Application Note

Increasing CAN/LIN Channels using Channel Expansion Feature of Select TI Mid-Range SBCs

Parker Dodson

ABSTRACT

System Basis Chips (SBCs) from TI offer many benefits to a system by integrating power electronics, communication transceivers, robust protection features, and a unified control system that ties all of the functionality into one package. TI SBCs either contain one LIN bus, one CAN bus, or both a CAN and LIN bus, but that is not the full scope of all potential SBC use cases across various applications. If an additional communication transceiver is required but not offered by the SBC, what options does the designer have? Luckily TI's designers thought of this exact scenario and integrated a general field output (GFO) pin to aid in transceiver channel expansion among other features. Utilizing the GFO pin on TI SBCs, primarily the TCAN28xx-Q1 and TCAN24xx-Q1 device families, allow a designer to add additional transceiver communication channels to system design.

Table of Contents

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

In many automotive and some industrial applications, the need for a robust module for communication, power, and protection is paramount to most, if not all, applications. TI's SBCs, especially from the TCAN28xx-Q1 and TCAN24xx-Q1 device families, meet many of these goals by providing power through integrated LDOs and a BUCK (available on TCAN24xx-Q1 devices), integrating a CAN bus and/or a LIN bus (CAN + LIN available on TCAN28x7-Q1 devices) for communication needs, integrating multiple safety features including items such as watchdog timer, voltage supervision, and an optional fail-safe mode. These SBC devices provide a solid base towards a communication node design – while not all applications use only one CAN or LIN channel some applications can require additional CAN or LIN transceivers. This complicates the control system and the designer need a new transceiver to pair with the SBC while integrating that new transceiver device into the application control system. This is the motivation behind adding the GFO channel expansion pin on SBC devices. This application note discusses: what does channel expansion look like, how does the GFO pin functions and how it applies to channel expansion, and finally some examples of how this connection looks for a CAN transceiver, LIN transceiver, and even another SBC.

2 What is Channel Expansion

While briefly touched on in the introduction and abstract – channel expansion is simply the act of adding another, independent, communication transceiver to the end application. At a high-level, channel expansion doesn't require an SBC; channel expansion just requires an additional transceiver output, but in complex systems this is a non-trivial addition to the control system which require more control pins from the applications host controller.

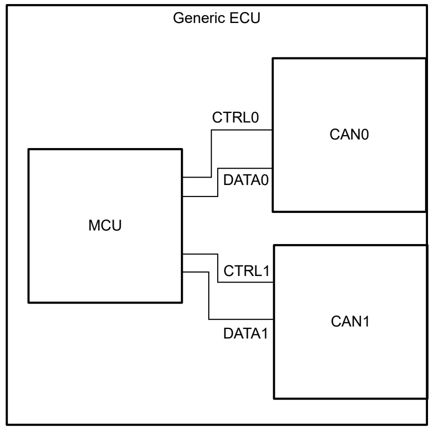

Figure 2-1. High Level Simplified Generic ECU Setup

Not all applications are able to spare GPIO pins to control a secondary transceiver and designers can face an impasse forcing a redesign. Not only are the MCU GPIO pins limiting in the design; there also may not be enough power regulation to power the additional transceiver. CAN transceivers are powered off of primarily 5V supplies, but sometimes 3.3V CAN can be used and since most of these applications run off of a minimum of 12V inputs there must be some type of power management IC within the node. In many cases, if an SBC is used instead of a stand-alone transceiver, the power management can be done by the SBC itself. That is not the case on every system.

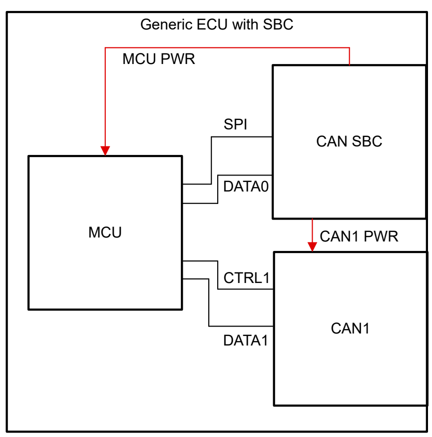

Figure 2-2. High Level Simplified Generic ECU + SBC

TI designers of the TCAN28xx-Q1 and TCAN24xx-Q1 SBC families solved this issue and by implementing a channel expansion feature on these devices so that there is no need for additional control lines. In most channel expansion use cases the power from the SBC is sufficient to power the external transceiver as well, allowing for a simpler more integrated power tree. A high-level view of a more beneficial channel expansion scheme using TI's SBCs pushes the control line away from the MCU and into the SBC.

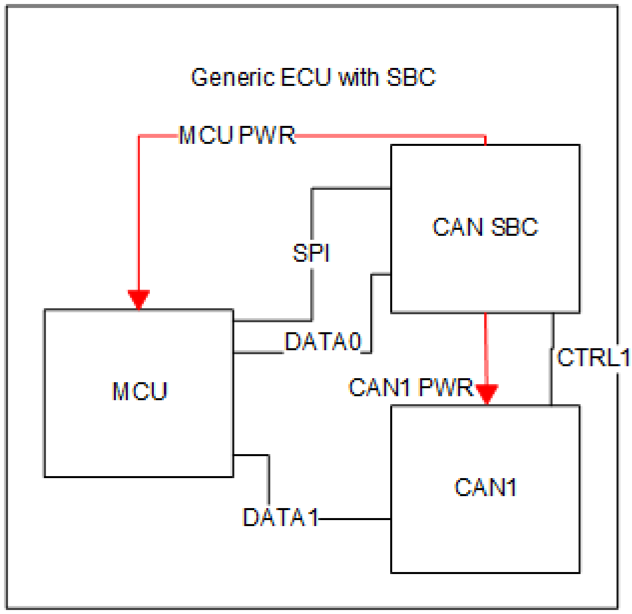

Figure 2-3. High Level Simplified Generic ECU with SBC using Channel Expansion

So, to put this succinctly, channel expansion is the act of adding an additional communication transceiver to the design of the ECU. Channel expansion can be implemented using TI SBCs and a GFO pin. The following section discusses what the GFO pin is and how the pin applies directly to channel expansion applications.

3 What is the GFO Pin and How Does it Apply to Channel Expansion

With a basic understanding of what channel expansion is, the next pressing question is how to implement channel expansion using TI SBCs with a GFO pin.

GFO is an acronym for *general field output* – for example, a generic function pin. Think of this pin as a GPIO pin without the ability to take inputs (for example, such as a *GPO pin*). This is a digital output pin that can output a high or low signal with the voltage domain referenced to the primary power source on the SBC (denoted VCC1 - which is 3.3V or 5V depending on specific device and use case). The GFO pin has two overarching functions depending on application, the first being a general digital output that is controlled through the SPI bus. The second function is a status flag allowing for certain interrupts to not only trigger the nINT pin but also the GFO pin.

The first category (general digital output) is the main focus on with respect to channel expansion. Remember that channel expansion using the GFO pin essentially means moving the control path to the external transceiver from the MCU to the SBC. So instead of using a GPIO pin to control the inhibit and/or enable pins on an external transceiver, designers can save an MCU GPIO pin and use the GFO pin on the SBC instead. This is beneficial as it reduces the resources needed on the MCU side to facilitate transceiver channel expansion. This is also a resourceful use case because the SPI connection from the MCU to the SBC exist regardless of whether the GFO pin is used or not, so the designer is not adding any additional hardware resources to implement this type of design.

There are two minor considerations when using the GFO pin for channel expansion: what are the requirements of GFO for sinking and sourcing current; and is there any fault that needs to be on GFO in addition to nINT.

The first consideration is the current sinking and sourcing ability of the GFO pin. The pin is a push-pull output that is recommended to source no more than 2mA and sink no more than 2mA – so the overall drive strength of this pin is low. In cases where only one additional communication channel is needed, this limit is usually not an issue (digital high impedance inputs should draw low current). However if multiple channels are added, the lower drive strength may prove to be less than ideal. In those cases, it may be worth while to look to a high-speed buffer, however most applications are fine with just the GFO pin.

The other consideration is if the application work without alt. GFO functionality. Hardware interrupts are indicated through the nINT pin – but for more granular details, the interrupt registers must be read first, which is not always preferred depending on application. The GFO pin has alt functions that can be used to flag issues with one of the following: Power supply interrupt, WD interrupt, Local Wake Up (LWU), Bus Wake request (WUP), restart counter overflow (indicated in standby), or a CAN bus fault. These alt functions can be required if the time allowed to address one of the aforementioned issues through the traditional nINT -> read interrupt registers -> take appropriate action is too long for system requirements and the GFO -> Read specific register of indicated problem -> take appropriate action meets the needs of the timing in application (This can be quicker as no iterating through registers would be required). The previously listed concern is not a problem in the vast majority of applications, but it is something that must be taken into consideration during the application design process.

4 Example Setups of Using GFO Pin in Channel Expansion Based Applications

Conceptually – channel expansion via the GFO pin is very simple. Connect GFO to the control input (some type of enable pin) of the external transceiver and use the MCU to send SPI commands to the SBC that controls when the external transceiver is on and ready to communicate. This section is going to show some real examples used in multiple systems. There are three main examples that are shown: channel expansion with a CAN FD transceiver, channel expansion with a CAN FD SBC, and channel expansion with a LIN transceiver.

First, channel expansion with a CAN FD transceiver. This example utilizes a TCAN2847-Q1 or TCAN2857-Q1 as the SBC and the TCAN1044A-Q1 as the external CAN transceiver.

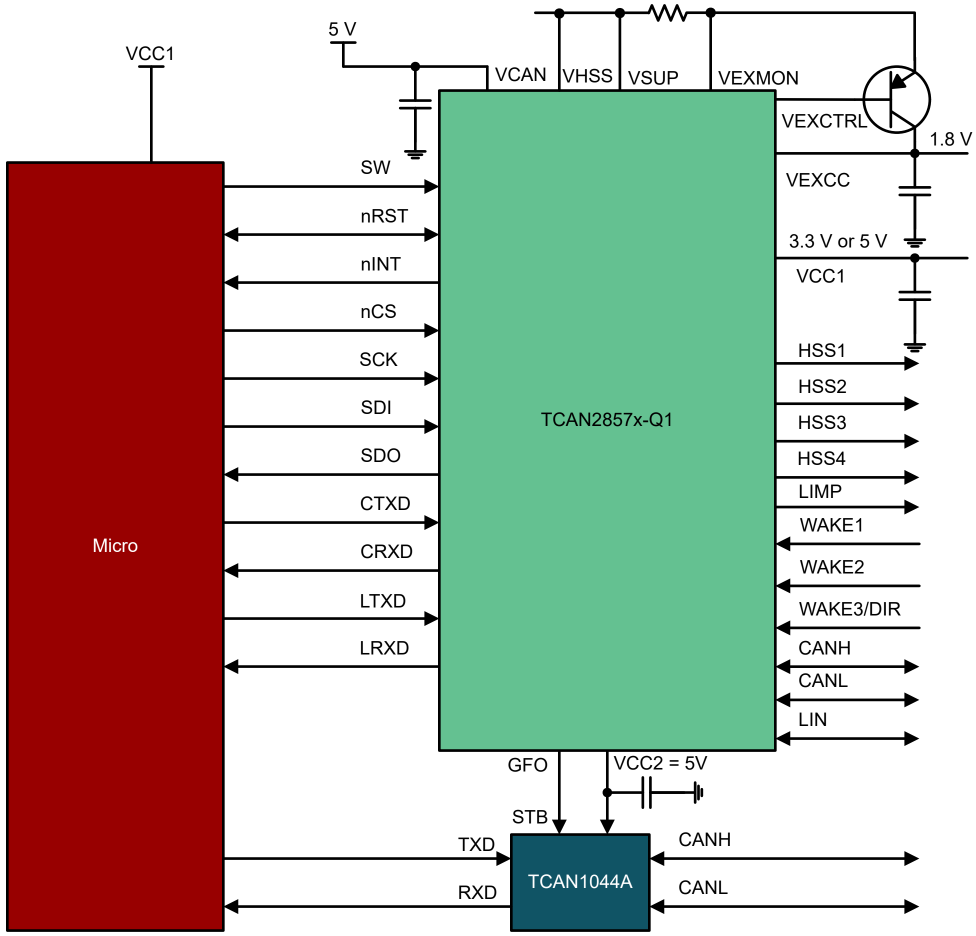

Figure 4-1. CAN SBC Adding Additional CAN Channel with GFO Pin

In this instance of channel expansion, the reality is very close to the concept. The STB pin of the TCAN1044A-Q1 is controlled through the GFO pin on the TCAN2847-Q1 device while VCC2 (5V) provides power to the external CAN transceiver. Note that the TCAN2847-Q1 family of SBC devices is not required for the application; any SBC with a GFO pin can be used for channel expansion.

Second, the channel expansion can also be used to facilitate another CAN SBC such as the TCAN1162x-Q1 family of devices.

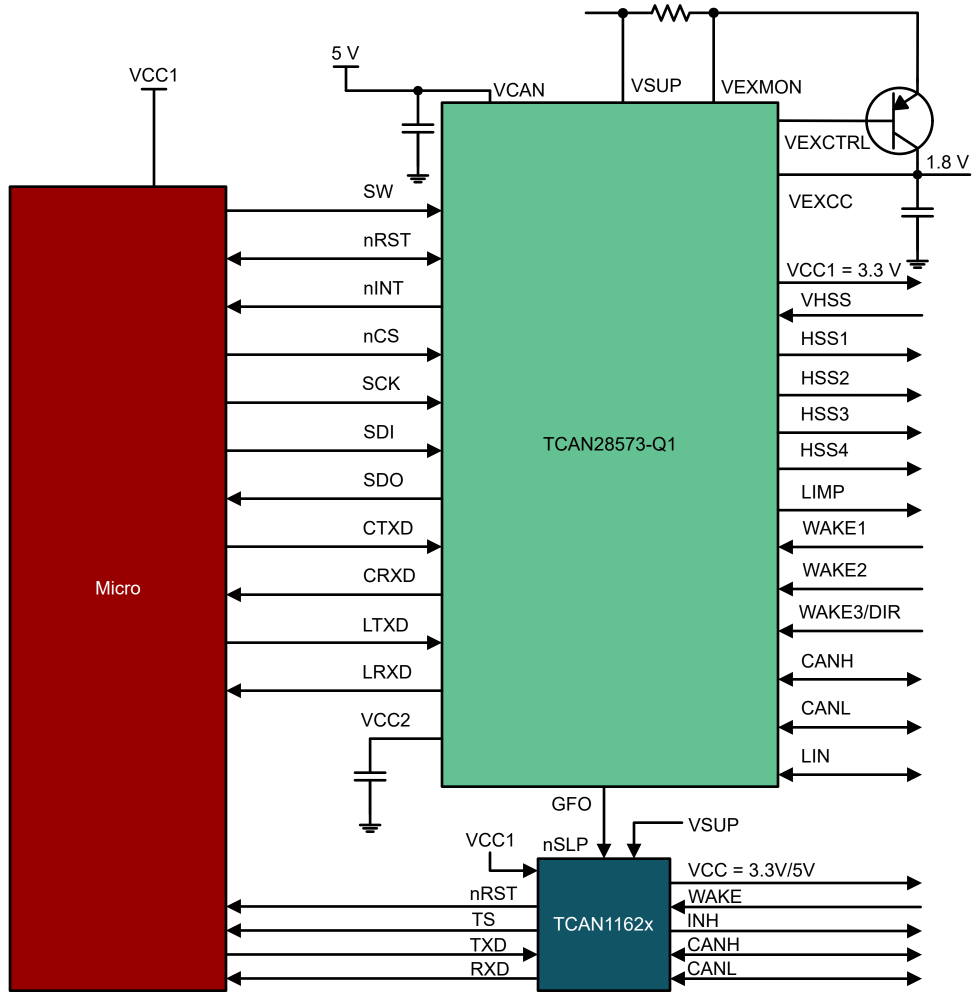

Figure 4-2. CAN SBC Adding Additional CAN SBC with GFO Pin

This is very similar to the CAN channel expansion, except nSLP is now the *enable* pin that GFO controls. VCC1 from the primary SBC is used to power the integrated CAN transceiver within the TCAN1162x-Q1 device with the main supply voltage coming from the battery, which is the same as the TCAN2847-Q1 in this application.

The third example is using channel expansion with a basic LIN transceiver, such as the TLIN1029A-Q1.

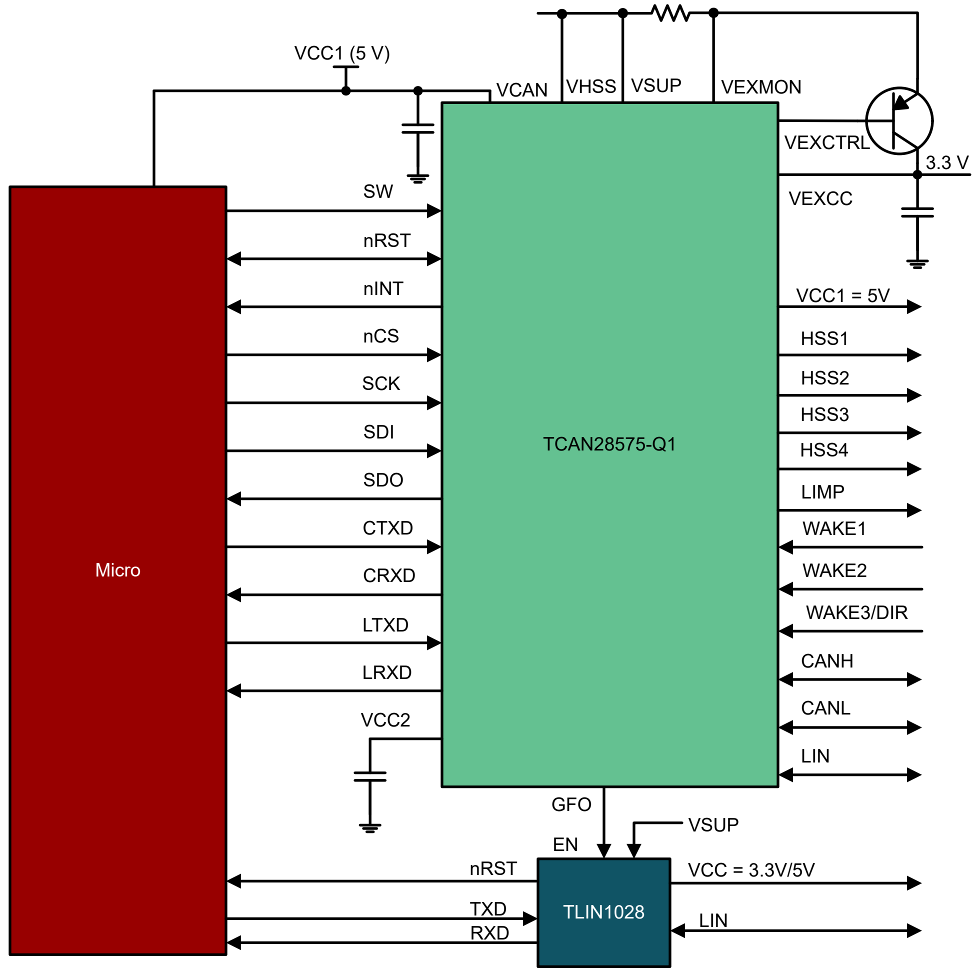

Figure 4-3. CAN SBC Adding LIN Transceiver with GFO Pin

The channel expansion control line is the GFO pin, and nothing else has. However, for a LIN device the main supply voltage is battery. This means the battery supply is also powering the LIN device. For another level of control, the HSS4 output of the TCAN2847-Q1 device can be used as a load switch between the LIN transceiver and the battery.

There are numerous examples, but the general idea is the same across the applications: GFO controls the enable and disable inputs to the external transceiver and the primary SBC can be used to facilitate device power if not directly powering the external transceiver.

5 Summary

In many applications there can be a need to add an additional transceiver channel for communication, adding another CAN and LIN transceiver to the application. The general design is simple: connect the GFO pin to the proper control input of an external transceiver and use the application software to determine when to turn on the external transceiver. With this knowledge, another design tool has been added to the toolbox of strategies to employ when working with TI SBCs.

6 References

- Texas Instruments, *TCAN241x-Q1 Automotive CAN FD System Basis Chip (SBC) with Integrated Buck Regulator and Watchdog*, datasheet.
- Texas Instruments, *TCAN245x-Q1 Automotive Signal Improvement Capable CAN FD System Basis Chip (SBC) and Integrated Buck Regulator and Watchdog*, datasheet.
- Texas Instruments, *TCAN284x-Q1 Automotive CAN FD and LIN System Basis Chip (SBC) with Wake Inputs and High-Side Switches*, datasheet.
- Texas Instruments, *TCAN285x-Q1 Automotive CAN FD SIC and LIN System Basis Chip (SBC) with Wake Inputs and High-side Switches*, datasheet.