

Vehicular Wiring Harness FM Transmitter Table-top Test Configuration

**Sirius XM-FMCLA Adapter
6.30.09 Rev 3**

1. Sirius XM FMCLA vehicle adapter description:

The Sirius XM FMCLA adapter serves the dual purpose of providing power to Sirius XM satellite radios from a vehicle's 12 volt cigarette lighter socket, while simultaneously injecting into the vehicle's wiring harness an FM modulated signal of approximately 200 KHz bandwidth, which is a part of the down converted and decoded RF satellite signal. With this arrangement, the vehicle's wiring harness effectively becomes an antenna transmitting in the FM band of 88 MHz – 108 MHz. An illustration of this concept is shown below in Figure 1.

FMCLA in Vehicle Diagram

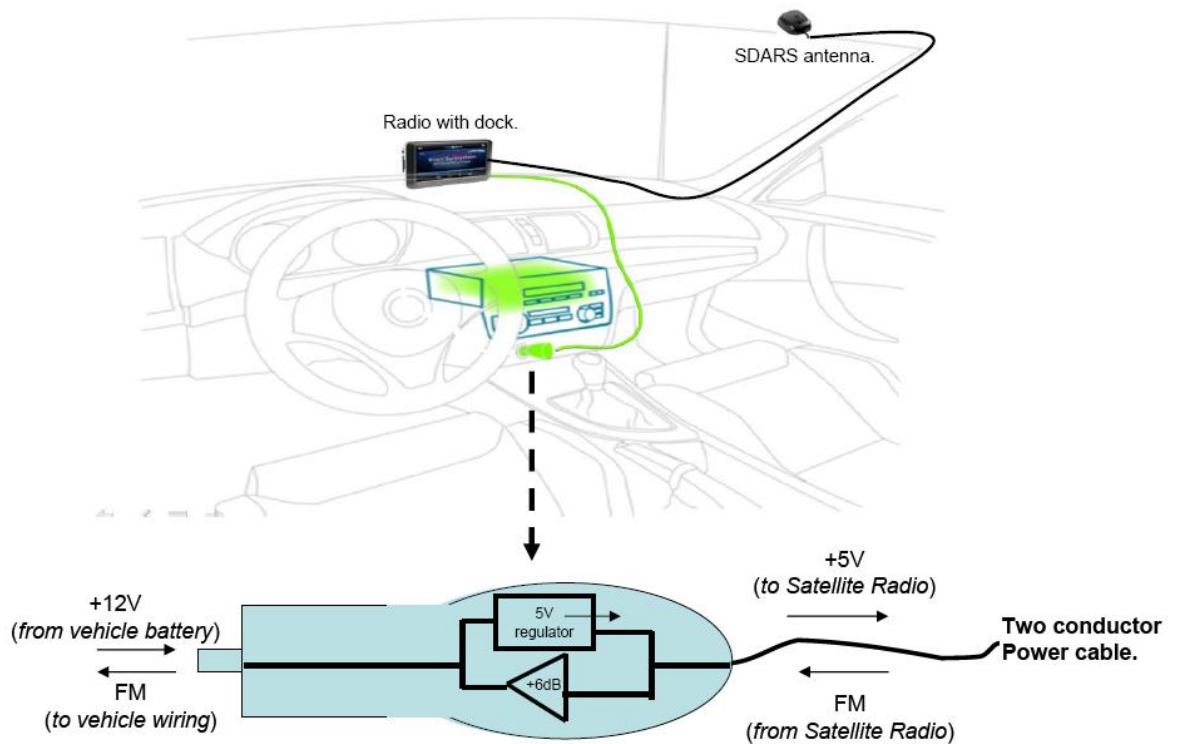


Figure 1: FMCLA in Vehicle Diagram

2. Potential concerns FCC has expressed with vehicle in-situ measurements

Recognizing the difficulty of accurately representing a particular vehicle's wiring harness on a table top -- much less the range of wiring harnesses that might be found across all vehicle makes and models -- Section 15.31(d) of the FCC rules and FCC knowledge database article #470998 (April 2006), clearly require in situ testing for this type of product. Sirius XM however, had previously become aware of the FCC's reticence to accept in situ testing for FM modulators in vehicles. A meeting was therefore requested with the FCC staff to discuss the issue. The goal of the meeting was to understand how the FCC would expect a product such as this to be tested, and to ensure that Sirius XM would meet the emissions limits when this procedure was used for its upcoming line of products, which were expected to be submitted for certification over the following several months.

The issue, as described by Julius Knapp at the meeting, which occurred on March 4, 2009, stems from the known wide variation in measured emissions from a radiating source inside of a vehicle, depending on the particular vehicle chosen. His concern was that the power output of a device could be set to a level that met FCC limits when used in the 3 vehicles chosen for in situ certification tests; yet, when the same device was used in other vehicles, it could radiate at levels substantially above the limits.

To address this concern, Mr. Knapp asked Sirius XM to develop a "table top" measurement method that could be used in conjunction with in situ measurements. It was understood that the table top method would not be used by itself to show compliance, but that it would be a check on the in situ measurements to ensure that those measurements were not based on a non-representative selection of vehicles.

It should also be noted that proposals of alternative test methods acceptable to the FCC are expressly allowed in Section 2.947(a) (3) of the FCC's rules and regulations.

3. Proposed table top configuration/method and results

In order to create a table top method for the measurement of emissions from injected FM CLA's, Sirius XM began by collecting in situ data on 18 vehicles of varying size, make, and model. The goal then, was to develop a table top method that correlated with the worst case in situ measurements. Results of the in situ testing are shown below in Figure 2.

1/13/2009

Make - Model	Type	Vertical (dB μ V)	Horizontal (dB μ V)	CF (dB/m)	Vertical (dB μ V/m)	Horizontal (dB μ V/m)	Limit (dB μ V/m)	Vert Margin (dB)	Horiz Margin (dB)
Saturn SL2	Composite Body	51.8	45.3	14.1	37.7	31.2	48	10.3	16.8
BMW 525	Sedan	50.2	48.0	14.1	36.1	33.9	48	11.9	14.1
Toyota Celica 1	Small car	49.4	43.1	14.1	35.3	29.0	48	12.7	19.0
Mustang	Small car	50.9	44.5	14.1	36.8	30.4	48	11.2	17.6
Toyota Celica 2	Sedan	50.1	45.7	14.1	36.0	31.6	48	12.0	16.4
Toyota Camry	Sedan	55.8	48.4	14.1	41.7	34.3	48	6.3	13.7
Lincoln town car	Large car	51.9	50.7	14.1	37.8	36.6	48	10.2	11.4
Nissan Quest	SUV	53.5	51.7	14.1	39.4	37.6	48	8.6	10.4
Toyota Avalon	Sedan	58.8	52.9	14.1	44.7	38.8	48	3.3	9.2
Hyundai	Sedan	58.8	50.6	14.1	44.7	36.5	48	3.3	11.5
Honda Acura	Sedan	58.7	50.2	14.1	44.6	36.1	48	3.4	11.9
Nissan Maxima SE	Sedan	57.2	54.1	14.1	43.1	40.0	48	4.9	8.0

3/12/2009

Make - Model	Type	Vertical (dB μ V)	Horizontal (dB μ V)	CF (dB/m)	Vertical (dB μ V/m)	Horizontal (dB μ V/m)	Limit (dB μ V/m)	Vert Margin (dB)	Horiz Margin (dB)
Ford Explorer	SUV	56.6	55.8	16.5	40.1	39.3	48.0	7.9	8.7
Jeep Grand Cherokee	SUV	57.0	57.3	16.5	40.5	40.8	48.0	7.5	7.2
Hyundai Veracruz	SUV	53.2	52.4	16.5	36.7	35.9	48.0	11.3	12.1
Nissan Titan	Pickup Truck	55.2	57.6	16.5	38.7	41.1	48.0	9.3	6.9
Nissan Pathfinder	SUV	48.8	48.5	16.5	32.3	32.0	48.0	15.7	16.0
Honda Minivan	Minivan	52.2	50.2	16.5	35.7	33.7	48.0	12.3	14.3

Figure 2: In Situ Test Results

Note that for the power level utilized by the Sirius XM injected FM device, the worst case emissions were approximately 3 dB under the FCC emissions limit of 48 dB μ V/m at 3m.

Sirius XM does not believe that any table top method should be utilized that would result in emissions being measured that are significantly higher than the worst case in situ emissions because in that case, the table top method would not be representative of a real world scenario. Moreover, the procedure would not serve the stated purpose of being a check on the in situ results. Again, it is not possible to represent a vehicle wiring harness on the table top, and that was not the goal. It was with that in mind that the table top method as shown below in figure 3 was developed. Measured results from the proposed method are shown in figure 3 as well.

Recommended Table Top Configuration

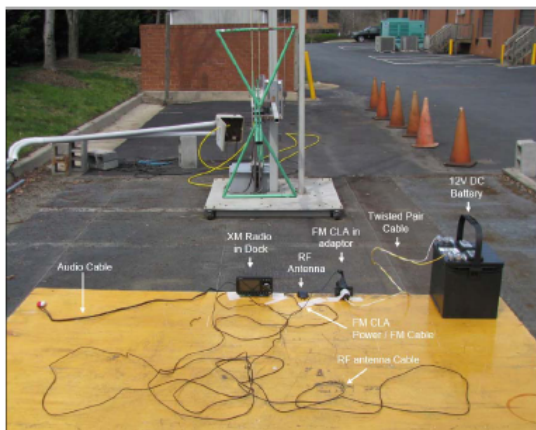


Table top data taken at Rhein Tech Laboratories in Herndon, VA.

Good correlation to worst case vehicle measurements was found for the test set up as pictured, and as described below.

Cable length: 1 meter not including length of CLA socket	Positive and Ground wires are twisted ~10 times.
Wire gauge: 12 or 14 AWG stranded.	Battery Location: Table top
Spacing: 10 cm between EUT and accessories.	All cables manipulated for maximum emissions.
CLA receptacle next to battery	Rotate turntable and raise antenna to maximize emissions

Cable Length (cm)	Cable Config	Battery	Frequency (MHz)	Polarization (H/V)	SA Reading (dB μ V)	CF (dB/m)	E_Field (dB μ V/m)	FCC Limit (dB μ V)	Margin to limit (dB)
100	twisted	Grey	89.1	H	67.6	-21.8	45.8	48	2.2
			89.1	V	59.5	-21.8	37.7	48	10.3
100	twisted	Grey	97.7	H	66.9	-19.9	47.0	48	1.0
			97.7	V	59.5	-19.9	39.6	48	8.4
100	twisted	Grey	106.3	H	63.4	-18.8	44.6	48	3.4
			106.3	V	58.9	-18.8	40.1	48	7.9

Figure 3: Table Top Method and Test Results

The proposed table top configuration/method has been found to correlate well with the worst case in-situ results at each location where testing has been performed. Further, in situ and table top testing during development, and during testing for certification purposes (see report that this addendum is attached to for a partial account of the additional testing results) has resulted in additional data showing correlation between in situ results and the results from the proposed table top method. These testing results show the method to be valid across the entire FM band. Harmonics and other spurious emissions were too low to be measured for correlation purposes, but are included in the report to which this addendum is attached. The method as described here is applicable to all FM modulator systems using RF injection into the automobile wiring harness.

Note that the battery is placed on the table top in the proposed method. While this might initially seem to be contrary to the ANSI C63.4 test setup guidelines, this is not the case for injected FM systems, because the power cable and battery are now part of the EUT. As such, they are required to be on the table top.

It should also be noted that in addition to Section 2.947(a) (3), which allows alternative test procedures to be proposed, Section 15.31(b) allows alternative measurement procedures to be used if they can be shown to “produce measurement results compatible with the FCC measurement procedures.” Since the FCC measurement procedures call for in situ testing, and since the proposed table top procedure has been shown to correlate with worst case in situ test results, the proposed method satisfies these requirements.

4. Conclusion

Sirius XM believes that the proposed table top method for measuring emissions from injected FM CLA's, when used in conjunction with in-situ testing, provides a viable method for verifying compliance to the FCC-specified radiated emissions limits for intentional radiators. And while it may be possible to make incremental improvements to the testing methodology in the future, there is no reason to believe that the current methodology would allow products to be certified that would be over the FCC's power limit when used in the real world. This method also is believed to be similar in capability to currently approved methods already used for certifications of compliance and poses no significant risk to the Commission's processes or precedent.

5. TCB request:

The FCC has asked for Sirius XM to submit in-situ and table top data for the certification of its line of injected FM products, and has requested that the TCB provide its own opinion regarding the validity of the table top test procedure to accomplish the goal as described in Section 2 above.