

Best in Class Radiated Emissions EMI Performance with the AMC1300B-Q1 Isolated Amplifier

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ABSTRACT

Several industrial and automotive applications require some type of isolation to protect the digital circuitry from the high-voltage circuit performing a function. Texas Instruments has an [extensive portfolio](#) of isolated amplifiers and converters featuring a capacitive isolation barrier to help customers address their isolated data conversion needs. Texas instruments' capacitive isolation barrier allows for exceptional reliability, often over 100 years of operation. For more information on TI's capacitive isolation barrier, please review the [Isolation link](#). Radiated emissions testing is common in these applications to verify the system does not produce radiated emissions that exceed the defined levels which may negatively impact other components or circuits in the system. Please see this [application note](#) for a more in-depth description of EMI. The magnitude of acceptable radiation and testing procedure for radiated emissions is put in place by the Comité International Spécial des Perturbations Radio, also known as CISPR. Industrial applications measure according to the CISPR 11 standard, while automotive applications measure to the CISPR 25 standard. For more information on the CISPR standards and their respective magnitudes over frequency, please see this [application note](#).

This document shows the radiated emissions electromagnetic interference (EMI) performance for Texas Instruments newest isolated amplifier, the [AMC1300B-Q1](#), as well as radiated emissions performance for previous isolated amplifier generations.

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1 Introduction

In isolated amplifiers with a capacitive isolation barrier, radiated emissions can be created when the capacitors that span the barrier are charged and discharged to transmit data in the form of either a 1 or a 0. The charges flow through the differential capacitors in opposite directions mostly cancelling each other, however any difference in magnitude or time between these charge flows results in electro-magnetic energy injected between the isolated grounds GND1 and GND2. Because of the nature of the isolation barrier, the energy is unable to find a conductor to return to the source. With no path back to the source, the energy radiates from the device pins (and any traces or PCB planes they are connected to) in the form of radiated emissions. This radiation can extend to frequencies significantly above the amplifier signal bandwidth and data rates, since it is caused by timing mismatches in the pico-second range.

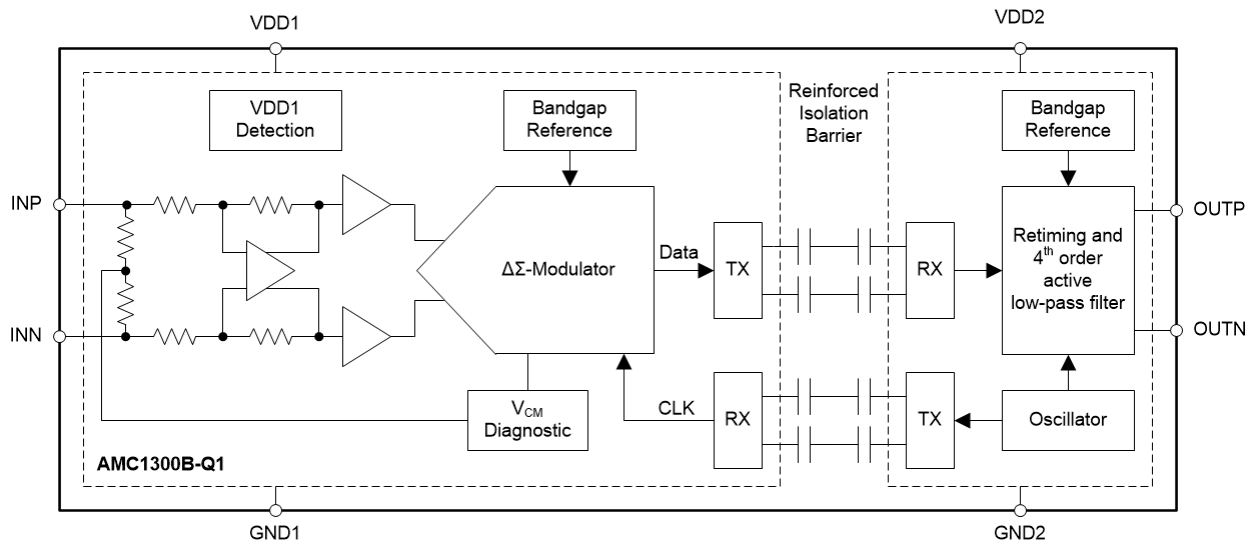


Figure 1. Isolated Amplifier Block Diagram

Within the recent years, there have been significant improvements to the architecture of Texas Instruments isolated amplifiers to optimize radiated EMI performance. Isolated amplifiers released from 2017 to 2019, AMC1300, AMC1302, AMC1311, and ISO224 use on/off keying (OOK) signal modulation, while older products such as AMC1301 use pulse coding. The OOK modulation enabled significantly improved Common-Mode Transient Immunity levels. At the same time, these devices also have significantly reduced the amount of energy crossing over the isolation barrier, which reduces the radiated emissions, providing sufficient margins to the standard specifications.

These design changes, as well as a re-designed isolated signal path are present in the AMC1300B-Q1, being released to production at the end of 2020. The optimized timing and amplitude in the signal chain yields a reduction of radiated emissions EMI at high frequencies to an even lower level.

The following sections show the radiated emissions EMI performance for Texas Instruments' isolated amplifiers starting with the newest AMC1300B-Q1 and also shows data for the previous generation devices. The radiated emissions scans were all performed according to the standards set in place by CISPR 11. All tests were performed using the [AMC1300EVM](#) printed circuit board (PCB) with the inputs shorted to ground, transformer driver (U3) removed, and external 3.6V batteries with short leads. Each scan shows the horizontal sweep results from the device under test (DUT) in blue as well as the ambient scan overlaid in red to show the noise floor of the chamber. Both CISPR 11 Class A and Class B limits are shown on the plots as well. The horizontal polarization was selected because the emissions levels detected by the test equipment's antenna were higher than for the vertical polarization, due to alignment with the PCB.

2 AMC1300B-Q1 Radiated Emissions Performance

The AMC1300B-Q1 reinforced isolation amplifier will soon release to production and incorporates several years of radiated emissions EMI performance advancements. Including, but not limited to: an optimized analog signal chain, the amount of energy crossing over the isolation barrier was more closely managed, and OOK data transmission. As shown in Figure 2, this device has excellent radiated emissions EMI performance, with only a few high frequency radiated emissions visible above the noise floor of the chamber. These high-frequency emissions are visible around 820MHz with 20dB of margin and extends to 980MHz with 16dB of margin. The industrial temperature version of the AMC1300B-Q1 will be released in the near future.

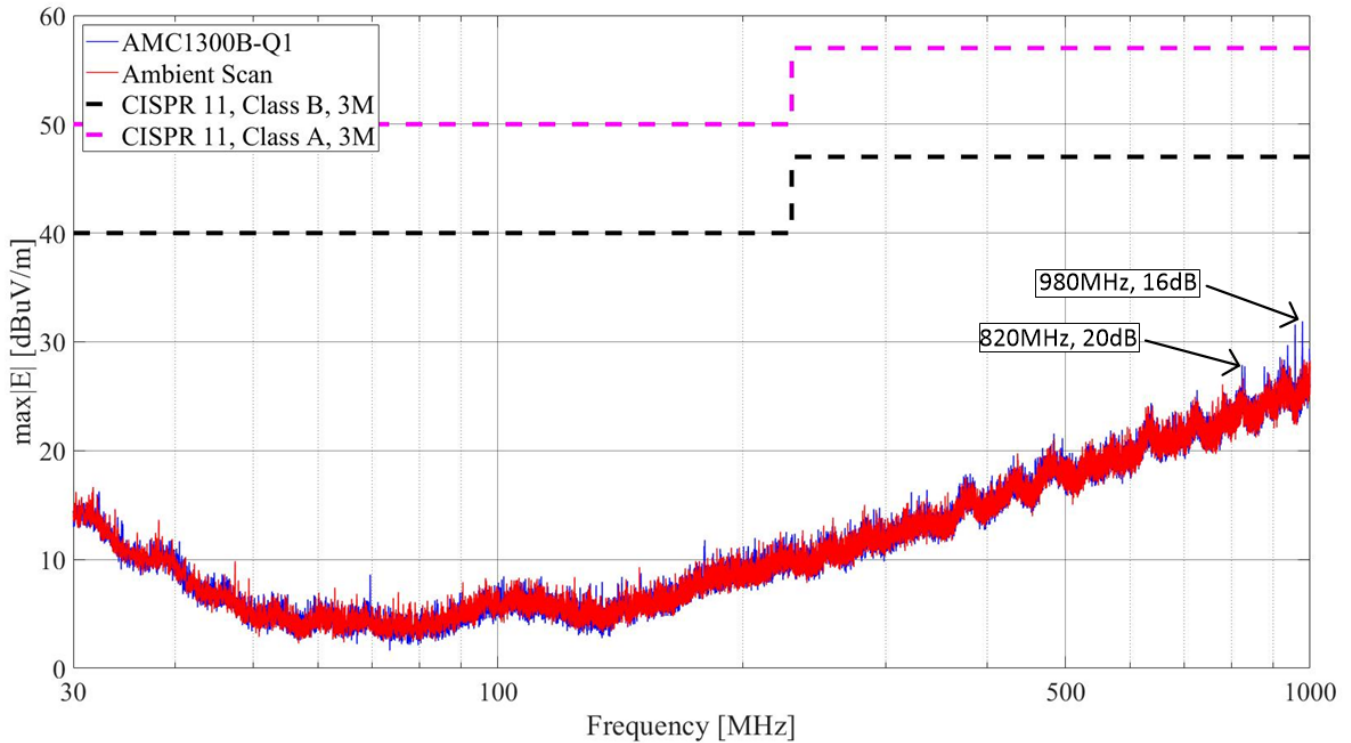


Figure 2. AMC1300B-Q1 CISPR 11 Radiated Emissions EMI Scan

3 Previous Generations of Texas Instruments Isolated Amplifiers

The generation of reinforced isolation amplifiers released from 2017 to 2019 includes the [AMC1300](#), [AMC1302](#), [AMC1311](#), and [ISO224](#). This generation of devices closely managed the energy crossing over the isolation barrier, and added OOK data transmission. These devices will be updated to include the optimized analog signal chain in the near future. The radiated emissions EMI scan shown in [Figure 3](#) was performed using the AMC1300, and the emissions are first seen around 540MHz with 18dB of margin and continues to 1GHz which is the CISPR 11 test limit, with 6dB of margin at 940MHz.

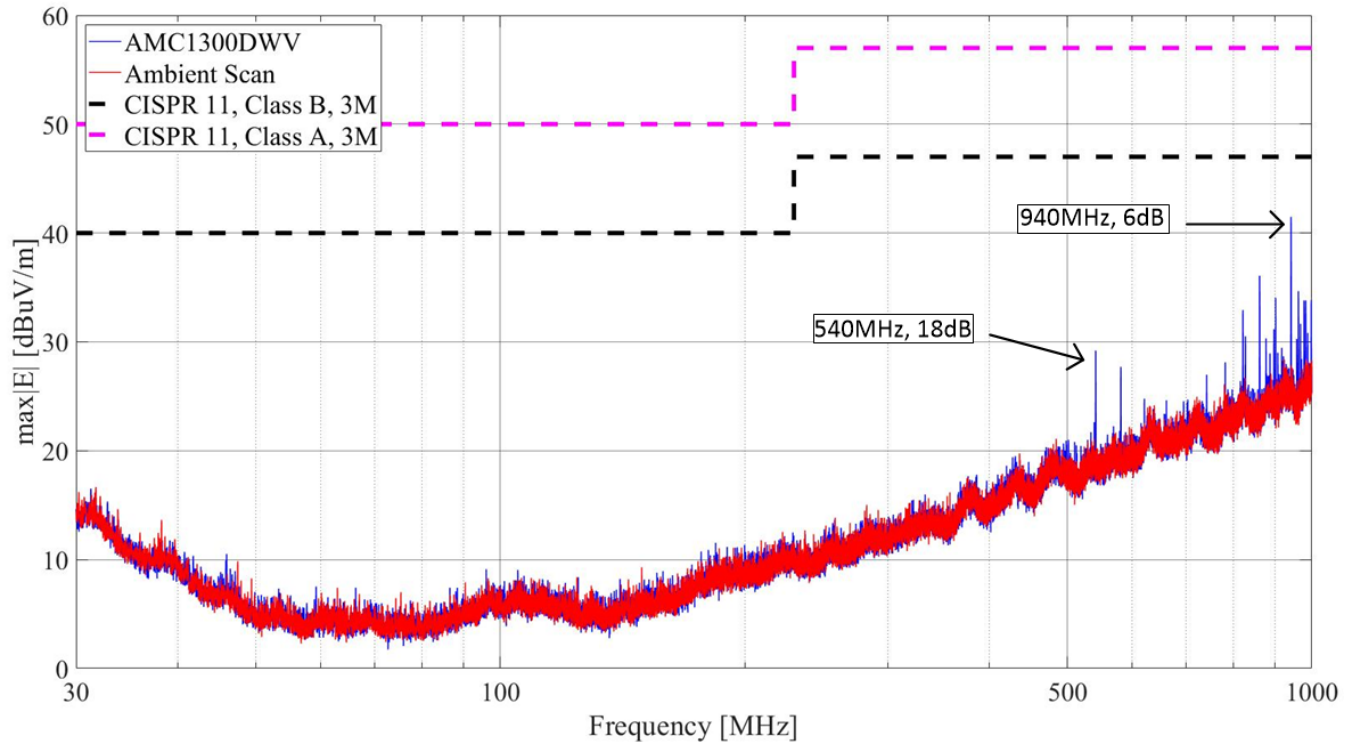


Figure 3. AMC1300 CISPR 11 Radiated Emissions EMI Scan

Texas Instruments released the [AMC1100](#) and [AMC1200](#) isolated amplifiers in 2011. These devices feature a basic isolation barrier and meet the CISPR 11 Class A and Class B standards with sufficient margin.

As shown in [Figure 4](#), the AMC1200 has several radiated emissions peaks above the noise floor, however, there is a significant amount of margin available to the CISPR class B limit shown in black. The noise peaks in the 100MHz to 230MHz region have 24dB of margin from the CISPR11 Class B limit, while the noise peaks in the higher frequency range, 480MHz to 630MHz, have 13dB of margin.

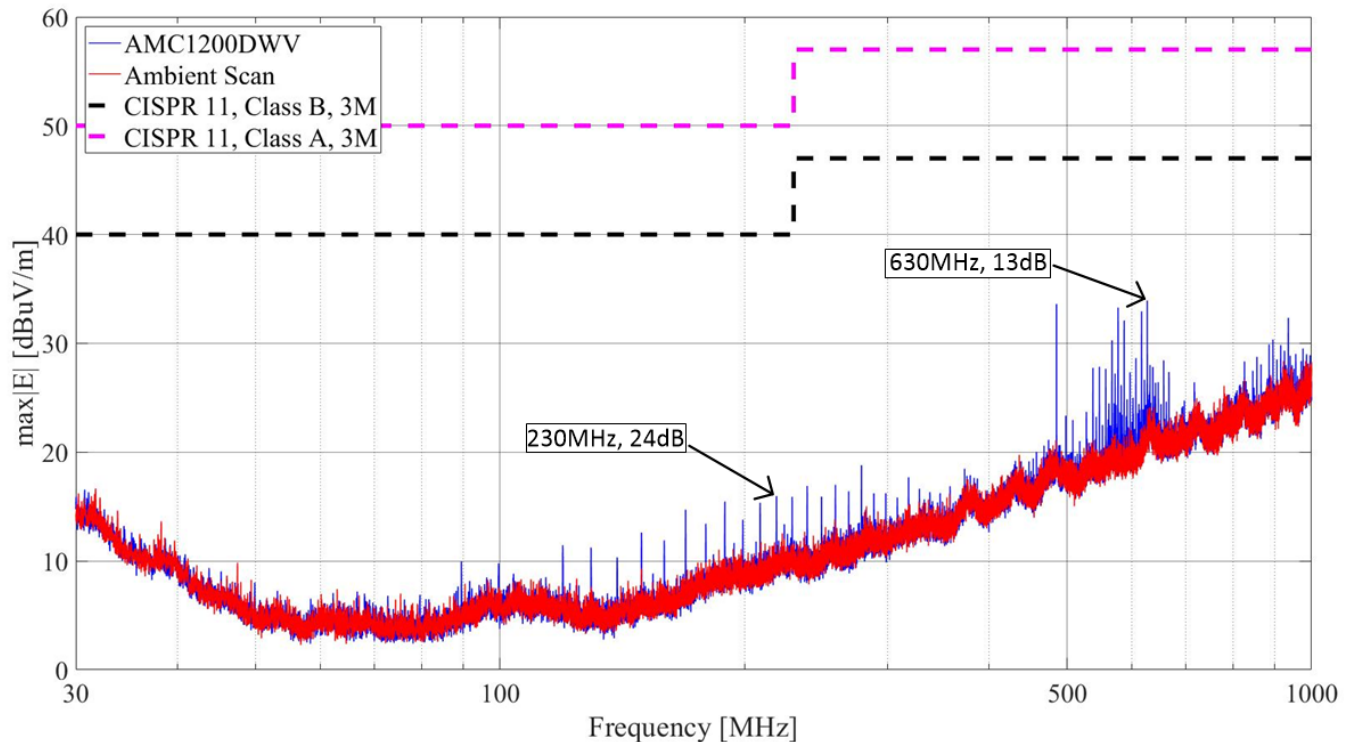


Figure 4. AMC1200 CISPR 11 Radiated Emissions EMI Scan

4 Conclusion

Over the past several years, capacitive isolation has been a popular choice for many customers in need of isolated amplifiers and converters due to the long term reliability and strong analog performance. Texas Instruments continues to innovate and will soon release the AMC1300B-Q1 to production. When using the AMC1300B-Q1, customers can confidently create designs featuring the high reliability and high analog performance that capacitive isolation brings, with best in class radiated emissions EMI performance.

5 References

- Texas Instruments, [Understanding Electromagnetic Compliance Tests in Digital Isolators Application Note](#)
- Texas Instruments, [An Overview of Conducted EMI Specifications for Power Supplies Application Note](#)

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