EMC and Transient Performance

For the Dual SOIC 24 V High-side Switch Family (MC24XS4)

1 Introduction

This application note describes the EMC and fast transient pulse capability of the MC22XS4200 and MC50XS4200 devices. These intelligent high-side switches are designed to be used in 24 V systems such as trucks, busses, and special engines. They can be used in some industrial and 12 V applications as well. The low $R_{DS(on)}$ channels can control incandescent lamps, LEDs, solenoids, or DC motors. Control, device configuration, and diagnostics are performed through a 16-bit SPI interface, allowing easy integration into existing applications. For a complete feature description, refer to the individual data sheets.

Contents

2 EMC Board Setup

The KIT22XS4200EKEVB and KIT50XS4200EKEVB are composed of four layers. They are used for testing with the following resistor and capacitor values (X7R 100 V):

- On VPWR: 100 nF and 1.0 uF are placed close to the 22XS4200 and 50XS4200 devices
- For each output: 22 nF is located at the output connector
- Low pass filter on the CSNS output pin: 10 Ω + 22 nF

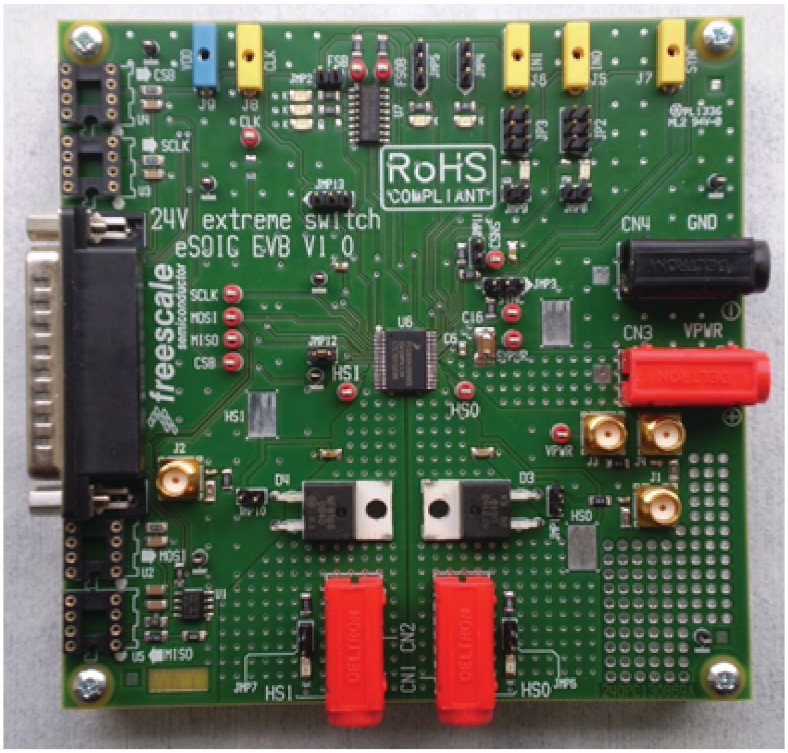

Figure 1. 24 V High-side Switch Evaluation Board

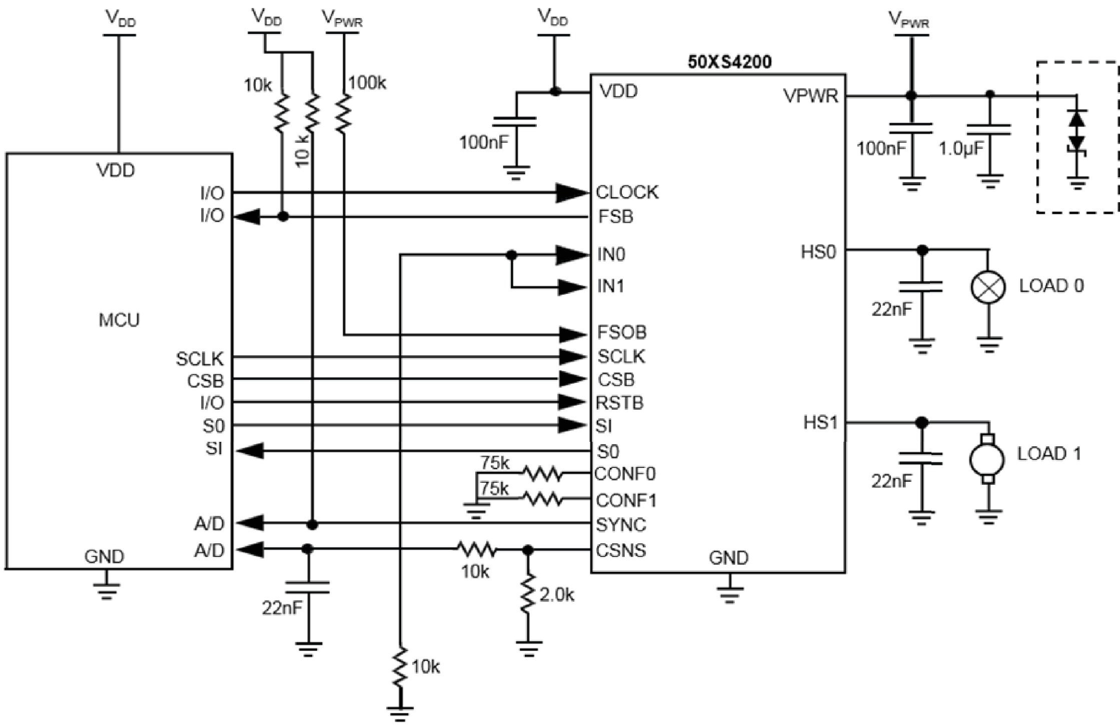

Figure 2. Application Schematic

3 Measurements

3.1 Conducted Emission Measurements

Conducted emission is the emission produced by the device on the battery cable. The bench test is described by the CISPR25 standard. The Line Impedance Stabilization Network (LISN), also called the Artificial Network (AN), in a given frequency range (150 kHz to 108 MHz), provides a specified load impedance for the measurement of disturbance voltages, and isolates the equipment under test (EUT) from the supply in that frequency range. The EUT must operate under typical loading and other conditions, just as it is in the vehicle, so that a maximum emission state occurs. These operating conditions are clearly defined in the test plan to ensure that both supplier and customer are performing identical tests.

For the testing described, the device was in 24 V, 160 mA Sleep and Normal modes, and each output pins of the 22XS4200 and 50XS4200, was connected to 24 V lamp(s) or 24 V 160 mA LEDs. One 2.2 nF COG was added on VPWR for better performance.The ground return of the lamps was connected to the chassis and the ground path of the EUT flowed into the LISN. The power supply voltage is 24 V (double car battery). The SPI watchdog feature was disabled for this test.

The results of those measurements are represented in Table 2:

Table 1. Conducted Emission Results 22XS4200

				CISPR25 2008 Level (peak)	
Conducted Emissions	**Loads per Output**	**Mode**	**Slew Rate**	**Low Band < 1.0 MHz**	**High Band > 1.0 MHz**
All outputs OFF	21 W Lamp + 5.0 W Lamp	Sleep		Class5	Class5
Outputs PWMing with 0 phase shift at 400 Hz with 50% of duty cycle	21 W Lamp + 5.0 W Lamp	Normal	Medium	Class5	Class5
	21 W Lamp + 5.0 W Lamp		Fast	Class4	Class5
	160 mA LED		Medium	Class5	Class5
			Fast	Class5	Class5
Outputs PWMing with 180 ° phasing at 400 Hz with 50% of duty cycle	21 W Lamp + 5.0 W Lamp		Medium	Class4	Class5
			Fast	Class4	Class5

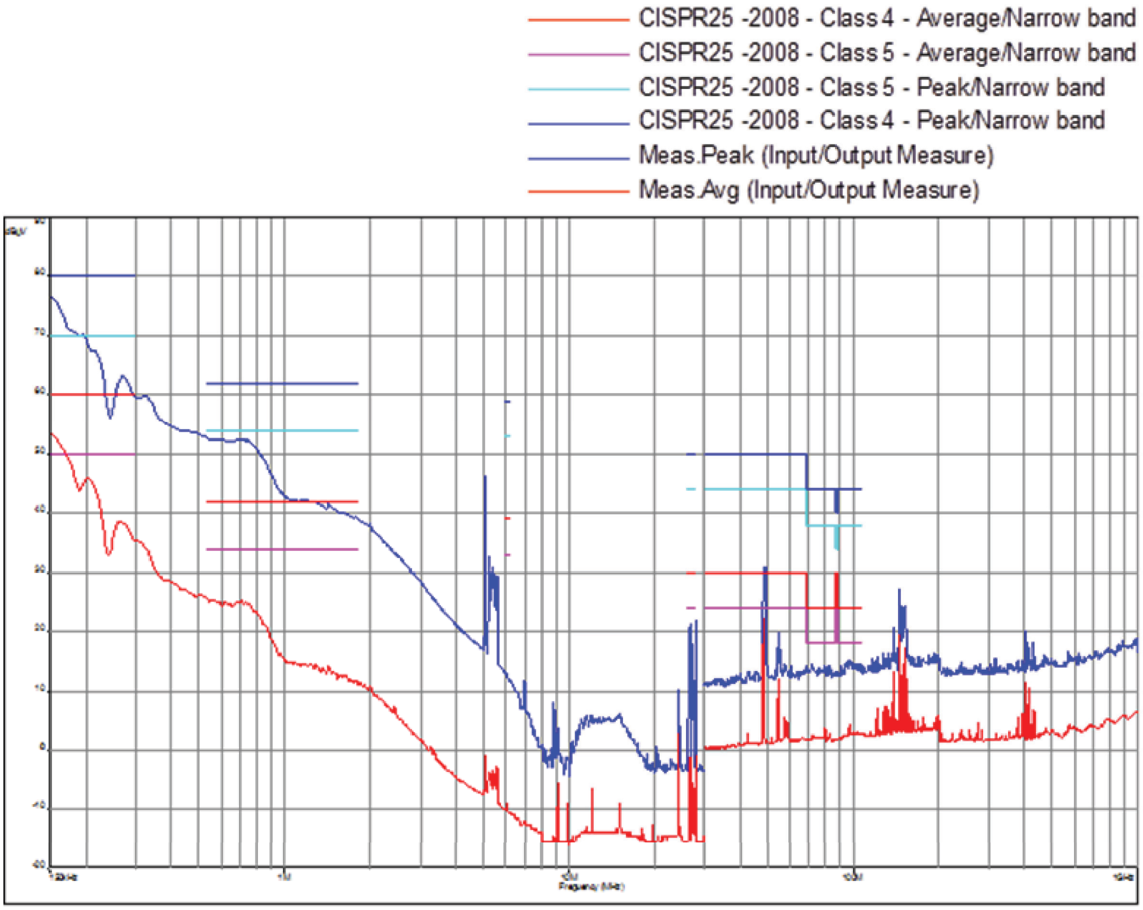

Figure 3. 22XS4200 Normal Mode - Both Outputs in Phase PWMing at 400 Hz with 50% of Duty Cycle

Table 2. Conducted Emission Results 50XS4200

Conducted Emissions	Loads per Output	Mode	Slew Rate	CISPR25 2008 Level (average)
All outputs OFF	2 x 5.0 W Lamp	Sleep		Class5
Outputs PWMing in same time at 400 Hz with 50% of duty cycle	2 x 25 W Lamp	Normal	Medium	Class5
			Fast	Class5
	160 mA LED		Medium	Class5
			Fast	Class5
Outputs PWMing with 180 ° phasing at 400 Hz with 50% of duty cycle	2 x 5.0 W Lamp	Normal	Medium	Class5
			Fast	Class5

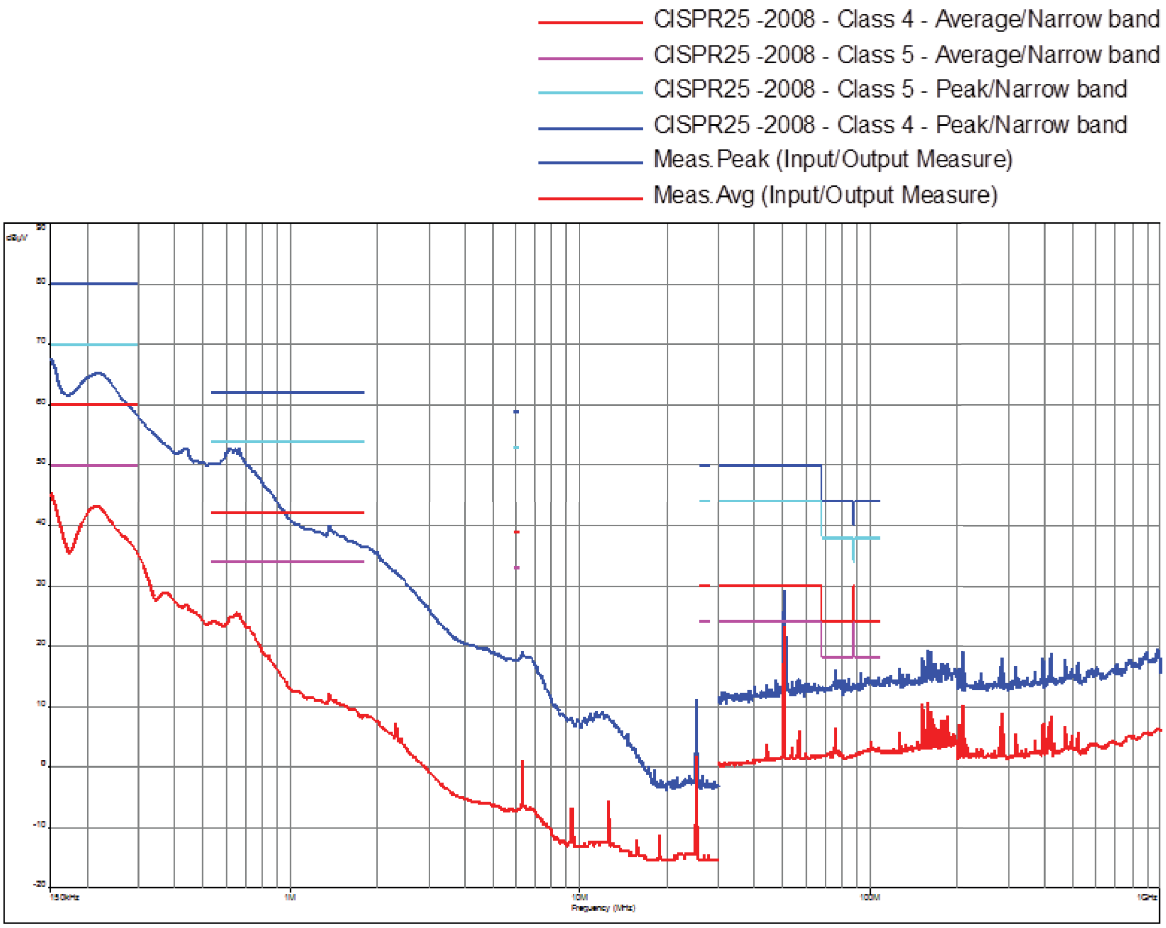

Figure 4. 50XS4200 Normal Mode - Both Outputs in Phase PWMing at 400 Hz with 50% of Duty Cycle

3.2 Conducted Immunity Measurements

Conducted immunity is the device susceptibility for RF injection applied directly on a device terminal. The bench test is described by the 62132-4 specification (Direct Power Injection) from the International Electrotechnical Commission. Table 3 describes the performance grades have been used to characterize the device performance:

Table 3. Performance Grades Description

Class A	All functions of the IC perform as designed during and after exposure to a disturbance.
Class B	All functions of the IC perform as designed during exposure, however, one or more of them may go beyond the specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions shall remain in class A.
Class C	A function of the IC doesn't perform as designed during exposure but returns automatically to normal operation after exposure is removed.
Class D	A function of the IC doesn't perform as designed during exposure, and doesn't return to normal operation until exposure is removed and the IC is reset by simple operator action (e.g. put off supply...).
Class E	One or more functions of an integrated circuit do not perform as designed during and after exposure and cannot be returned to proper operation.

For the testing described, the device was in Sleep, and Normal modes, and each output terminal of the 50XS4200 was connected to 5.0 W lamp(s). The ground return of the bulb was connected to the chassis, and the ground path of the EUT flowed into the LISN. The power supply voltage is 24 V (double car battery).

The results of these measurements are represented in Table 4. Output states, analog current sensing, and digital fault reporting are in accordance with the grade description and power injection from 1.0 MHz to 1.0 GHz on the VPWR pin.

Table 4. 50XS4200 Conducted Immunity Results

Feature	Load	Mode	Power Injection (CW)	Power Injection (AM)	Class
All outputs OFF	2 x 5.0 W lamps	Sleep	31 dBm	35 dBm	A
All outputs ON	2 x 5.0 W lamps	Normal	31 dBm	37 dBm	A
Outputs PWMing in same time at 400 Hz with 50% of duty cycle	2 x 5.0 W lamps	Normal	29 dBm	33 dBm	A

3.3 Fast Transient Pulse Measurements

Transient pulse immunity is the device susceptibility for fast transient pulse applied directly on the VPWR and HS pins. The transient pulses are described by the ISO7637-2 standard from the International Electrotechnical Commission. The power supply voltage is 28 V.

For the testing on VPWR, the device was in Sleep state or Fail-safe mode and the output pins of the 50XS4200 were connected to a resistive load. The 22XS4200 performances are covered by 50XS4200 results The results of those measurements are represented in Table 5.

Table 5. 50XS4200 Fast Transient Pulse Results (disturbance on VPWR)

Schaffner Pulses Applied on VPWR	Sleep State All Outputs OFF
Pulse 1 (RI = 50 Ω, -600 V, 1000 occurrences, Rload = 2 Ω)	Class C
Pulse 2a (RI = 2.0 Ω, +50 V, 1000 occurrences)	Class C
Pulse 3a (RI = 50 W, -200 V, 8.0 min)	Class C
Pulse 3b (RI = 50 W, +200 V, 8.0 min)	Class C
Pulse 5b (RI = 1.0 W, +87 V clamped at +58 V, 10 occurrences)	Class C
Pulse 4 (No load, VPWR – 16 V, 1 occurrence)	Class C

In the case of an open load condition or high-ohmic load (> 2 Ω), the transient pulses are handled by the application with a transient voltage suppressor between VPWR and GND, as presented in Decoupling Capacitors Role section.

3.4 Decoupling Capacitors Role

The following table summarizes the mission of each component.

Table 6. Component Role and Value

V_{PWR}	Close to 06XS4200 device	Reduction of emission and immunity	100 nF (X7R 100 V) 1.0 µF (X7R 100 V)
V_{DD}	Close to 06XS4200 device	Reduction of emission and immunity	100 nF (X7R 100 V)
HSx	Close to output connectors	Reduction of emission and fast transient negative pulse sustaining	22 nF (X7R 100 V)
CSNS	Close to MCU	Low pass filter to remove noise during immunity test	10 kΩ + 22 nF (X7R 16 V)

To increase device robustness against fast transient pulse robustness:

V_{PWR}	Close to ECU connector to increase device robustness	Sustain pulse #1 in case of high-ohmic load (or without loads)	40 V zener diode and 1N5353 diode in series per battery line

4 References

Following are URLs where you can obtain information on related Freescale products and application solutions:

Freescale.com Support Pages	Description	URL
MC22XS4200	Data Sheet	http://cache.freescale.com/files/analog/doc/data_sheet/MC22XS4200.pdf
MC50XS4200	Data Sheet	http://cache.freescale.com/files/analog/doc/data_sheet/MC50XS4200.pdf
KIT22XS4200EKEVB	Evaluation Board User Guide	http://cache.freescale.com/files/analog/doc/user_guide/KT22XS4200UG.pdf
KIT50XS4200EKEVB	Evaluation Board User Guide	http://cache.freescale.com/files/analog/doc/user_guide/KT50XS4200UG.pdf
KITUSBSPIEVME	Interface Dongle	http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=KITUSBSPIEVME

5 Revision History

Revision	Date	Description
1.0	11/2014	• Initial release

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

Document Number: AN5000
Rev. 1.0
11/2014