Application Report
SLAA454–June 2010

Headset Detection for TLV320AIC33 and TLV320AIC3101/4/5/6 Family

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Audio Converters

ABSTRACT

A common feature in most of today's electronic devices – including cell phone, PDAs, notebooks, handheld media players, game systems, etc. – is the provision for connecting to external accessories. The devices therefore include dedicated logic circuitry that can detect not only the presence of an accessory, but also its type.

The TLV320AIC33 and TLV320AIC3101/4/5/6 family includes extensive capability to monitor a headphone, microphone (mic), or headset jack, determine if an audio plug has been inserted, and then detect what type of headset is wired to the plug. This application report mainly discusses the headset detection scheme for two different headset output configurations: pseudo-differential (capacitor-less) output, and ac-coupled output. The content of this document applies to the TLV320AIC33 and TLV320AIC3101/4/5/6 family.

Contents

List of Figures

1 Headset Plugs/Connection Diagrams

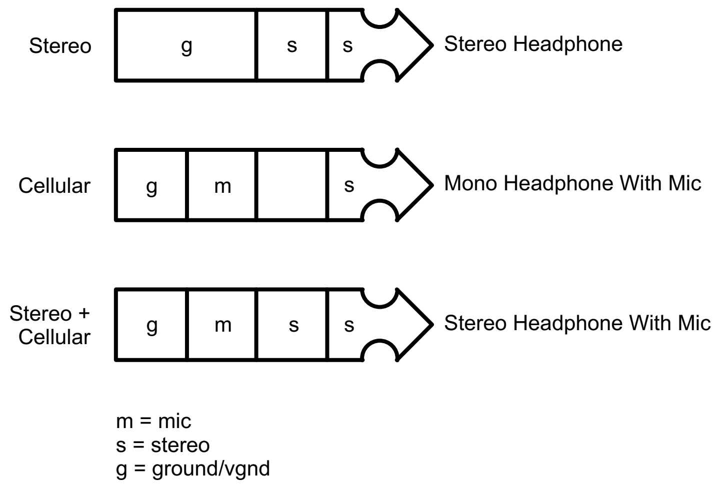


Figure 1. Different Configurations of 4-Conductor Headset Plug

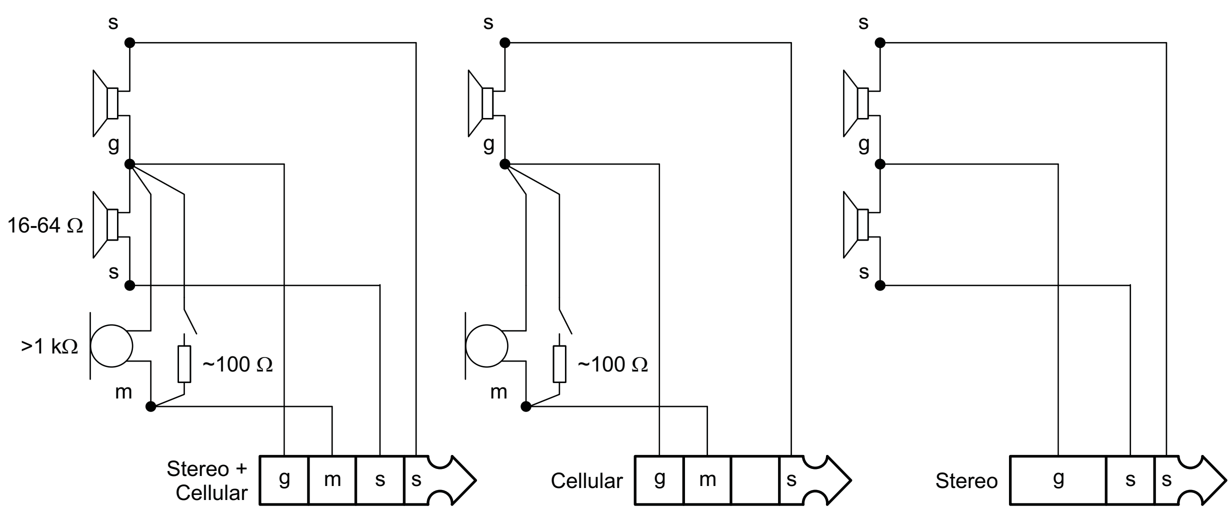


Figure 2. Connection Diagrams for Various Headsets

1.1 *Part I: Pseudo-Differential (Capacitor-less) Headset Output Configuration*

Figure 3 shows one configuration of the device that enables detection and determination of headset type when a pseudo-differential (capacitor-less) stereo headphone output connection is used. Note that for best results, it is recommended to select a MICBIAS value as high as possible, and to program the output driver common-mode level at a 1.35-V or 1.5-V level.

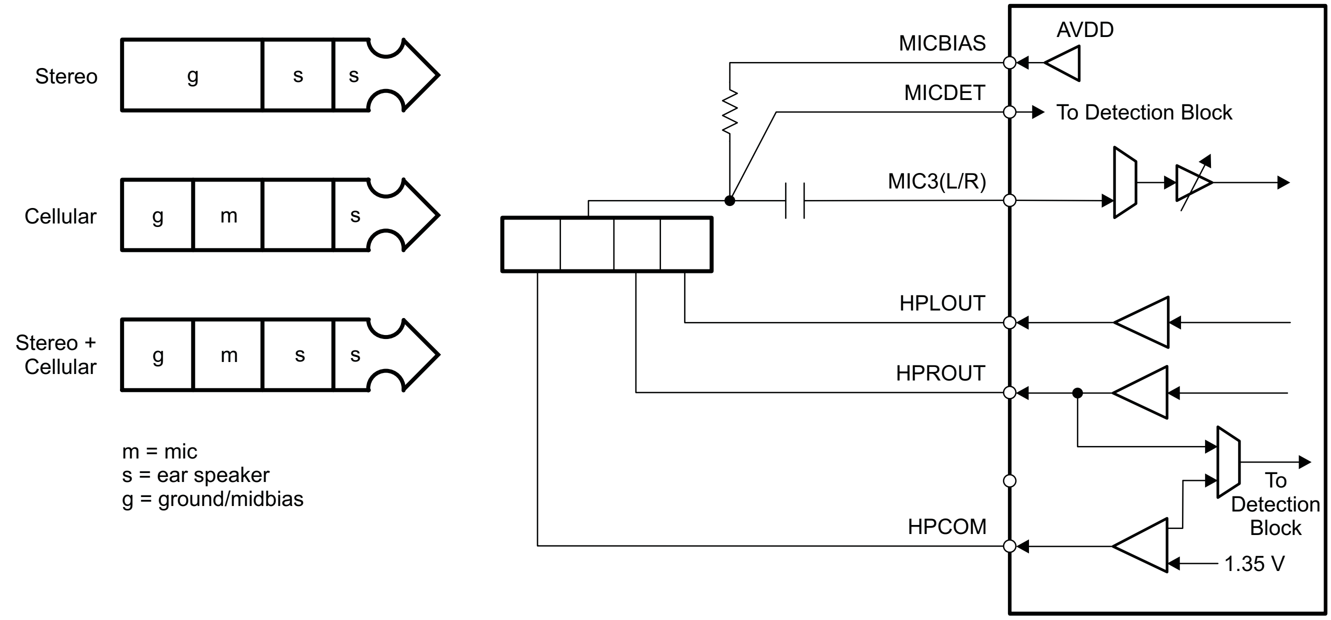


Figure 3. Device with a Pseudo-Differential (Capacitor-less) Headset Output Connection

Figure 4 demonstrates the internal circuitry that implements the detection logic. The detection block circled in red consists of three main components – comparator A, B, and C.

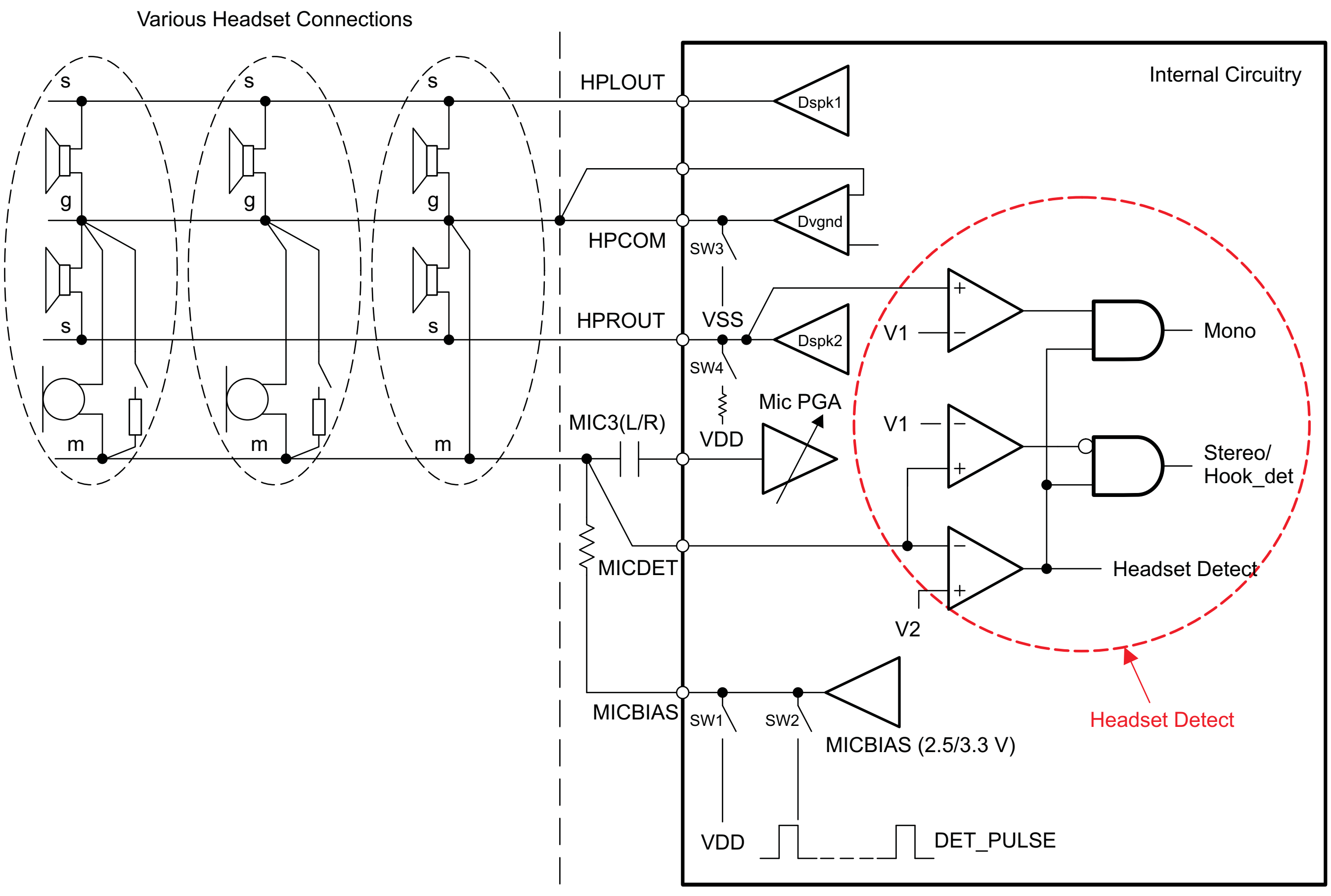


Figure 4. Circuit Diagram of Detection Scheme for Capacitor-less Interface

1.1.1 Detection Block, Capacitor-less Interface

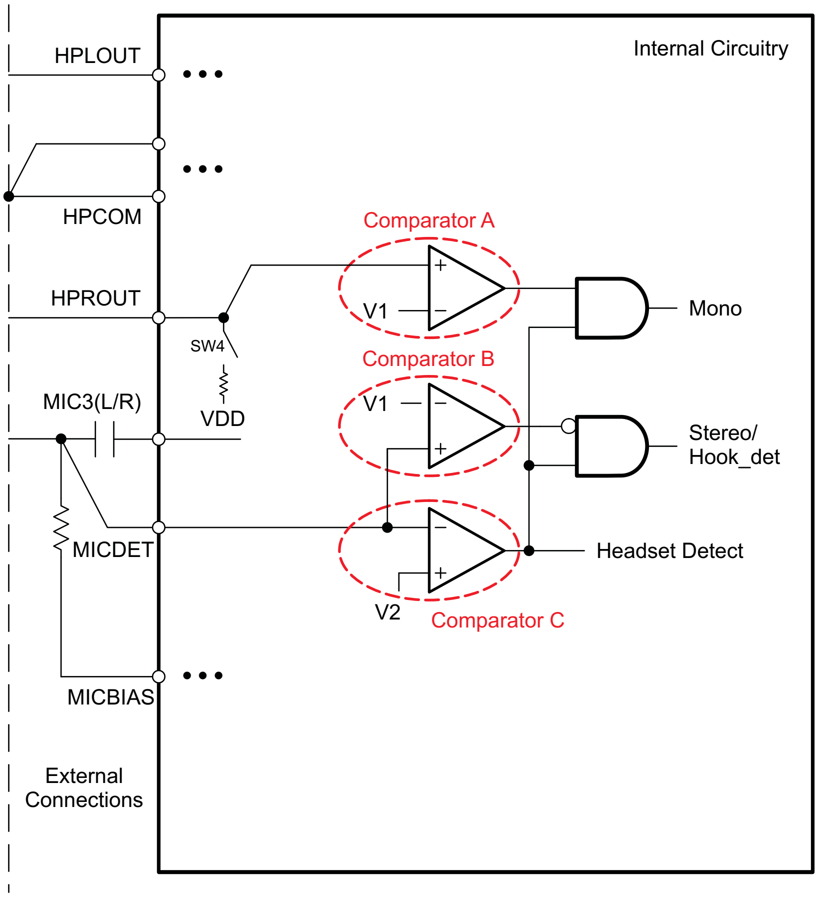


Figure 5. Detection Block for Pseudo-Differential (Capacitor-less) Interface

Comparator C is used to detect headset insertion and removal. Headset insertion and removal detection is always active inside device.

MICDET < V2	Insertion detected
MICDET > V2	No insertion

Comparator B is used to detect the type of headset inserted. Headset type detection becomes active only when the headset is inserted and detected.

MICDET > V1	Headset with mic
MICDET < V1	Headset without mic

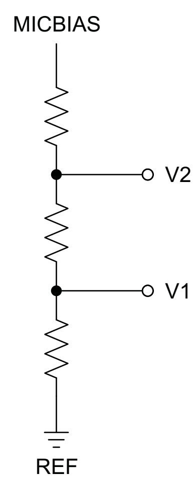
Comparator B is also used to detect hook button press. However, button press detection becomes active only when headset with mic is detected.

Given headset with mic is already detected:	
MICDET > V1	No button press
MICDET < V1	Button press detected

Comparator A is used to differentiate mono headset with mic from stereo headset with mic.

HPROUT > V1	Mono headset with mic
HPROUT < V1	Stereo headset with mic

1.1.2 How to Determine the Comparator Threshold V1 and V2 (Capacitor-less Interface)



$$V1 = (MICBIAS - ref) \times \frac{3}{46} + ref$$

$$V2 = (MICBIAS - ref) \times \frac{43}{46} + ref$$

ref = HPCOM

MICBIAS varies with detection mode

1.1.3 How Does the Bias Voltage Vary With Detection Mode?

If MICBIAS is turned off or if headset insertion is not detected, then MICBIAS = DVDD

If MICBIAS is turned on and if headset insertion is detected, then MICBIA= Mic_bias

1.1.4 Detection Sequence – Capacitor-less Interface

- Enable headset detection scheme (Page 0, Reg 13, D7) and set Capacitor-less interface (Page 0, Reg 14, D7 = 0)
- Detect insertion (with headset detection scheme enabled, headset insertion detection is always active inside device)

  Insertion detected:

  $$\text{MICDET} < (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = (\text{DVDD} - \text{ref}) \times \frac{43}{46} + \text{ref}$$

  No Insertion:

  $$\text{MICDET} > (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = (\text{DVDD} - \text{ref}) \times \frac{43}{46} + \text{ref}$$

- Headset type detection (ONLY active when headset is inserted and detected)

  Headset with mic:

  $$\text{MICDET} > (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{3}{46} + \text{ref}$$

  Headset without mic:

  $$\text{MICDET} < (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{3}{46} + \text{ref}$$

- Button press detection (button press detection becomes active ONLY when headset with mic is detected)

  No button push:

  $$\text{MICDET} > (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{3}{46} + \text{ref}$$

  Button push detected:

  $$\text{MICDET} < (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{3}{46} + \text{ref}$$

- Headset removal detection (With headset detection scheme enabled, removal detection is always active inside device.)

  Headset removed:

  $$\text{MICDET} < (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{43}{46} + \text{ref}$$

  Insertion detected:

  $$\text{MICDET} > (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = (\text{Mic\_bias} - \text{ref}) \times \frac{43}{46} + \text{ref}$$

1.2 Part II: AC-Coupled Stereo Headset Output Configuration – Capacitor Interface

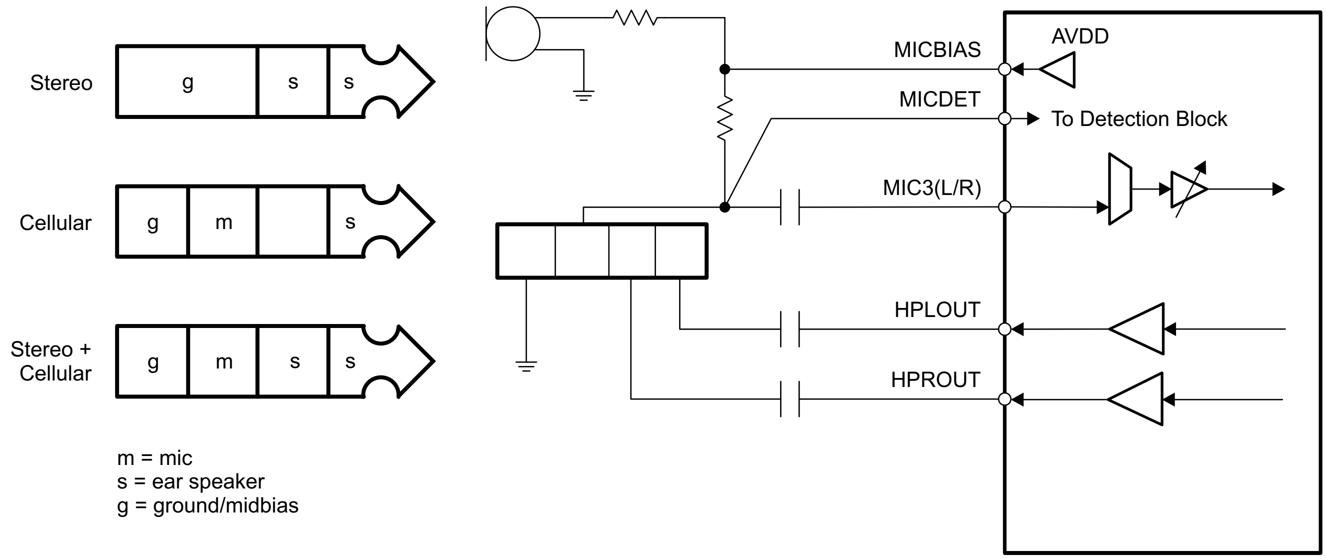


Figure 6. Device With an AC-Coupled Stereo Headset Output Connection

Figure 7 shows the detection logic implemented by the detection block circled in red. The detection block consists of three main components – comparator A, B, and C.

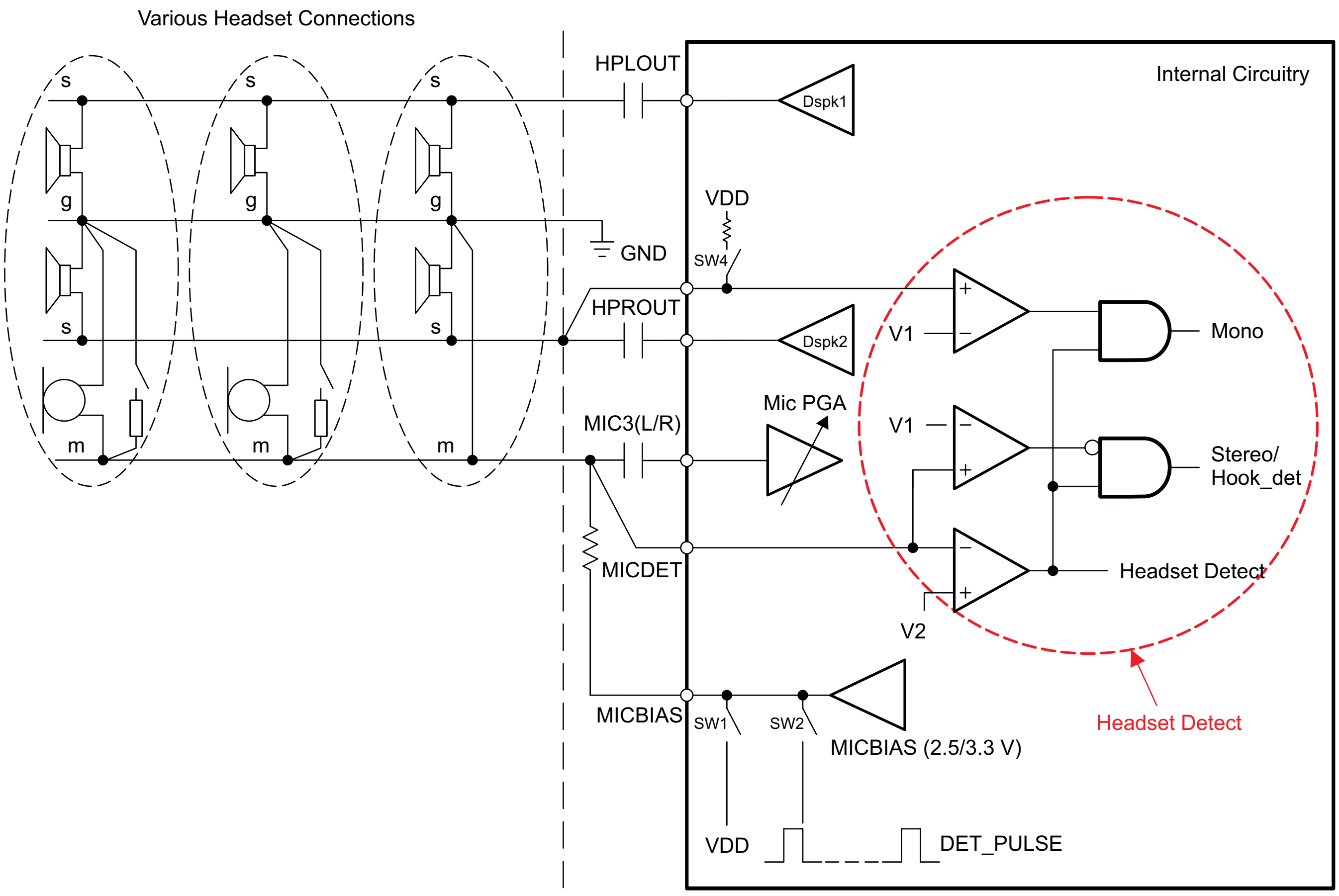


Figure 7. Circuit Diagram of Detection Scheme for Capacitor Interface

1.2.1 Detection Block – Capacitor Interface

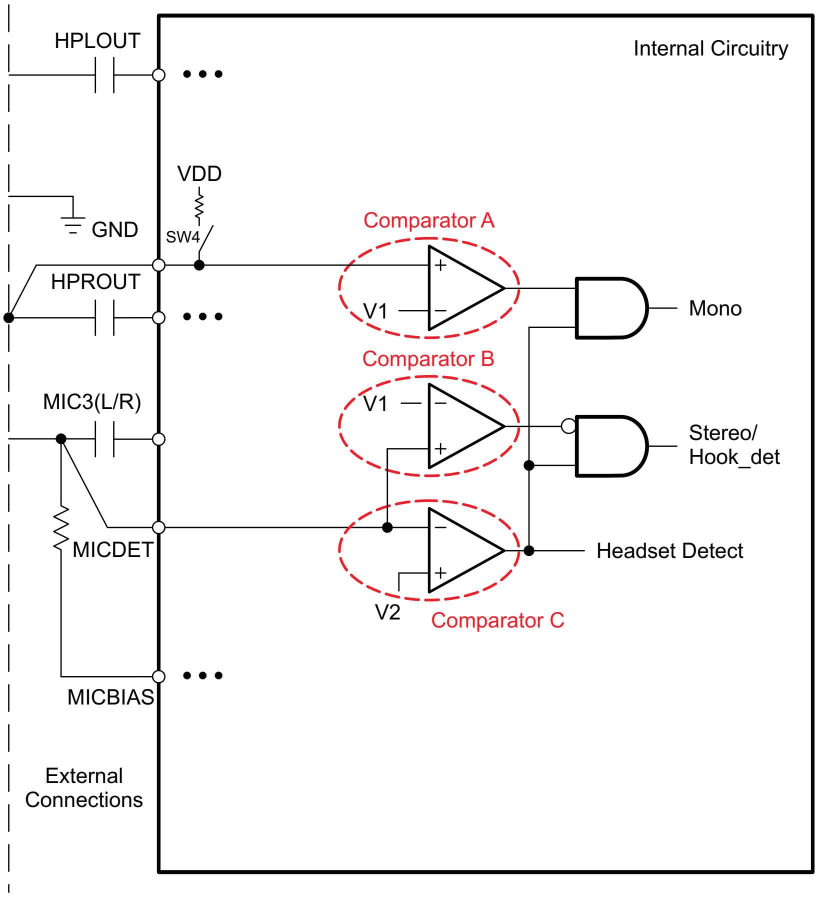


Figure 8. Detection Block for AC-Coupled (Capacitor) Interface

Comparator C is used to detect headset insertion and removal. Headset insertion and removal detection is always active inside device.

MICDET < V2	Insertion detected
MICDET > V2	No insertion

Comparator B is used to detect the type of headset inserted. Headset type detection becomes active only when the headset is inserted and detected.

MICDET > V1	Headset with mic
MICDET < V1	Headset without mic

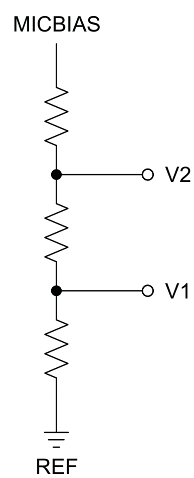
Comparator B is also used to detect hook button press. However button press detection becomes active only when headset with mic is detected.

Given headset with mic is already detected:	
MICDET > V1	No button press
MICDET < V1	Button press detected

Comparator A is used to differentiate mono headset with mic from stereo headset with mic.

HPROUT > V1	Mono headset with mic
HPROUT < V1	Stereo headset with mic

1.2.2 How to Determine the Comparator Threshold V1 and V2 – Capacitor Interface



$$V1 = (MICBIAS - ref) \times \frac{3}{46} + ref$$

$$V2 = (MICBIAS - ref) \times \frac{43}{46} + ref$$

ref = VSS = 0 V

MICBIAS varies with detection mode

1.2.3 How Does the Bias Voltage Change With Detection Mode?

If MICBIAS is turned off or if headset insertion is not detected, then MICBIAS = DVDD

If MICBIAS is turned on and if headset insertion is detected, then MICBIAS = Mic_bias

1.2.4 Detection Sequence – Capacitor Interface

- Enable headset detection scheme (Page 0, Reg 13, D7) and set AC-coupled interface (page 0, Reg 14, D7 = 1)
- Detect insertion (With headset detection scheme enabled, headset insertion detection is always active inside device.)

  Insertion detected:

  $$\text{MICBIAS} < (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = \text{DVDD} \times \frac{43}{46}$$

  No insertion:

  $$\text{MICBIAS} > (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = \text{DVDD} \times \frac{43}{46}$$

- Headset type detection (only active when headset is inserted and detected)

  Headset with mic:

  $$\text{MICBIAS} > (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = \text{Mic\_bias} \times \frac{3}{46}$$

  Headset without mic:

  $$\text{MICBIAS} < (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = \text{Mic\_bias} \times \frac{3}{46}$$

- Button press detection (button press detection becomes active only when headset with mic is detected)

  No button push:

  $$\text{MICBIAS} > (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = \text{Mic\_bias} \times \frac{3}{46}$$

  Button push detected:

  $$\text{MICBIAS} < (\text{MICBIAS} - \text{ref}) \times \frac{3}{46} + \text{ref} = \text{Mic\_bias} \times \frac{3}{46}$$

- Headset removal detection (with headset detection scheme enabled, removal detection is always active inside device.)

  Headset removed:

  $$\text{MICBIAS} > (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = \text{Mic\_bias} \times \frac{43}{46}$$

  Insertion detected:

  $$\text{MICBIAS} < (\text{MICBIAS} - \text{ref}) \times \frac{43}{46} + \text{ref} = \text{Mic\_bias} \times \frac{43}{46}$$

Note: The ratio above $\left(\frac{3}{46} \text{ or } \frac{43}{46}\right)$ are determined by the on-chip resistance. A mismatch of on-chip resistance can cause a variation in the ratio by ±10%.

1.2.5 Why Does False Detection Occur When no External Microphone is Inserted?

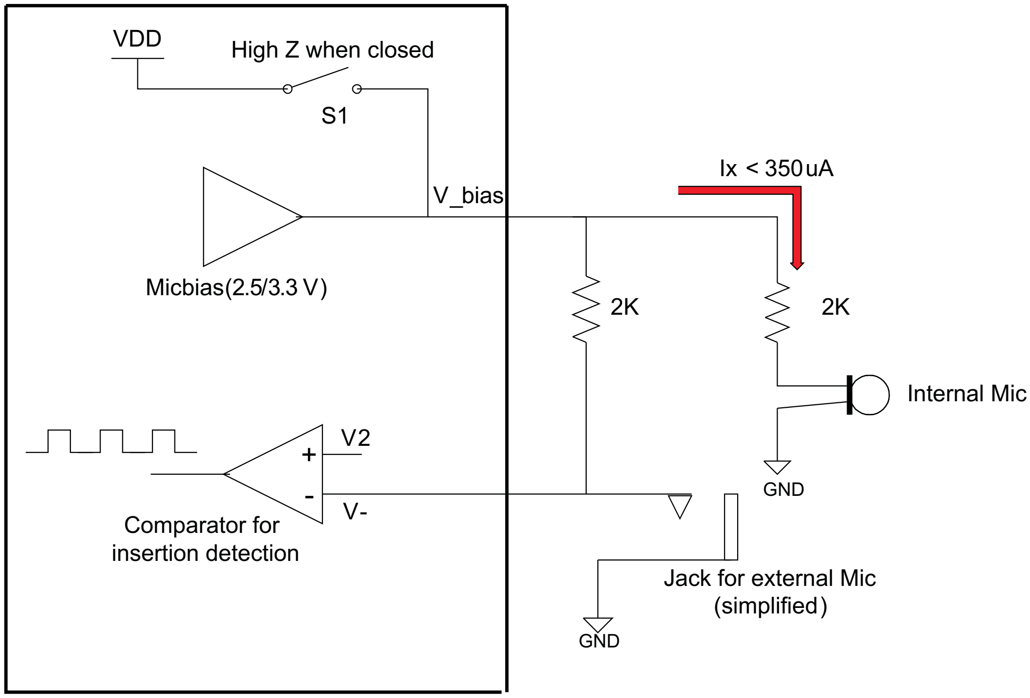


Figure 9. False Detection Due to Overdrawn Current Into Internal Mic

In both capacitor-less and capacitor interface, Reg 14/D6 = 0. Under this condition, bias voltage V_bias adjusts its value based on the detection status:

With Reg14/D6 = 0	
Before detection	V_bias = VDD
After detection	V_bias = Micbias

A portable device like a cell phone not only provides a jack for an external mic, but also has an internal mic embedded inside the device. The TLC320AIC33 and TLC320AIC3101/4/5/6 family device is designed in a way such that it can only accommodate a current flow of no more than 350 µA into the internal mic. A false detection occurs if the internal mic is drawing more than 350-µA current. The paragraph below gives a detailed explanation of the false detection.

With Reg14/D6 =0, V_bias is set at VDD when no insertion is detected. That is, switch S1 is switched on when no insertion is detected. Current flow into the Internal mic Ix has to be less than 350 µA in order to keep V_bias on a level such that V≥V2. With V≥V2, the comparator outputs a logic 0 which indicates no insertion is detected. However, false detection occurs when the internal mic draws more than 350-µA current. The extra current drawn by the internal mic pulls V_bias down so that V≤V2. With V≤V2, comparator outputs a logic 1 which indicates insertion is detected.

Once this false detection occurs, S1 is switched off and V_bias is set at Micbias instead of VDD. The new bias voltage sets V≥V2 again and comparator outputs a logic 0 which implies no detection again. The output of comparator therefore switches between 0 and 1 due to the extra current drawn by the internal mic.

To summarize, the current drawn by the internal mic has to be less than 350 µA in order to avoid false detection. When the current Ix is larger than 350 µA, the comparator generates a false detection even when nothing is actually inserted into the mic jack. A good check in a real application is to double-check the current drawn by the internal mic and make sure that it is under 350 µA.

2 References

1. http://www.india.ti.com/cgi-bin/mstc/twiki/bin/view/DAPIND/AIC33Apps
2. *TLV320AIC3100, Low Power Stereo CODEC with integrated Mono Class-D Speaker Amplifier* data sheet (SLOS545)

Appendix A Example for a Pseudo-Differential (Capacitor-less) Output Configuration

DVDD = 2 V
Mic_bias = 3.3 V
Ref = HPRCOM = 1.3 V

- Before insertion, set Bias = DVDD – HPCOM = 2.0 V – 1.3 V = 0.7 V

  $$\text{Insertion detected: Mic\_detect} < \text{Bias} \times \frac{43}{46} + \text{Ref} = 0.7 \times \frac{43}{46} + 1.3 = 1.95\ \text{V}$$

  $$\text{No insertion: Mic\_detect} > \text{Bias} \times \frac{43}{46} + \text{Ref} = 0.7 \times \frac{43}{46} + 1.3 = 1.95\ \text{V}$$

- Headset type detection, set Bias = Mic_bias – HPCOM = 3.3 – 1.3 = 2.0 V

  $$\text{Headset with Mic: Mic\_detect} > \text{Bias} \times \frac{3}{46} + \text{Ref} = 2.0 \times \frac{3}{46} + 1.3 = 1.43\ \text{V}$$

  $$\text{Headset without Mic: Mic\_detect} < \text{Bias} \times \frac{3}{46} + \text{Ref} = 2.0 \times \frac{3}{46} + 1.3 = 1.43\ \text{V}$$

- Hook button press detection, set Bias = Mic_bias – HPCOM =3.3 –1.3 = 2.0
  Button press detection is active only when headset with mic has been detected.

  $$\text{No button push: Mic\_detect} > \text{Bias} \times \frac{3}{46} + \text{Ref} = 2.0 \times \frac{3}{46} + 1.3 = 1.43\ \text{V}$$

  $$\text{Button push detected: Mic\_detect} < \text{Bias} \times \frac{3}{46} + \text{Ref} = 2.0 \times \frac{3}{46} + 1.3 = 1.43\ \text{V}$$

- Headset removal detection, set Bias = Mic_bias – HPCOM = 3.3 – 1.3 = 2 V

  $$\text{Headset removed: Mic\_detect} > \text{Bias} \times \frac{43}{46} + \text{Ref} = 2.0 \times \frac{43}{46} + 1.3 = 3.17\ \text{V}$$

  $$\text{Insertion detected: Mic\_detect} < \text{Bias} \times \frac{43}{46} + \text{Ref} = 2.0 \times \frac{43}{46} + 1.3 = 3.17\ \text{V}$$

Appendix B Example for an AC-Coupled (Capacitor) Output Configuration

DVDD = 2 V
Mic_bias = 3.3 V
Ref = VSS = 0 V

- Before insertion, set Bias = DVDD = 2 V

  $$\text{Insertion detected: Mic\_detect} < \text{Bias} \times \frac{43}{46} + \text{Ref} = 2.0 \times \frac{43}{46} + 0 = 1.87\ \text{V}$$

  $$\text{No insertion: Mic\_detect} > \text{Bias} \times \frac{43}{46} + \text{Ref} = 2.0 \times \frac{43}{46} + 0 = 1.87\ \text{V}$$

- Headset type detection, set Bias = Mic_bias = 3.3 V

  $$\text{Headset with Mic: Mic\_detect} > \text{Bias} \times \frac{3}{46} + \text{Ref} = 3.3 \times \frac{3}{46} + 0 = 0.22\ \text{V}$$

  $$\text{Headset without Mic: Mic\_detect} < \text{Bias} \times \frac{3}{46} + \text{Ref} = 3.3 \times \frac{3}{46} + 0 = 0.22\ \text{V}$$

- Button press detection, set Bias = Mic_bias = 3.3 V
  Button press detection is active only when headset with mic has been detected.

  $$\text{No button push: Mic\_detect} > \text{Bias} \times \frac{3}{46} + \text{Ref} = 3.3 \times \frac{3}{46} + 0 = 0.22\ \text{V}$$

  $$\text{Button push detected: Mic\_detect} < \text{Bias} \times \frac{3}{46} + \text{Ref} = 3.3 \times \frac{3}{46} + 0 = 0.22\ \text{V}$$

- Headset removal detection, set Bias = Mic_bias = 3.3 V.

  $$\text{Headset removed: Mic\_detect} > \text{Bias} \times \frac{43}{46} + \text{Ref} = 3.3 \times \frac{43}{46} + 0 = 3.08\ \text{V}$$

  $$\text{Insertion detected: Mic\_detect} < \text{Bias} \times \frac{43}{46} + \text{Ref} = 3.3 \times \frac{43}{46} + 0 = 3.08\ \text{V}$$

Appendix C Flowchart for Pseudo-Differential (Capacitor-less) Output Configuration

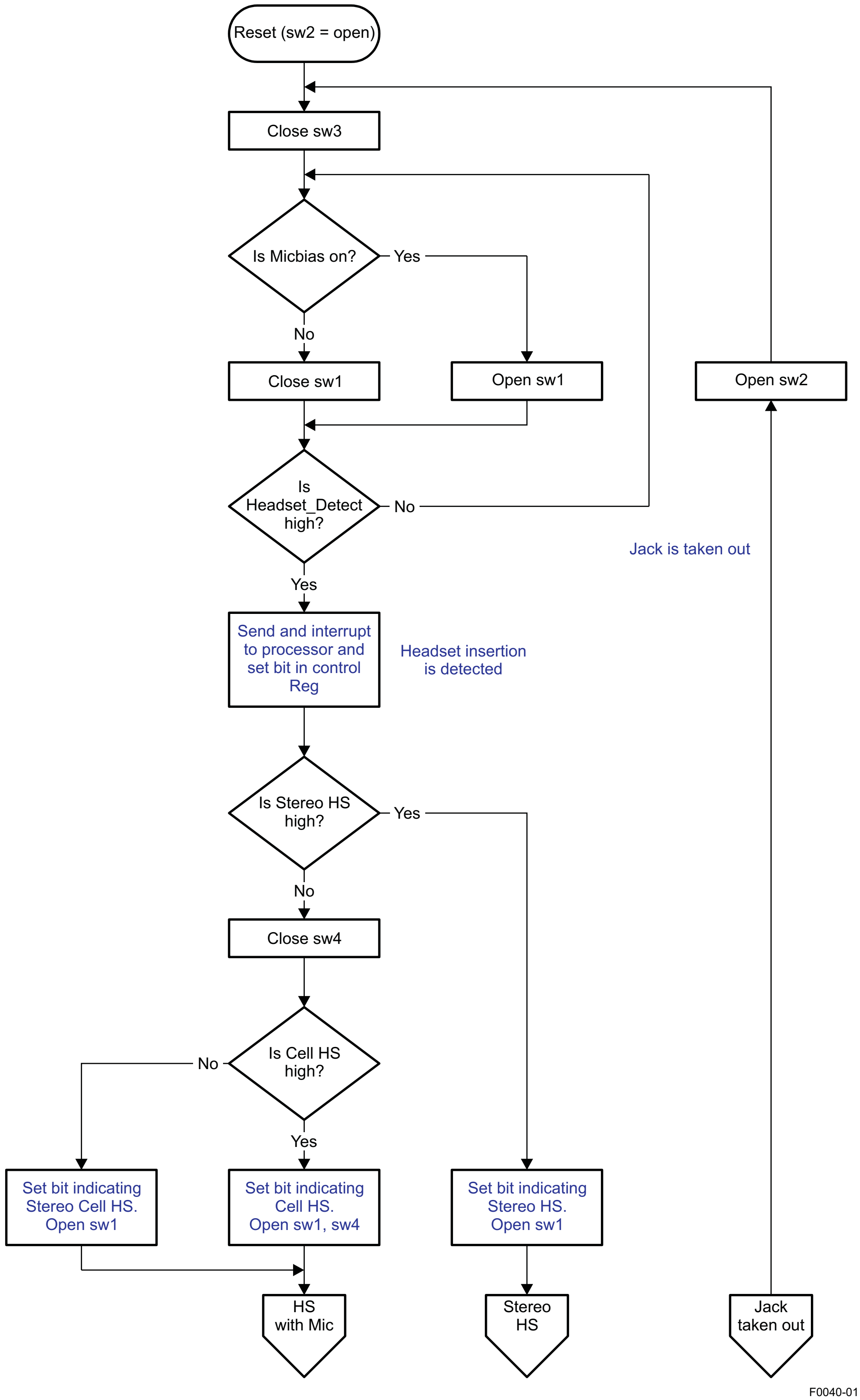


Figure 10. Flowchart for Insertion Detection and Headset-Type Detection

The insertion detection and the headset-type detection are evaluated in Figure 10

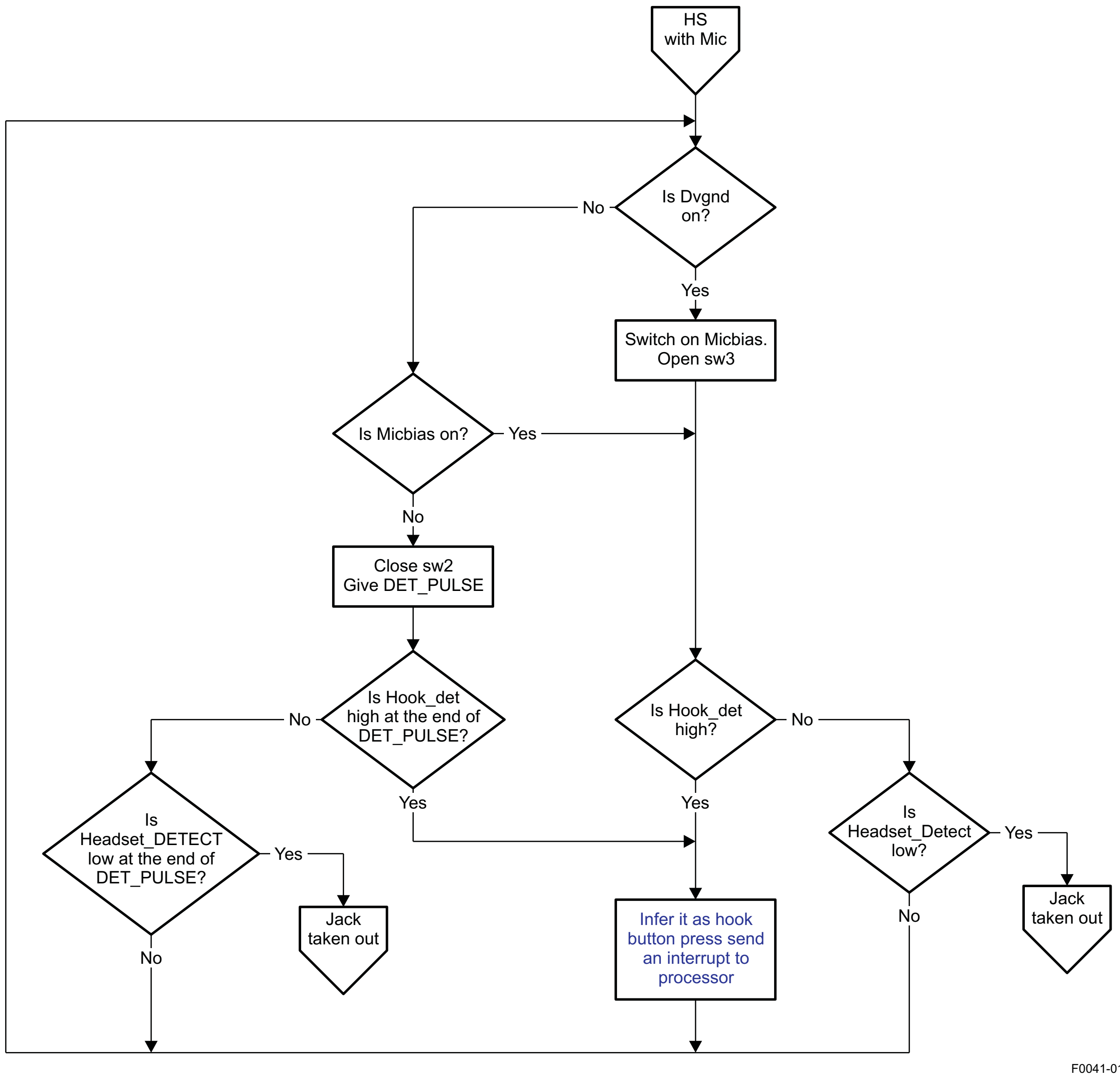


Figure 11. Flowchart for Hook Button Press Detection and Headset Removal Detection (With Mic)

If Dvgnd (VGND driver) is on, Micbias is switched on in order to do the hook button press detection and plug removal detection. Power due to Micbias is insignificant as compared to speaker power. If both Dvgnd and Micbias are off, pulse scheme which takes less than 50 µA is used to complete the detection. Detection is done at the end of high period of pulse.

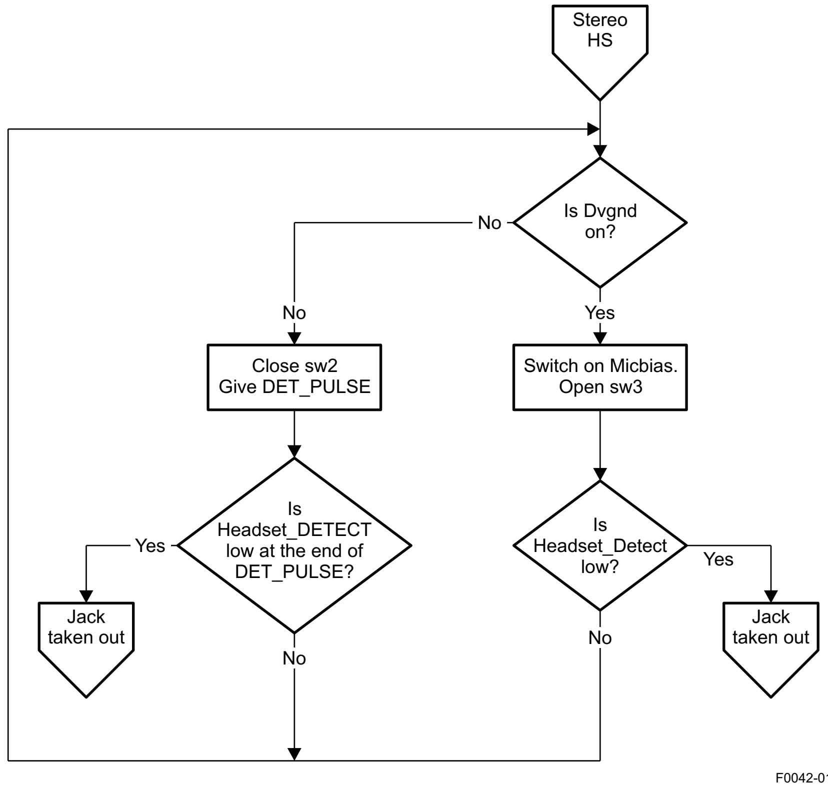


Figure 12. Flowchart for Headset Removal Detection (Without Mic)

If Dvgnd (VGND driver) is on, Micbias is switched on in order to do the plug removal detection. Power due to Micbias is insignificant as compared to speaker power. If Dvgnd is off, pulse scheme which takes less than 50 µA is used to complete the detection. Detection is done at the end of the high period of the pulse.

Appendix D Flowchart for AC-Coupled (Capacitor) Output Configuration

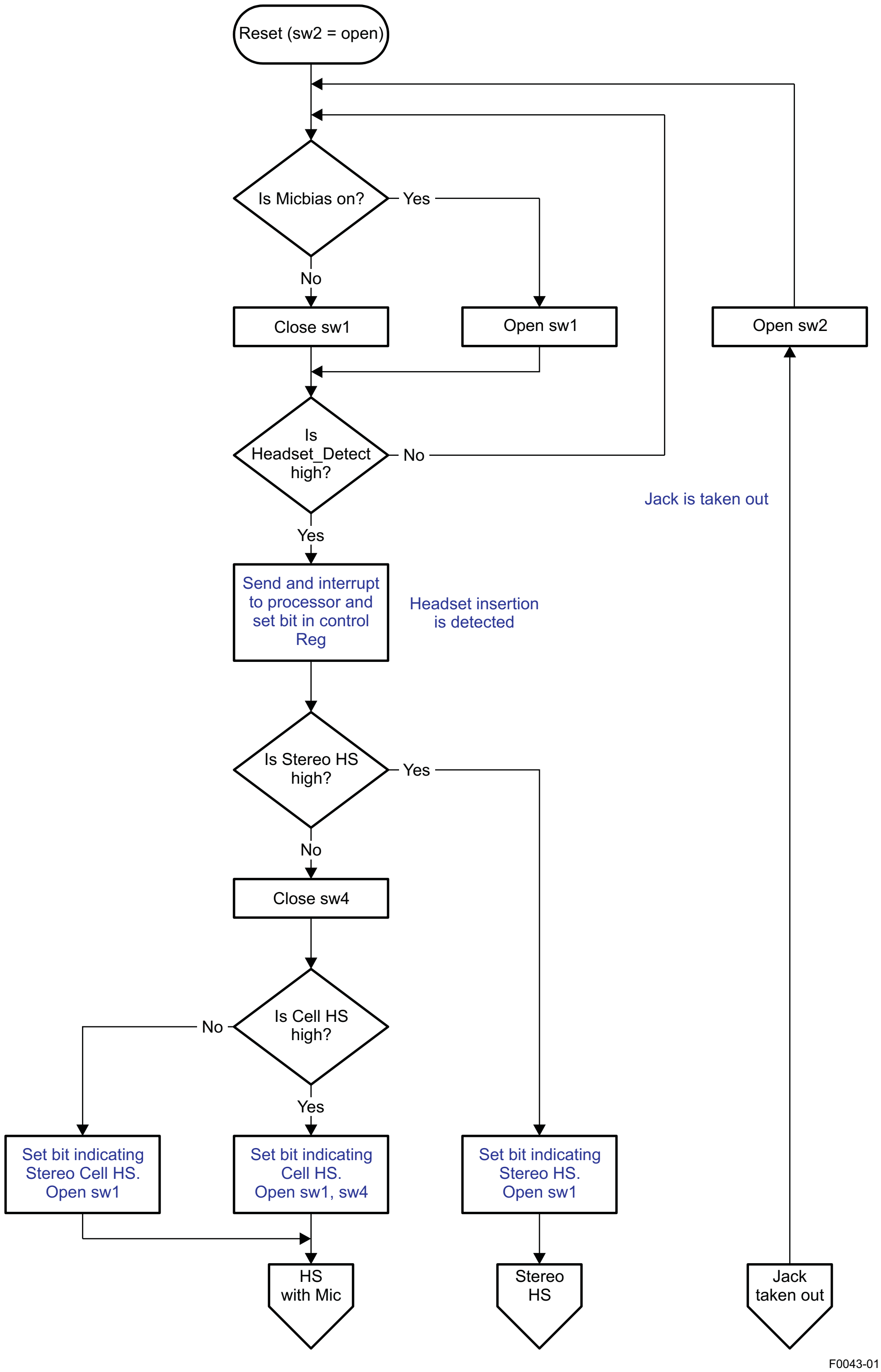


Figure 13. Flowchart for Insertion Detection and Headset-Type Detection

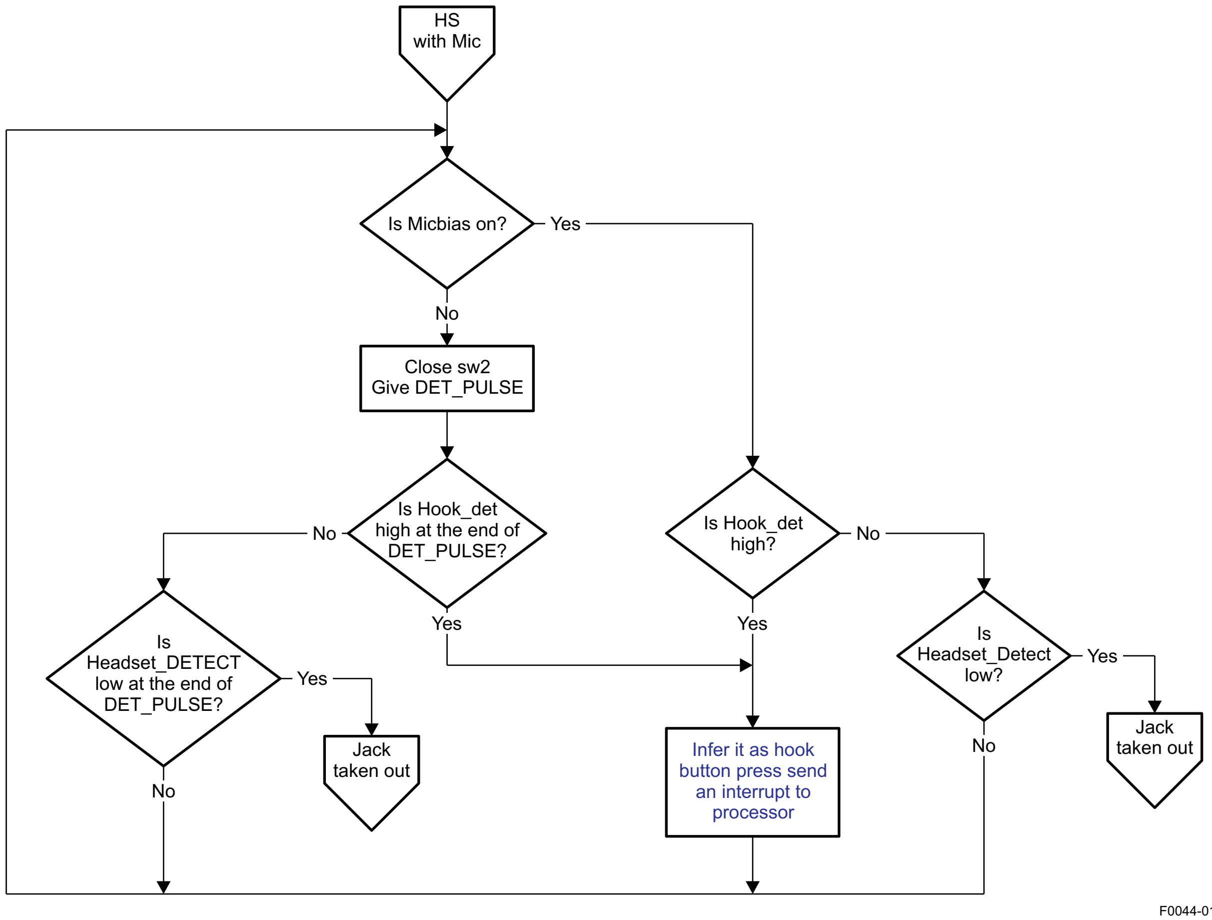


Figure 14. Flowchart for Hook Button Press Detection and Headset Removal Detection (With Mic)

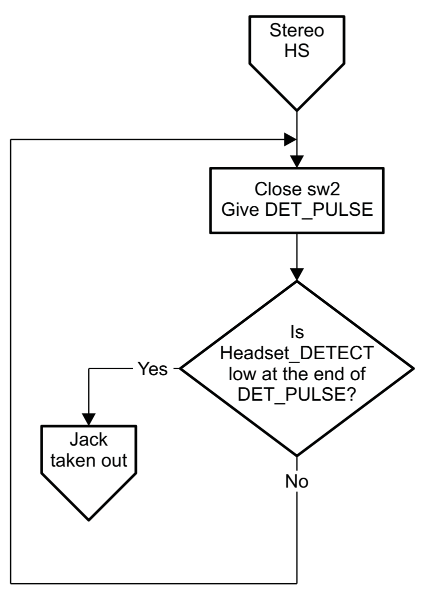


Figure 15. Flowchart for Headset Removal Detection (Without Mic)

Pulse Scheme

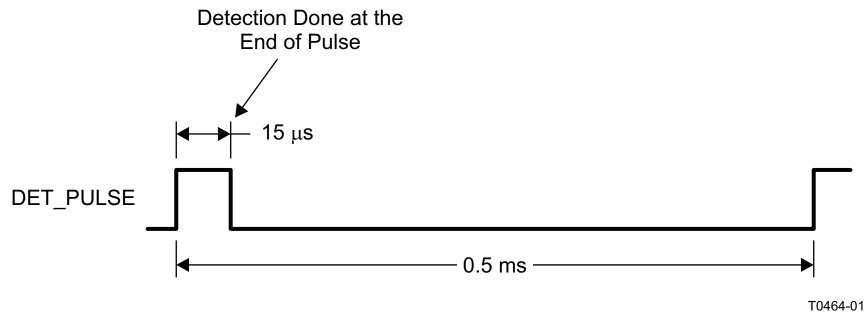


Figure 16. Pulse Scheme

DET_PULSE, which is generated using an internal oscillator, is used for hook button detection. DET_PULSE period is 0.5 ms with high time of 15 µs.