

TCAN4550 Watchdog Configuration Guide

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ABSTRACT

This application report presents the configuration, function, and use of the watchdog feature integrated into the TCAN4550 family of system basis chips (SBC) with integrated CAN FD controller and transceiver. Use cases and examples featuring the TCAN4550 are also provided to help further explain the features benefits.

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1 Introduction

As Controller Area Network (CAN) technology moves to faster and faster data rates in applications, the need for developers to move from classical CAN to CAN flexible data-rate (FD) is apparent. Part of the challenge from moving from classic CAN to CAN FD is having to find a new controller: either a dedicated CAN FD controller, which are few and far between and add cost, or a microcontroller with the CAN FD stack integrated, which is also an expensive addition to the application. The TI TCAN4550 helps overcome the cost and complexity challenges when moving to CAN FD, bridging the gap by allowing the use of an MCU only requiring SPI, and converting the SPI message to CAN frames on the CAN bus.

The TCAN4550 also integrates an LDO for self-supplied CAN, as well as an low-dropout (LDO) output, and a Watchdog, making it a part of Texas Instruments' CAN SBC family, and the first to be released to market. This application report goes into detail about the configuration and servicing of the TCAN4550 device.

2 General Description of Watchdog

A watchdog function is common in the electronics industry, and is a timer meant to verify that the controller of a device is working correctly. This is done by the controller periodically updating or resetting a timer in the controlled device based upon a specific timing sequence. If this is not executed correctly, an interrupt or timeout signal is generated. Depending on the system design, some kind of corrective action takes place. The idea is that in systems where human intervention is not easy, possible, or cannot take place quick enough, the system autonomously fixes any issues with its main controller by forcing a reset on it.

3 Timeout Watchdog

The timeout watchdog is the simplest implementation of the watchdog function. The general concept goes as follows: a timer is started as soon as the first watchdog trigger is sent, and that same trigger must be sent within the configured time limit, or an error is asserted. In most cases, an error counter is incremented when the timer runs out before a trigger occurs, and when this counter reaches a certain value, a fault (interrupt) is sent to the controller to initiate the diagnostic and/or fixing mechanisms.

4 Explanation of Watchdog Specific to TCAN4550

The TCAN4550 integrates a timeout watchdog for monitoring the microprocessor. When using the watchdog function, it runs continuously and is default enabled. There are four different timer values for the timeout length and three options for watchdog failure indication. The watchdog is active in normal and standby modes, but off in sleep mode. However, the watchdog timer does not begin until the first correct trigger is received. Once the first correct trigger is received, the watchdog runs continuously until it is serviced incorrectly, where a watchdog failure occurs.

There are two options for triggering the watchdog service: writing to a register, or by toggling the voltage on the GPIO1 pin either high or low. Until the first trigger is issued, the watchdog does not run even if it is enabled through the registers, and the first trigger can happen in standby or normal mode.

If the watchdog timer expires with no correct service, then a watchdog event occurs. This event can be indicated in three different ways, all configurable through SPI registers. The three indicators are setting an interrupt to output on the nINT pin, pulsing INH pin and placing the device into standby mode, or pulsing the watchdog output pin. The watchdog output pin in this case is GPO2, which can be configured to be the watchdog event output in the same register as the rest of the watchdog configuration bits. It is important to note that even if the option of toggling INH or the GPO2 is chosen, the watchdog timeout interrupt is still set and nINT still toggles, giving two indications. However, if the interrupt option is chosen, only that indicates the watchdog failure event.

5 Watchdog Configuration

The configuration options for the watchdog on TCAN4550 are located in register 0x0800. The watchdog timer, GPO2 configuration, watchdog service bit, watchdog failure event indication configuration, GPIO1 configuration, and watchdog enable are all contained in the register.

5.1 Watchdog Timer Configuration

The watchdog timer is configured by setting bits [29:28] in register 0x0800; the four options are 60 ms, 600 ms, 3 s, and 6 s. By default, the timer is set to 60 ms, meaning that once the first correct watchdog trigger is sent, the timer begins to count to 60 ms. If a correct trigger is received before the 60 ms timer runs out, then the watchdog has been correctly serviced. The moment the correct trigger is sent, the timer restarts from that point to count up to 60 ms again. The timer does not go the full duration, even when correctly serviced. If the watchdog is not correctly serviced within the 60 ms timer, a watchdog failure event occurs.

Table 1. Watchdog Timer Configuration Options

REGISTER 0x0800 BITS [29:28] VALUE	DESCRIPTION
00	60 ms
01	600 ms
10	3 s
11	6 s

5.2 GPO2 Configuration

GPO2 can be configured as an M_CAN_INT 0 interrupt, the watchdog output, or to mirror the nINT pin. So while it is not specific to the watchdog function, it does have an option that affects the watchdog failure indication. Configuring GPO2 to be the watchdog output pin causes the pin to toggle high to low to high in 300 ms in the case of a watchdog failure. If GPO2 is configured to mirror the nINT pin, it still signals the watchdog failure event, but as a result of the watchdog failure interrupt being set.

Table 2. GPO2 Configuration Options

REGISTER 0x0800 bits [23:22] VALUE	DESCRIPTION
00	No action
01	M_CAN_INT 0 interrupt (active low)
10	Watchdog output
11	Mirror nINT pin

5.3 Watchdog Service Configuration

Bit 18 in register 0x0800 is designated as the watchdog service bit. This bit is used to service the watchdog if the GPIO1 analog trigger is not enabled. To correctly service using the bit, write bit 18 in register 0x0800 to 1 within the watchdog timer, and the timer resets from the moment the bit was written. There is also the option to enable GPIO1 as the watchdog service input. The GPIO1 configuration bits are [15:14] in register 0x0800, and writing a 10 to those bits configures the GPIO1 as the watchdog input trigger. To correctly service the watchdog using GPIO1, a pulse from low to high or high to low must happen within the watchdog timer; the service is recognized on the transition edge. Once the edge transition is seen by GPIO1 within the watchdog timer, the timer resets and begins counting up to the configured timer value.

Table 3. GPIO1 Configuration Options

REGISTER 0x0800 BITS [15:14] VALUE	DESCRIPTION
00	GPO
01	Reserved
10	GPI - Automatically becomes a WD input trigger pin
11	Reserved

5.4 Watchdog Failure Event Indication Configuration

As mentioned in [Section 4](#), there are three different options for watchdog failure indication: set the interrupt flag toggling nINT, pulse INH pin then place the device in standby mode, or pulse the watchdog output pin (GPO2 if enabled). Again, it is important to remember that no matter what the watchdog timeout interrupt flag is set as in the case of a watchdog failure, meaning that nINT also always toggles in a watchdog failure. Selecting this option in register 0x0800 bits [17:16] merely makes it so that only the interrupt is set, and nothing else indicates the watchdog failure.

Table 4. Watchdog Action Configuration Options

REGISTER 0x0800 BITS [17:16] VALUE	DESCRIPTION
00	Set interrupt flag and if a pin is configured to reflect WD output as an interrupt, the pin shows low.
01	Pulse INH pin and place device into standby mode - high to low to high in 300 ms
10	Pulse watchdog output pin if enabled - high to low to high in 300 ms
11	Reserved

6 Summary

The watchdog configuration and service can be a daunting task for any device. Hopefully this report sheds some light on the function of the watchdog module on the TCAN4550-Q1 CAN SBC, and allows the development to be as smooth and straightforward as possible.

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