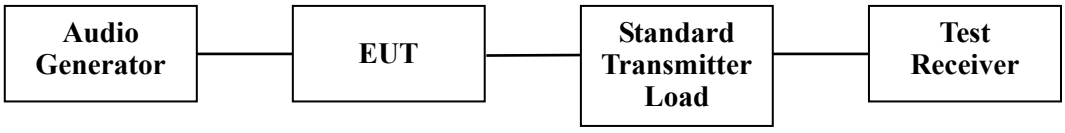
7. Modulation Limiting: FCC 2.1047(b)

7.1. Limit

Minimum Standard - The transmitter modulation must not exceed rated system deviation at any frequency input or reasonable change in input level.

7.2. Test Procedure

1. Modulation limiting is the transmitter circuit's ability to limit the transmitter from producing deviations in excess of rated system deviation.
2. The modulation response is measured at certain modulation frequencies, related to 1000Hz reference signal.
3. The basic setting is 60% of full rated deviation which will be increased the audio generator level from –20 dB to 20 dB in nine steps.
4. Tests are performed for positive and negative modulation.



7.3. Test Results

Ambient temperature : 25℃ Relative humidity : 51%

Operating Frequency : 160.0250 MHz

Channel : Middle

Nominal DC Voltage: 7.5 Vdc

12.5 kHz channel spacing

Audio input level Relative [dB]	Positive peak deviation [kHz]			Negative peak deviation [kHz]		
	300 Hz	1000 Hz	3000 Hz	300 Hz	1000 Hz	3000 Hz
-20	0.049	0.154	0.343	0.054	0.163	0.349
-15	0.072	0.270	0.591	0.072	0.274	0.602
-10	0.116	0.470	1.048	0.113	0.475	1.665
-5	0.193	0.834	1.765	0.189	0.875	1.785
0	0.323	1.500	1.934	0.329	1.500	1.953
5	2.248	2.257	1.956	0.561	2.224	1.970
10	2.122	2.134	1.963	1.353	2.098	1.974
15	2.119	2.120	1.960	1.986	2.099	1.982
20	2.106	2.113	1.962	2.001	2.108	1.978

25 kHz channel spacing

Audio input level Relative [dB]	Positive peak deviation [kHz]			Negative peak deviation [kHz]		
	300 Hz	1000 Hz	3000 Hz	300 Hz	1000 Hz	3000 Hz
-20	0.083	0.291	0.647	0.085	0.304	0.645
-15	0.131	0.516	1.131	0.137	0.529	1.143
-10	0.219	0.900	2.013	0.227	0.934	2.021
-5	0.376	1.623	3.428	0.382	1.653	3.376
0	0.669	3.000	3.759	0.667	3.000	3.671
5	1.178	4.760	3.796	1.170	4.261	3.712
10	3.480	4.481	3.806	2.901	4.020	3.717
15	4.370	4.440	3.802	4.012	4.024	3.722
20	4.172	4.420	3.801	4.014	4.030	3.730

8. Occupied Bandwidth : FCC 2.1049, FCC 90.210

8.1. Limit

According to §90.210, Emission Mask B – 25 kHz channel bandwidth. For Transmitters that are equipped with an audio low-pass filter. Measured Data:(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than100 percent of the authorized bandwidth : At least 25 dB.(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth : At least 35 dB.(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth : At least 43+10 log10(P) dB.

Emission Mask D - 12.5 kHz channel bandwidth. For Transmitters that designed to operate with 12.5kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows: Measured Data:(1) On any frequency from the center of the authorized bandwidth fo to 5.625kHz removed from fo : Zero dB.(2)On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5kHz. At least 7.27 (fd - 2.88kHz) dB.(3)On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5kHz: At least 50+10 log10(P) dB or 70 dB, whichever is the lesser attenuation.

8.2. Test Procedure

1. The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.
2. The transmitter is modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation.
3. The input level shall be established at the frequency of maximum response of the audio modulating circuit.

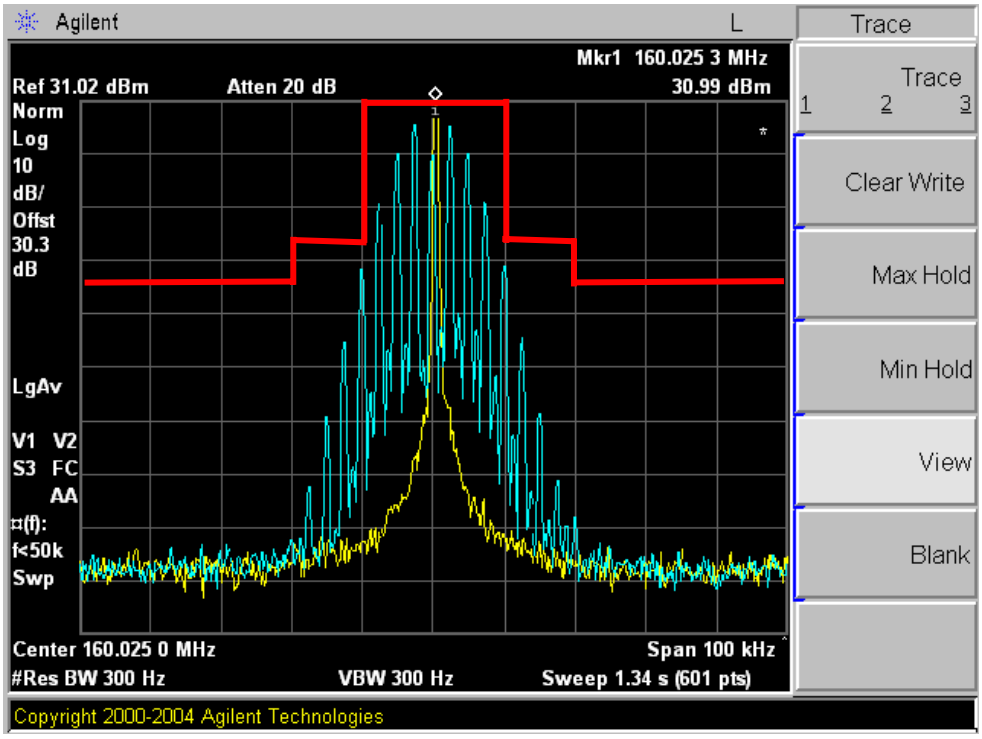
8.3. Test Results

Ambient temperature : 25℃ Relative humidity : 49%

Operating Frequency : 160.250 MHz

Channel : Middle Nominal DC Voltage: 7.5 Vdc

MASK B CHANNEL SPACING = 25 kHz

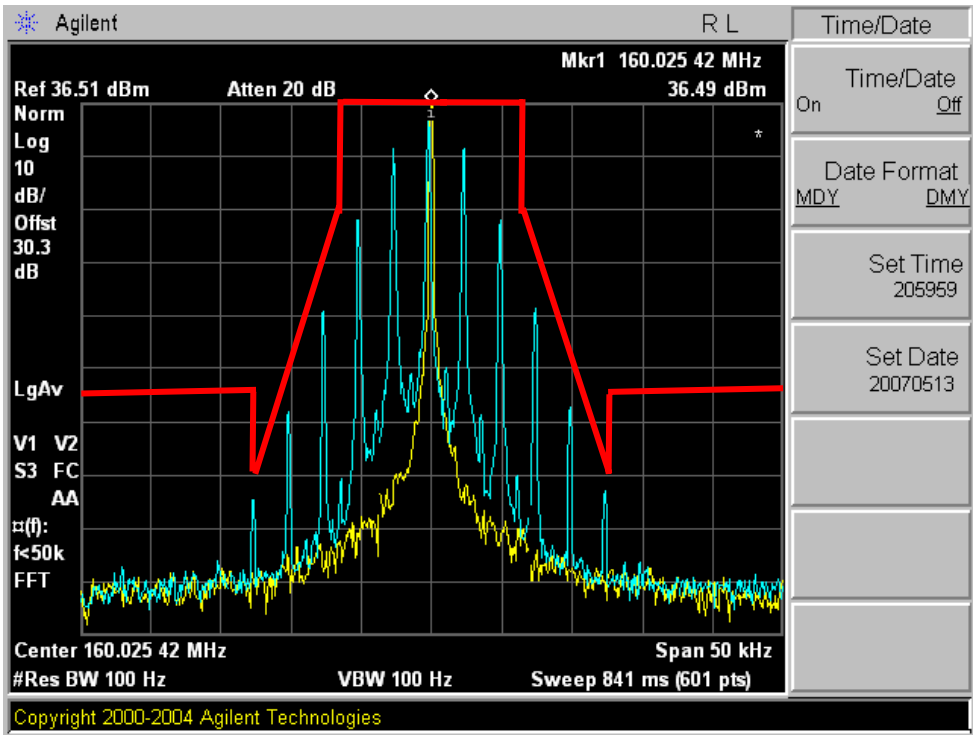


Limits: Are determined by used emission mask.

Operating Frequency : 160.0250 MHz

Channel : Middle Nominal DC Voltage: 7.5 Vdc

MASK D CHANNEL SPACING = 12.5 kHz



Limits: Are determined by used emission mask.

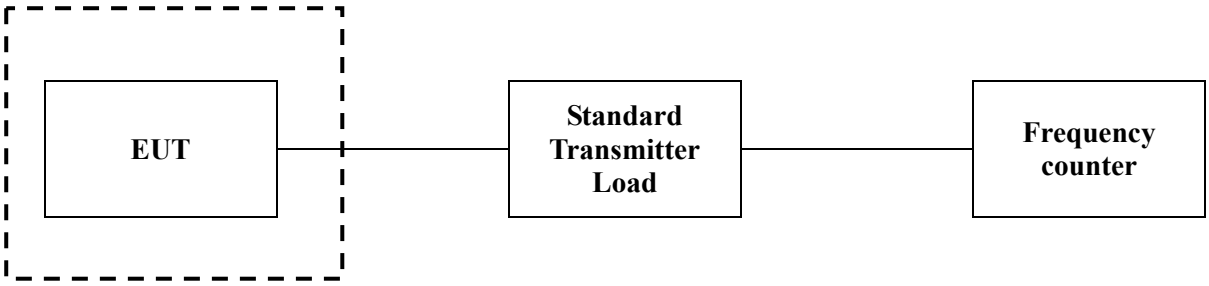
9. Frequency Stability FCC 90.213, FCC2.1055

9.1. Limit

According to §90.213, Temperature - Frequency Stability of +/- 2.5 ppm(channel spacing 12.5 kHz), +/- 5 ppm(channel spacing 25 kHz), from -30 to +60 degrees centigrade.

9.2. Test Procedure

1. The carrier frequency is the stability of the transmitter to maintain an assigned carrier frequency.
2. The frequency stability is measured with variation of ambient temperature from -30℃to+60℃.



Climatic chamber

9.3. Test Results

Ambient temperature : 20℃ Relative humidity : 51%

Channel spacing: 12.5 kHz , Frequency:160.0250 MHz

Voltage [%]	Voltage [V]	Temperature [deg C]	Measured Frequency [Hz]	Frequency Error [ppm]
100%	7.5	-30	160025337	2.106
100%	7.5	-20	160025409	2.556
100%	7.5	-10	160025437	2.731
100%	7.5	0	160025468	2.925
100%	7.5	+10	160025466	2.912
100%	7.5	+20	160025444	2.775
100%	7.5	+30	160025443	2.768
100%	7.5	+40	160025438	2.737
100%	7.5	+50	160025424	2.650
100%	7.5	+60	160025413	2.581
85%	6.38	+20	160025449	2.806
115%	8.63	+20	160025448	2.800

Channel spacing: 25 kHz , Frequency:160.0250 MHz

Voltage [%]	Voltage [V]	Temperature [deg C]	Measured Frequency [Hz]	Frequency Error [ppm]
100%	7.5	-30	160025322	2.012
100%	7.5	-20	160025408	2.550
100%	7.5	-10	160025435	2.718
100%	7.5	0	160025462	2.887
100%	7.5	+10	160025462	2.887
100%	7.5	+20	160025457	2.856
100%	7.5	+30	160025455	2.843
100%	7.5	+40	160025442	2.762
100%	7.5	+50	160025427	2.668
100%	7.5	+60	160025412	2.575
85%	6.38	+20	160025459	2.868
115%	8.63	+20	160025456	2.850

10. Transient Frequency Behaviour of the Transmitter : FCC 90.214

10.1. Limits:

Time intervals [1, 2]	Maximum Frequency Difference [3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behaviour for Equipment Designed to Operate on 25 kHz Channel			
t_1 [4] ----------	±25.0 kHz	5.0 ms	10.0 ms
t_2 ----------	±12.5 kHz	20.0 ms	25.0 ms
t_3 [4] ----------	±25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behaviour for Equipment Designed to Operate on 12.5 kHz Channel			
t_1 [4] ----------	±12.5 kHz	5.0 ms	10.0 ms
t_2 ----------	±6.25 kHz	20.0 ms	25.0 ms
t_3 [4] ----------	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behaviour for Equipment Designed to Operate on 6.25 kHz Channel			
t_1 [4] ----------	±6.25 kHz	5.0 ms	10.0 ms
t_2 ----------	±3.125 kHz	20.0 ms	25.0 ms
t_3 [4] ----------	±6.25 kHz	5.0 ms	10.0 ms

[1] $_{on}$ is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

t_{off} is the instant when the 1kHz test signal starts to rise.

[2] During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

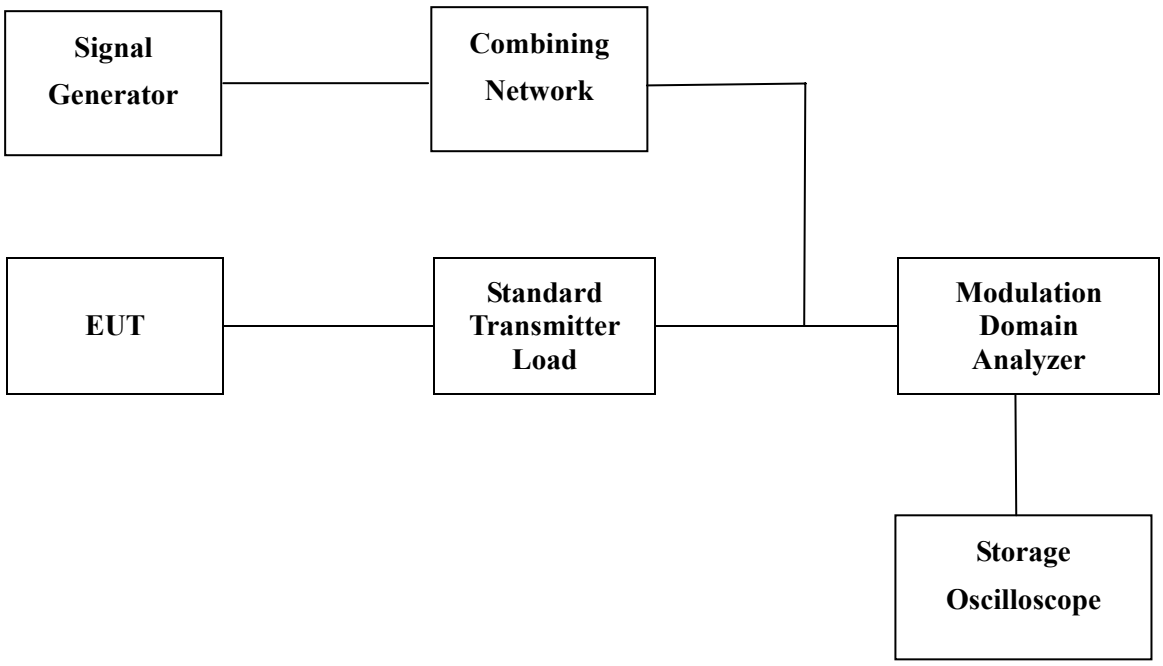
[3] Difference between the actual transmitter frequency and the assigned transmitter frequency .

[4] If the transmitter carrier output power rating is 6watts or less, the frequency difference during this time may exceed the maximum frequency difference for this period.

10.2. Test Procedure

1. Set the test receiver to measure FM deviation with the audio bandwidth set at ≤50 Hz to ≥15,000 Hz, and tune the RF frequency to the transmitter assigned frequency.
2. Set the signal generator to the assigned transmitter frequency and modulate it with a 1 kHz tone at ±25 kHz deviation and set its output level to -100dBm.
3. Key the transmitter.
4. Supply sufficient attenuation via the RF attenuator to provide an input level to the test receiver that is 40 dB below the test receiver maximum allowed input power when the transmitter is operating at its rated power level.
5. Unkey the transmitter.
6. Adjust the RF level of the signal generator to provide RF power into the RF power meter equal to the level This signal generator RF level shall be maintained throughout the rest of the measurement.
7. Connect the output of the RF combiner network to the input of the Modulation analyzer.
8. Set the horizontal sweep rate on the storage oscilloscope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone. Adjust the vertical amplitude control of the oscilloscope to display the 1000 Hz at ±4 divisions vertically centered on the display.
9. Key the transmitter and observe the stored display. once the modulation Analyzer demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on} . The trace should be maintained within the allowed divisions during the period t1 and t2 . See the figure in the appropriate standards section.
10. During the time from the end of t2 to the beginning of t3 the frequency difference should not exceed the limits set by the FCC in 47 CFR 90.214 and outlined in 3.2.2. The allowed limit is equal to the transmitter frequency times its FCC frequency tolerance times ±4 display divisions divided by 25 kHz.
11. Key the transmitter and observe the stored display. The trace should be maintained within the allowed divisions after the end of t2 and remain within it until the end of the trace. See the figure in the appropriate standards sections.
12. To test the transient frequency behavior during the period t3 the transmitter shall be keyed.

13. Adjust the oscilloscope trigger controls so it will trigger on a decreasing magnitude from the Modulation analyzer, at 1 division from the right side of the display, when the transmitter is turned off. Set the controls to store the display. The moment when the 1 kHz test signal starts to rise is considered to provide to t_{off}.
14. The transmitter shall be unkeyed.
15. Observe the display. The trace should remain within the allowed divisions during period t3. See the figures in the appropriate standards section.



10.3. Test Results

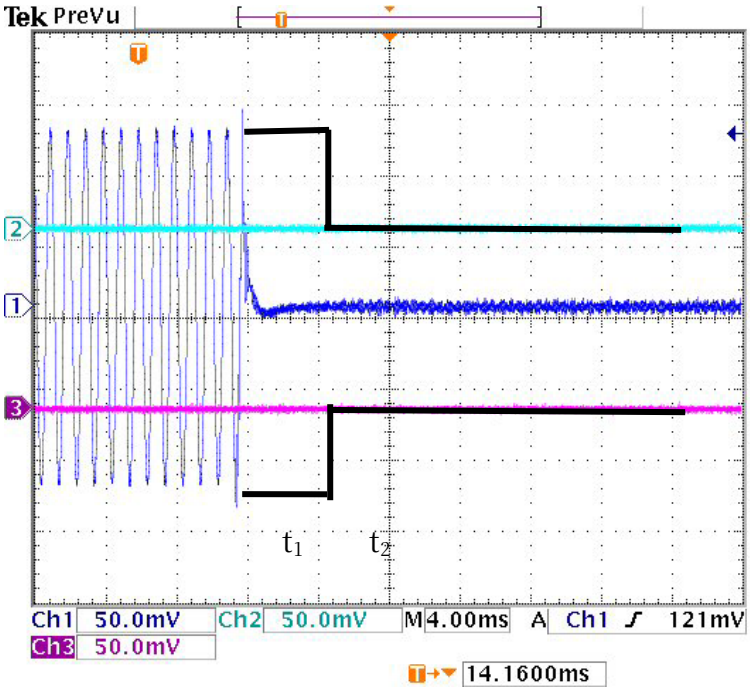
Ambient temperature : 24℃ Relative humidity : 51%

Please refer to the following plots.

Plot

Ch 1 Narrow

Switching from OFF to ON (t_1 & t_2)



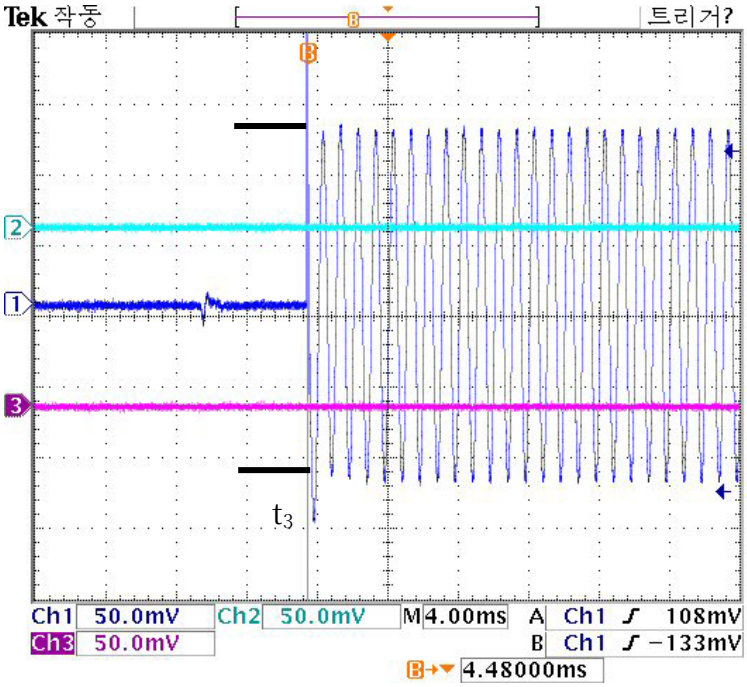
Channel separation

1/2 Channel separation

1/2 Channel separation

Channel separation

Switching from ON to OFF (t_3)



Channel separation

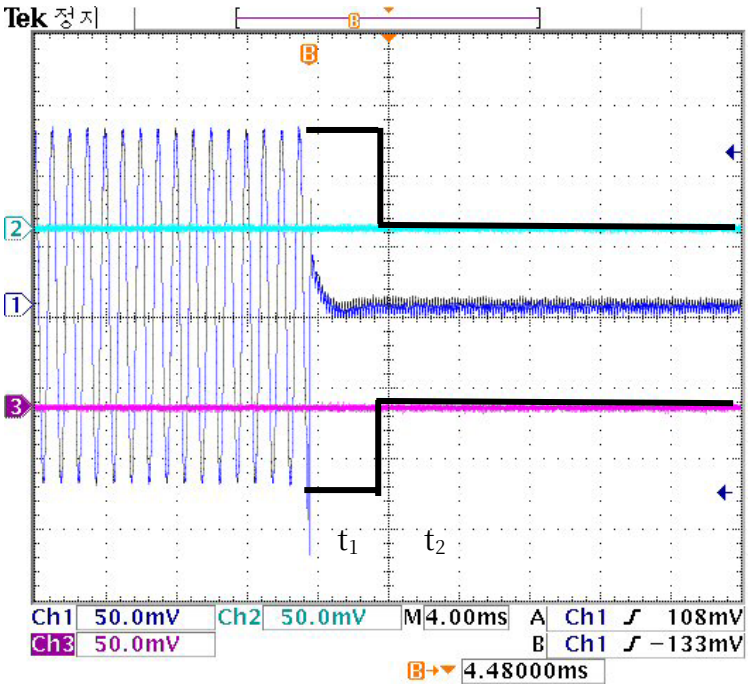
1/2 Channel separation

1/2 Channel separation

Channel separation

Ch 3 Narrow

Switching from OFF to ON (t_1 & t_2)



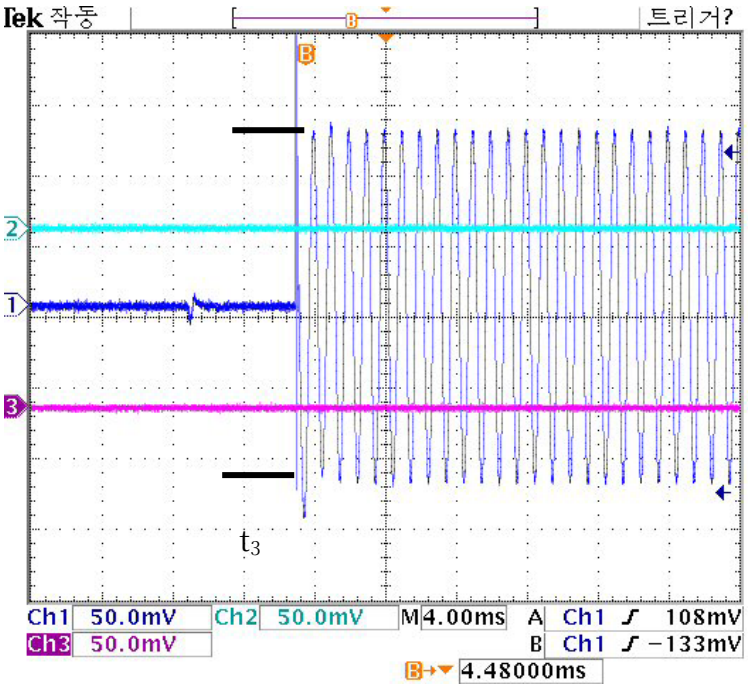
Channel separation

1/2 Channel separation

1/2 Channel separation

Channel separation

Switching from ON to OFF (t_3)



Channel separation

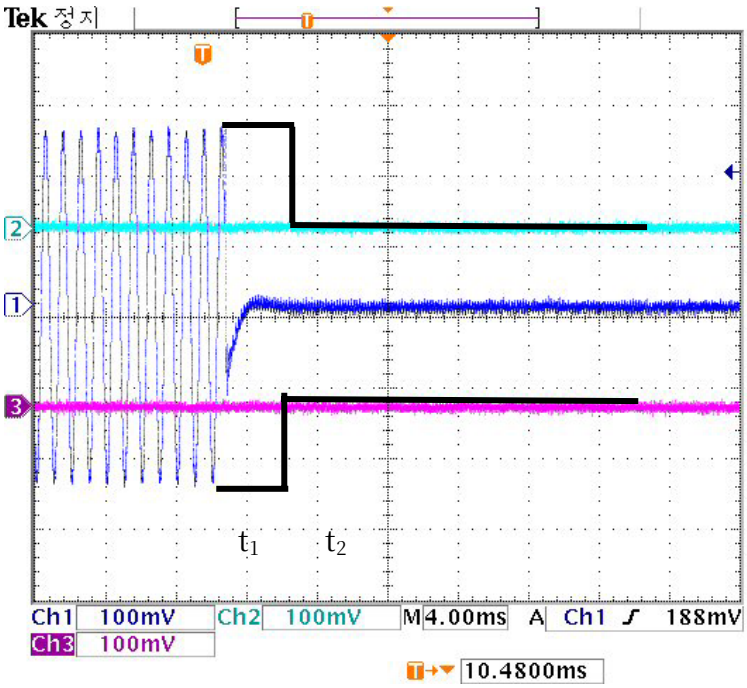
1/2 Channel separation

1/2 Channel separation

Channel separation

Ch 1 Wide

Switching from OFF to ON (t_1 & t_2)



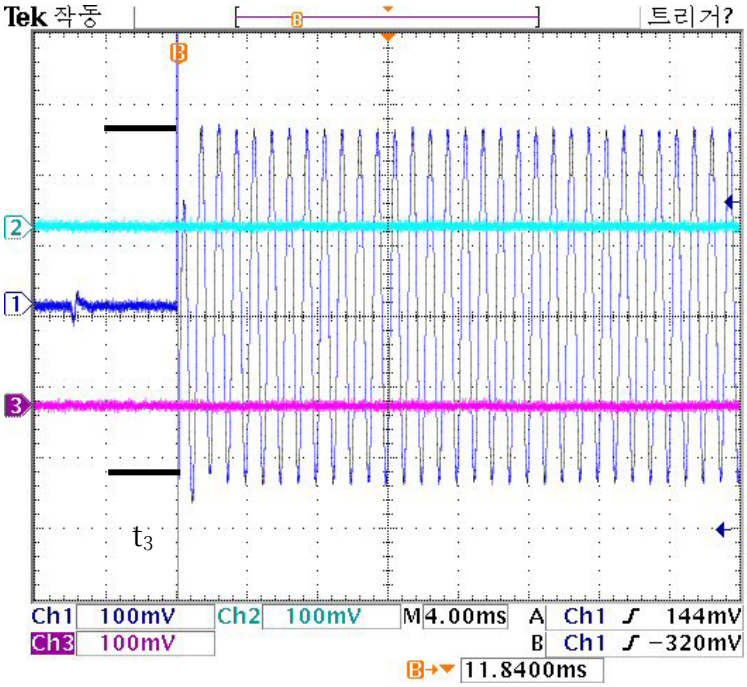
Channel separation

1/2 Channel separation

1/2 Channel separation

Channel separation

Switching from ON to OFF (t_3)



Channel separation

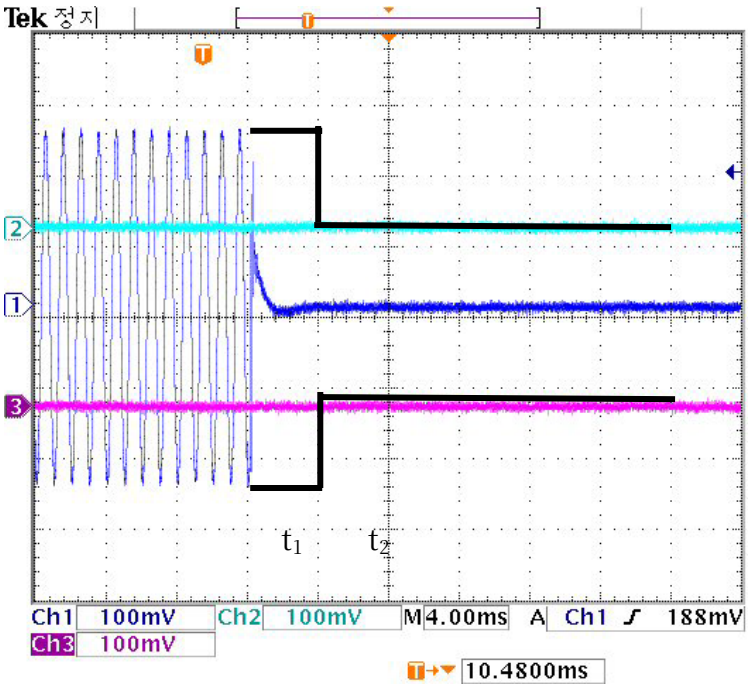
1/2 Channel separation

1/2 Channel separation

Channel separation

Ch 3 Wide

Switching from OFF to ON (t_1 & t_2)



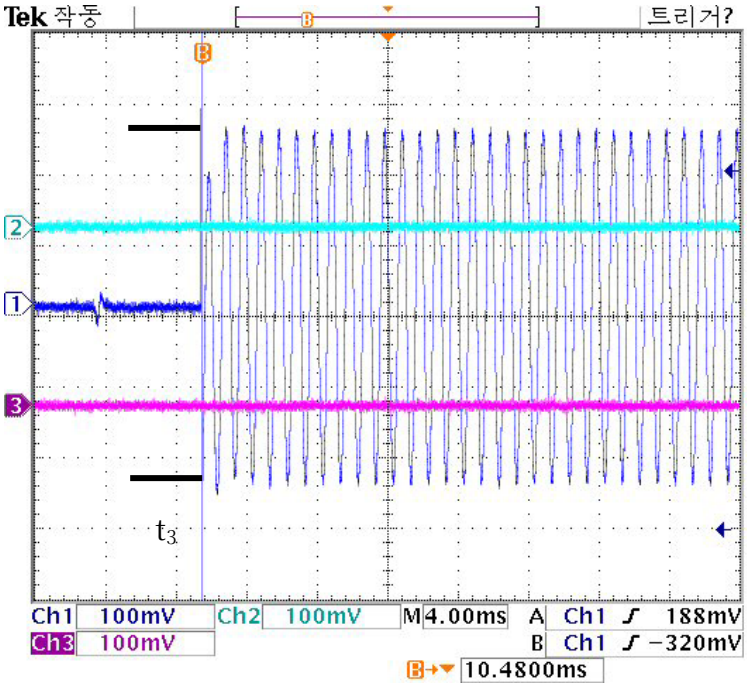
Channel separation

1/2 Channel separation

1/2 Channel separation

Channel separation

Switching from ON to OFF (t_3)



Channel separation

1/2 Channel separation

1/2 Channel separation

Channel separation

Appendix A Photo of Radiated Spurious Emission Test