Application Report
SCDA014–March 2016

Detecting Selfie Sticks Using TI Audio Jack Switches TS3A227E and TS3A225E

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ABSTRACT

Selfie sticks are becoming as common of a smart phone accessory as a pair of headphones. Because of the selfie stick's increasing popularity, smart phone manufacturers need to be able to accommodate the accessory. This report describes the procedure required for a smart phone to detect when a selfie stick accessory is inserted into a smart phone's audio jack receptacle using TI audio jack switches TS3A227E and TS3A225E. It shows how these devices respond to common selfie-stick implementations and how to adjust the audio jack switch's register settings to accommodate both traditional audio accessories as well as the new selfie stick accessory.

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1 Selfie Stick Schematic Overview

Smart phones must know when a user presses a button on the selfie stick to take a picture. The early selfie stick implementation for communicating this button press was using the Bluetooth® capability of the smart phone. This was a functional solution but it required the selfie stick to include the necessary hardware to communicate through Bluetooth as well as include a rechargeable battery. Selfie stick manufacturers have implemented a simpler solution leveraging the smart phone's audio jack.

The selfie stick communicates a button press to take a picture in a similar way a headphone accessory communicates a button press to adjust the volume. The selfie stick implements this button press by placing a mechanical switch between the mic and ground lines of the audio jack. When the user presses the selfie stick button to take a picture, the smart phone must recognize the change in resistance between Ring 2 and Sleeve of a 4-pole audio jack plug.

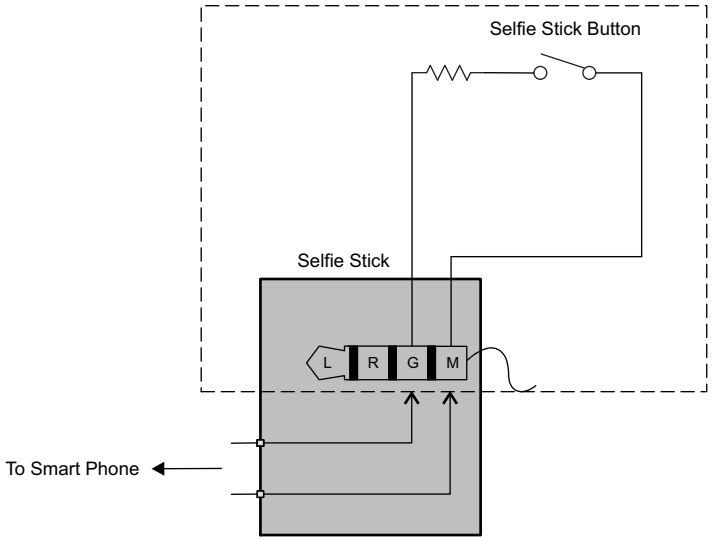

Figure 1. Typical Selfie Stick Schematic

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2 TS3A227E and TS3A225E Selfie Stick and Accessory Detection Overview

TI's audio jack switches require a closed path between the Tip and Ring2 and the Tip and Sleeve to accurately detect accessories. Selfie stick's schematics do not create a closed circuit from the Tip to Ring2 or Sleeve like a pair of headphones which causes the TI audio jack switches to incorrectly identify a selfie stick accessory.

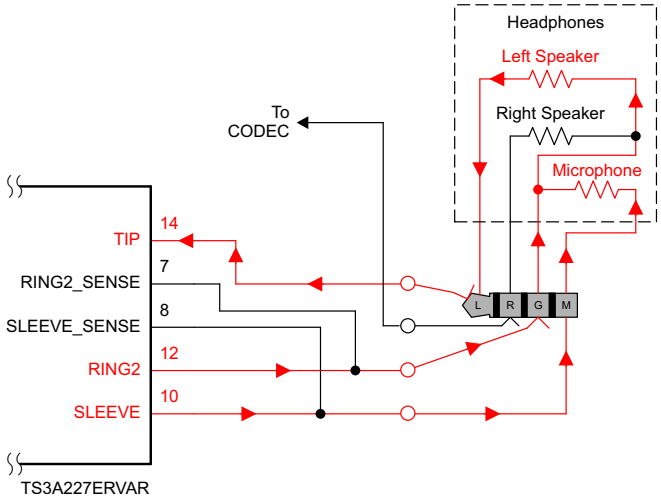

Figure 2. TS3A227E Application Circuit With Closed Circuit From Ring2 To Tip Made With Headphone Accessory

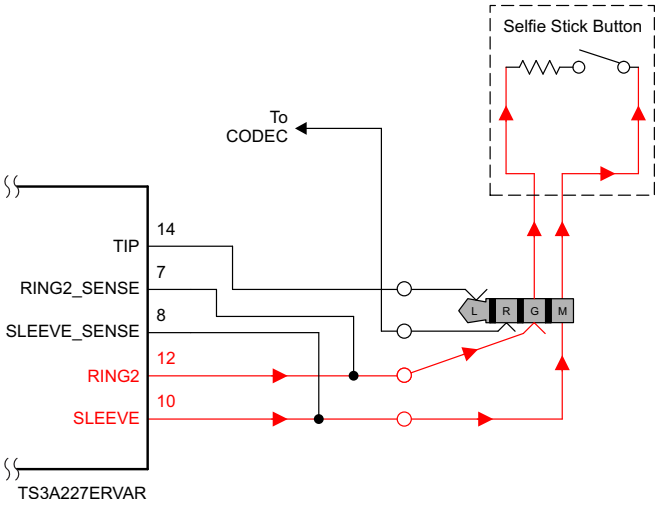

Figure 3. TS3A227E Application Circuit With Open Circuit From Ring2 To Tip Schematic With Selfie Stick Inserted

Figure 3 shows that a selfie stick does not create closed circuit from the Tip to Ring2 or from to Tip to Sleeve when inserted into the audio jack receptical. Since there is no closed path from the Ring2/Sleeve pin to the Tip pin, TI's audio jack switches will detect the selfie stick as a 3-pole device instead of a 4-pole device. The audio jack switch then automatically configures the internal switch network to support a 3-pole device which will not support a selfie stick.Figure 4 shows that the TS3A227E 3-pole configuration shorts out the selfie stick button so the smart phone cannot detect the resistance change when a user presses the selfie stick button.

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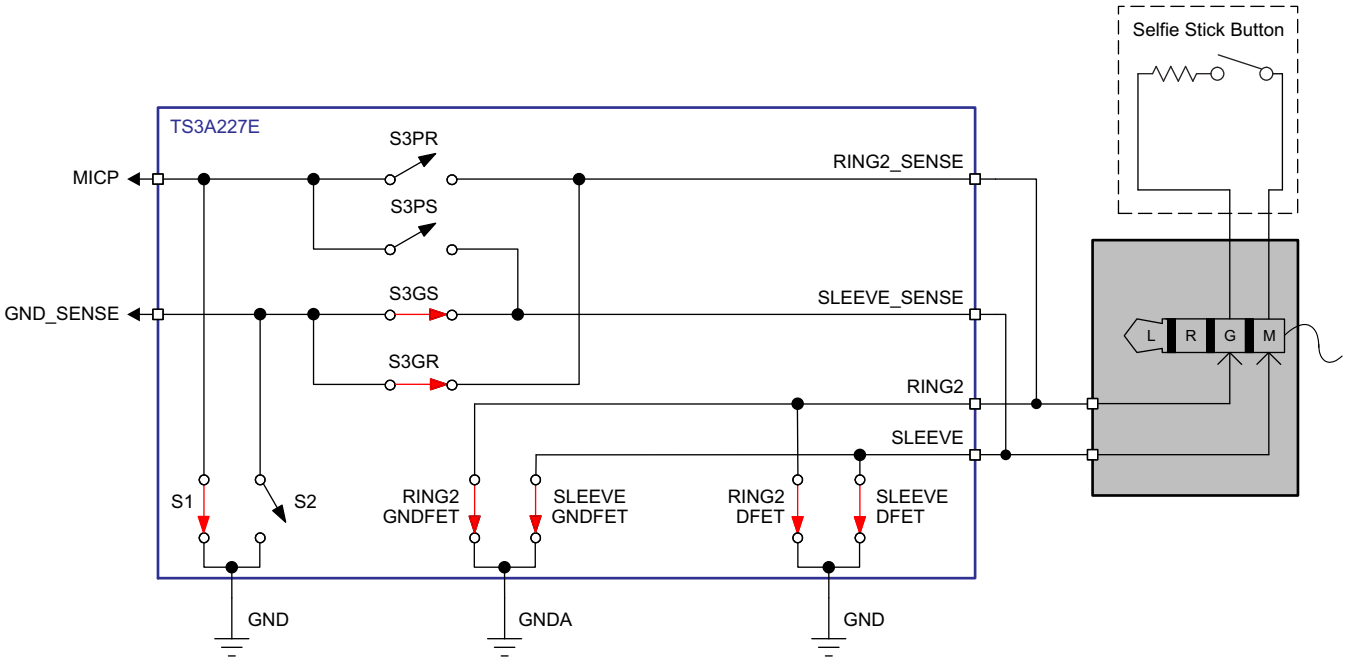

Figure 4. TS3A227E Switch State After Manually Configuring Internal Switch Network to Support Selfie Stick

The internal audio jack switch network must be configured to support a 4-pole device in order for the smart phone to be able to detect the change in resistance from a user pressing the selfie stick button. Figure 5 shows that with the switch network configured to support a 4-pole device, thecircuit allows a smart phone to detect a change in resistance when a selfie stick button is pressed.

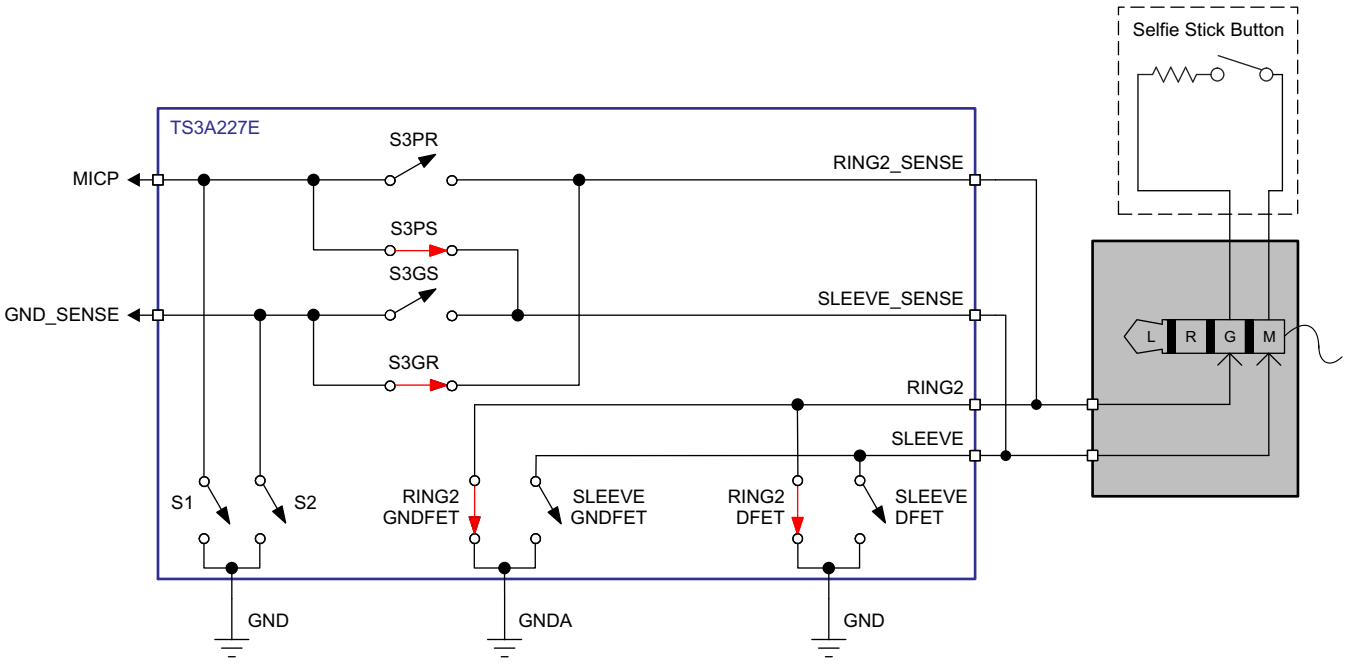

Figure 5. TS3A227E Switch State After Detecting a 4-Pole OMTP Headset

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3 How to Support a Selfie Stick Using TI's Audio Jack Switches

3.1 Selfie Stick Detection and Configuration Flow

Both the TS3A227E and TS3A225E audio jack switches can support selfie sticks because they have an additional feature to allow manual switch control using an I2C interface. The manual switch control is required to reset the internal switch network to support the 4-pole selfie stick circuit after the audio jack switch automatically detects and configures itself to support a 3-pole configuration.

Figure 6 shows the logic flow of when to manually control the TS3A227E or TS3A225E internal switch network to correctly support a selfie stick. See Section 3.3.3 for example pseudo-code of this operation.

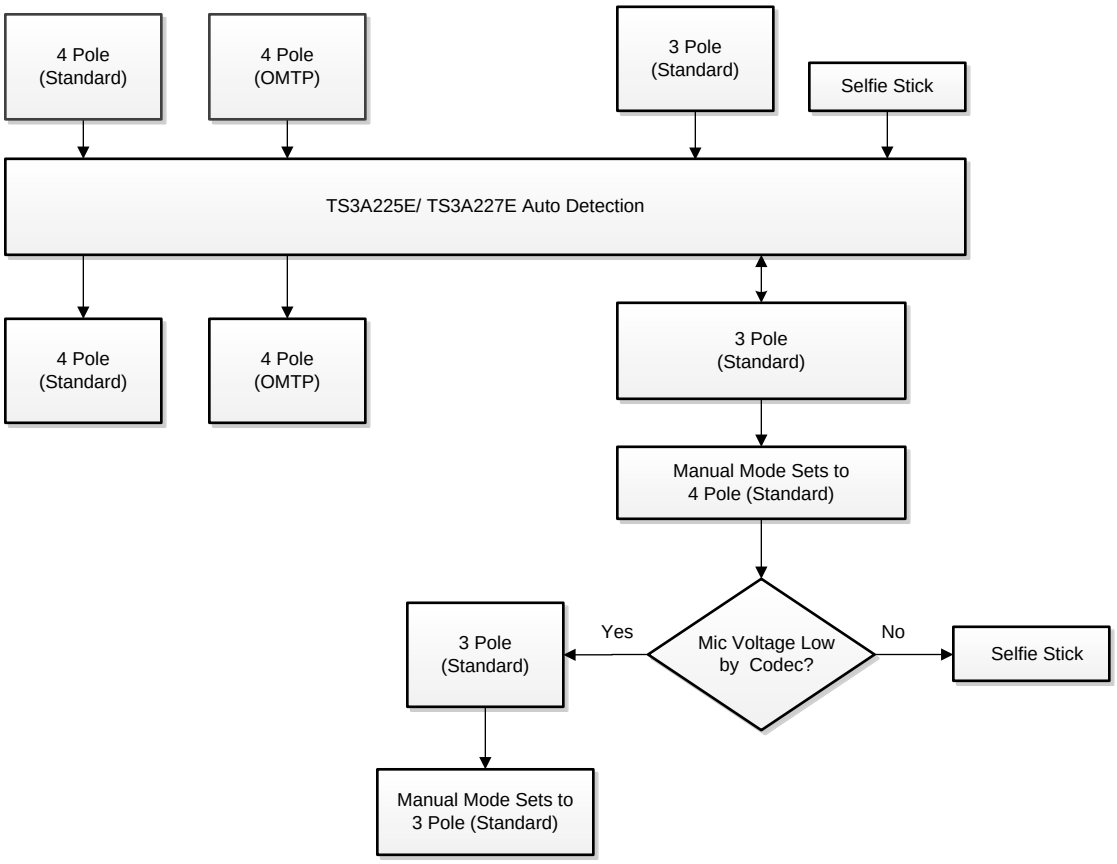

Figure 6. Selfie Stick Usage Logic Flow

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3.2 Manually Switching Audio Jack Switches

Manual switching of the TS3A227E and TS3A225E audio jack switches is accomplished by writing I2C commands to the switch control registers. For more information on reading and writing I2C commands, see I2C communication application report (SLVA704).

To manually control the internal switch network of the TS3A227E or TS3A225E, refer to the manual switch control procedures in the datasheets.

After the TS3A227E has completed the auto-detection and results in a 3-pole configuration, the switch control registers and switch status registers read as shown in the following table:

Addr (xxh)	Name	Type	Reset	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
07h	Switch Control 1	R/W	00h	Reserved		SLEEVE GNDFET (1)	RING2 GNDFET (1)	SLEEVE DFET (1)	RING2 DFET (1)	Switch 2 (0)	Switch 1 (0)
08h	Switch Control 2	R/W	00h	Reserved				S3PS (0)	S3PR (0)	S3GS (1)	S3GR (1)
09h	Switch Status 1	R	0Ch	Reserved		SLEEVE GNDFET (1)	RING2 GNDFET (1)	SLEEVE DFET (1)	RING2 DFET (1)	Switch 2 (0)	Switch 1 (0)
0Ah	Switch Status 2	R	00h	Reserved				S3PS (0)	S3PR (0)	S3GS (1)	S3GR (1)

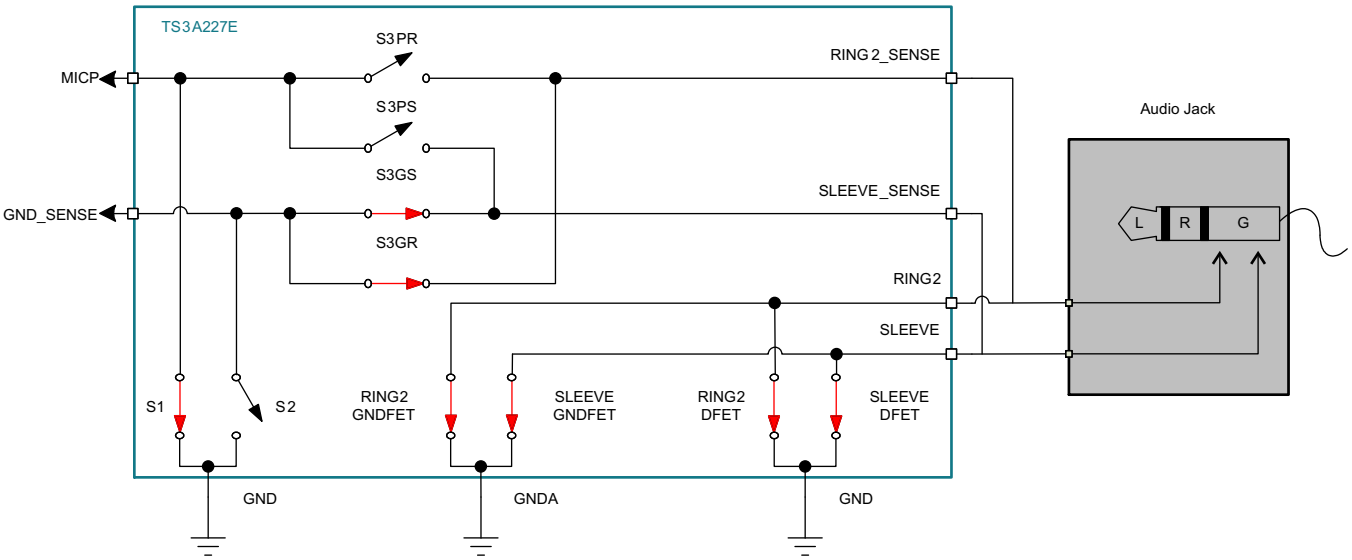

Figure 7. TS3A227E Switch State After Detecting a 3-Pole Headphone

Manually switch the TS3A227E audio jack switch from a 3-pole configuration to a 4-pole configuration by setting the switch control 1 and 2 registers to the desired configuration.

Addr (xxh)	Name	Type	Reset	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
07h	Switch Control 1	R/W	00h	Reserved		SLEEVE GNDFET (0)	RING2 GNDFET (1)	SLEEVE DFET (0)	RING2 DFET (1)	Switch 2 (0)	Switch 1 (0)
08h	Switch Control 2	R/W	00h	Reserved				S3PS (1)	S3PR (0)	S3GS (0)	S3GR (1)
09h	Switch Status 1	R	0Ch	Reserved		SLEEVE GNDFET (0)	RING2 GNDFET (1)	SLEEVE DFET (0)	RING2 DFET (1)	Switch 2 (0)	Switch 1 (0)
0Ah	Switch Status 2	R	00h	Reserved				S3PS (1)	S3PR (0)	S3GS (0)	S3GR (1)

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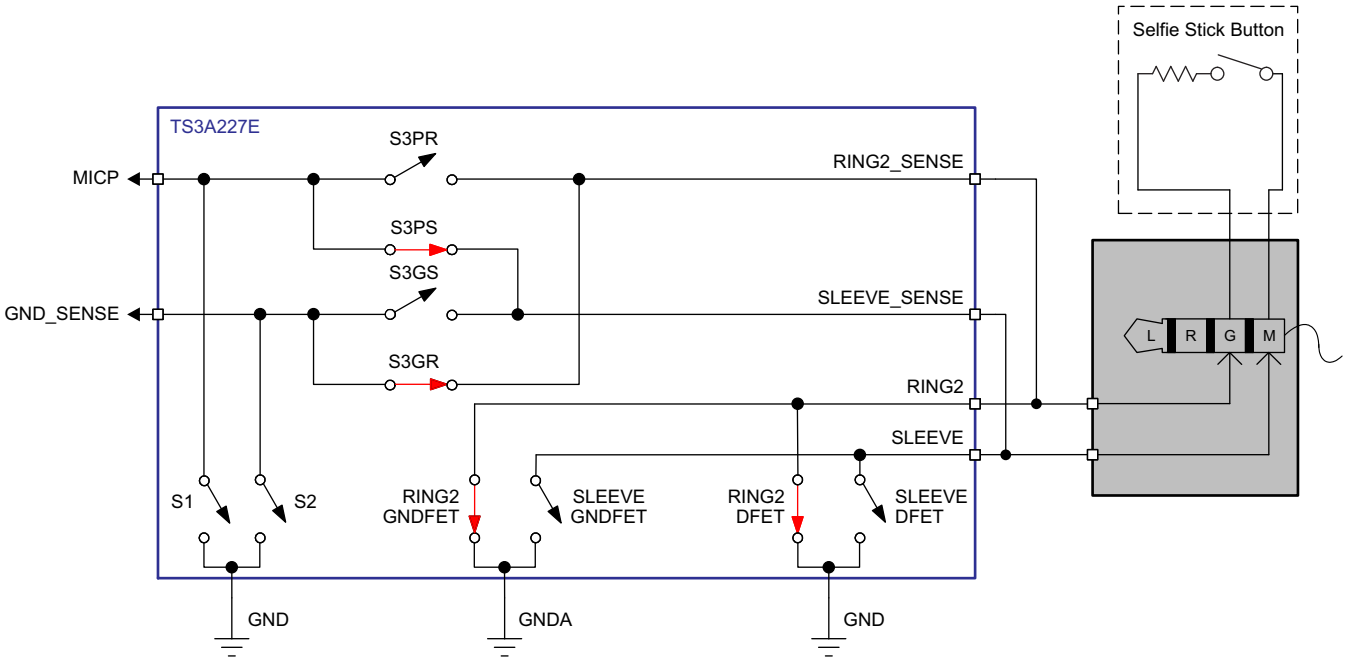

Figure 8. TS3A227E Switch State After Manually Configuring Internal Switch Network to Support Selfie Stick

3.3 Microphone Bias Voltage Detection

3.3.1 Why do I Need to Detect the Microphone Bias Voltage?

After the audio jack switch is manually switched from a 3-pole to a 4-pole configuration, the microphone bias voltage must be detected to know if a selfie stick has been inserted into the audio jack or a standard 3-pole audio accessory. The microphone bias voltage can be detected in two different ways. One way is to use the smart phone codec to detect the voltage level of the microphone bias voltage. The other way is to use the key press detection feature of the TS3A227E.

If there is a selfie stick inserted into the audio jack receptacle, the mic bias voltage is high and no further manual manipulation of the internal switch network is needed.

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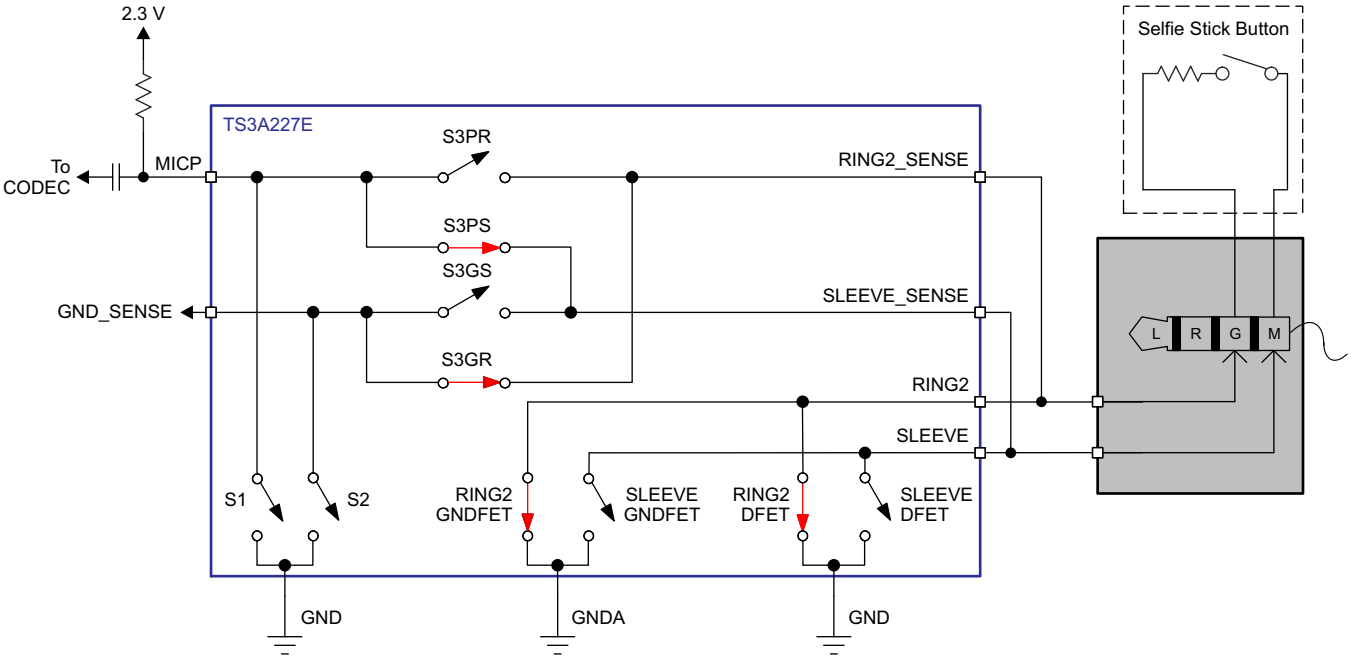

Figure 9. Microphone Bias is High With Selfie Stick Inserted Into the Audio Jack Receptacle

If there is a 3-pole audio accessory inserted into the audio jack receptacle, the mic bias is pulled low by the RING2 GNDFET and RING2 DFET because of the manual configuration of the TS3A227E switch network to support a 4-pole device.

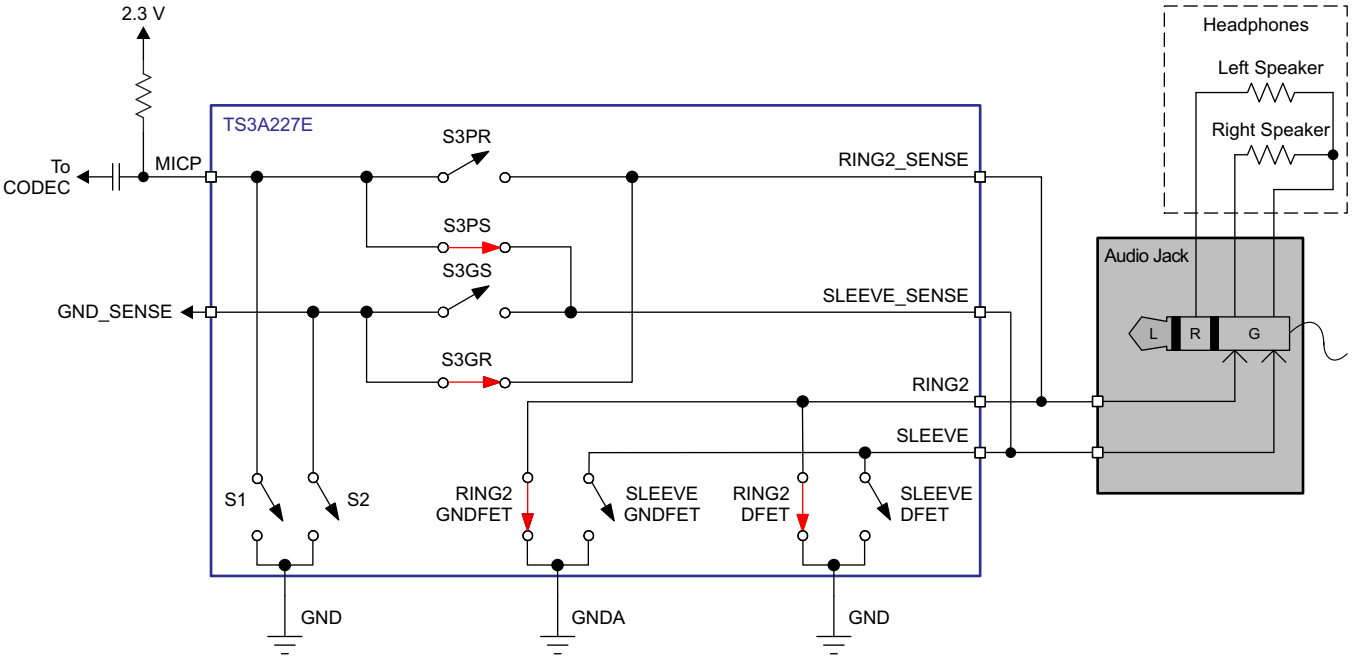

Figure 10. Microphone Bias is Low With 3-pole Headphones Inserted Into the Audio Jack Receptacle

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3.3.2 What if my Audio Codec Cannot Determine the Microphone Bias Level?

Many codecs have the ability to detect the microphone bias voltage level to determine if it is high or low. If your system codec does not have that capability, turn on the *Key Press Detection* of the TS3A227E to determine if the microphone bias voltage is high or low. The TS3A227E key press detection feature can measure the voltage on SLEEVE/RING2 that is created by the divider network between the microphone bias output of the codec and the system ground. See the TS3A227E datasheet (SCDS358) for more information on using the TS3A227E key press detection feature.

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3.3.3 Example Pseduo Code using the TS3A227E

```
registerValue = readRegister(0x01);
if (registerValue & 0x01) { // Bitwise AND for bit 0 (Ins/Rem Event) in Interrupt Register is set to 1
     registerValue = readRegister(0x0B); // After an Ins/Rem Event read the Accessory Status register
     if (registerValue & 0x01) { // Bitwise AND for bit 0 (3-pole) in Accessory Status Register is set to 1
               // If Accessory Status is 3-pole, manually switch the device into a 4-pole configuration
               writeDataToRegister(0x14, 0x07); // Write 0x14 to register 0x07 (Switch Control 1)
               writeDataToRegister(0x03, 0x08); // Write 0x03 to register 0x08 (Switch Control 2)
               registerValue = readRegister(0x02); // Reading the Key Press Interrupt register to determine if the mic bias voltage is
pulled low because a 3-pole device has been inserted into the audio jack.
               if (registerValue & 0x01) { // Bitwise AND for bit 0 (Key Press 1) in Key Press Interrupts Register is set to 1
                         // If the Key Press interrupt register shows there has been a key press then the mic bias voltage was pulled
low by the 3-pole accessory
                         //Manually switch the audio jack internal switches to support a 3-pole accessory
                         writeDataToRegister(0x3C, 0x07);
                         writeDataToRegister(0x03, 0x08);
               } else {
                         // Do nothing because it is a selfie stick
                         // If the Key press interrupt register does not show a key press then detection is complete and a selfie stick
has been inserted into the audio jack
               }
     }

} else {
// If the Accessory Status is a standard 4-pole or OMTP 4-pole accessory then detection is complete
// Do nothing since accessory is a 4-pole device
}
```

4 Conclusion

Selfie sticks are a popular smart phone accessory being inserted into the 3.5-mm audio jack receptacle. Smart phones now need the ability to support and detect the difference between selfie sticks, 3-pole, standard 4-pole, and OMTP 4-pole audio accessories. TI's TS3A227E and TS3A225E audio jack switches provide cell phones with the ability to detect and support all of these different accessories. They can support these devices because of their added manual switching control feature using the I2C protocol. With some simple I2C read and writes and a little bit of logic, the TI audio jack provides the smart phone with the intelligence it needs to support the popular selfie sticks as well as traditional audio accessories.

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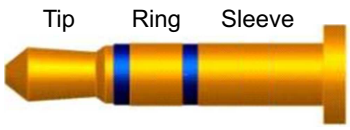
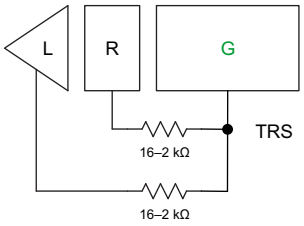
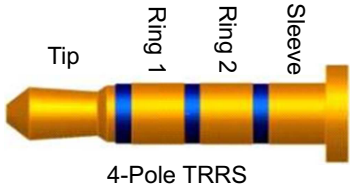
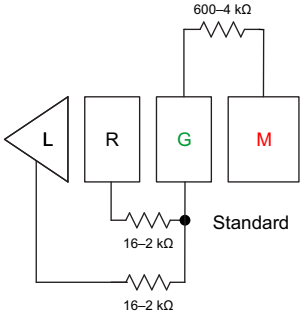
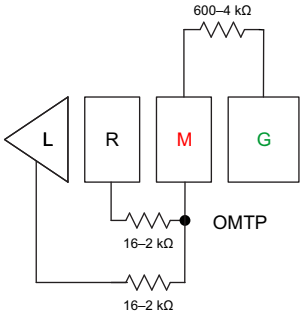
A.1 Audio Jack Plug Configurations

There are different audio jack plug configurations for audio headsets, ones with microphones (4-pole) and ones without microphones (3-pole). There are also two different 4-pole configurations, standard and OMTP where the microphone may be either on the Ring 2 or Sleeve of the audio jack plug. Many codecs require system designers to make a tough decision via a hardware connection which configuration they support. This is done by directly connecting the microphone bias and the ground connections to the Sleeve and Ring 2 pins of the audio jack. Hardwiring the microphone bias directly to the audio jack in the standard configuration leaves the OMTP configuration unsupported and hardwiring the microphone bias directly to the audio jack in the OMTP configuration leaves the standard configuration unsupported.

Table 1. Audio Jack Plug Configurations

Physical Connector	Internal Impedance Network	Pin Name	Configuration
 3-Pole TRS		**Tip**	Audio Left
		Ring	Audio Right
		Sleeve	Ground
 4-Pole TRRS		**Tip**	Audio Left
		Ring1	Audio Right
		Ring2	Ground
		Sleeve	Microphone
		**Tip**	Audio Left
		Ring1	Audio Right
		Ring2	Microphone
		Sleeve	Ground

TI's audio jack switches allow hardware designers to support the multiple audio jack plug configurations by detecting the presence and location of the microphone and routing the microphone bias and ground lines appropriately. This allows smart phones to support all audio jack plug configurations.

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A.2 TI's Audio Jack Switches Automatic Accessory Detection and Configuration

TI's audio jack switches include the TS3A225E, TS3A226AE, and TS3A227E. The audio jack switches can differentiate between the 3-pole, standard 4-pole, and OMTP 4-pole configurations by leveraging the closed circuit path between the Tip and Ring 2 and the Tip and Sleeve that is created when an audio jack plug is inserted into the audio jack receptacle.

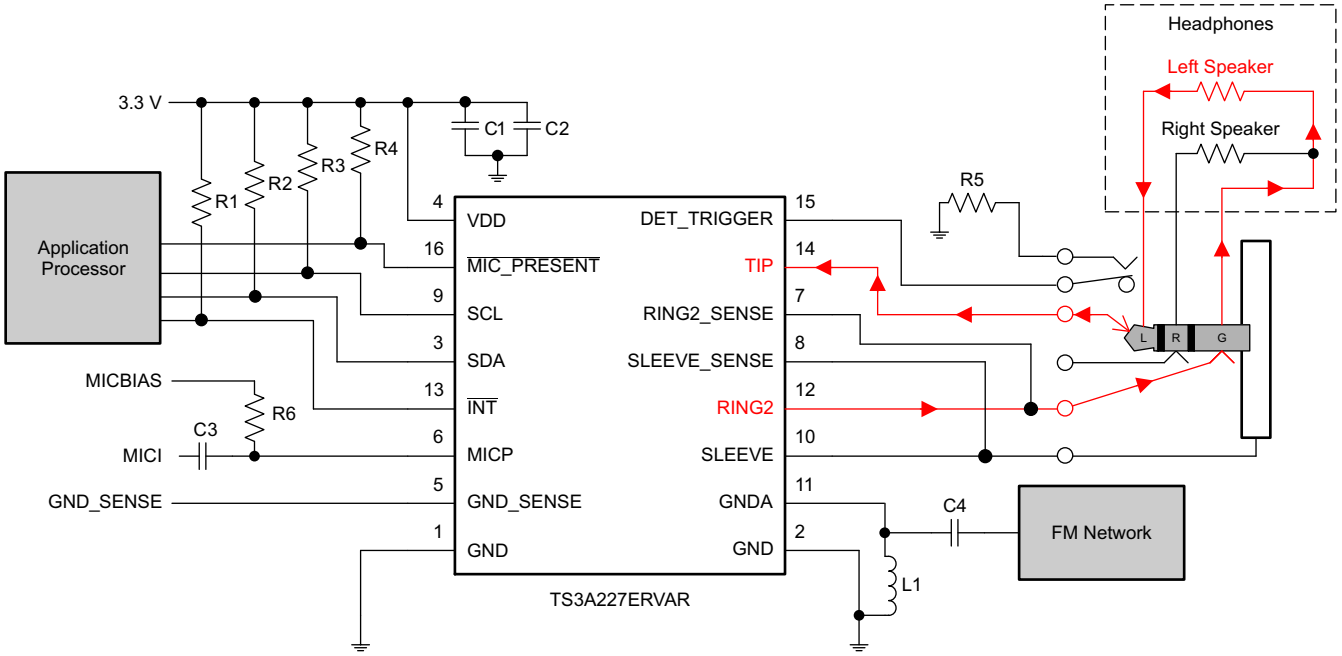

Figure 11. Typical Application Schematic With Headphone Accessory

Once an accessory is inserted closing the path between the Tip and Ring2 or Sleeve, the audio jack switches automatically manipulate their internal switching network to route the microphone and ground signals appropriately. Figure 12 – Figure 15 show examples of the TS3A227E switch network status with and without different accessories inserted into the audio jack receptacle.

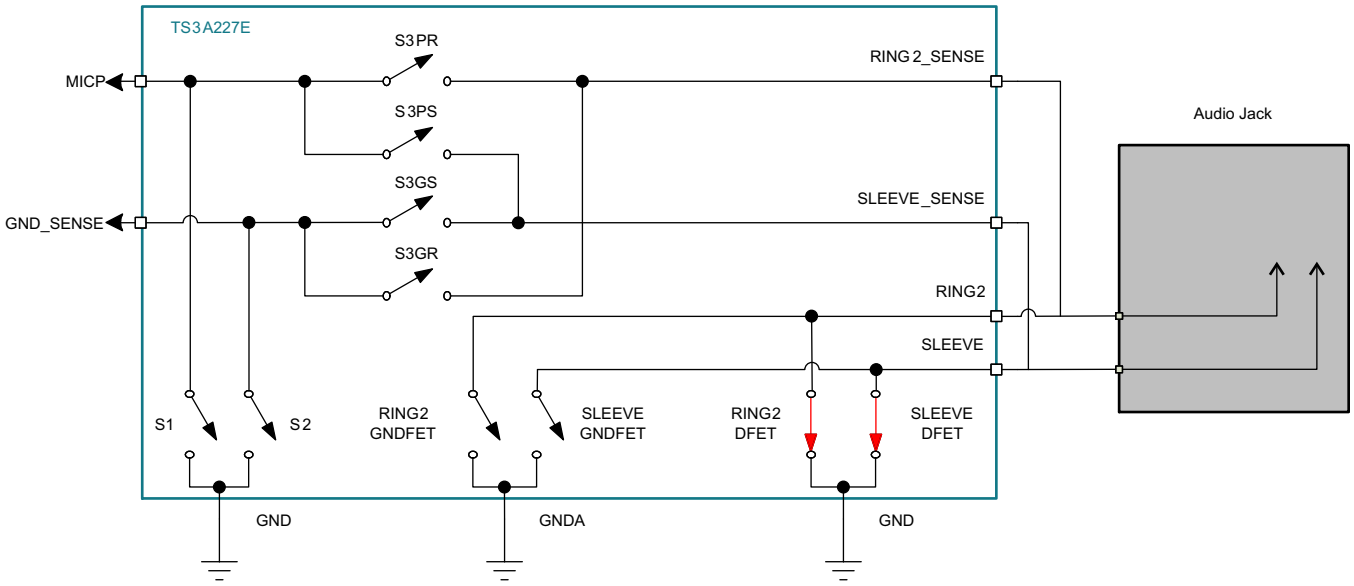

Figure 12. TS3A227E Default Switch State With no Accessory Inserted

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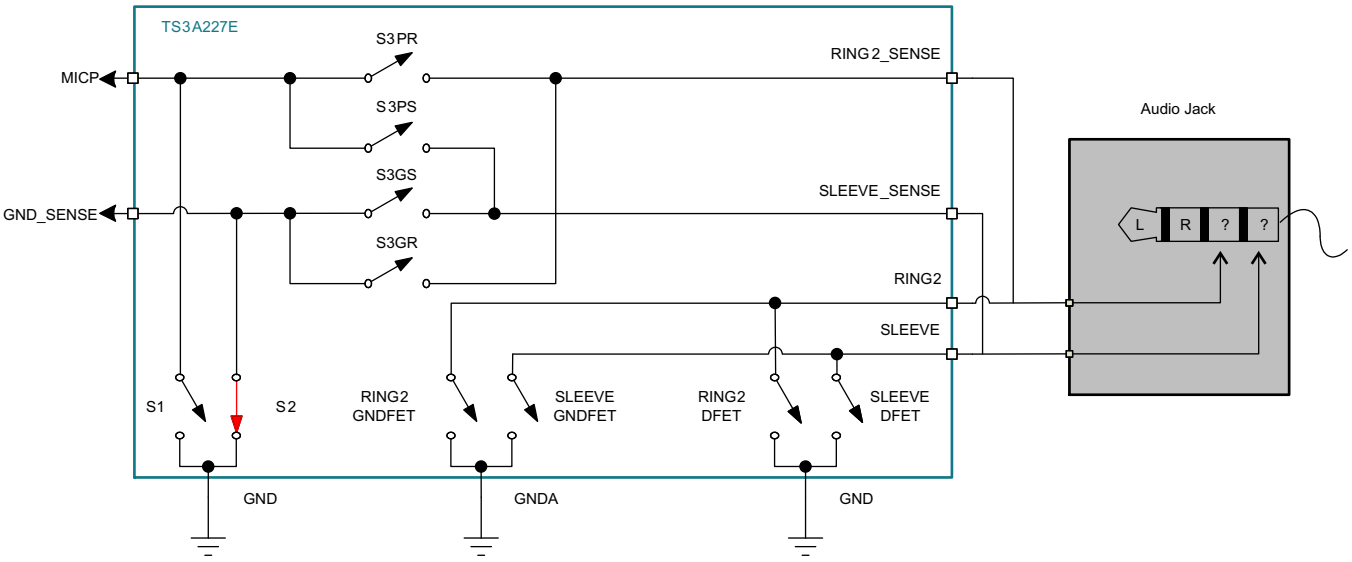

Figure 13. TS3A227E Switch State During Detection

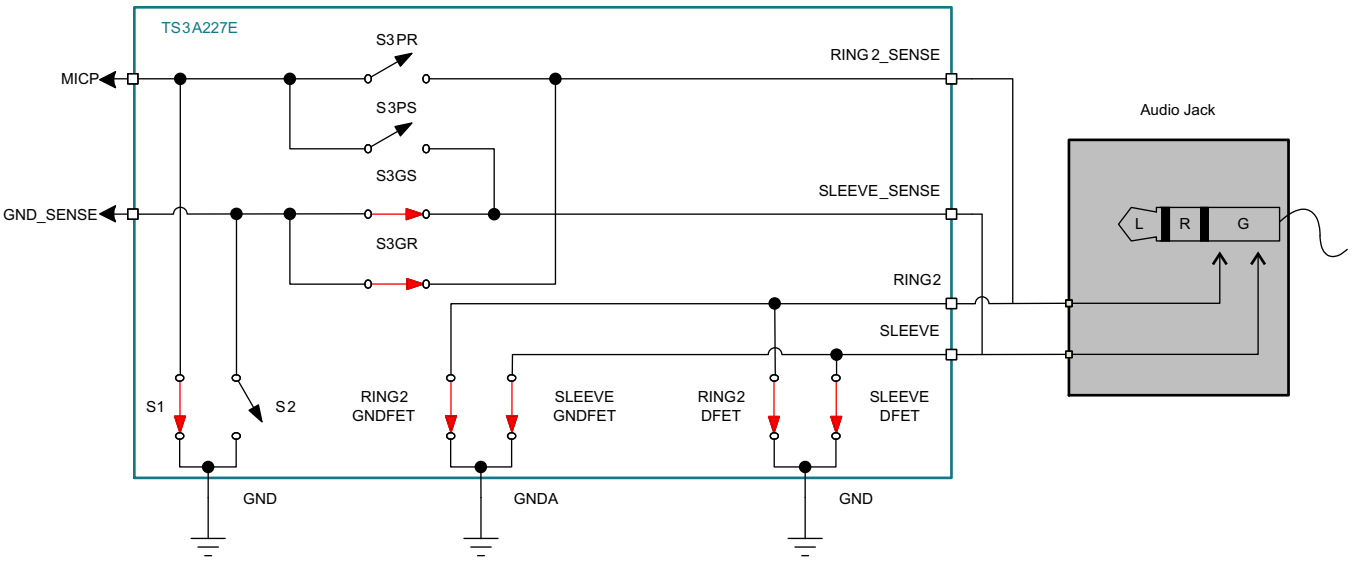

Figure 14. TS3A227E Switch State After Detecting a 3-Pole Headphone

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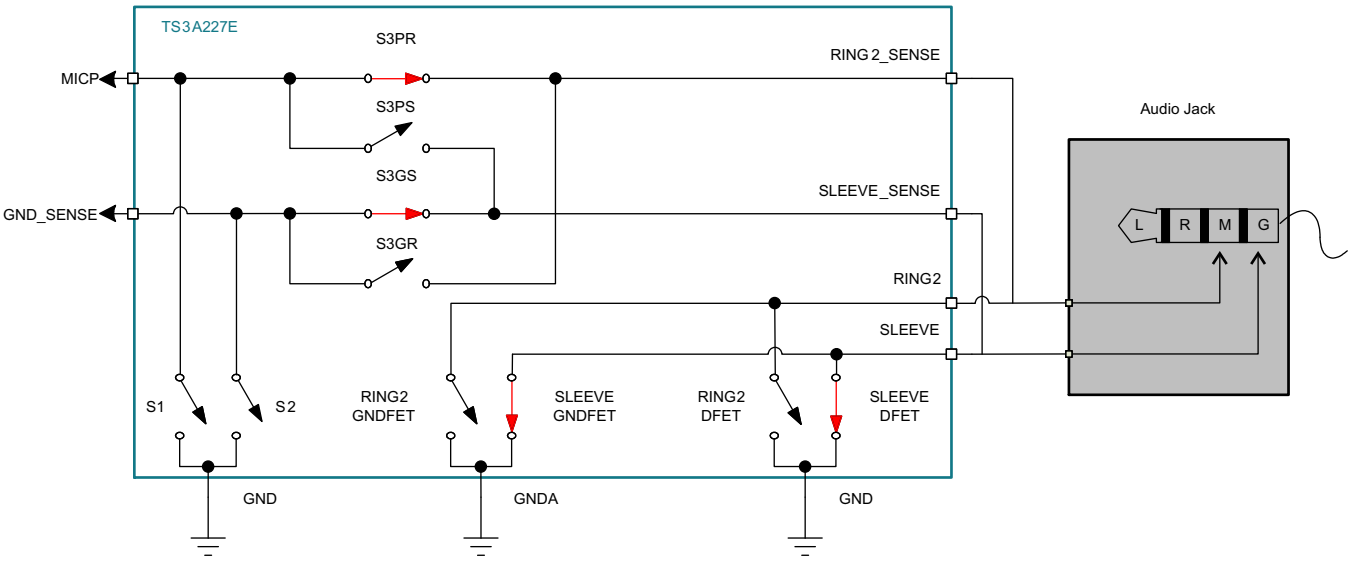

Figure 15. TS3A227E Switch State After Detecting a 4-Pole OMTP Headset

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