Application Brief

Reference Voltage Applications in the UCC57108, UCC57102, and UCC57102Z Gate Drivers

Integrated circuits (ICs) continue to become more feature-rich as the demands for higher safety standards and smaller PCBs increase. System designers are starting to look for ICs that increase design flexibility and alleviate system complexity, size, and cost by integrating useful features. The UCC57108, UCC57108-Q1, UCC57102, UCC57102-Q1, UCC57102Z, and UCC57102Z-Q1 (known together as UCC5710x) are all examples of ICs that can provide flexibility with built-in reference voltage due to low dropout regulators (LDO). This application brief focuses on the voltage reference that is integrated on the UCC5710x devices.

The voltage reference on Texas Instruments UCC5710x devices is an LDO that can generate a regulated 5V and output up to 20mA of current. Figure 1 is the internal block diagram of UCC5710x devices showing the voltage reference on pin 2.

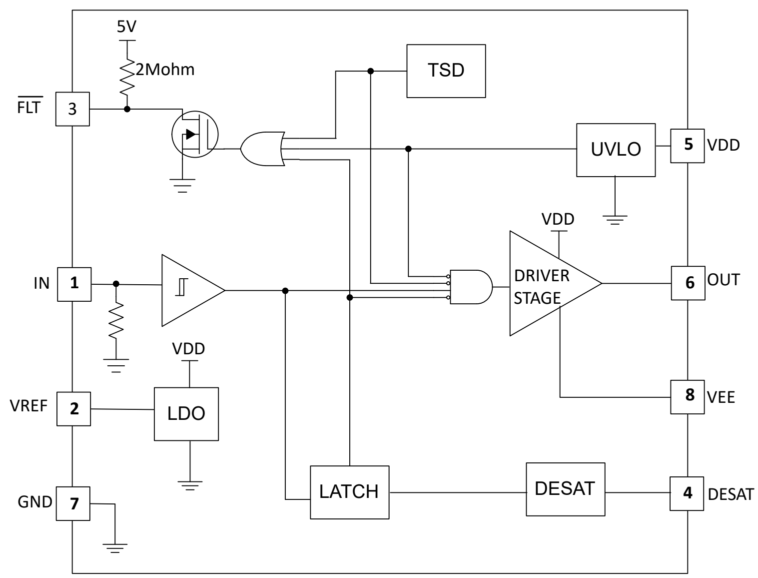

Figure 1. UCC5710xB, UCC5710xB-Q1, UCC57102Z, UCC57102Z-Q1 Functional Block Diagrams

The UCC5710x devices have two variants, B and C, that have the integrated LDO. Diagrams in this application brief use the UCC57108B pinout for visual purposes, but the use cases and benefits of the LDO apply to any UCC5710x device with an LDO.

5V Bias Use Cases

One of the most useful applications of this VREF pin is the convenient second bias supply. Having a 5V bias from the LDO built directly into the gate driver allows for greater flexibility in placement of the 5V bias, as well as ease in design. This is particularly useful when designing in components such as voltage-sensing modulators, current-sensing modulators, or thermistors, which is further explained in the next section.

One other use of the integrated LDO is to provide a 5V bias when only a 3.3V bias is available. While a 3.3V power rail is common, sometimes there is a need for a 5V bias due to the greater noise immunity that the extra headroom provides. This greater noise immunity is useful for proper behavior of external components. If a system uses mainly 3.3V power rail but needs 5V compatibility with certain components, the integrated LDO can save on BOM cost since there is not a need for an external LDO.

One system this becomes relevant is automotive heating, ventilation, and air conditioning (HVAC), where protection features and careful implementation of components is critical to the robust operation of the vehicle. Modulators or thermistors are beneficial in this end equipment and a gate driver with a reference voltage from UCC5710x device can allow for cheaper implementation.

Typical Applications of the Reference Voltage

Consider an engineer wanting to design a modulator for sensing; this design engineer most likely does not want to redesign the power supply architecture to accommodate only a singular component. However, if the modulator cannot be placed close to a 5V power rail, a long trace on the PCB is needed and is susceptible to noise and can cause problems in the system. A fix to this is using a gate driver with an integrated LDO that can bias the modulator if placed close to the gate driver.

Similar to the modulator, having a thermistor with the internal 5V bias from the LDO can be advantageous in a system while providing minimal additional design.

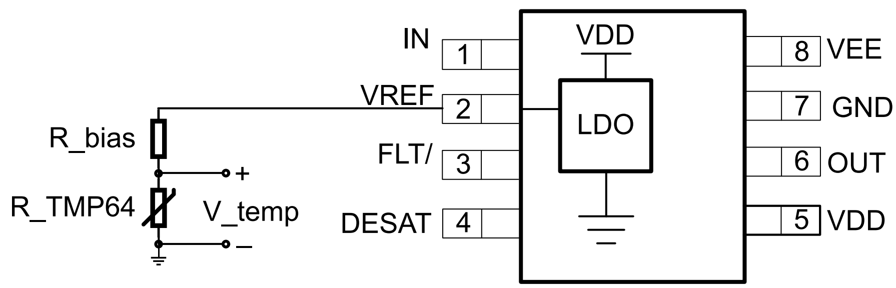

Figure 2. Application Diagram of the UCC5710x Gate Driver LDO Biasing the TMP64 Thermistor

Using the UCC5710x and a thermistor like the TMP64-Q1 together can work because the 5V typical output voltage of the LDO sits comfortably within the operating range of the TMP64-Q1 device.

Table 1. The UCC5710x Typical Reference Voltage of 5V

Parameter		Test Conditions	Typ	Max	Unit
V_{REF}	Voltage Reference	I_{REF} = 10mA	5		V
I_{REF}	Reference output current			20	mA

Table 2. TMP64-Q1 Thermistor V_{Sns} Specification

Parameter	Test Condition	Min	Max	Unit
V_{Sns}	Voltage across Pins 2 (+) and 1 (-)	0	5.5	V

One other use-case is to bias the fault reporting on the UCC5710x family of devices themselves.

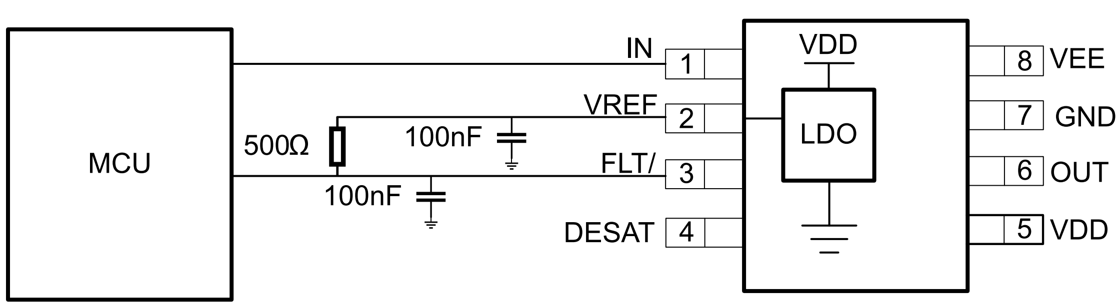

Figure 3. Typical Application Diagram for Biasing the FLTb on the UCC5710x Gate Driver

Using the LDO as a 5V bias, we can use a pull-up resistor between the VREF pin and the fault reporting pin to bias the fault reporting. For example, by using a 5kΩ pull-up resistor, we see 10mA typical current on the FLTb pin. This falls well within the specification of both the maximum sink current on the FLTb as well as the maximum VREF output current. The capacitors are not necessary but are generally recommended due to improvements in noise immunity. The value of the resistor can be variable due to the current load, but is marked as 500Ω assuming a 10mA draw.

$$Resistance \quad = \quad V \div A \quad = \quad 5V \quad (typ.) \quad \div \quad 10mA \quad = \quad 500\Omega$$

Another use case of an internal LDO is operating on the high-side driver. A system generally has more power rails available on the microcontroller side. The high-side is typically powered with an integrated supply or a bootstrap. On the high-side of the system, the LDO can add value as another bias supply where there are not as many. This allows for using the UCC5710x as a high-side driver with an isolator.

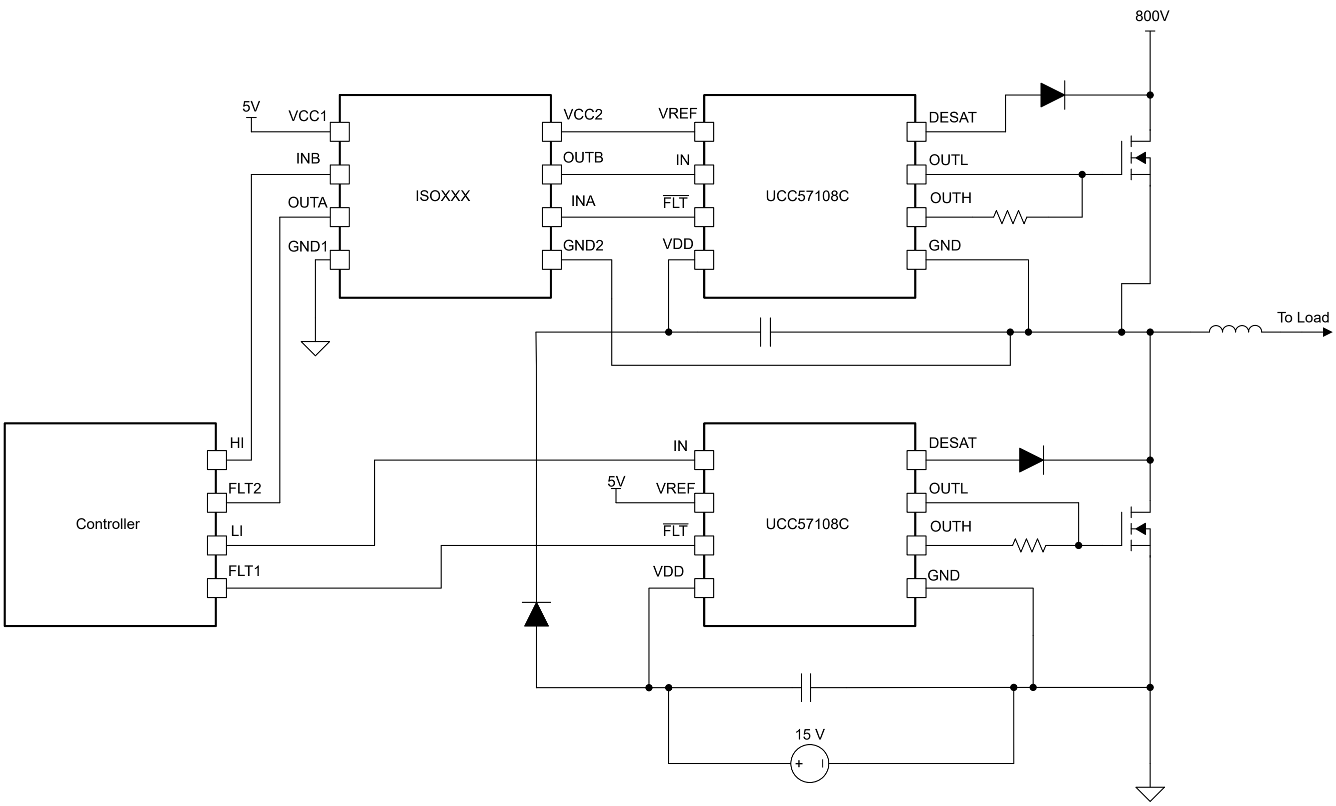

Figure 4. UCC5710x Gate Driver as a Low-Side and a High-Side with Help of an Isolator

One other use case is load management, especially in regards to the microcontroller. A microcontroller can bias multiple components in a system. However, managing the thermals of the microcontroller can be an issue if the microcontroller is biasing too many components or high current-load components. Thus, the LDO inside of the UCC5710x gate drivers can help manage the current load of the microcontroller, by being able to bias up to 20mA of load current. This can prevent the need to tinker with the bias supply rail or change the power rating of the power rail to accommodate additional components that can be added in generational upgrades to a system.

Performance of the Voltage Reference in UCC5710x

One important aspect of implementing an internal voltage reference is verifying performance similar to a standalone external LDO. The LDO inside the UCC5710x devices has the following performance.

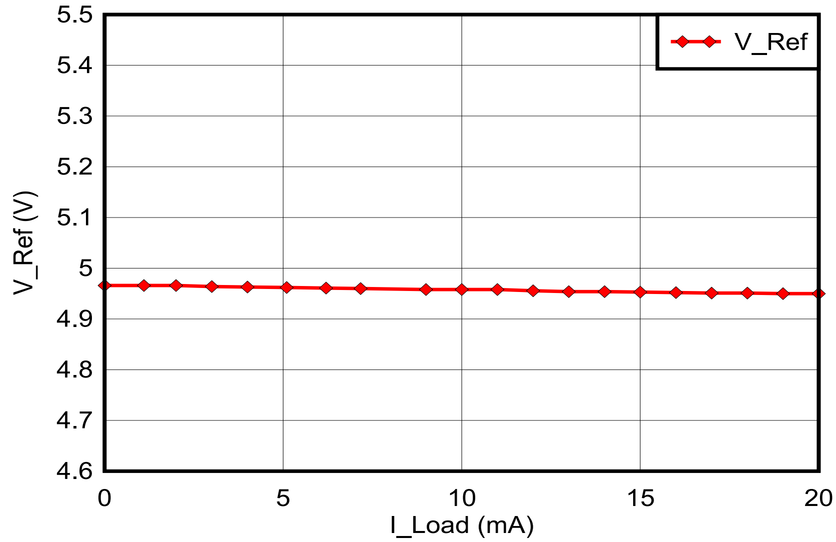

Figure 5. UCC57108-Q1 LDO Performance Over Various Current Loads (Performance at VDD = 15V, 25°C)

We can see that the LDO performs well inside of the acceptable 10% tolerance of electrical specifications. Over the entire range of output current loads, the LDO maintained a constant 5V bias, which shows proper operation of the components biased. The LDO also had good performance over the entire recommended operating VDD range.

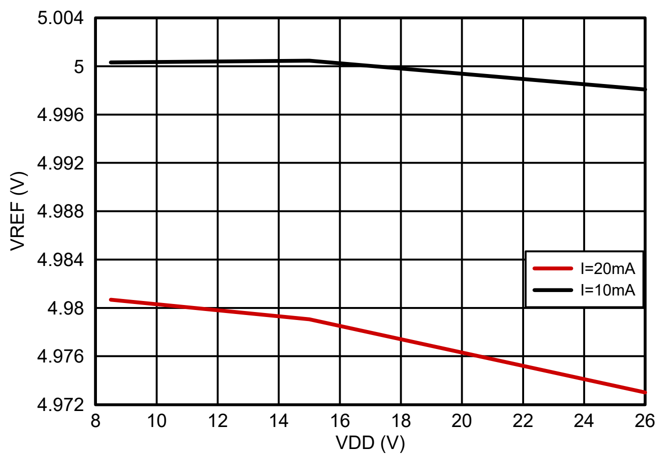

Figure 6. UCC5710x VREF Performance Over Different VDD

One other performance metric is seeing how the LDO on the UCC5710x devices changes depending on when the DESAT and fault reporting triggers. When DESAT detects a voltage over a certain threshold, DESAT switches high, and fault reporting FLTb switches low. When the output turns off of the UCC5710x, DESAT goes back to low, and FLTb switches back high. Figure 7 shows the performance of the LDO when FLTb is switching high-to-low and low-to high.

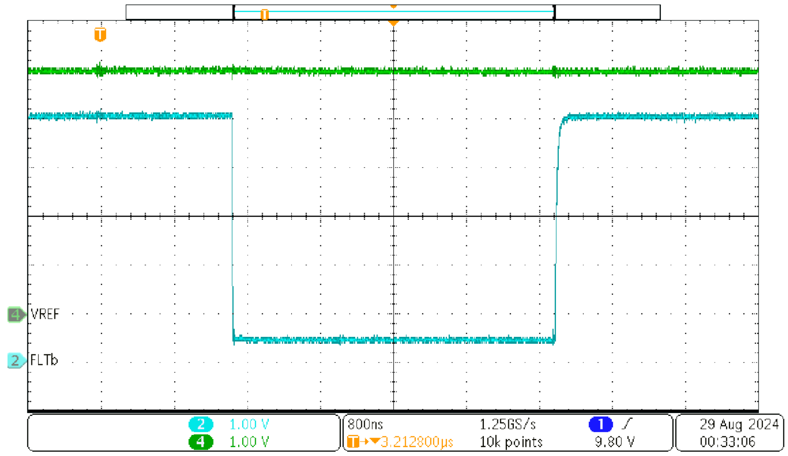

Figure 7. LDO Performance on the UCC57108-Q1 Gate Driver During FLTb Pin Switching (Test conditions: 15V VDD, 25°C)

We can see that the LDO has consistent behavior even through the FLTb switching. This indicates that the performance of the LDO is robust even when the outputs of the gate driver are shut down during a fault.

Additionally, an LDO inside of a gate driver is not the main selling point, but becomes a great complimentary feature if the gate driver is also robust and has high performance. Table 3 shows a comparison of two gate drivers with a reference voltage integrated.

Table 3. Comparison of UCC5710x Devices and Competitor Device

	UCC5710x	Competitor Device
Configuration	Low Side	Low Side
VREF Voltage Reference (Typ.)	5V	5V
VREF output current (Max.)	20mA	20mA
VDD-GND (Abs. Max/Rec. Max.)	30V/26V	22V/20V
Input (Abs. Min./Rec. Min.)	-5V/-2V	-0.3V/0V
Drive Current (Typ.)	3/-3A	4A/-6A
Propagation Delay (Typ.)	28ns/26ns	59ns/54ns
Rise/Fall Time (Typ.)	8ns/14ns (Typ at 1.8nF)	9ns/7ns (Typ at 1nF)
Minimum Input Pulse Width	9ns	40ns
Theta JA	126 ºC/W	176 ºC/W

With this comparison table, we can see that the UCC5710x devices not only has a competitive LDO, but also that LDO is embedded inside of a high-performance, robust device with flexibility in VDD.

LDOs are simplistic but can provide immense value when implemented directly into a gate driver. The flexibility an implemented robust LDO provides for a system is a great design consideration when choosing a gate driver for a system like automotive HVAC.

Trademarks

All trademarks are the property of their respective owners.

IMPORTANT NOTICE AND DISCLAIMER

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265