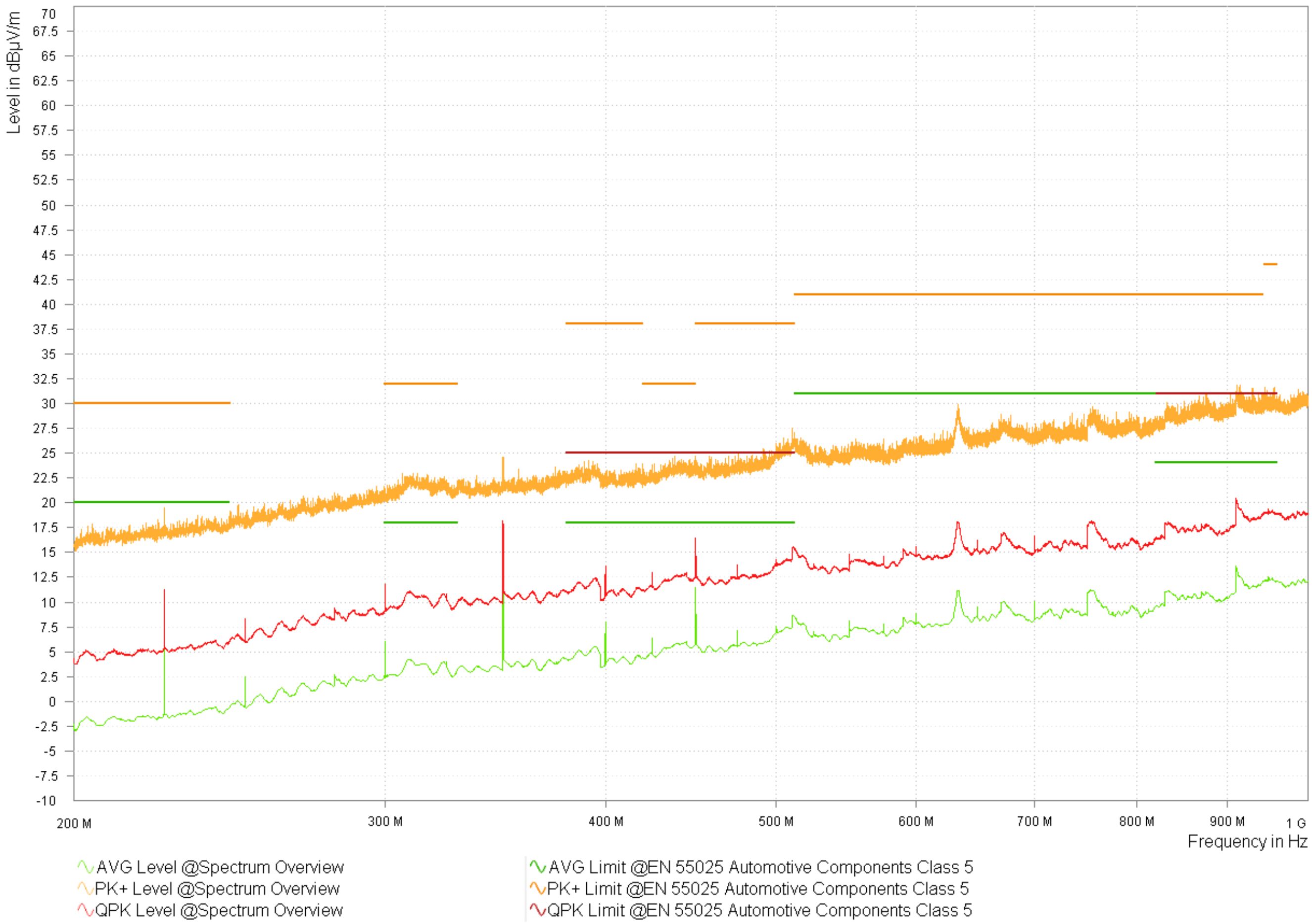

Figure 3-9. Variant 2 DLY - 3.3V - Spectrum Overview - Log-Periodic

3.2.4 Horn

Table 3-5. Board Variation Summary Table

Board Variant	Device	Frequency	Package	Slow Mode	Termination
1	CDC6C	25MHz	DLE	2	5pF
2	CDC6C	25MHz	DLY	2	5pF

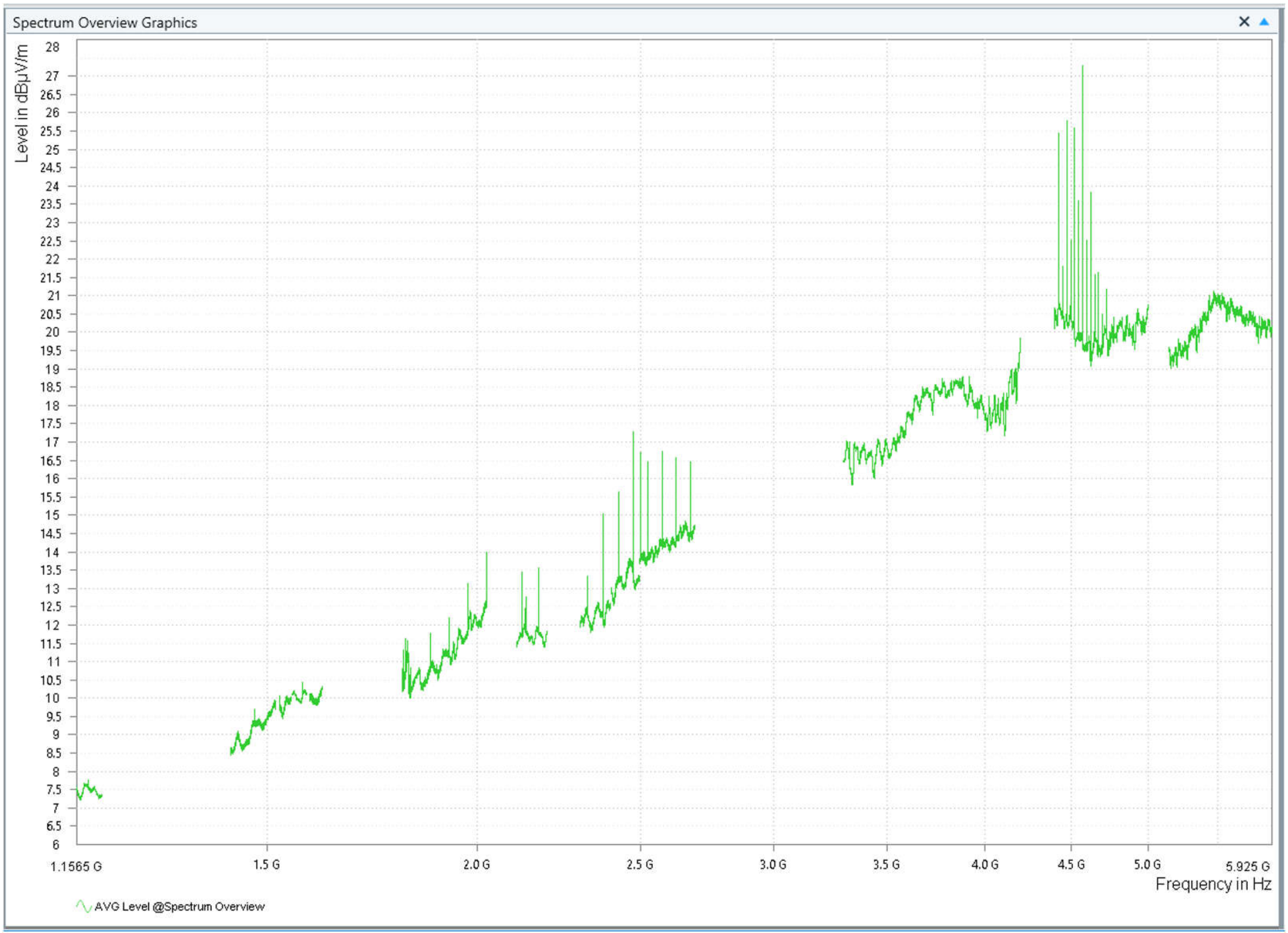

Figure 3-10. Variant 1 DLE - 3.3V - Horizontal Spectrum Overview - Horn

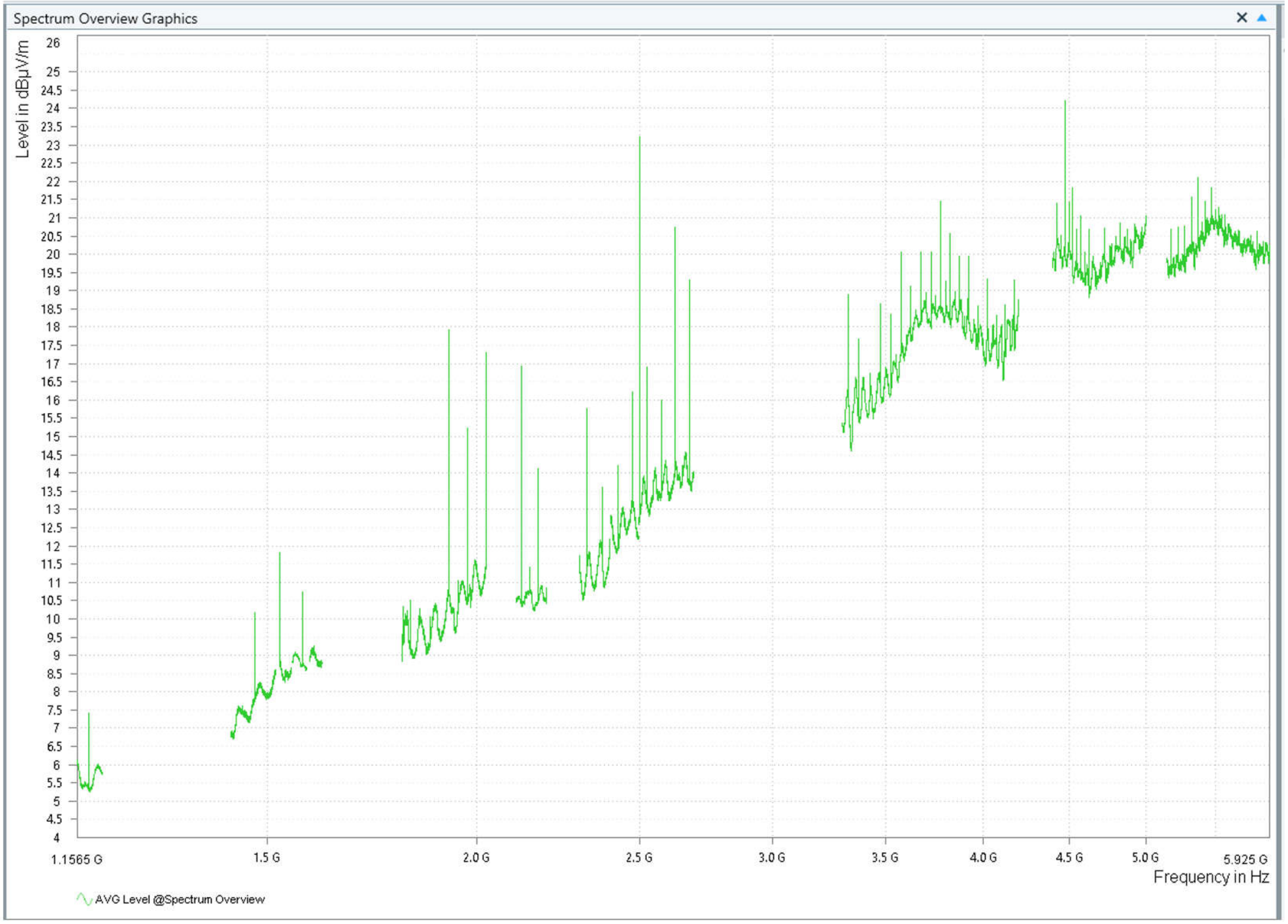

Figure 3-11. Variant 1 DLE - 3.3V - Vertical Spectrum Overview - Horn

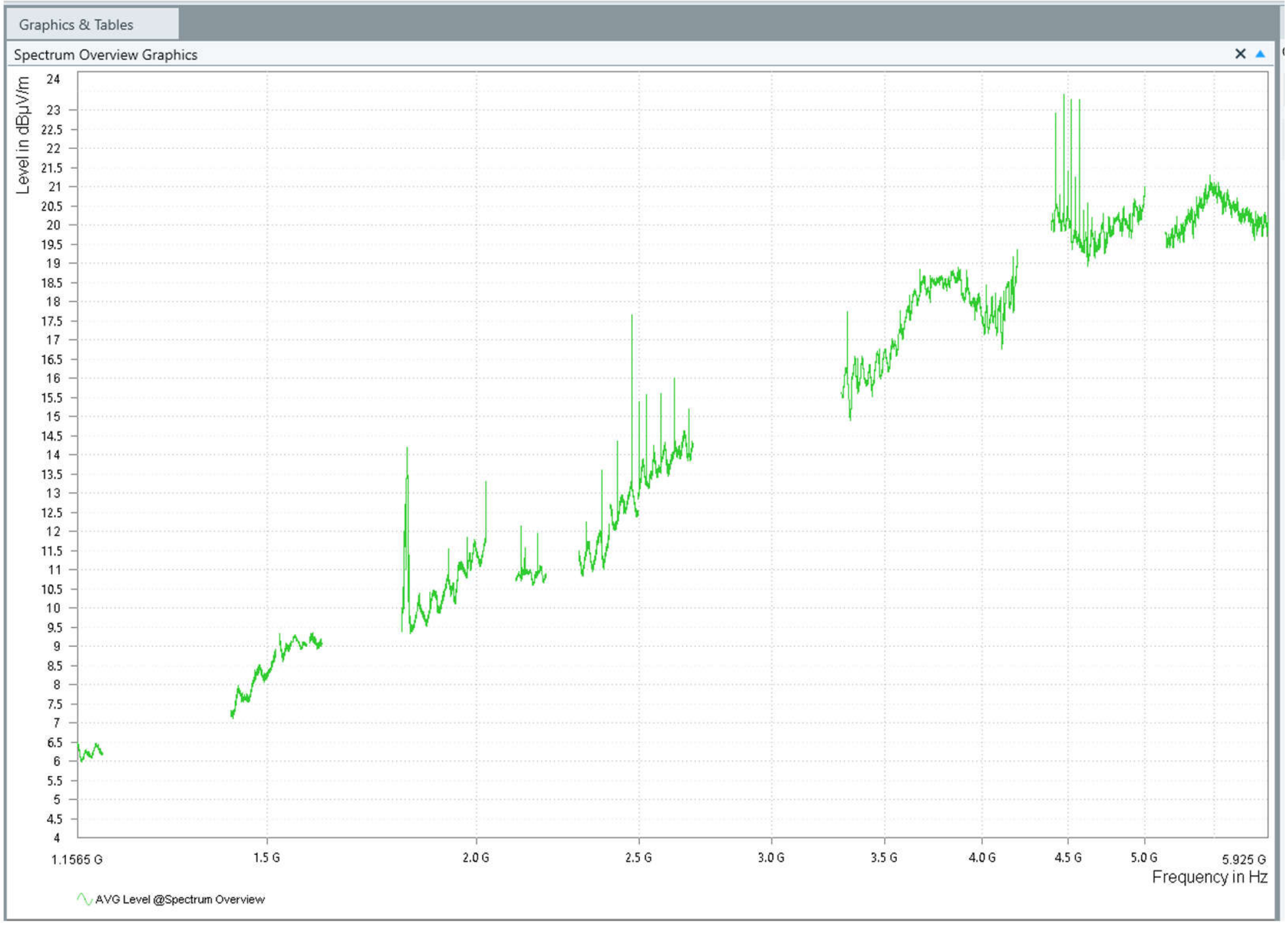

Figure 3-12. Variant 2 DLY - 3.3V - Horizontal Spectrum Overview - Horn

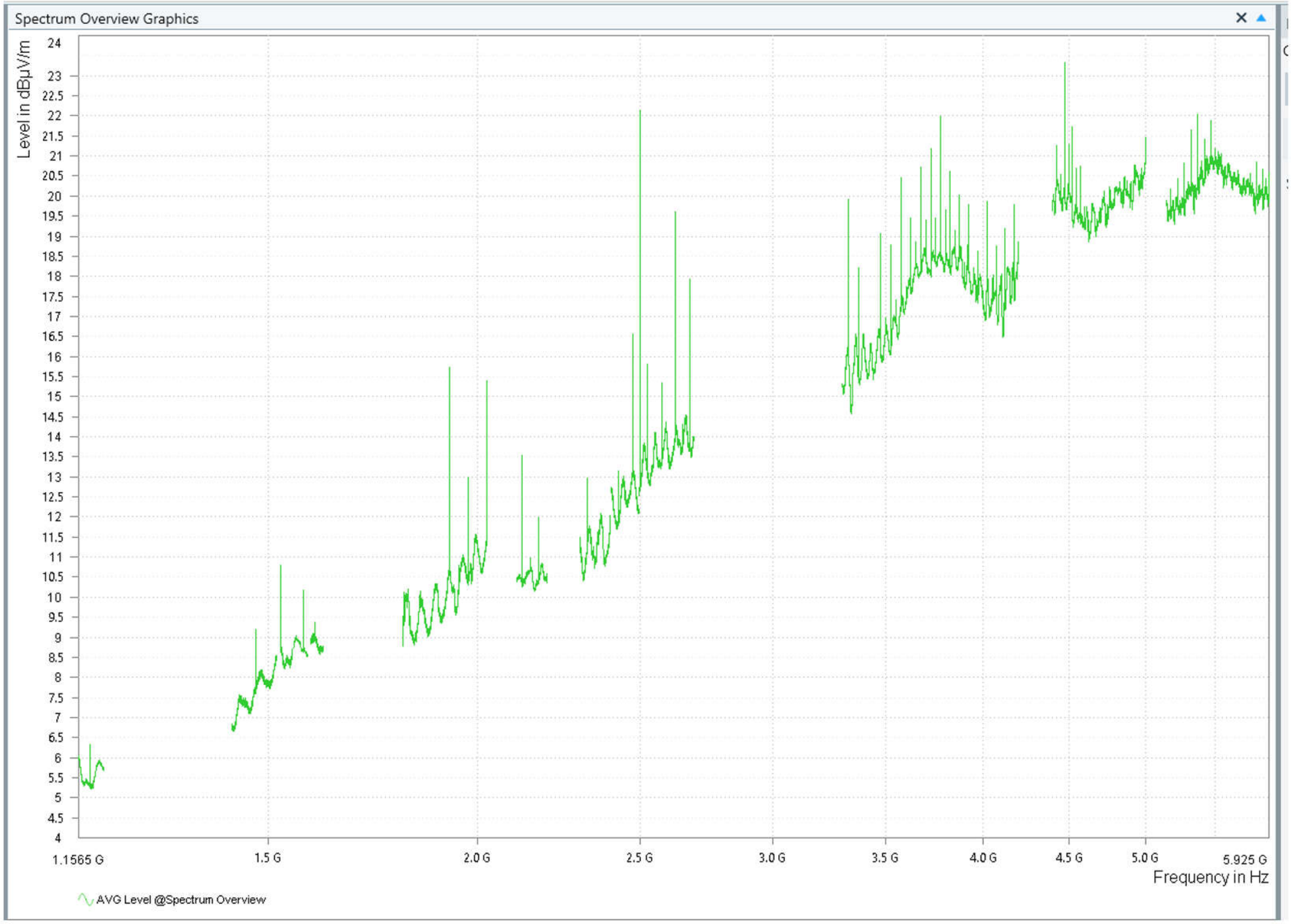

Figure 3-13. Variant 2 DLY - 3.3V - Vertical Spectrum Overview - Horn

4 Summary

When designing PCBs for EMI performance, consider using common tactics such as GND vias and slew rate control.

4.1 CISPR-25

At 3.3V, the CDC6C passes CISPR-25 Class 5 for all bands except BDS (1156.45MHz to 1196.45MHz), GPS L1 (1567.42MHz to 1583.42MHz), and GLONASS L1 (1590.781MHz to 1616.594MHz), where the device passes Class 4. For best performance, the DLY package, use of slew rate control, and lower supply voltage is recommended.

5 References

- International Electrotechnical Commision, *2021 CISPR-25 Standards*