

EMC and Transient Performance for the Dual 24 V High-Side Switch Family

1 Introduction

This application note describes the EMC and fast transient pulse capability of the MC06XS4200, MC10XS4200, and MC20XS4200 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.

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2 EMC Board Setup

KIT06XS4200EVBE, KIT10XS4200EVBE, and KIT20XS4200EVBE 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 μ F are placed close to the 06XS4200 device
- For each output: 22 nF is located at the output connector
- Low pass filter on the CSNS output pin: 10 k Ω + 22 nF

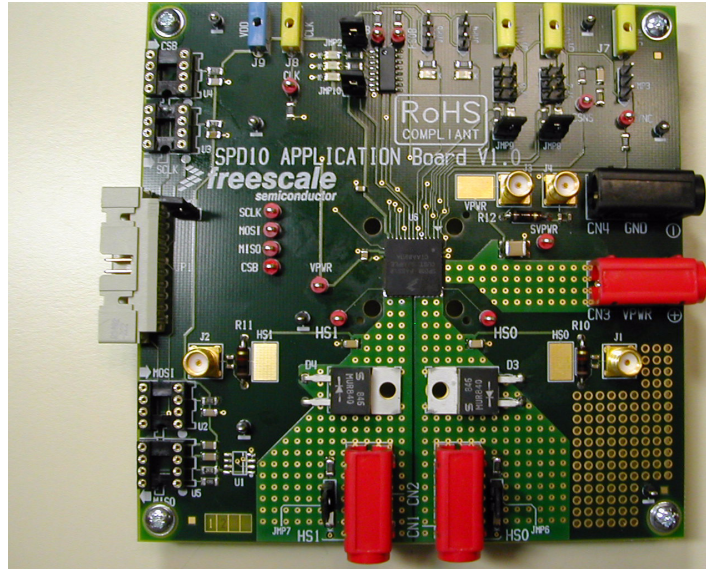


Figure 1. 24 V High Side Switch Evaluation Board

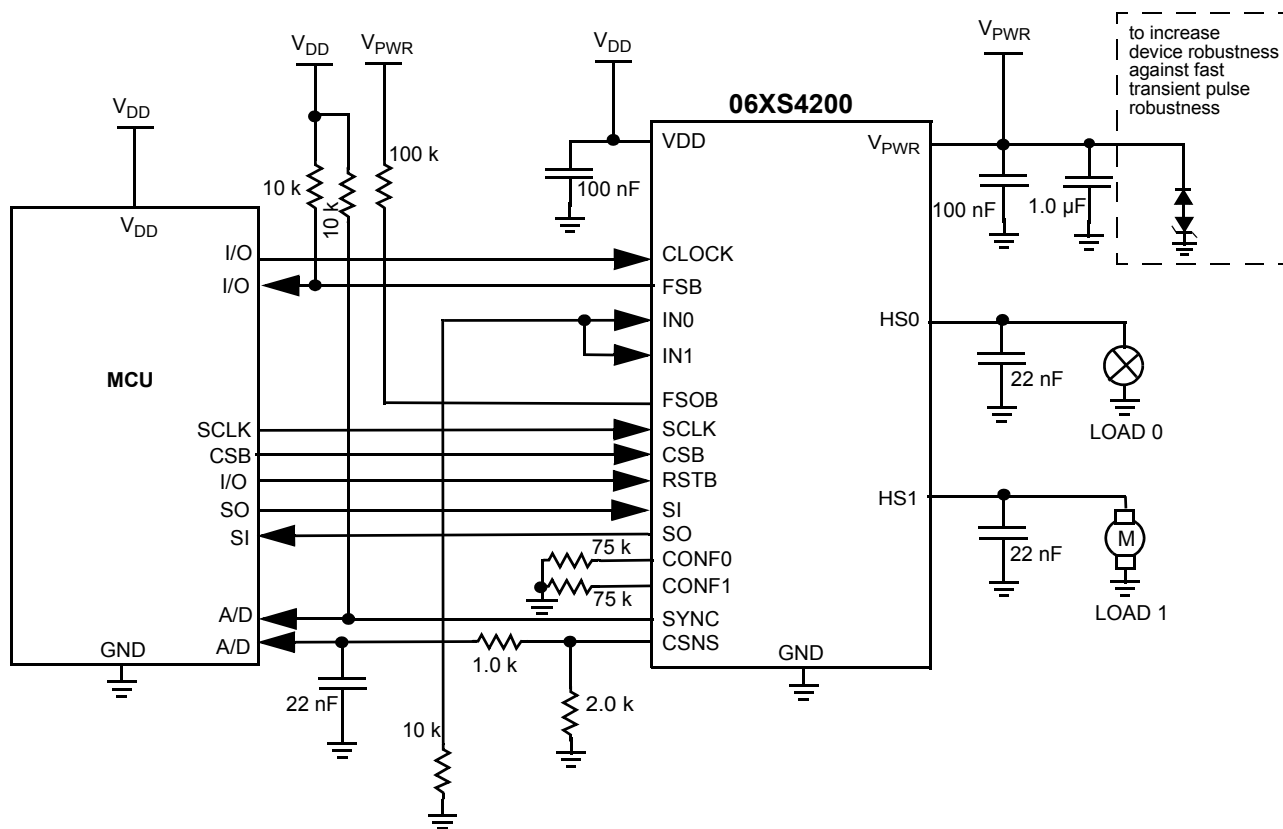


Figure 2. Application Schematic

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 Sleep, Standby, and Normal modes, and each output pins of the 06XS4200, was connected to 24 V 70 W lamp(s) or 24 V 160 mA LEDs. 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 the following table:

Table 1. Conducted Emission Results

Conducted Emissions	Load per output	Mode	CISPR25:2008 level
All outputs OFF	70 W lamp	Sleep	Class 5
All outputs OFF	70 W lamp	Standby	Class 5
Outputs PWMing in same time @ 400 Hz with 50% of duty-cycle	2x70 W lamps	Normal	Class 4 with Medium Slew rate SPI setting Class 5 with Fast Slew rate SPI setting
	160 mA LED		Class 5 with Medium Slew rate SPI setting Class 5 with Fast Slew rate SPI setting
Outputs PWMing with 180° phasing @ 400 Hz with 50% of duty-cycle	2x70 W lamps		Class 5 with Medium Slew rate SPI setting Class 5 with Fast Slew rate SPI setting as presented in Figure 3

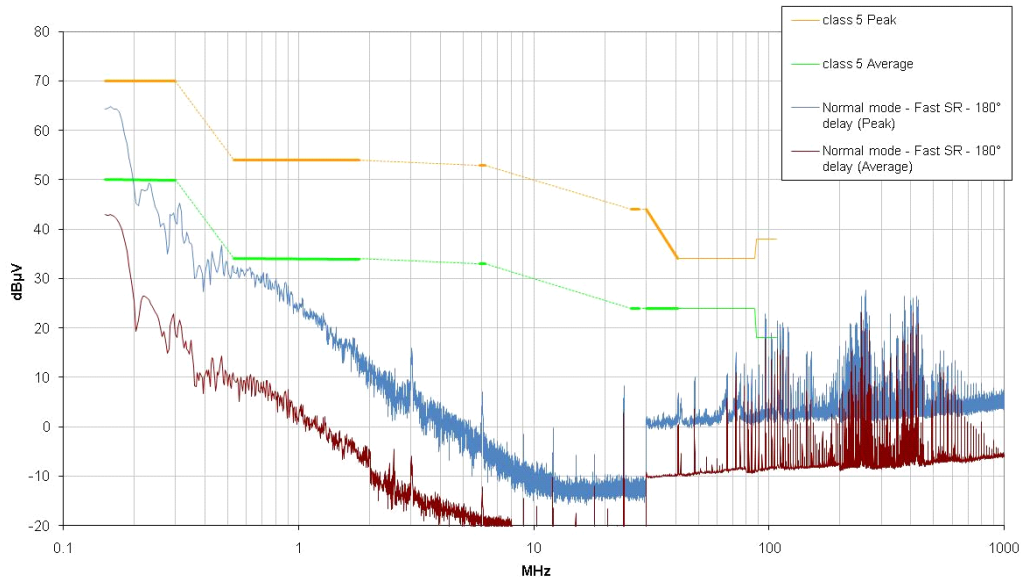


Figure 3. Normal Mode - Both Outputs PWMing @ 400 Hz with 50% of Duty Cycle

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. The following performance grades have been used to characterize the device performance:

Table 2. 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, Standby, and Normal modes, and each output terminal of the 06XS4200 was connected to 70 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 the following table. Output states, analog current sensing, and digital fault reporting are in accordance with the Class A for 25 dBm of power injection from 1.0 MHz to 1.0 GHz on the VPWR pin.

Table 3. Conducted Immunity Results

Feature	Load	Mode	Class
All outputs OFF	70 W lamp	Sleep and Standby	A
All outputs ON	2x70 W lamps	Normal	A
Outputs PWMing in same time @ 400 Hz with 50% of duty cycle			

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 with IGN = 5.0 V, and the output pins of the 06XS4200 were connected respectively to a resistive load. The results of those measurements are represented in [Table 4](#).

Table 4. Fast Transient Pulse Results (disturbance on VPWR)

Schaffner pulses applied on VPWR	Sleep state All outputs OFF
Pulse 1 ($R_I = 50 \Omega$, -600 V, 1000 occurrences)	Pass for HS0 loaded with a resistive load $\leq 2.2 \Omega$
Pulse 2a ($R_I = 2.0 \Omega$, +50 V, 1000 occurrences)	Pass
Pulse 3a ($R_I = 50 \Omega$, -200 V, 8.0 min)	Pass
Pulse 3b ($R_I = 50 \Omega$, +200 V, 8.0 min)	Pass
Pulse 5b ($R_I = 1.0 \Omega$, +87 V clamped at +58 V, 10 occurrences)	Pass

In the case of an open load condition or high-ohmic load ($> 2.2 \Omega$), the transient pulses are handled by the application with a transient voltage suppressor between VPWR and GND, as presented in [Decoupling Capacitors Role](#).

For testing on one output, the device was in Sleep state mode and the fast negative pulse is applied on one unloaded output. The second output is unloaded as well. Results of these measurements are described in the following table.

Table 5. Fast Transient Pulse Results (disturbance on HSx)

Schaffner pulses applied on the output (HSx)	Sleep state mode All outputs OFF
Pulse 1 ($R_I = 50 \Omega$, -600 V, $t_{RISE} = 1.0 \mu\text{sec}$, 100 occurrences)	Pass

3.4 Decoupling Capacitors Role

The following table summarizes the mission of each component.

Table 6. Component Role and Value

Signal	Location	Mission	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 the 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 against fast transient pulse 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
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4 References

PART NUMBER	DOCUMENT TYPE	DESCRIPTION / URL
MC06XS4200	Data sheet	• Dual 24 V High Side Switch (6.0 mΩ)
MC10XS4200	Data sheet	• Dual 24 V High Side Switch (10 mΩ)
MC20XS4200	Data sheet	• Dual 24 V High Side Switch (20 mΩ)
MC06XS4200	Evaluation Board User Guide	• Dual 24 V High Side Switch (6.0 mΩ)
MC10XS4200	Evaluation Board User Guide	• Dual 24 V High Side Switch (10 mΩ)
MC20XS4200	Evaluation Board User Guide	• Dual 24 V High Side Switch (20 mΩ)
	White Paper	• CISPR Standard white paper
	Specification	• IEC 62132-4 Specification (Direct Power Injection)
	Standards Document	• ISO 7637-2 Standard

5 Revision History

REVISION	DATE	DESCRIPTION OF CHANGES
1.0		<ul style="list-style-type: none"> Initial Release
2.0		<ul style="list-style-type: none"> Wording clarifications

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Document Number: AN4474

Rev. 2.0

9/2012