Application Note

EMI Mitigation Techniques Using the TPSM33620-Q1

ABSTRACT

Electromagnetic interference (EMI) is a prevailing challenge in today's digital world. From buck converter to microcontroller, virtually every electronic device is susceptible to both emitting and receiving EMI. While invisible to the naked eye, EMI has the potential to disrupt critical signals and systems, potentially degrading performance. Within automotive applications, there is great demand to achieve power efficient systems that can comply with the strict EMI guidelines that govern the electronic world. This application note analyzes various techniques and practices that are used to achieve emission compliance (EMC) with the TPSM33620-Q1, an efficient buck converter power module.

Table of Contents

Trademarks

1 Introduction

According to the Maxwell equations, any time-varying electric field produces a time varying magnetic field. These field lines travel through space and can be coupled into other systems through parasitic capacitances and inductances. These coupling signals have the potential to affect any victim system by inducing unwanted electric fields on sensitive signals. Through this principle, any application with varying currents can produce unwanted EMI. However, the focus of this application note is a popular topology for power, the buck converter.

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0} \tag{1}$$

$$\nabla \cdot \mathbf{B} = 0 \tag{2}$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial \mathbf{t}} \tag{3}$$

$$\nabla \times \mathbf{B} = \mu_0\left(\mathbf{J} + \varepsilon_0 \frac{\partial \mathbf{E}}{\partial \mathbf{t}}\right) \tag{4}$$

At the core, a buck converter takes an input voltage and converts this into a lower, regulated output voltage. The most common form of a buck converter employs the use of two switches in a latch configuration, alternating them on and off. When the input voltage is fed into the buck converter, the switches generate a pulse width modulating (PWM) signal, alternating between a source potential (VIN) and return potential (GND). Once the PWM pules are averaged through an inductor-capacitor filter at the output stage of the buck converter, the buck converter effectively *bucks-down* a high potential into a lower one. Furthermore, the output voltage is sensed and fed-back into the IC, creating a regulated output. Buck converters can convert high potentials into lower ones with greater efficiency than other common power converter topologies such as the common low-dropout regulator (LDO). As the MOSFET switches are driven into the linear region of operation, the buck converter dissipates less power than an LDO, making these devices desirable among high power applications or systems where low power dissipation is key.

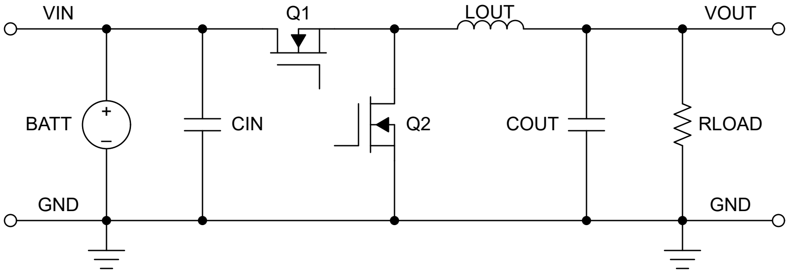


Figure 1-1. Synchronous Buck Converter Topology

One of the main tradeoffs with using a buck converter is the higher amount of EMI generation when compared to an LDO. In order to achieve high efficiency conversions, a buck converter alternates the voltage (dv/dt) at the node between the two MOSFETs. As a result, a time-varying current (di/dt) is generated in portions of the buck's loop as shown by Figure 1-2. Together, the high dv/dt and di/dt waveforms emit the time-varying electric and magnetic field that characterizes EMI noise. If the EMI noise of a buck converter can be mitigated, the design has both an efficient and sufficiently quiet power supply.

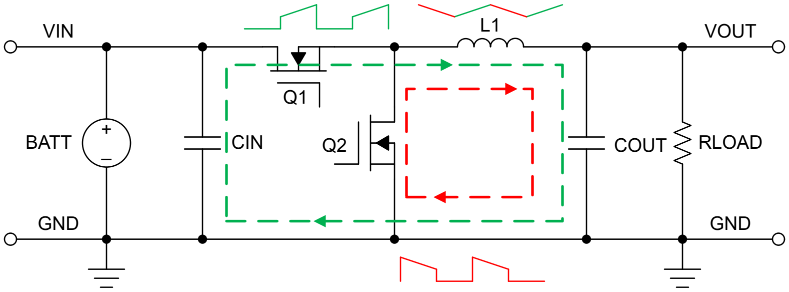


Figure 1-2. Time-Varying Currents in the Buck Converter Topology

The first step to achieving a sufficiently quiet system is to understand what qualifies as quiet from an EMI perspective. In the 1930's, the Comité International Special des Perturbations Radiophoniques (CISPR) was formed to create standards for limiting high frequency voltage interference from systems. The United States Federal Communications Commission (FCC) adopted the CISPR guidelines in the 1980's as a method of enforcing EMC compliance among all commercially sold electronic devices. The adopted CISPR guidelines outline different limits on interfering voltages for all types of systems. Because the TPSM33620-Q1 is an automotive device, the focus of this paper is to meet EMC with the CISPR25 automotive standards.

CISPR EMI standards include limits for both conducted and radiated EMI. For any device to pass the CISPR standards, both conducted and radiated compliance must be achieved. Conducted EMI represents the portion of EMI that occurs due to the electrical connection between the emitter and receiver. Alternatively, radiated EMI represents the component of EMI that comes from the through-air radiation to receivers that are not electrically connected to the EMI emitters. Many buck converter applications have trouble passing both the conducted and radiated EMI standards, requiring various filtering and board design techniques to achieve EMC. The rest of this application note discusses into the common EMI mitigation techniques used on the TPSM33620-Q1 to pass the CISPR25 Automotive Class 5 EMI standard.

2 Conducted EMI

Conducted EMI encapsulates the emissions through systems that are directly connected to the emitter. To measure conducted EMI, a Line Impedance Stabilization Network (LISN) is placed between the power supply and the device under test (DUT). The purpose of the LISN is two-fold, to filter out any conducted EMI that can result from extraneous connections required for the test setup and to provide a constant impedance that standardizes the test for conducted EMI test setups around the world. Figure 2-1 shows the high impedance filter used to accomplish the first task as well as the constant 50-ohm loads connected between both the phase and neutral connection that succeeds in the second aim. The 50Ω resistor is cleverly chosen to impedance match common 50Ω coaxial connection wires between the power supply and the LISN, avoiding transmission line reflections from the otherwise noisy power supply.

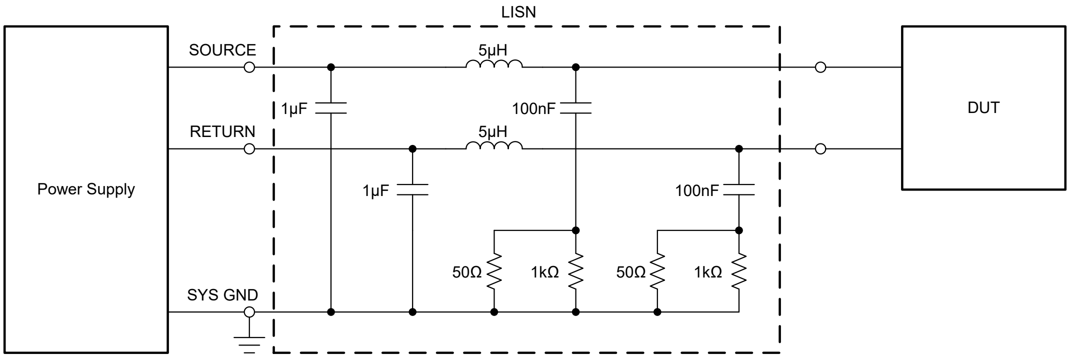


Figure 2-1. LISN Schematic and Setup for EMI Testing

Conducted EMI can be further split into two components, differential-mode and common-mode noise. Differential-mode noise comes from the source and return of the system with currents flowing in opposite directions. Figure 2-2 shows the discontinuous current flow of the device that creates noise between VIN and GND. Common-mode noise consists of currents flowing in source and return, but in the same direction. For the buck converter, this is the result of the parasitic capacitances that come from both the VIN and GND lines with respect to chassis ground as shown by Figure 2-3. For conducted EMI to be sufficiently mitigated, both noises must be analyzed from a qualitative perspective. Only by individually tackling these modes of EMI, can a designer improve the overall conducted EMI profile of a system.

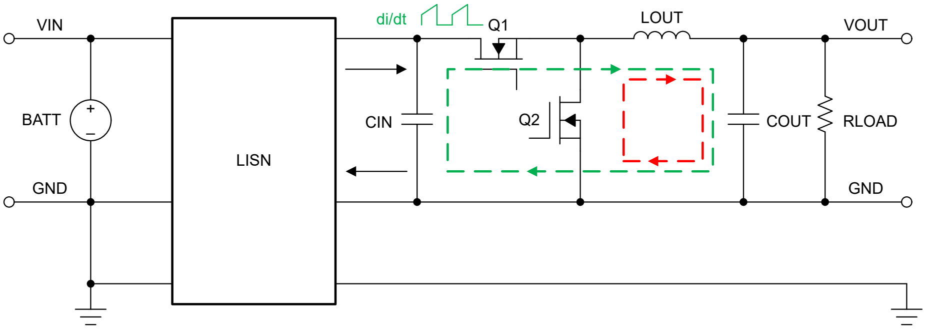


Figure 2-2. Differential-Mode Noise in a Buck Converter

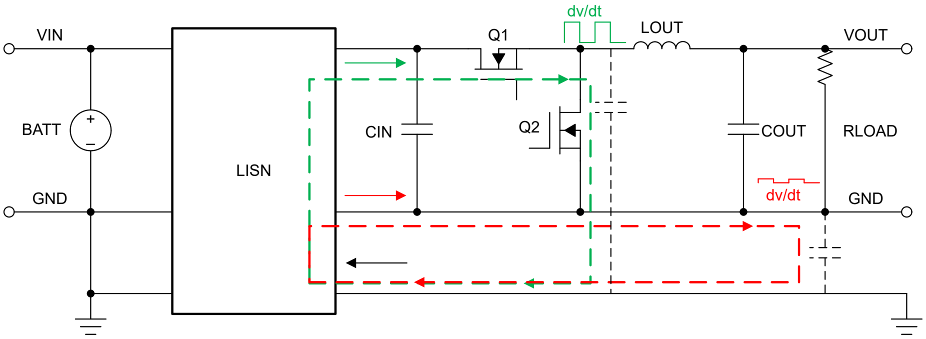


Figure 2-3. Common-Mode Noise in a Buck Converter

2.1 Differential-Mode Noise

For differential-mode noise, the current travels from line to line (VIN to GND), generating noise through the main current loops of the device. Figure 2-2 represents how the discontinuous current from the switching MOSFETs results in a high di/dt in the VIN line. The green waveform shows the discontinuous nature of the current through Q1. The opposite similarly discontinuous di/dt will be generated once Q1 is turned off and Q2 is turned on as a function of the buck. As the discontinuous currents travel through the loop created by CIN, Q1, and Q2, electromagnetic forces (emf) are generated due to the parasitic inductances in the VIN and GND lines. This emf characterizes most of the conducted differential-mode noise in a buck converter.

Differential mode noise is filtered by utilizing passive components that impede and shunt the unwanted energy from VIN to GND. The most common way to filter out differential-mode noise for a buck converter is with a low pass pi-filter. Named after its schematic shape, the low pass pi-filter consists of a capacitor between VIN and GND and an inductor in series with the VIN line. The inductance impedes the noise whereas the capacitance shunts it to the GND line at various frequency ranges. An additional bulk capacitance with sufficient equivalent series resistance (ESR) to damp the natural resonance created by an LC filter is added on the IC side to prevent inductive ringing and stabilize the overall loop.

As the pi-filter utilizes passive components, the simple equations below can be used to determine the appropriate size of the filter components for a given attenuation. First, an inductor (L_F) must be selected. As L_F partially defines the resonance of the filter, a reasonable range for 400kHz to 2.2MHz applications is usually 1μH to 10μH. Once L_F is chosen, equations 5 and 6 give a minimum value for the filtering capacitor (C_F). As long as C_F is greater than both the values of equations 5 and 6, the resonance of the EMI filter will remain at least one decade below the device switching frequency (F_S) and the required attenuation in dB (Att_{dB})for the filter to pass EMI will be achieved. Finally, the damping capacitance (C_D) is calculated using equation 7 along with the required damping resistance (ESR_D) in equation 8. Multiple combinations of these components can be used to achieve similar attenuation curves. It is up to the application designer to determine what components values will be restricted.

$$C_F = \frac{C_{IN}}{C_{IN}L_F(2\pi F_S/10)^2 - 1} \tag{5}$$

$$C_F = \frac{1}{L_F}\left(\frac{10^{|Att|_{dB}/40}}{2\pi F_S}\right)^2 \tag{6}$$

$$C_D \geq 4C_{IN} \tag{7}$$

$$ESR_D \approx \sqrt{\frac{L_F}{C_{IN}}} \tag{8}$$

For an ideal inductor, the impedance, and thus the ability to attenuate, rises with increasing frequency. In practice inductors are limited by a struggle between size and high frequency efficacy due to the interwinding capacitance between the coils of the inductor. As frequency increases, the interwinding capacitance dominates the inductor's characteristics, reducing much of its ability to attenuate noise. Inductor manufacturers often specify the self-resonant frequency (SRF) of an inductor to represent where the attenuation is no longer effective. In general, as the SRF of an inductor increases, so to will its size as it increases the spacing between its coils to reduce its interwinding capacitance.

On the other hand, ferrite beads resemble resistors instead of capacitors as frequency rises. While the operation of a ferrite bead can be more lossy than an inductor, the result is a more forgiving attenuation curve over a wider frequency range in a relatively smaller package. For the TPSM33620-Q1, a ferrite bead is utilized instead of an inductor as the increased losses from the ferrite on a low current application are acceptable when compared to the increased simplicity and smaller size of a ferrite compared to a similar inductor. This understanding, along with Equation 5 and Equation 6 from above, produced the input filter in Figure 2-4.

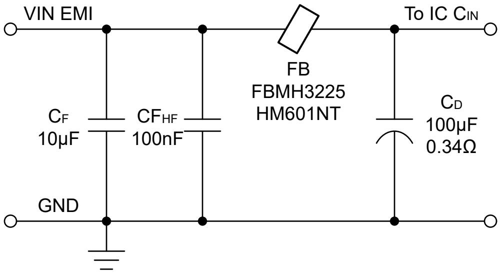


Figure 2-4. Ferrite Differential-Mode EMI Filter for the TPSM33620-Q1

Figure 2-5 shows the conducted EMI results of TPSM33620-Q1 without an input filter. The largest spike of noise is at 2.2MHz, the F_S of the device. Left unimpeded, the differential-mode switching noise propagates to higher harmonics, eventually violating the CISPR25 limit lines for conducted EMI. Once the input filter from Figure 2-4 is implemented, an immediate improvement can be seen. Figure 2-6 shows much lower noise levels with the switching frequency effectively attenuated. The conducted EMI in the higher frequencies is also reduced due to the supression of the differential-mode noise. With only a simple ferrite bead filter, the TPSM33620-Q1 can pass the CISPR25 Conducted EMI standard.

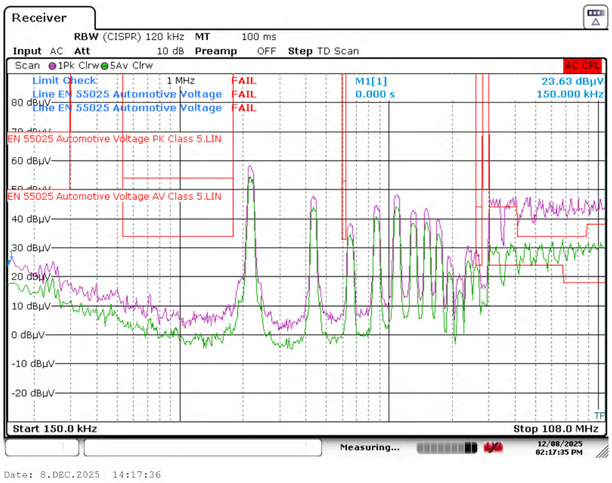

Receiver
RBW (CISPR) 120 kHz MT 100 ms
Input AC Att 10 dB Preamp OFF Step TD Scan
Scan 1Pk Clrw 5Av Clrw AC CPL
Limit Check FAIL
Line EN 55025 Automotive Voltage FAIL
Line EN 55025 Automotive Voltage FAIL
M1[1] 23.63 dBµV
0.000 s 150.000 kHz
Start 150.0 kHz Stop 108.0 MHz
Measuring...
12/08/2025 02:17:35 PM
Date: 8.DEC.2025 14:17:36

Figure 2-5. TPSM33620-Q1 Conducted EMI without an Input Filter, 12.5VIN, 3.3VOUT, 2A

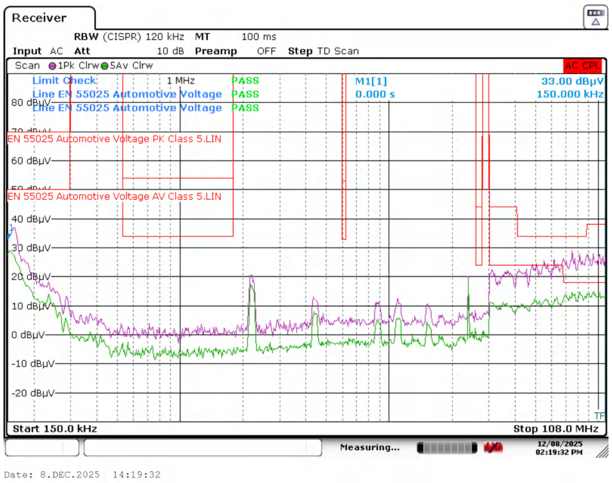

Receiver
RBW (CISPR) 120 kHz MT 100 ms
Input AC Att 10 dB Preamp OFF Step TD Scan
Scan 1Pk Clrw 5Av Clrw AC CPL
Limit Check PASS
Line EN 55025 Automotive Voltage PASS
Line EN 55025 Automotive Voltage PASS
M1[1] 33.00 dBµV
0.000 s 150.000 kHz
Start 150.0 kHz Stop 108.0 MHz
Measuring...
12/08/2025 02:19:32 PM
Date: 8.DEC.2025 14:19:32

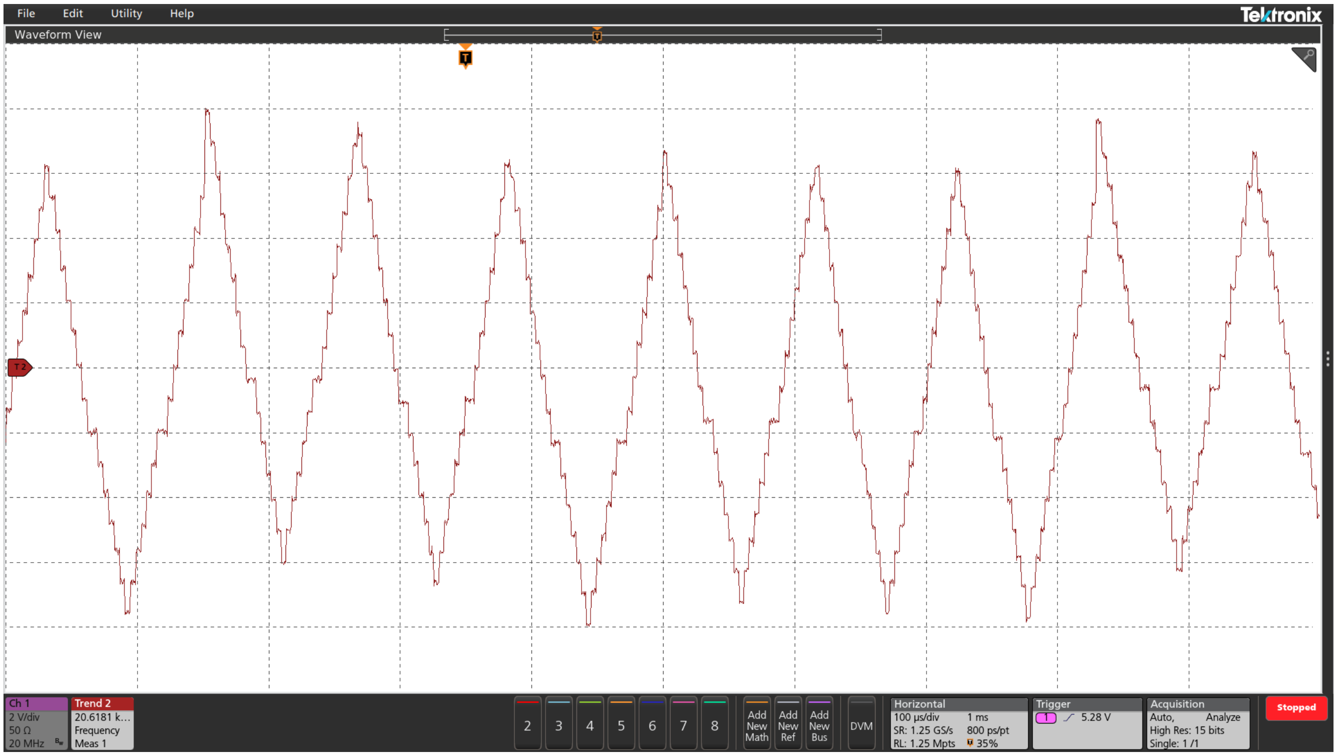
Figure 2-6. TPSM33620-Q1 Conducted EMI with an Input Filter, 12.5VIN, 3.3VOUT, 2A

2.2 Common-Mode Noise

Common-mode noise is more difficult than differential-mode noise to tackle. In theory, common-mode noise must not exist as there are no electrical connections between the VIN and GND lines to the measurement chamber-ground. However, due to parasitic capacitances between the two lines to chamber-ground, common-mode noise has a path to the LISN. Figure 2-3 shows the high dv/dt waveform generated at the switching node (SW) that connects the source of Q1 to the drain of Q2. Through the parasitic capacitance between SW and chamber-ground, this high dv/dt signal can propagate through the LISN, creating the green current loop that often dominates common-mode noise. Within the GND line, parasitic impedances and capacitances on each of the components returns as well as the general switching noise in the device results in a phenomenon known as ground bounce, where the reference ground across the board is inconsistent. The usually smaller, but still present, dv/dt creates the red current loop that further contributes to common-mode noise. With these two paths, common-mode noise prevails.

Similar to differential-mode noise, many common-mode noise filtering techniques involve impeding and shunting the noise. Like the differential-mode ferrite beads and inductors, Common-mode chokes can be placed in series with both the VIN and GND lines to provide attenuation. Y-capacitors can also be placed between the system and the chassis ground to shunt common-mode noise, creating an effective filter for common-mode noise. However, both components have key caveats that usually prohibit use. Common-mode chokes are large and reduce the device's efficiency, whereas Y-capacitors require a physical connection to the chassis ground of a system, which may not be feasible for many applications. As a result, the TPSM33620-Q1 does not utilize a common-mode choke or Y-capacitors to combat conducted common-mode noise.

Instead, to help combat common-mode noise, TPSM33620-Q1 utilizes a technique known as spread spectrum. Spread spectrum dithers the switching frequency of the device by a set percentage, spreading the energy of the high dv/dt switching noise across the frequency spectra to reduce EMI peaks. While this does have the effect of increasing the output voltage ripple slightly as the frequency modulation is expressed at the buck's output, the EMI performance is greatly improved. Figure 2-7 shows the spread spectrum implementation in the TPSM33620-Q1.



Ch 1
2 V/div
50 Ω
20 MHz

Trend 2
20.6181 k...
Frequency
Meas 1

Horizontal
100 µs/div 1 ms
SR: 1.25 GS/s 800 ps/pt
RL: 1.25 Mpts 35%

Trigger
1 5.28 V

Acquisition
Auto, Analyze
High Res: 15 bits
Single: 1 /1

Figure 2-7. Frequency Variation over Time due to the Spread Spectrum Scheme on TPSM33620-Q1

Furthermore, the TPSM33620-Q1 contains an integrated boot capacitor and low-profile inductor. This simplifies the layout process by shrinking the switch node to a minimum, limiting the ability to radiate noise efficiently and reducing its parasitic capacitance with chamber ground. Utilizing a simple pi differential-mode filter while leveraging a spread-spectrum implementation and key integrated elements the TPSM33620-Q1 passes the automotive CISPR25 Class 5 Conducted EMI standard.

3 Radiated EMI

While the TPSM33620-Q1 achieves EMC against the conducted EMI standards with the use of filtering elements, radiated EMI is often a trickier problem to tackle. Radiated EMI consists of emissions that affect systems not electrically connected to the potential emitter. As such, the CISPR guidelines for radiated EMI can encapsulate frequencies beyond 1GHz and are measured with sensitive antennae away from the device. Devices that meet EMC with conducted standards can still fail the counterpart radiated standards as the techniques used to achieve conducted EMC along electrical lines cannot affect the radiation noise of electromagnetic waves in space. Achieving radiated EMC focuses more on identifying and limiting the effectiveness of the noise sources that radiate EMI.

Like conducted EMI, the sources of radiated EMI lie with the discontinuous currents and voltages in the buck converter's operation. As previously discussed with differential-mode noise, high di/dt currents propagate through the loop created by CIN, Q1, and Q2 due to the switching nature of the device. Through Ampere's Law, the time-varying current in the loop generates a magnetic field that is a main contributor to radiated EMI noise. By increasing the loop size, parasitic inductance, or current, the flux and magnetic field through this loop is magnified.

The high dv/dt loop from the SW node is the other main source of radiated noise. Inherently, the dv/dt loop creates an electric field that propagates through space. Parasitic capacitances between the SW node and ground further exacerbate the radiated noise by creating unwanted voltage spikes in the SW waveform. Figure 3-1 shows how both the di/dt and dv/dt signals responsible for the radiated EMI emitted by a buck converter.

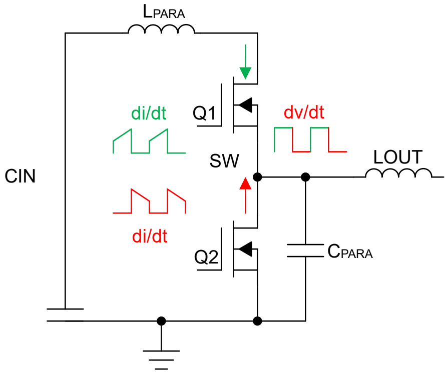


Figure 3-1. Radiated EMI Paths in a Buck Converter

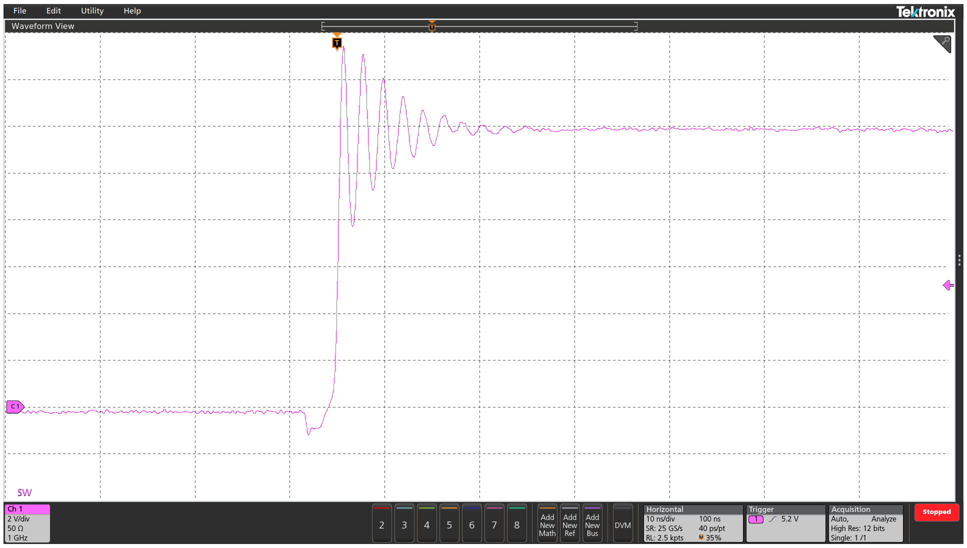
3.1 Critical Loop Routing

One of the main ways of reducing the radiated EMI from the high di/dt signal is by decreasing the area traced by CIN, Q1, Q2, and GND. As a buck module already has the MOSFETs and inductor integrated within the IC, the only critical component that can be routed to reduce the area of the current loop is the VIN capacitor. The VIN capacitors are the first line of defense in providing filtering to the application against the high di/dt loop of the device. Furthermore, low value capacitors (in the 100nF range) provide the low-impedance path at high frequencies to ground problematic noises. For the TPSM33620-Q1 layout, the low value capacitors are laid out beneath the device as this placement proved to be the shortest current loop and the least inductive path for the VIN high frequency capacitors. In addition, two capacitors were parallelized to further reduce the inductance in this portion of the current loop. Larger capacitors are placed in a parallel configuration on the top and bottom of the board to help decouple the lower frequency noise as close as possible to the buck's pins. Altogether, the capacitor combination on the TPSM33620-Q1 EMI EVM provides a good, short decoupling path that helps to limits the propagation of radiated EMI. throughout the device.

3.2 Snubber Circuit

A common way to reduce the EMI radiation of the high dv/dt in a buck converter, is to slow down the SW node. By slowing down the SW node, voltage peaks from the device parasitic capacitances are less pronounced, reducing the associated radiating electric field. For many devices this is accomplished by a resistor in series with the boot capacitor. However, as the TPSM33620-Q1 has an integrated boot capacitor, the boot capacitor is not accessible. Furthermore, adding resistance in series with the boot capacitor can cause the device to generate more heat as this forces the high side FET to be on for a longer amount of time. With only access to SW, a snubber circuit is the only method on TPSM33620-Q1 to reduce the dv/dt speed.

Figure 3-2 shows the switching node of the TPSM33620-Q1. As is the case with any high dv/dt loop there are overshoots and undershoots in the high frequency range. These voltage spikes create correlated EMI peaks at these frequency ranges. Measuring the frequency of the dv/dt peaks yields frequencies in the 400MHz to 500MHz range, which matches the EMI spikes seen in Figure 3-3 and Figure 3-4. As a result of this noisy switch node, the TPSM33620-Q1 misses EMC by a couple dB in the 400MHz to 500MHz frequency range.



Ch 1
2 V/div
50 Ω
1 GHz

Horizontal
10 ns/div 100 ns
SR: 25 GS/s 40 ps/pt
RL: 2.5 kpts 35%

Trigger
1 5.2 V

Acquisition
Auto, Analyze
High Res: 12 bits
Single: 1 /1

Figure 3-2. TPSM33620-Q1 Switch Node Rising Edge Ripple

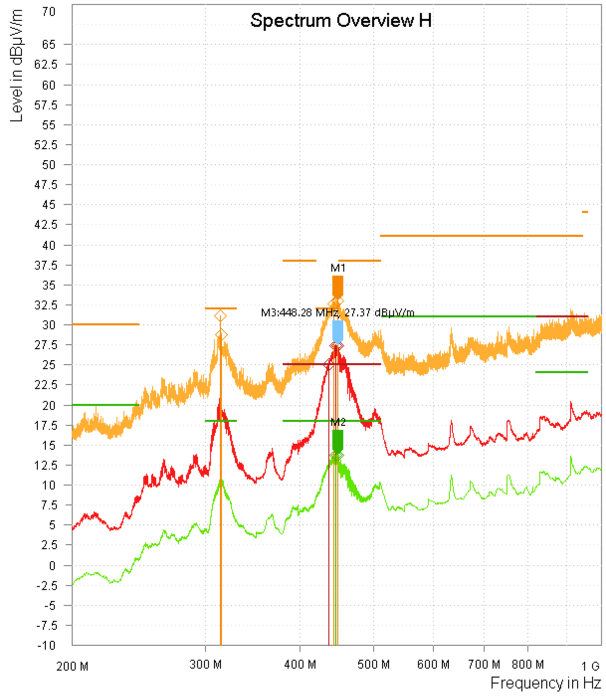
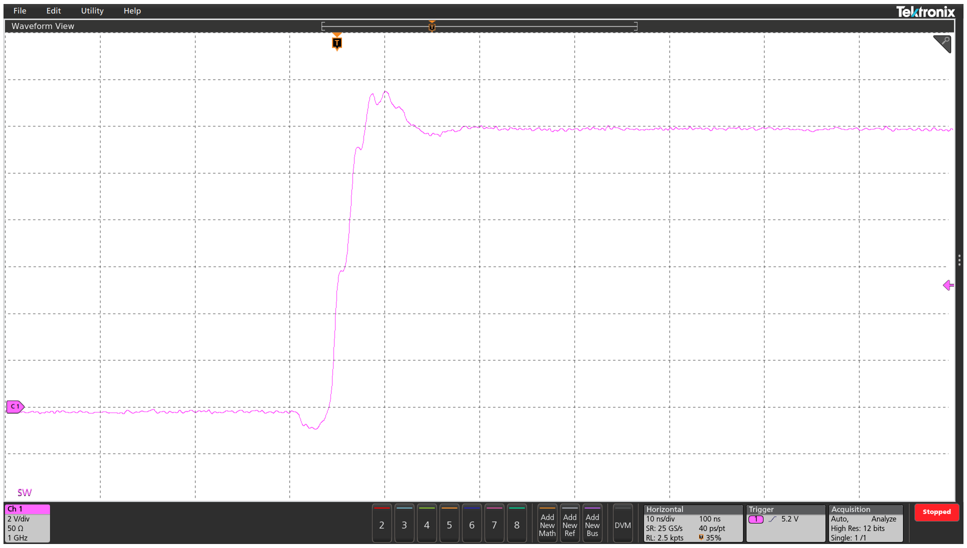


Figure 3-3. TPSM33620-Q1 Radiated EMI without Snubber, Horizontal Polarization, 12VIN, 3.3VOUT, 2A

Figure 3-4. TPSM33620-Q1 Radiated EMI without Snubber, Vertical Polarization, 12VIN, 3.3VOUT, 2A

To combat these emissions, a capacitor and resistor is added to "snub" the high frequency dv/dt by dampening the parasitic inductance in this node. The snubber circuit siphons energy from the switch node, reducing the impact on EMI. This technical article can be used to calculate the required RC constant to effectively dampen the switch node. It is worth noting that by decreasing the resistance and increasing the capacitance of the snubber, the amount of energy that is attenuated can be increased. For the TPSM33620-Q1, the snubbing resistor was reduced to 1Ω and the snubbing capacitor was increased to 1000pF to compensate. Figure 3-5 shows the reduced dv/dt spikes in the switch node. As a result, Figure 3-6 and Figure 3-7 show an improvement in the high-frequency areas where the switching ring was generating noise. While effective at reducing EMI, the snubber circuit dissipates more energy decreasing the efficiency of the application. With this snubber circuit, TPSM33620-Q1 dissipates 30mW more energy at a 2A load.



Ch 1
2 V/div
50 Ω
1 GHz

Horizontal
10 ns/div 100 ns
SR: 25 GS/s 40 ps/pt
RL: 2.5 kpts 35%

Trigger
1 5.2 V

Acquisition
Auto, Analyze
High Res: 12 bits
Single: 1 /1

Figure 3-5. TPSM33620-Q1 Switch Node Rising Edge Ripple with Snubber

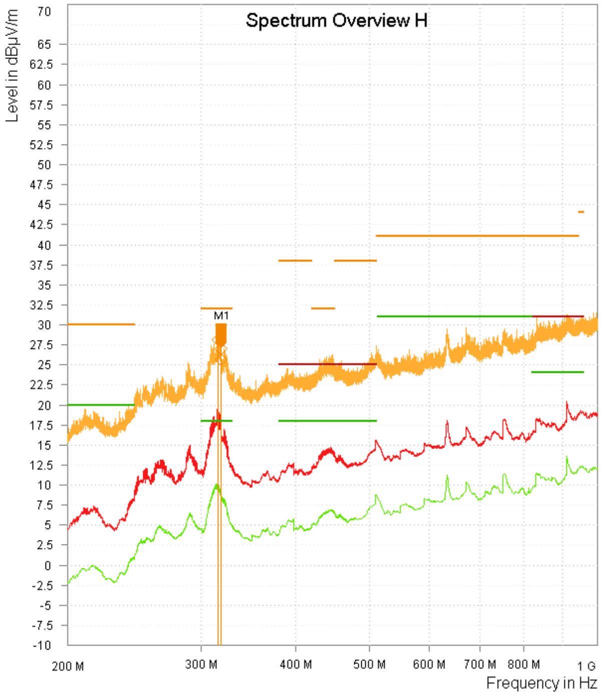


Figure 3-6. TPSM33620-Q1 Radiated EMI with Snubber Circuit, Horizontal Polarization, 12VIN, 3.3VOUT, 2A

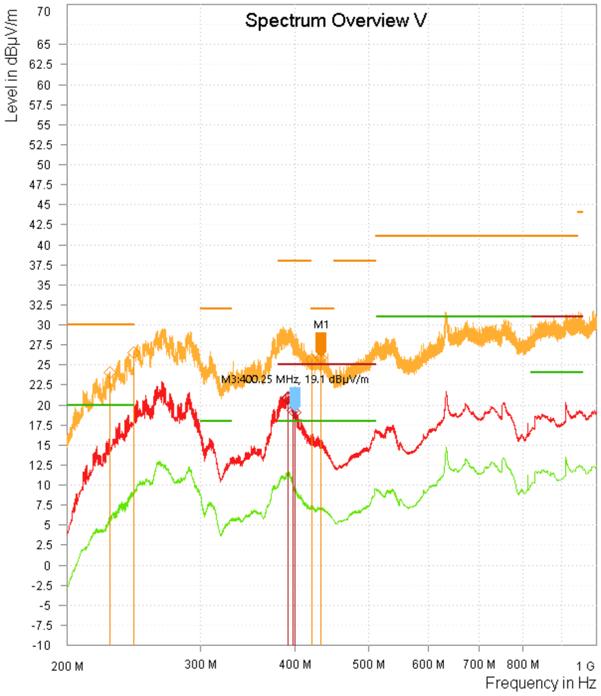


Figure 3-7. TPSM33620-Q1 Radiated EMI with Snubber Circuit, Vertical Polarization, 12VIN, 3.3VOUT, 2A

3.3 PCB Layout Techniques

Another method for reducing the overall radiated emissions in a buck converter is to bury problematic traces and surround them in copper ground plane. A portion of the VIN trace can be routed underneath the second ground layer. Effectively, this sandwiches this trace between the GND planes on layer 2 and 4, providing a makeshift faraday cage for the noise critical VIN signal. For applications that require longer power traces between the board supply and the buck converter this can result in a simple board noise filter. This technique can also be employed for the output voltage, but with lesser effects as this does not carry nearly as much of the energy from the high dv/dt switching loop.

In a similar vein to burying traces in the PCB, vias can be utilized to accomplish a similar effect. By surrounding noisy high potential lines with through-hole ground vias, the EMI of the trace can be effectively fenced off from the rest of the board. This interrupts any potential receiving antenna and provides low impedance paths to ground for the noise from the fenced traces. Both the VIN and VOUT power traces can be fenced off with ground vias, helping to keep any unintended antenna from radiating EMI. These are most effective with power traces that span multiple layers such as VIN and VOUT, essentially surrounding the VIN and VOUT traces entirely with GND.

Through the culmination of the careful routing of sensitive signals, a snubber circuit, and PCB layout techniques, the TPSM33620-Q1 passes the CISPR25 radiated EMI standard. Figure 3-8, Figure 3-9, and Figure 3-10 represent the measured peak and average radiated EMI performance of the TPSM33620-Q1 spanning the 150kHz to 1GHz range.

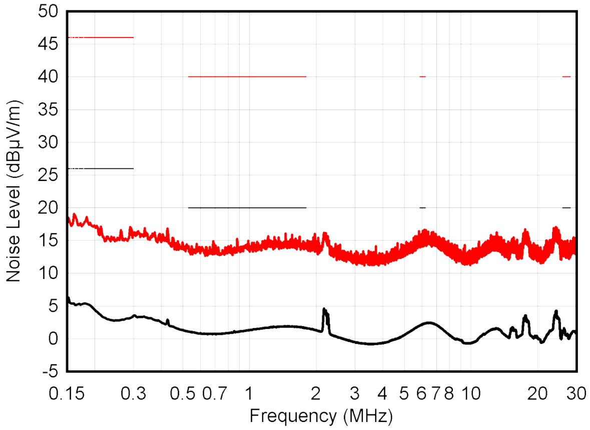


Figure 3-8. TPSM33620-Q1 Radiated EMI 150kHz to 30MHz, 12.5VIN, 3.3VOUT, 2A

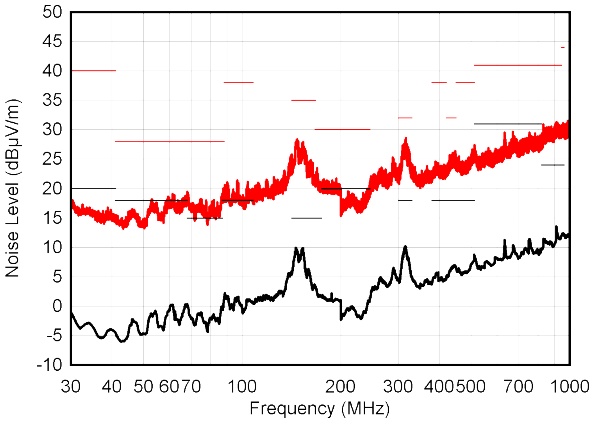


Figure 3-9. TPSM33620-Q1 Radiated EMI 30MHz to 1GHz, Horizontal Polarization, 12.5VIN, 3.3VOUT, 2A

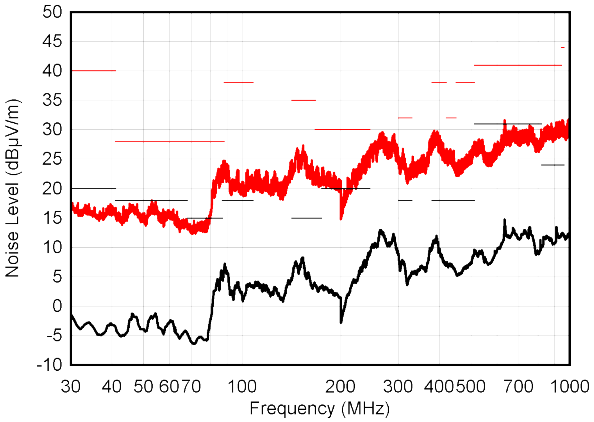


Figure 3-10. TPSM33620-Q1 Radiated EMI 30MHz to 1GHz, Vertical Polarization, 12.5VIN, 3.3VOUT, 2A

4 Summary

Electromagnetic compliance is an important aspect of any electronic system. While buck modules are essential to the power electronics space due to the relative simplicity and high efficiency; the switching behavior can lead to EMI issues. Although the TPSM33620-Q1 already uses an integrated inductor and boot capacitor to help limit EMI emittance, careful board level design is required to reach EMC across both radiated and conducted standards. Using a ferrite pi-filter, a snubber, and the described board techniques, the TPSM33620-Q1 accomplishes EMC for CISPR25 Class 5 conducted and radiated standards.

5 References

- Alan Martin, *AN-2162 Simple Success With Conducted EMI from DC-DC Converters*
- Clayton R. Paul, *Introduction to Electromagnetic Compatibility, 2nd ed.*
- F. A. Kharanaq, A. Emadi and B. Bilgin, *Modeling of Conducted Emissions for EMI Analysis of Power Converters: State-of-the-Art Review* in *IEEE Access*, vol. 8, pp. 189313-189325, 2020
- In Compliance News, *History of CISPR*
- Jerry Freeman, *EMI/EMC: From IC to PCB Worldwide FAE Meeting*
- Reto B. Keller, *Design for Electromagnetic Compatibility - In a Nutshell*

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