

Multiplexers Beyond the Supply Operations



Nir Gilgur

ABSTRACT

Most multiplexers are capable of passing a voltage signal equal or less than their power supply; however, some multiplexers have the capability to allow to pass a signal that exceeds their supply or falls below ground, despite not having a negative rail. These multiplexers have a feature referred to as *Beyond the Supply*. There are three distinct types of this feature that can be used and implemented into systems.

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1 Introduction

Common multiplexers are usually designed to pass voltage signals equal or less than their power supply. In most system applications this can suffice, but in unique cases where there is a need to pass a signal exceeding the power supply, Beyond the Supply multiplexers can be used. These multiplexers have the capability to allow to pass a signal that exceeds their supply or falls below ground, despite not having a negative rail. The Beyond the Supply feature has three different types of operations.

2 The Three Types of Beyond the Supply Operation

2.1 Negative Beyond the Supply

Negative beyond the supply is defined as the capability of a device to pass a voltage signal below ground and less than the power supply. One common application for this feature originates from the audio industry. In audio systems, the power supply is usually in the range of 1.8V to 5V. In these types of applications, at times there is a requirement to pass a signal below ground, or for example a negative signal. That is where the Negative Beyond the Supply comes in, where it allows the device to pass a negative signal while being powered by a single positive supply. This capability is shown in Table 2-1 where the TS5A22364 signal path voltage can be negative, while the supply is positive.

Table 2-1. Recommended Operation Conditions of the TS5A22364

	MIN	MAX	UNIT
V_{CC} Supply Voltage	2.3	5.5	V
V_{NC} V_{NO} Signal path voltage V_{COM}	$V_{CC} - 5.5$	V_{CC}	V

Figure 2-1 is an example of a use case, showing the TS5A22364 switching between two input signals of -1.8V to output speakers, while being powered by a positive supply of 3.3V.

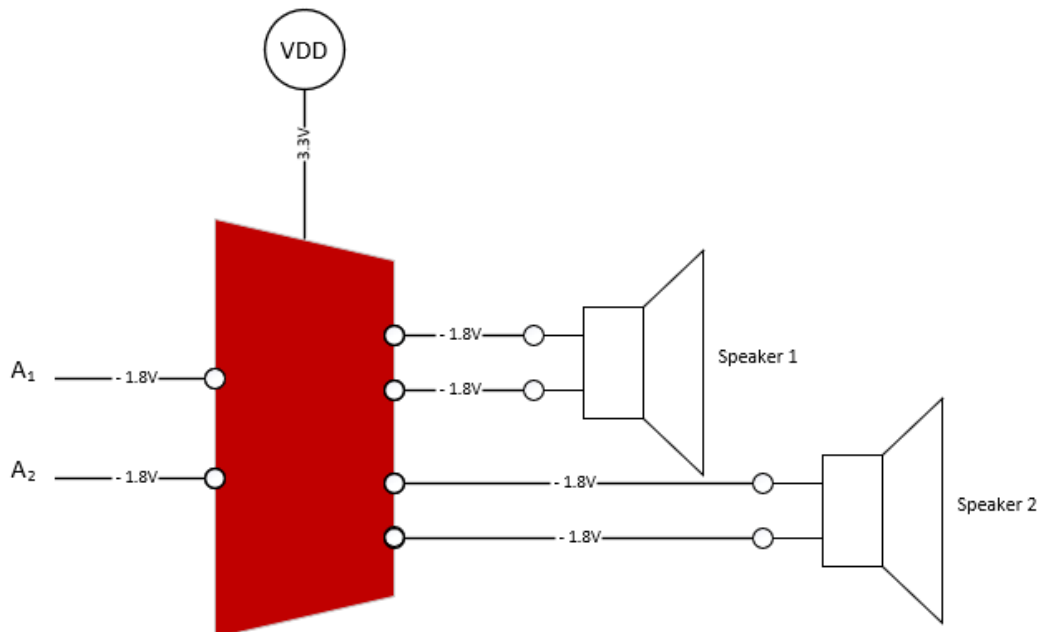


Figure 2-1. TS5A22364 a 2:1 2-Channel Multiplexer Powered by a Positive Supply, Passing Negative Signals

2.2 Positive Beyond the Supply

Positive Beyond the Supply can be defined as the capability of a device to pass a positive voltage signal greater than the power supply voltage. An application using this feature is commonly seen in interface, where an engineer is connecting an offboard interface operating at 5V to an onboard interface operating at 3V. The interfacing device needs to be capable of being powered by a lower voltage supply, than the voltage it is passing. In this case, the Positive Beyond the Supply can be used.

Table 2-2 highlights the beyond the supply capability of the TMUX1574. Signal path I/O is capable to pass a signal up to 2 x the supply

Table 2-2. Recommended Operation Conditions for the TMUX1574

		MIN	MAX	UNIT
V_{DD}	Supply voltage	1.5	5.5	V
V_S or V_D	Signal path input or output voltage (source or drain pin). $V_{DD} \geq 1.5V$	0	$V_{DD} \times 2$	V

Figure 2-2 shows an example of an application for the TMUX1574 where it is used to switch between two interface boards with different voltage levels.

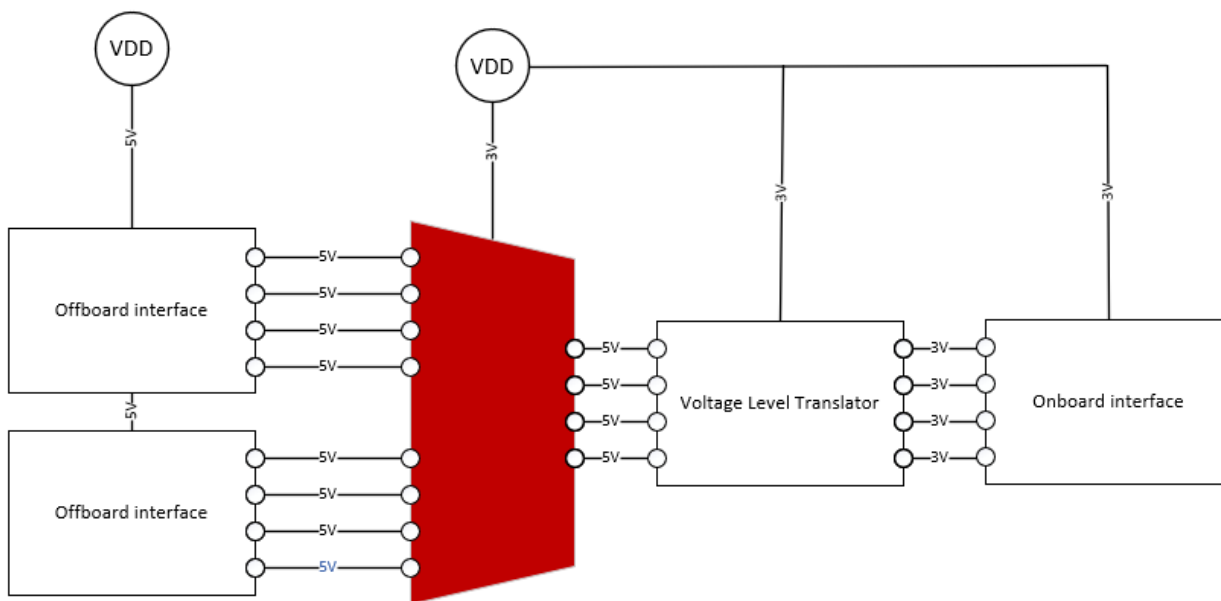


Figure 2-2. TMUX1574 a 2:1 4-Channel Multiplexer Powered by a 3V Supply, Passing Four 5V Input Signals to a Voltage Translator Then to the Onboard Interface.

Multiplexers with the capability of Beyond the Supply with positive signal operation also have powered-off-protection. The protection makes sure the device maintains high impedance performance while the device is not powered, while also preventing the device from back powering. Which prevents a device from providing power to downstream components in the system.

2.3 Negative and Positive Beyond the Supply

You can also have a device that supports both positive and negative beyond the supply use-cases, which is often used where audio signals are switched between multiple audio sources, such as internal and external speakers, in a system. A mux can be a useful tool to help switch the audio source between these different sources. As mentioned earlier, in these audio settings the usual voltage supply in the system is at the range of 1.8V to 5V; however, audio signals can exceed the range of the system power supply. To accommodate the audio signal range requirements a multiplexer with beyond the supply feature is needed, specifically with Positive and Negative Beyond the Supply. Table 2-3 shows the TMUX4827 beyond the supply capabilities. The Signal path I/O is capable to pass a signal between -12V and 12V.

Table 2-3. Recommended Operation Conditions for the TMUX4827

		MIN	MAX	UNIT
V_{DD}	Positive power supply voltage	1.8	5.5	V
V_S or V_D	Signal path input/output voltage (source or drain pin) (Sx, D)	-12	12	V

In Figure 2-3, shows an example using the TMUX4827 to switch between audio sources. The codec can send a negative signal, while the amplifier output can exceed the typical supply range.

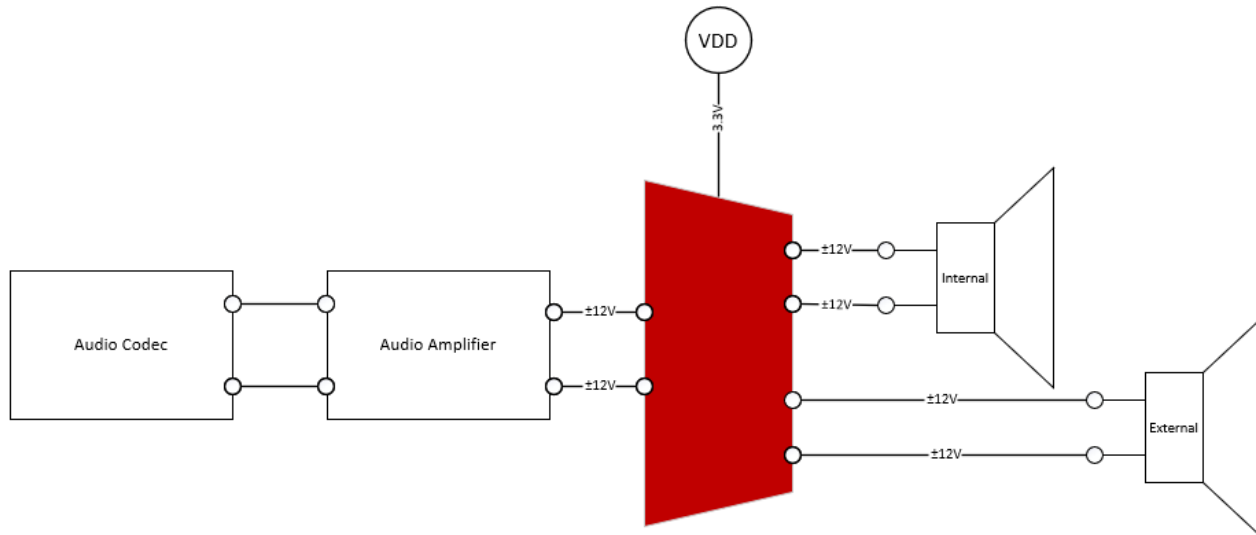


Figure 2-3. TMUX4827 a 2:1 2-Channel Multiplexer Powered by a 3.3V Supply, Passing 12V and -12V Input Signals to an Internal and External Speakers

Multiplexers with beyond the supply feature such as the TMUX4827 and the TS5A22364 are mainly used for audio applications.

3 Summary

The Beyond the Supply feature comes in three different types. Negative, positive, or Negative and Positive signal operations. The feature allows multiplexers to pass a signal above or below the supply range, or both. This feature is mainly used in audio application due to the systems requirements of passing audio signals exceeding the power supply of that said system. Multiplexers with such a feature also usually have powered off protection such as the TMUX1574 and the TMUX4827. Additionally, having low internal resistance is crucial to maintain signal integrity, which the TS5A22364 and the TMXU4827 have.

Table 3-1. Recommended Devices for Beyond the Supply

Device	Channel and Configuration	Operating Voltage and Supply	On Resistance	Negative Beyond the Supply	Positive Beyond the Supply	Negative and Positive Beyond the Supply
TMUX4827	2:1 2-channel	1.8Vto 5.5V ±12V I/O	0.12Ω			✓
TMUX2889	2:1 2-channel	1.8Vto 5.5V ±5.5V I/O	0.16Ω	✓		
TMUX1574	2:1 4-channel	1.5Vto 5.5V VDD x 2 I/O	2Ω		✓	
TS5A22364	2:1 2-channel	2.3V to 5.5V VDD - 5.5V I/O	0.52Ω	✓		

4 References

- Texas Instruments, [Multiplexers and Signal Switches Glossary](#) application note.
- Texas Instruments, [Selecting the Correct Texas Instruments Signal Switch](#) application note.

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