OMAP35x-11 SOM-LV Radiated Emissions Scan: 30 MHz – 1 GHz

White Paper 469

Logic PD // Products
Published: February 2011

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Revision History

REV	EDITOR	DESCRIPTION	APPROVAL	DATE
1	NJK	Preliminary draft release	—	06/14/10
A	JCA	Initial release	NJK	02/22/11

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1 OMAP35x-11 SOM-LV Radiated Emissions Scans: 30 MHz – 1 GHz

The OMAP353x-11 SOM-LV was scanned at Northwest EMC in Brooklyn Park, MN.

2 Wi-Fi & Bluetooth Depopulated Test Results

A standard OMAP35x-11 SOM-LV with Wi-Fi (U35), Bluetooth (U12), and the supporting circuitry removed was scanned for unintentional radiated emissions. This testing was completed to provide a baseline scan of the SOM-LV for customers not using these interfaces.

The SOM-LV was connected to a standard SDK2-APP-10 baseboard. The only connection to the baseboard was the power supply.

The unit under test used software that looped through the following interfaces: NOR flash, PMIC, touch, RAM, NAND flash, and ID chip. All tests used the same software, with the exception of the modified register settings noted in Section 2.2.

Table 2.1 lists the known frequencies generated on the OMAP35x-11 SOM-LV with the functional test code running.

Table 2.1: Frequencies Generated while Running Functional Test Code

Source	Frequency
DPLL1	500 MHz
DPLL3	166 MHz
DPLL4	864 MHz
DPLL5	120 MHz
LPDDR interface	166 MHz (332 MHz actual)
GPMC bus	166 MHz (internal frequency)
System oscillator	26 MHz
uP_CLKOUT1_26MHz	26 MHz
uP_CLKOUT2_26MHz	54 MHz

NOTE: The noise around 40 MHz in some of the scans was due to the power supply. Midway through the testing, a ferrite was added to the power supply cable dissipating much of this noise. The ferrite was present on Run #4 and later.

2.1 Run #1

Run #1 shows a baseline scan of the OMAP35x-11 SOM-LV (see Figure 2.1 and Figure 2.2). The software was looping through the peripherals as indicated above. Some of the signals were slightly above the Class B line in this configuration.

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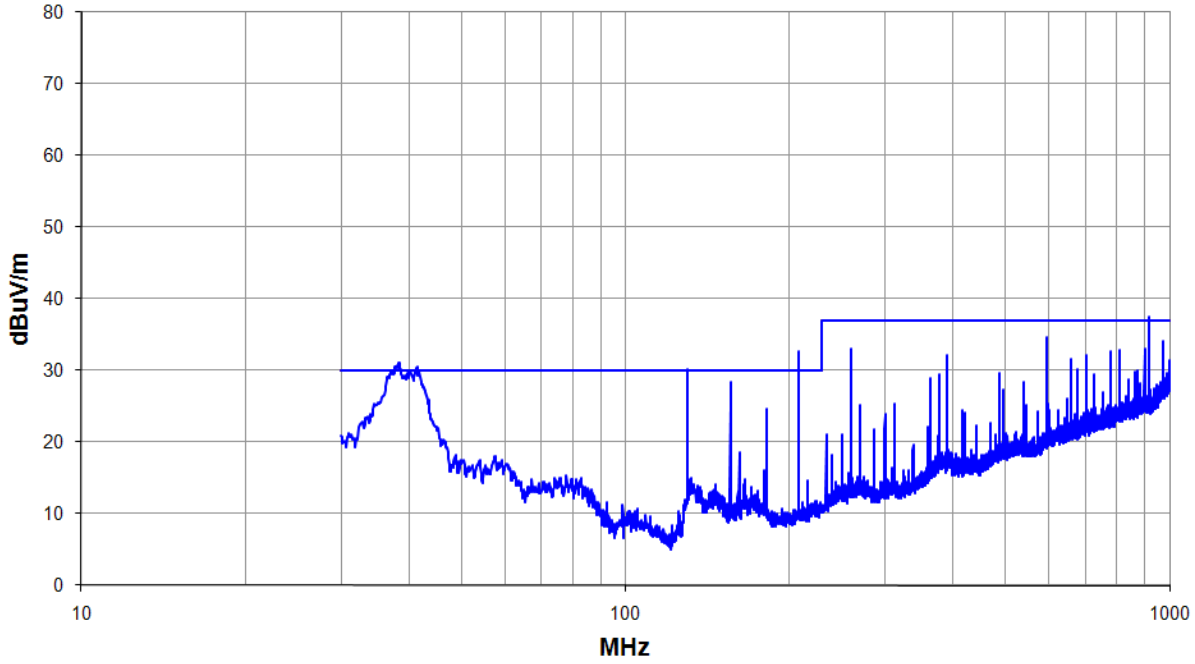
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	1	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
207.989	60.5	43.0	1.0	13.7	1.4	0.0	Vert	PK	0.0	32.6	30.0	2.6
38.290	57.3	43.1	1.0	16.2	0.7	0.0	Vert	PK	0.0	31.1	30.0	1.1
917.933	51.3	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	37.5	37.0	0.5
130.067	62.3	43.0	1.0	9.9	1.1	0.0	Vert	PK	0.0	30.3	30.0	0.3
156.002	58.9	43.0	1.0	11.2	1.2	0.0	Vert	PK	0.0	28.4	30.0	-1.6
593.929	52.1	43.7	1.5	23.8	2.4	0.0	Horz	PK	0.0	34.6	37.0	-2.4
971.934	46.3	44.4	1.0	29.3	3.0	0.0	Horz	PK	0.0	34.2	37.0	-2.8
259.977	59.0	43.1	1.0	15.7	1.5	0.0	Vert	PK	0.0	33.1	37.0	-3.9
900.051	46.7	44.5	1.0	28.0	2.9	0.0	Horz	PK	0.0	33.1	37.0	-3.9
809.932	47.0	43.8	1.5	26.9	2.7	0.0	Horz	PK	0.0	32.9	37.0	-4.1
779.971	47.4	43.7	1.5	26.3	2.7	0.0	Horz	PK	0.0	32.7	37.0	-4.3
207.989	53.5	43.0	3.0	13.7	1.4	0.0	Horz	PK	0.0	25.6	30.0	-4.4
917.933	46.0	44.5	2.0	27.8	2.9	0.0	Vert	PK	0.0	32.2	37.0	-4.8
702.049	47.7	43.5	1.5	25.4	2.5	0.0	Horz	PK	0.0	32.1	37.0	-4.9
390.005	54.4	43.1	2.5	18.9	1.9	0.0	Horz	PK	0.0	32.1	37.0	-4.9
181.936	53.4	43.0	1.0	12.9	1.3	0.0	Vert	PK	0.0	24.6	30.0	-5.4

Figure 2.1: Run #1—Peak Full Scan

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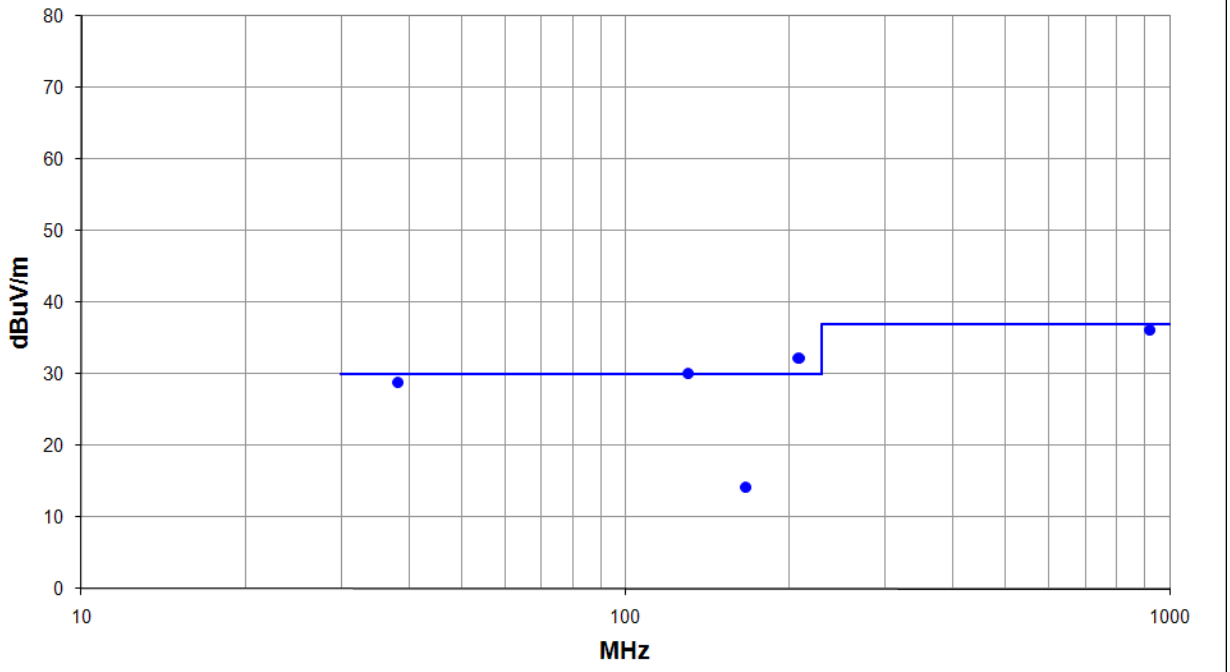
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	1	Test Distance (m)	10	Antenna Height(s)	1-4m	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Test Distance (meters)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
208.011	60.1	-27.9	1.0	44.0	10.0	0.0	Vert	QP	0.0	32.2	30.0	2.2
130.011	62.2	-32.0	1.0	303.0	10.0	0.0	Vert	QP	0.0	30.2	30.0	0.2
918.009	50.0	-13.8	1.0	77.0	10.0	0.0	Horz	QP	0.0	36.2	37.0	-0.8
38.169	55.0	-26.1	1.0	213.0	10.0	0.0	Vert	QP	0.0	28.9	30.0	-1.1
166.006	43.9	-29.7	1.6	75.0	10.0	0.0	Vert	QP	0.0	14.2	30.0	-15.8

Figure 2.2: Run #1—Quasi-Peak Scan

2.2 Run #2

Run #2 included built-in EMI control from the OMAP35x processor. EMI control was turned on using the register settings in Table 2.2.

Table 2.2: EMI Control Register Settings

Register	Address	Value
CONTROL_DSS_DPLL_SPREADING	0x4800_2450	0x0000_0011
CONTROL_CORE_DPLL_SPREADING	0x4800_2454	0x0000_0011
CONTROL_PER_DPLL_SPREADING	0x4800_2458	0x0000_0011
CONTROL_USBHOST_DPLL_SPREADING	0x4800_245c	0x0000_0011

The EMI control of the OMAP35x processor helped reduce much of the noise at the higher end of the spectrum.

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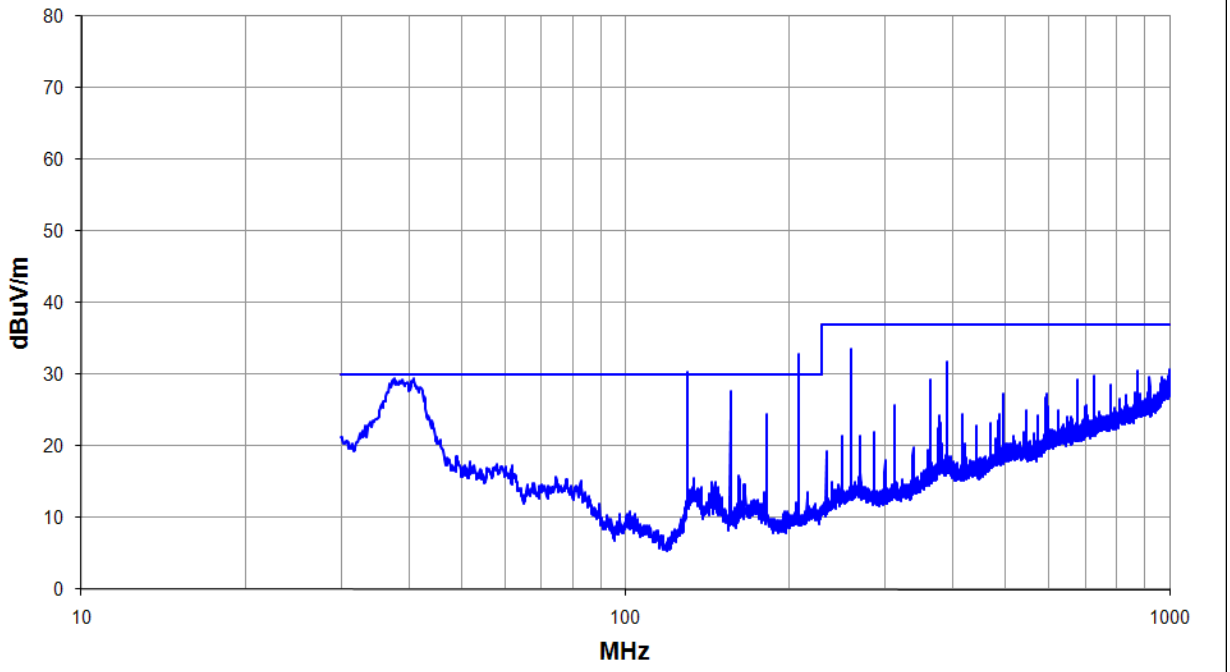
Test Specifications			Class B			Test Method	
FCC 15.109(g) (CISPR 22:1997):2010						ANSI C63.4:2003	
Run #	2	**Test Distance (m)**	10	**Antenna Height(s)**	1, 1.5, 2, 2.5, 3 (m)	**Results**	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
207.989	60.6	43.0	1.0	13.7	1.4	0.0	Vert	PK	0.0	32.7	30.0	2.7
130.067	62.3	43.0	1.5	9.9	1.1	0.0	Vert	PK	0.0	30.3	30.0	0.3
37.579	55.2	43.1	1.0	16.5	0.7	0.0	Vert	PK	0.0	29.4	30.0	-0.6
156.002	58.2	43.0	1.0	11.2	1.2	0.0	Vert	PK	0.0	27.7	30.0	-2.3
259.977	59.4	43.1	1.0	15.7	1.5	0.0	Vert	PK	0.0	33.5	37.0	-3.5
207.989	53.5	43.0	3.0	13.7	1.4	0.0	Horz	PK	0.0	25.6	30.0	-4.4
390.005	54.0	43.1	2.5	18.9	1.9	0.0	Horz	PK	0.0	31.7	37.0	-5.3
181.936	53.1	43.0	1.0	12.9	1.3	0.0	Vert	PK	0.0	24.3	30.0	-5.7
1000.000	42.2	44.4	1.0	29.8	3.0	0.0	Horz	PK	0.0	30.6	37.0	-6.4
875.064	44.1	44.3	1.5	27.8	2.9	0.0	Horz	PK	0.0	30.5	37.0	-6.5
129.949	55.4	43.0	3.0	9.9	1.1	0.0	Horz	PK	0.0	23.4	30.0	-6.6
992.184	41.4	44.4	3.0	29.7	3.0	0.0	Horz	PK	0.0	29.7	37.0	-7.3
727.983	45.0	43.6	2.5	25.7	2.6	0.0	Vert	PK	0.0	29.7	37.0	-7.3
919.473	43.4	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	29.6	37.0	-7.4
970.513	41.7	44.4	1.0	29.2	3.0	0.0	Horz	PK	0.0	29.5	37.0	-7.5
916.749	43.1	44.5	1.5	27.8	2.9	0.0	Horz	PK	0.0	29.3	37.0	-7.7

Figure 2.3: Run #2—Peak Full Scan

2.3 Run #3

Run #3 improved the EMI results by turning off uP_CLKOUT1_26MHz in addition to setting the built-in EMI control of the OMAP35x processor (see Section 2.2).

Software was turning on the uP_CLKOUT1_26MHz signal, which is only used if Bluetooth is populated or if the signal is used for reference off the SOM. Neither of these cases hold true for the OMAP35x-11 SOM-LV with Wi-Fi and Bluetooth circuitry removed. Turning off this clock allows the OMAP35x-11 SOM-LV to pass class B specification.

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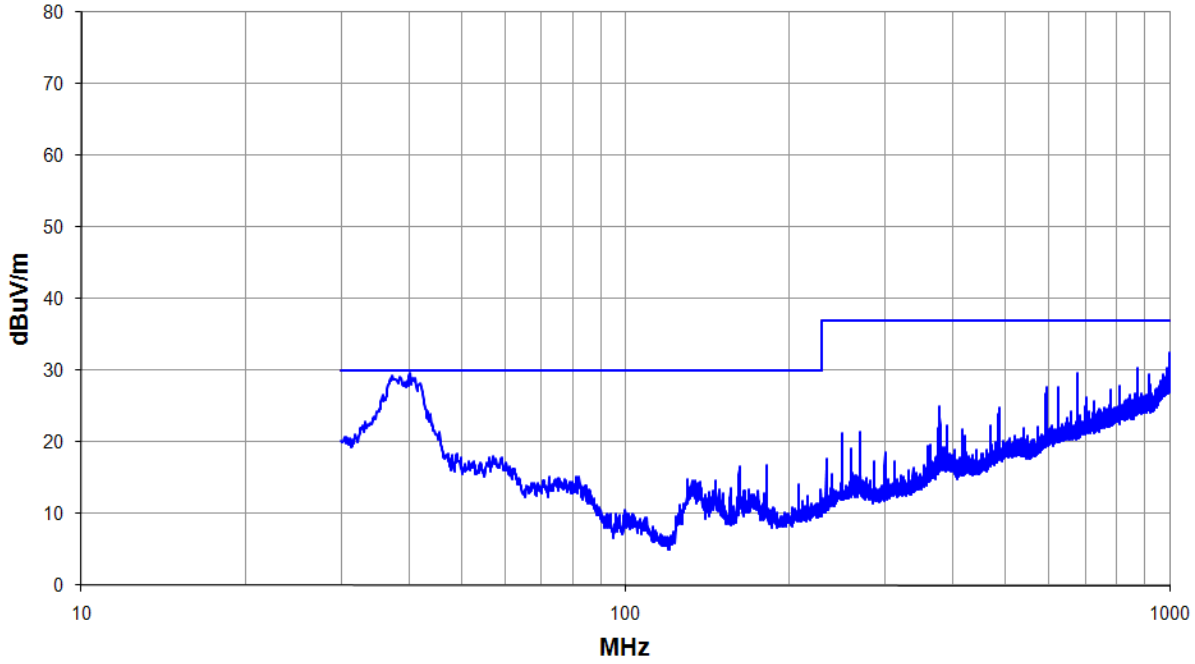
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	3	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
40.184	56.8	43.0	2.0	15.2	0.8	0.0	Vert	PK	0.0	29.7	30.0	-0.3
1000.000	44.1	44.4	1.0	29.8	3.0	0.0	Horz	PK	0.0	32.5	37.0	-4.5
875.064	44.0	44.3	1.5	27.8	2.9	0.0	Horz	PK	0.0	30.4	37.0	-6.6
991.829	42.0	44.4	2.5	29.7	3.0	0.0	Vert	PK	0.0	30.3	37.0	-6.7
675.996	45.8	43.5	1.5	24.9	2.5	0.0	Horz	PK	0.0	29.6	37.0	-7.4
916.749	43.3	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	29.5	37.0	-7.5
974.776	41.4	44.4	1.5	29.5	3.0	0.0	Vert	PK	0.0	29.4	37.0	-7.6
985.908	40.9	44.4	1.0	29.6	3.0	0.0	Horz	PK	0.0	29.1	37.0	-7.9
1000.000	40.7	44.4	1.5	29.8	3.0	0.0	Vert	PK	0.0	29.1	37.0	-7.9
961.868	40.9	44.4	2.0	28.8	3.0	0.0	Horz	PK	0.0	28.2	37.0	-8.8
810.405	41.9	43.8	1.0	26.9	2.7	0.0	Horz	PK	0.0	27.8	37.0	-9.2
593.929	45.2	43.7	1.5	23.8	2.4	0.0	Horz	PK	0.0	27.7	37.0	-9.3
624.008	44.4	43.7	1.5	24.5	2.4	0.0	Horz	PK	0.0	27.7	37.0	-9.3
594.876	45.1	43.7	1.5	23.8	2.4	0.0	Horz	PK	0.0	27.6	37.0	-9.4
916.630	41.3	44.5	1.5	27.8	2.9	0.0	Vert	PK	0.0	27.5	37.0	-9.5
941.854	40.9	44.5	2.0	28.0	2.9	0.0	Horz	PK	0.0	27.4	37.0	-9.6

Figure 2.4: Run #3—Peak Full Scan

2.4 Run #4

Run #4 was a repeat of Run #3, except a ferrite was added to the power supply cable. Much of the noise around 40 MHz was generated by the power supply; because the power supply was not a focus of this testing, adding a ferrite helped dissipate this noise. Subsequent tests also used this ferrite on the power supply cable.

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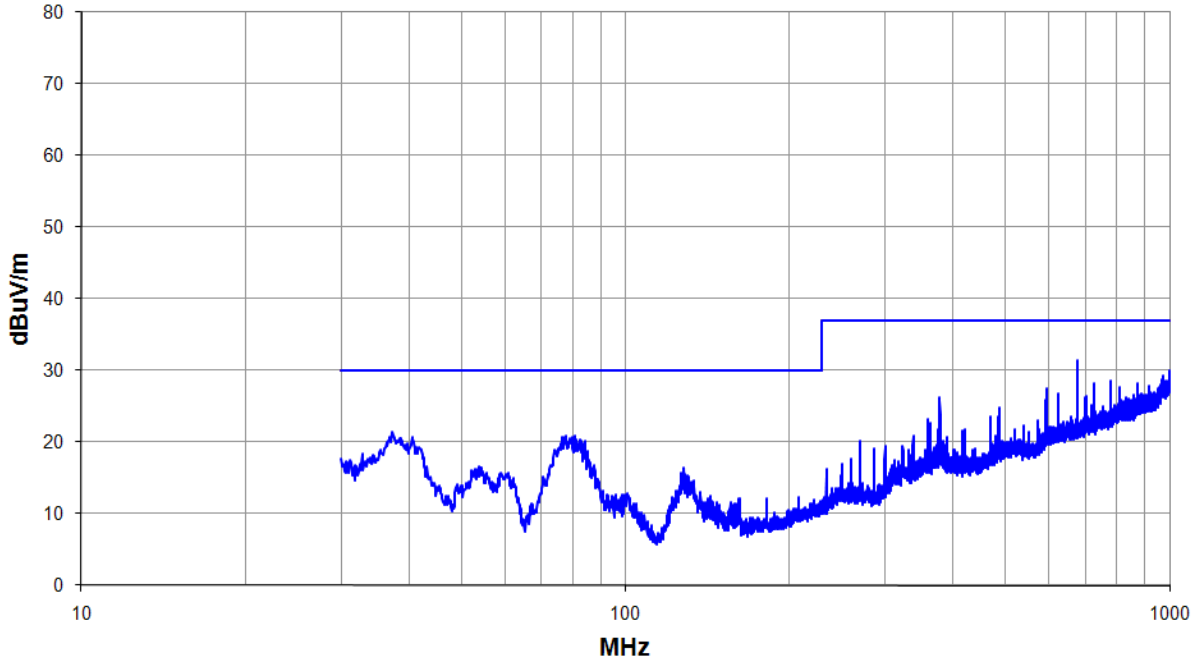
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	4	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
675.996	47.6	43.5	1.5	24.9	2.5	0.0	Horz	PK	0.0	31.4	37.0	-5.6
1000.000	41.7	44.4	1.0	29.8	3.0	0.0	Horz	PK	0.0	30.1	37.0	-6.9
973.237	41.3	44.4	1.0	29.4	3.0	0.0	Horz	PK	0.0	29.2	37.0	-7.8
998.105	40.6	44.4	1.5	29.8	3.0	0.0	Vert	PK	0.0	29.0	37.0	-8.0
779.971	43.3	43.7	1.5	26.3	2.7	0.0	Horz	PK	0.0	28.6	37.0	-8.4
37.342	47.1	43.1	1.0	16.6	0.7	0.0	Vert	PK	0.0	21.4	30.0	-8.6
875.064	41.9	44.3	1.0	27.8	2.9	0.0	Horz	PK	0.0	28.3	37.0	-8.7
727.983	43.5	43.6	1.0	25.7	2.6	0.0	Horz	PK	0.0	28.2	37.0	-8.8
80.803	53.5	43.1	2.0	9.6	0.9	0.0	Vert	PK	0.0	20.9	30.0	-9.1
916.512	41.7	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	27.9	37.0	-9.1
810.997	41.8	43.8	1.5	26.9	2.7	0.0	Horz	PK	0.0	27.7	37.0	-9.3
593.337	45.0	43.7	1.5	23.8	2.4	0.0	Horz	PK	0.0	27.5	37.0	-9.5
594.639	44.5	43.7	1.5	23.8	2.4	0.0	Horz	PK	0.0	27.0	37.0	-10.0
919.354	40.8	44.5	3.0	27.8	2.9	0.0	Vert	PK	0.0	27.0	37.0	-10.0
888.327	40.5	44.4	2.5	27.9	2.9	0.0	Vert	PK	0.0	26.9	37.0	-10.1
624.008	43.6	43.7	1.5	24.5	2.4	0.0	Horz	PK	0.0	26.9	37.0	-10.1

Figure 2.5: Run #4—Peak Full Scan

2.5 Run #5

Run #5 re-enabled the uP_CLKOUT1_26MHz signal on the OMAP35x-11 SOM-LV while keeping the processor's EMI control enabled. The uP_CLKOUT1_26MHz signal included a filter to lower radiated emissions; this filter consisted of a 330 ohm resistor populated at R33 and a 1000pF capacitor populated at C111. Adding this filter on the SOM produced noticeable improvement of the 26 MHz harmonics. **NOTE:** Filter values were chosen based on part availability; actual filter values may vary and need to be determined based on the end application.

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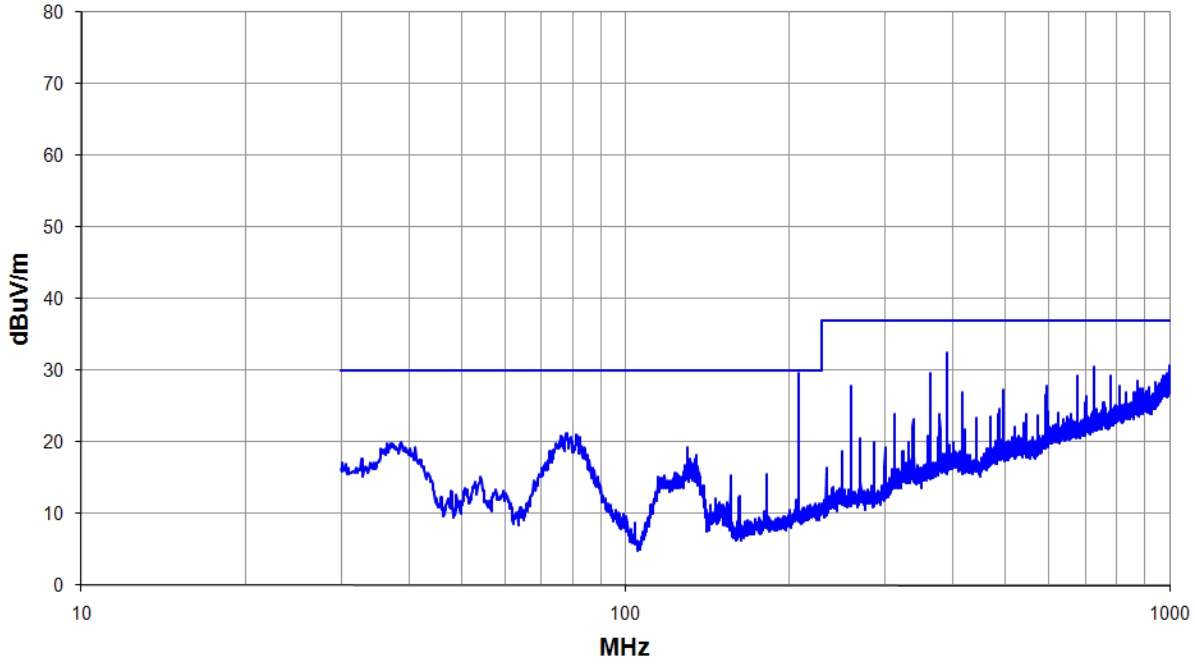
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	5	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
207.989	57.6	43.0	1.0	13.7	1.4	0.0	Vert	PK	0.0	29.7	30.0	-0.3
390.005	54.8	43.1	2.5	18.9	1.9	0.0	Horz	PK	0.0	32.5	37.0	-4.5
207.989	52.3	43.0	3.0	13.7	1.4	0.0	Horz	PK	0.0	24.4	30.0	-5.6
999.882	42.3	44.4	1.0	29.8	3.0	0.0	Horz	PK	0.0	30.7	37.0	-6.3
727.983	45.9	43.6	1.0	25.7	2.6	0.0	Horz	PK	0.0	30.6	37.0	-6.4
991.237	41.4	44.4	1.0	29.7	3.0	0.0	Vert	PK	0.0	29.7	37.0	-7.3
363.952	52.4	43.1	2.5	18.4	1.8	0.0	Horz	PK	0.0	29.6	37.0	-7.4
675.996	45.5	43.5	1.5	24.9	2.5	0.0	Horz	PK	0.0	29.3	37.0	-7.7
979.631	41.2	44.4	2.5	29.6	3.0	0.0	Horz	PK	0.0	29.3	37.0	-7.7
779.971	44.0	43.7	1.0	26.3	2.7	0.0	Horz	PK	0.0	29.3	37.0	-7.7
972.526	41.3	44.4	1.0	29.4	3.0	0.0	Horz	PK	0.0	29.2	37.0	-7.8
390.005	51.4	43.1	3.0	18.9	1.9	0.0	Vert	PK	0.0	29.1	37.0	-7.9
875.064	42.3	44.3	1.0	27.8	2.9	0.0	Horz	PK	0.0	28.7	37.0	-8.3
966.486	41.0	44.4	2.5	29.0	3.0	0.0	Horz	PK	0.0	28.6	37.0	-8.4
940.197	42.0	44.5	1.0	27.9	2.9	0.0	Vert	PK	0.0	28.4	37.0	-8.6
77.606	53.8	43.1	2.0	9.6	0.9	0.0	Vert	PK	0.0	21.2	30.0	-8.8

Figure 2.6: Run #5—Peak Full Scan

2.6 Run #6

Run #6 was an extension of Run #5; the same setup was used except the uP_CLKOUT1_26MHz trace was cut on the baseboard at the SOM-LV connector to eliminate the potential for creating an “antenna” on the baseboard.

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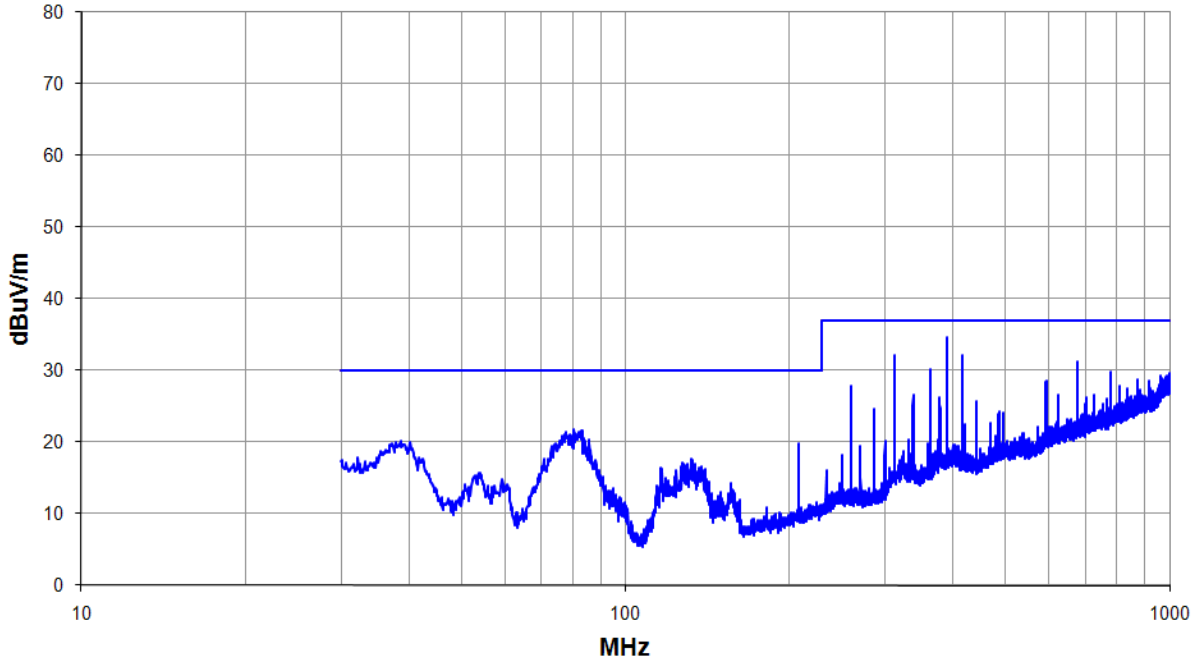
Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	6	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Evaluation



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
390.005	56.9	43.1	2.5	18.9	1.9	0.0	Horz	PK	0.0	34.6	37.0	-2.4
390.005	55.7	43.1	1.0	18.9	1.9	0.0	Vert	PK	0.0	33.4	37.0	-3.6
416.058	53.6	43.1	2.5	19.8	1.9	0.0	Horz	PK	0.0	32.2	37.0	-4.8
311.964	56.7	43.1	3.0	16.7	1.7	0.0	Horz	PK	0.0	32.1	37.0	-4.9
675.996	47.4	43.5	1.5	24.9	2.5	0.0	Horz	PK	0.0	31.2	37.0	-5.8
363.952	52.9	43.1	1.0	18.4	1.8	0.0	Vert	PK	0.0	30.1	37.0	-6.9
779.971	44.6	43.7	1.0	26.3	2.7	0.0	Horz	PK	0.0	29.9	37.0	-7.1
999.882	41.2	44.4	1.0	29.8	3.0	0.0	Horz	PK	0.0	29.6	37.0	-7.4
364.070	52.3	43.1	2.5	18.5	1.8	0.0	Horz	PK	0.0	29.5	37.0	-7.5
991.474	41.0	44.4	2.5	29.7	3.0	0.0	Vert	PK	0.0	29.3	37.0	-7.7
965.065	41.7	44.4	1.5	28.9	3.0	0.0	Vert	PK	0.0	29.2	37.0	-7.8
875.064	42.4	44.3	1.0	27.8	2.9	0.0	Horz	PK	0.0	28.8	37.0	-8.2
80.448	54.3	43.1	1.0	9.5	0.9	0.0	Vert	PK	0.0	21.7	30.0	-8.3
916.512	42.3	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	28.5	37.0	-8.5
593.218	46.0	43.7	1.5	23.7	2.4	0.0	Horz	PK	0.0	28.4	37.0	-8.6
919.236	41.8	44.5	1.0	27.8	2.9	0.0	Horz	PK	0.0	28.0	37.0	-9.0

Figure 2.7: Run #6—Peak Full Scan

3 Wi-Fi & Bluetooth Populated Test Results

For this test a fully populated OMAP35x-11 SOM-LV (SOMOMAP3530-11-1672IFCR) was placed in a standard SDK2-APP-10 baseboard. A ferrite EMI suppression filter was added to the power supply's cable. The EMI control registers presented in Table 2.2 were set, enabling clock spreading on four of the processor's DPLL clock generation modules.

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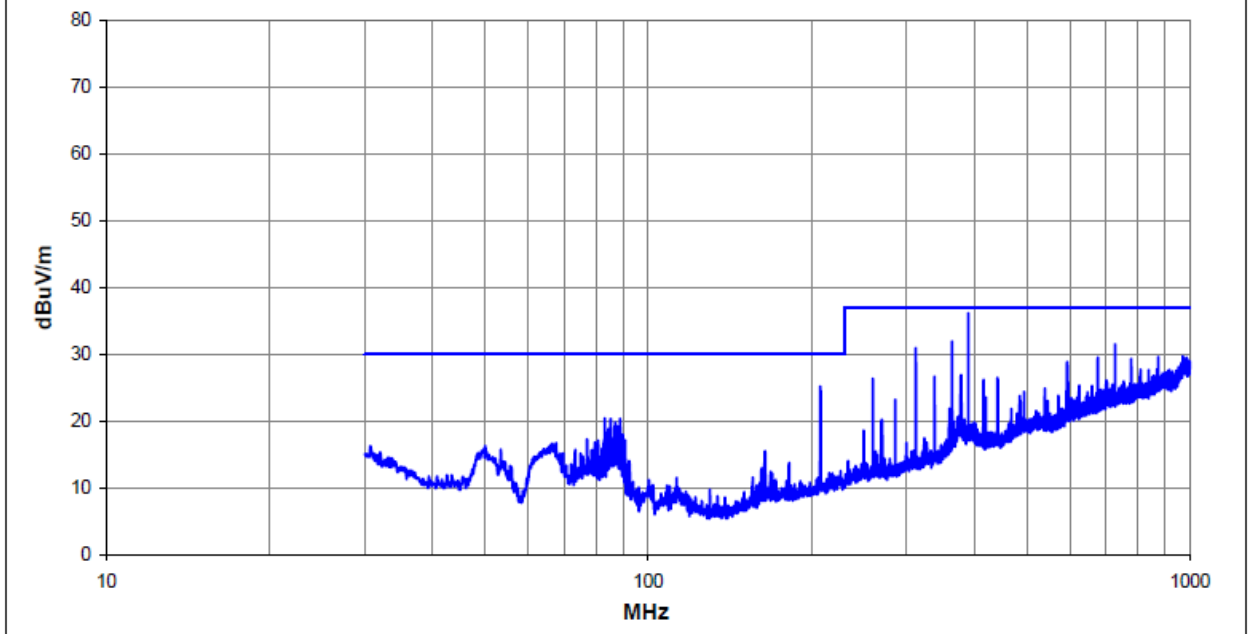
Various functional tests were looped in attempt to activate as many interfaces on the SOM as possible. These tests include: Bluetooth, Ethernet, PMIC, NOR flash, touch controller, NAND flash, RAM and ID chip.

Similar to the previous test setups, Table 2.1 lists the known frequencies generated on the OMAP35x-11 SOM-LV with the functional test code running.

Test Specifications	Class B	Test Method
FCC 15.109(g) (CISPR 22:1997):2010		ANSI C63.4:2003

Run #	3	Test Distance (m)	10	Antenna Height(s)	1, 1.5, 2, 2.5, 3 (m)	Results	Pass



Freq (MHz)	Amplitude (dBuV)	Preamp (dB)	Antenna Height (meters)	Transducer (dB)	Cable (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)
390.005	57.8	42.5	2.5	18.9	1.9	0.0	Horz	PK	0.0	36.1	37.0	-0.9
207.989	52.5	42.4	1.0	13.7	1.4	0.0	Vert	PK	0.0	25.2	30.0	-4.8
363.952	54.1	42.5	2.0	18.4	1.8	0.0	Horz	PK	0.0	31.9	37.0	-5.1
727.983	46.1	42.9	1.5	25.7	2.6	0.0	Horz	PK	0.0	31.5	37.0	-5.5
311.964	54.9	42.5	3.0	16.7	1.7	0.0	Horz	PK	0.0	30.9	37.0	-6.1
970.750	41.5	44.0	2.5	29.3	2.9	0.0	Vert	PK	0.0	29.7	37.0	-7.3
875.064	42.7	43.7	1.0	27.8	2.8	0.0	Horz	PK	0.0	29.6	37.0	-7.4
675.996	45.0	42.9	1.5	24.9	2.5	0.0	Horz	PK	0.0	29.5	37.0	-7.5
986.974	40.9	44.1	3.0	29.6	3.0	0.0	Horz	PK	0.0	29.4	37.0	-7.6
779.971	43.4	43.0	1.0	26.3	2.7	0.0	Horz	PK	0.0	29.3	37.0	-7.7
594.284	45.7	43.1	1.5	23.8	2.4	0.0	Horz	PK	0.0	28.8	37.0	-8.2
390.005	50.5	42.5	1.0	18.9	1.9	0.0	Vert	PK	0.0	28.8	37.0	-8.2

Figure 3.1: OMAP35x-11 SOM-LV with Wi-Fi and Bluetooth Populated

4 Summary

These radiated emissions scan provide a baseline for the performance of the OMAP35x-11 SOM-LV alone. Radiated emissions testing of a final product designed around the OMAP35x-11 SOM-LV is the responsibility of the developer.

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