*Application Note*

# *Headset Detection for TAx52xx Family*

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**ABSTRACT**

A common feature in most of today's electronic devices – including cell phone, PDAs, notebooks, handheld media players, game systems, and so on, 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 the type.

The TAx5x1x 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 note 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 TAD5212, TAD5112, TAC5212, TAC5112, TAC5211, TAC5111, TAD5212-Q1, TAD5112-Q1, TAC5212-Q1, TAC5112-Q1, and TAC5111-Q1


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# 1 Headset Plugs and Connection Diagrams

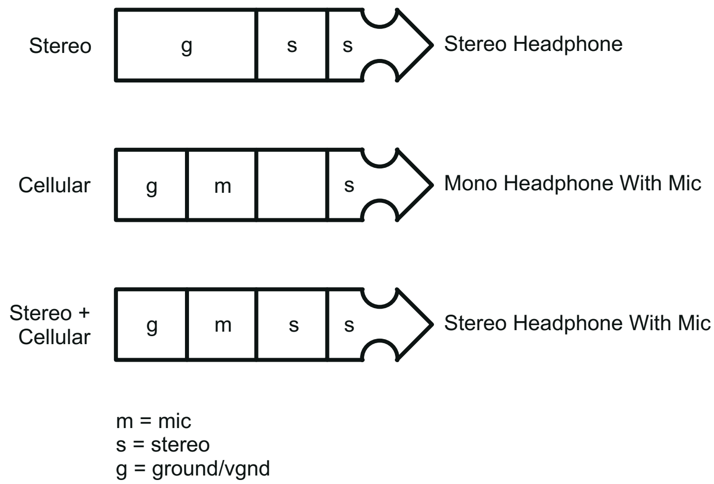



**Figure 1-1. Different Configurations of 4-Conductor Headset Plug**

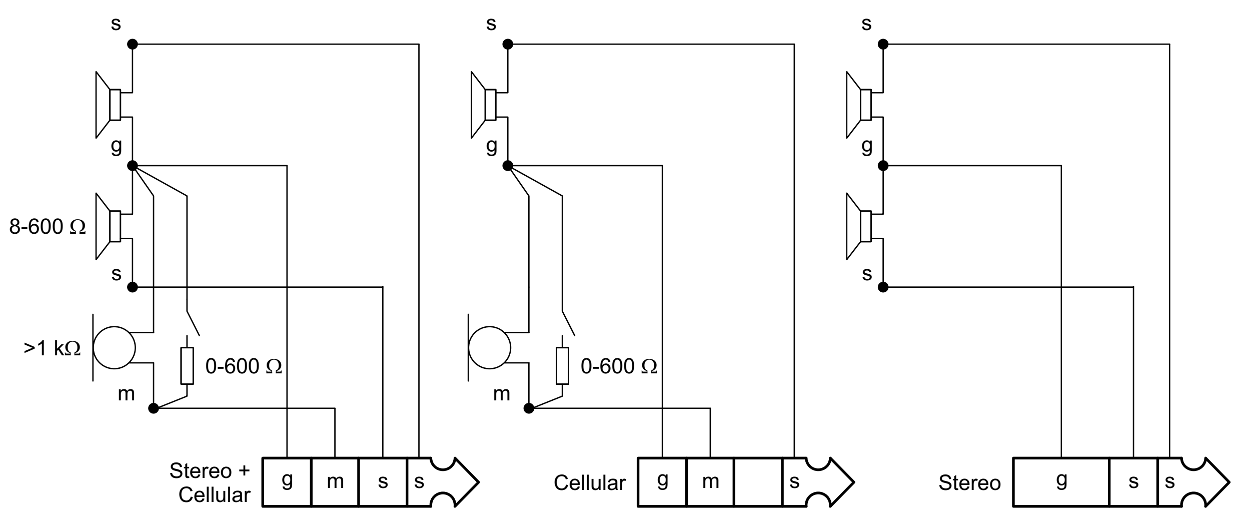



**Figure 1-2. Connection Diagrams for Various Headsets**

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

Figure 1-3 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 1.6-V or 1.5-V level.

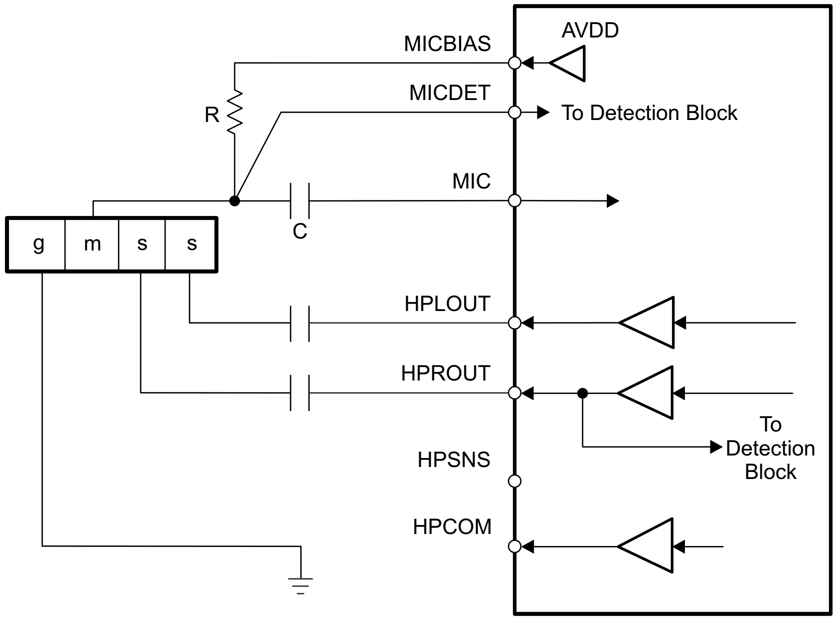



**Figure 1-3. Device With a Pseudo-Differential (Capacitor-less) Headset Output Connection**

Figure 1-4 demonstrates the internal circuitry that implements the detection logic. The two comparators in this figure is used for headphone and jack detection.

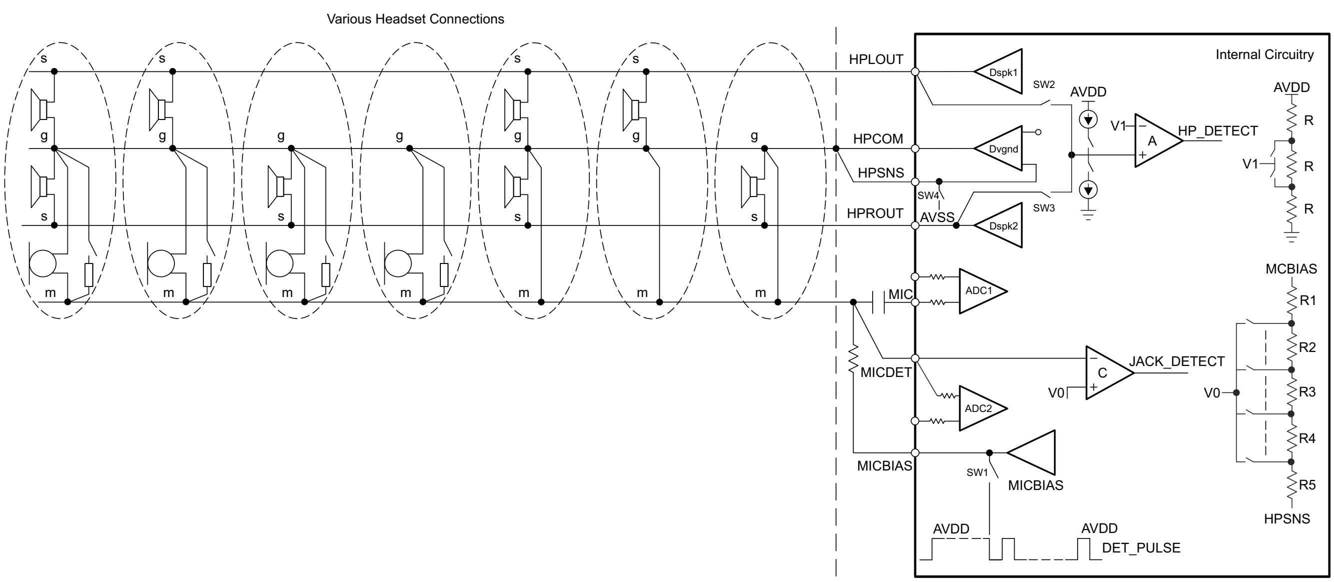



**Figure 1-4. Circuit Diagram of Detection Scheme for Capacitor-less Interface**

### 1.1.1 Detection Block, Capacitor-less Interface

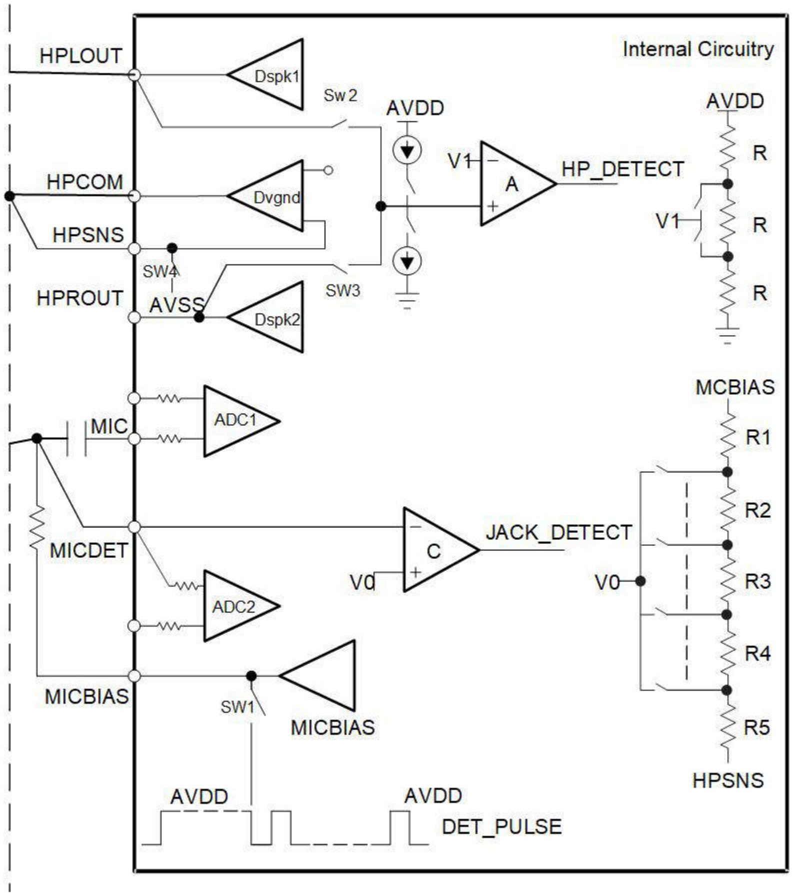



**Figure 1-5. Detection Block for Pseudo-Differential (Capacitor-less) Interface**

**Comparator C** is used to detect headset insertion type, bottom press and removal. However bottom press detection becomes available only when headset with mic is detected. Headset insertion and removal detection is always active inside device.

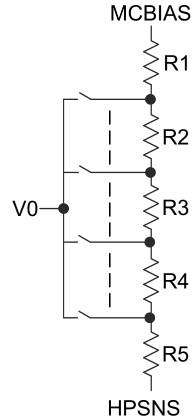
| | |
|---|---|
| MICDET < V2 | Insertion detected |
| MICDET > V2 | No insertion |

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

| Given headset with mic is already detected | |
|---|---|
| MICDET > V3 | No button press |
| MICDET < V3 | Button press detected |

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

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




$$V1 = \left(MICBIAS - ref\right) \times \frac{11}{100} + ref \qquad (1)$$
$$V2 = \left(MICBIAS - ref\right) \times \frac{22}{25} + ref$$
$$V3 = \left(MICBIAS - ref\right) \times \frac{11}{100} + ref$$
$$ref = HPSNS$$

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 = AVDD

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 26, D1) and set Capacitor-less interface (Page 0, Reg 26, D3 = 1)
- Detect insertion (with headset detection scheme enabled, headset insertion detection is always active inside device)

**Insertion detected:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{22}{25} + ref = \left(AVDD - ref\right) \times \frac{22}{25} + ref$$

**No Insertion:**

$$MICDET > \left(MICBIAS - ref\right) \times \frac{22}{25} + ref = \left(AVDD - ref\right) \times \frac{22}{25} + ref$$

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

**Headset with mic:**

$$MICDET > \left(MICBIAS - ref\right) \times \frac{11}{100} + ref = \left(AVDD - ref\right) \times \frac{11}{100} + ref$$

**Headset without mic:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{11}{100} + ref = \left(AVDD - ref\right) \times \frac{11}{100} + ref$$

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

**No button push:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{11}{100} + ref = \left(Mic\_bias - ref\right) \times \frac{11}{100} + ref$$

**Button push detected:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{11}{100} + ref = \left(Mic\_bias - ref\right) \times \frac{11}{100} + ref$$

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

**Headset removed:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{22}{25} + ref = \left(Mic\_bias - ref\right) \times \frac{22}{25} + ref$$

**Insertion detected:**

$$MICDET < \left(MICBIAS - ref\right) \times \frac{22}{25} + ref = \left(Mic\_bias - ref\right) \times \frac{22}{25} + ref$$

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

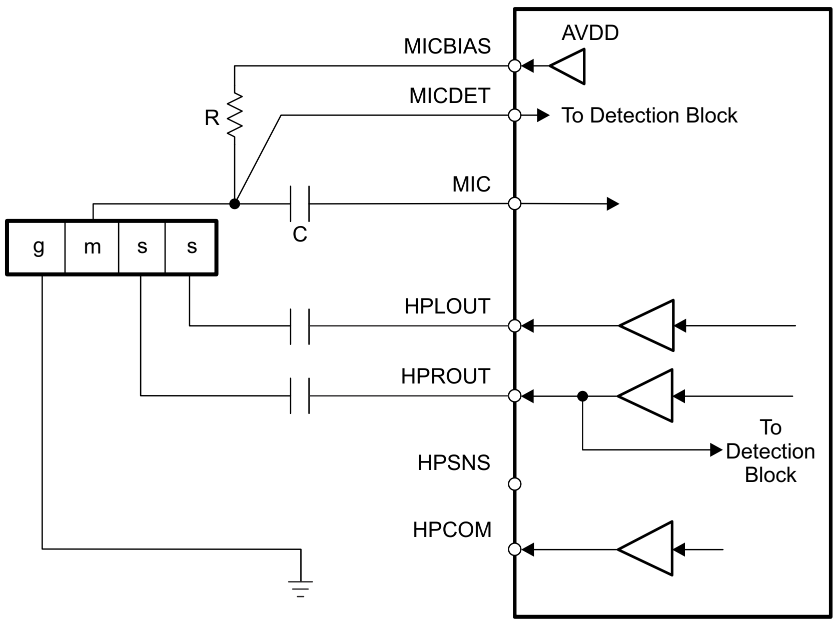



**Figure 1-6. Device With an AC-Coupled Stereo Headset Output Connection**

Figure 1-7 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.

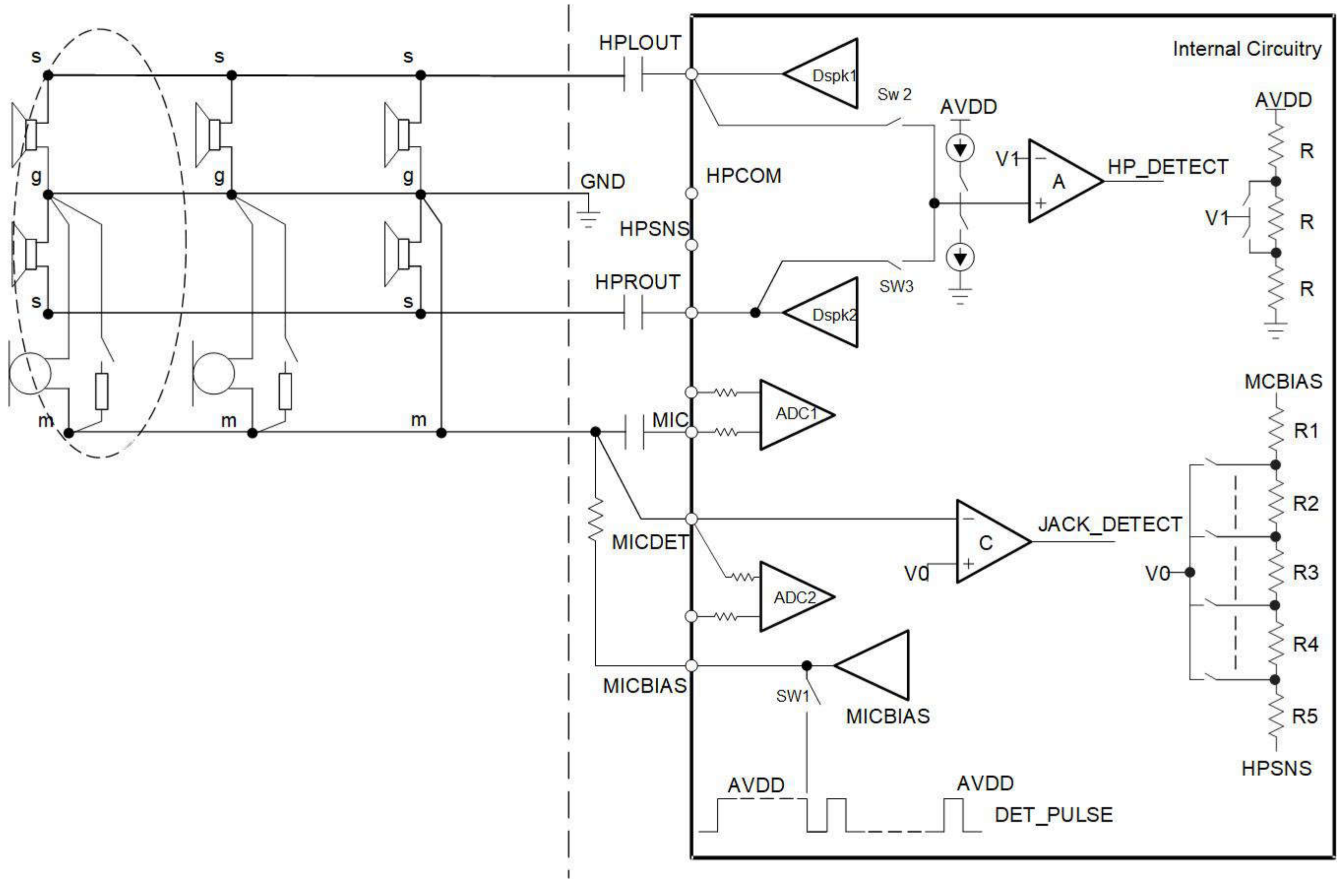



Figure 1-7. Circuit Diagram of Detection Scheme for Capacitor Interface

## 1.2.1 Detection Block – Capacitor Interface

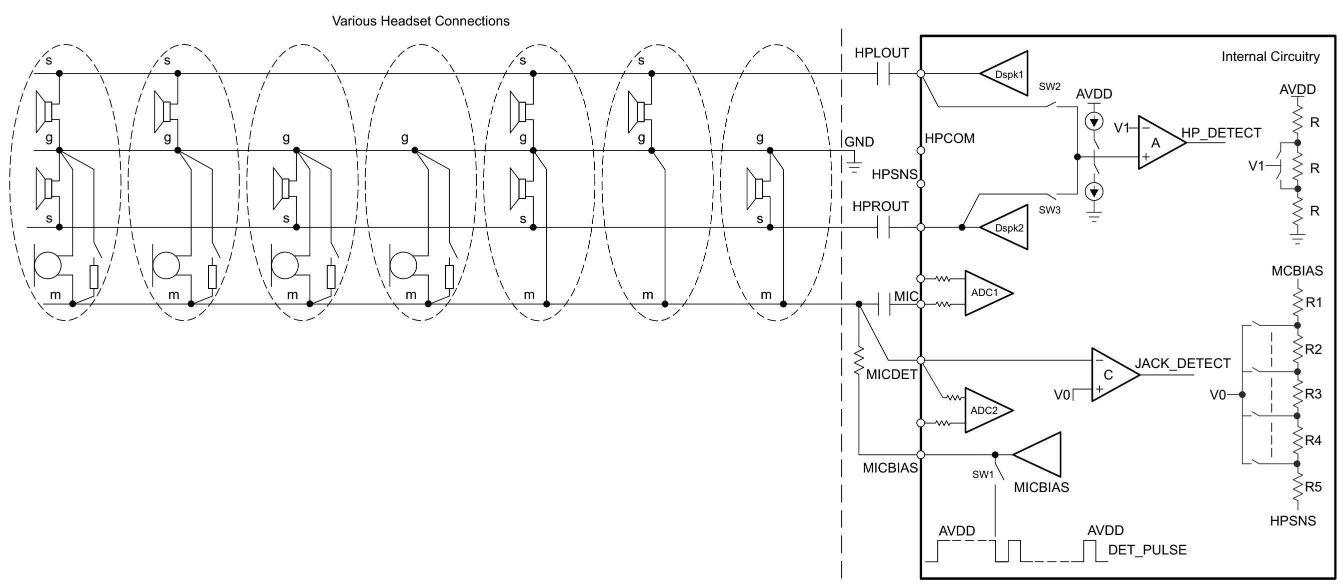



Figure 1-8. Detection Block for AC-Coupled (Capacitor) Interface

**Comparator C** is used to detect headset insertion and removal. However, button press detection becomes active only when headset with mic is detected. Headset insertion and removal detection is always active inside device.

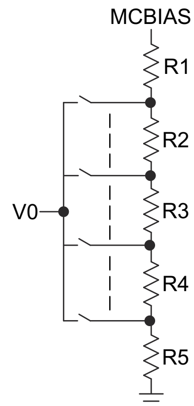
| | |
|---|---|
| MICDET < V2 | Insertion detected |
| MICDET > V2 | No insertion |

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

| **Given headset with mic is already detected** | |
|---|---|
| MICDET > V3 | No button press |
| MICDET < V3 | Button press detected |

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

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




$$V1 = \left(MICBIAS - ref\right) \times \frac{11}{100} + ref \quad or \quad V1 = \left(MICBIAS - ref\right) \times \frac{1}{5} + ref$$
$$V2 = \left(MICBIAS - ref\right) \times \frac{4}{5} + ref$$
$$ref = VSS = 0V$$
$$MICBIAS \quad varies \quad with \quad detection \quad mode$$

Note that for V1 and V2 there will be a lot more threshold possible than the ones shown previously which can be based on eternal resistor and ADC loading.

### 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 = AVDD

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

### 1.2.4 Detection Sequence – Capacitor Interface

A lot of combinations for register mpa controls are needed for different external resistor support and different type of loading of ADC on input pins

- Enable headset detection scheme (Page 0, Reg 26, D1) and set AC-coupled interface (page 0, Reg 26, D3 = 0
- Detect insertion (With headset detection scheme enabled, headset insertion detection is always active inside device.)

**Insertion detected:**

$$MICBIAS < \left(MICBIAS - ref\right) \times \frac{4}{5} + ref = \frac{4}{5}AVDD$$

**No insertion:**

$$MICBIAS > \left(MICBIAS - ref\right) \times \frac{4}{5} + ref = \frac{4}{5}AVDD$$

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

**Headset with mic:**

$$MICBIAS > \left(MICBIAS - ref\right) \times \frac{1}{5}\left(or \ \frac{1}{100}\right) + ref = \frac{4}{5} \left(or \ \frac{1}{100}\right)MIC\_bias$$

**Headset without mic:**

$$MICBIAS < \left(MICBIAS - ref\right) \times \frac{1}{5}\left(or \ \frac{1}{100}\right) + ref = \frac{4}{5} \left(or \ \frac{1}{100}\right)MIC\_bias$$

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

**No button push:**

$$MICBIAS > (MICBIAS - ref) \times 0.2 \ or \ 0.3 + ref = MIC\_bias$$

**Button push detected:**

$$MICBIAS < (MICBIAS - ref) \times 0.2 \ or \ 0.3 + ref = MIC\_bias$$

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

**Headset removed:**

$$MICBIAS > (MICBIAS - ref) + ref = MIC\_bias$$

**Insertion detected:**

$$MICBIAS < (MICBIAS - ref) + ref = MIC\_bias$$

## 2 Example for a Pseudo-Differential (Capacitor-less) Output Configuration

AVDD = 3.3V/3.0 V
Mic_bias = 2.75V/2.5V
Ref = HPRCOM = 1.65 V/1.5V

- Before insertion, set Bias = AVDD – HPCOM = 3.3V – 1.65 V = 1.65 V

$$Insertion\ \ detected:\ \ Mic\_detect < Bias\ \ * \frac{22}{25} + Ref = 1.65 * \frac{22}{25} + 1.65 = 3.102$$

$$No\ \ Insertion\ \ :\ \ Mic\_detect > Bias\ \ * \frac{22}{25} + Ref = 1.65 * \frac{22}{25} + 1.65 = 3.102$$

- Headset type detection, set Bias = Mic_bias – HPCOM = 2.75 – 1.65 = 1.1 V

$$Headset\ \ with\ \ MIC:\ \ Mic\_detect > Bias\ \ * \frac{11}{100} + Ref = 1.1 * \frac{11}{100} + 1.65 = 1.771$$

$$Headset\ \ without\ \ MIC:\ \ Mic\_detect < Bias\ \ * \frac{11}{100} + Ref = 1.1 * \frac{11}{100} + 1.65 = 1.771$$

- Hook button press detection, set Bias = Mic_bias – HPCOM =2.75 –1.65 = 1.1V.
Button press detection is active only when headset with mic has been detected.

$$No\ \ botton\ \ push:\ \ Mic\_detect > Bias\ \ * \frac{11}{100} + Ref = 1.1 * \frac{11}{100} + 1.65 = 1.771$$

$$Push\ \ botton\ \ detected\ \ :\ \ Mic\_detect < Bias\ \ * \frac{11}{100} + Ref = 1.1 * \frac{11}{100} + 1.65 = 1.771$$

- Headset removal detection, set Bias = Mic_bias – HPCOM = 2.75 –1.65 = 1.1V

$$Headset\ \ \ removed\ \ :\ \ Mic\_detect > Bias\ \ * \frac{22}{25} + Ref = 1.1 * \frac{22}{25} + 1.65 = 2.618$$

$$Headset\ \ \ removed\ \ :\ \ Mic\_detect < Bias\ \ * \frac{22}{25} + Ref = 1.1 * \frac{22}{25} + 1.65 = 2.618$$

# 3 Example for an AC-Coupled (Capacitor) Output Configuration

AVDD = 3.3/3.0/1.8 V
Mic_bias = 2.75/2.5/1.375 V
Ref = VSS = 0 V

- Before insertion, set Bias = DVDD = 2 V

$$Insertion\ \ detected:\ \ Mic\_detect < Bias\ \ * \frac{22}{25} + Ref = 2 * \frac{22}{25} + 0 = 1.76$$

$$No\ \ Insertion\ \ :\ \ Mic\_detect > Bias\ \ * \frac{22}{25} + Ref = 2 * \frac{22}{25} + 0 = 1.76$$

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

$$Headset\ \ with\ \ MIC:\ \ Mic\_detect > Bias\ \ * \frac{11}{100} + Ref = 3.3 * \frac{11}{100} + 0 = 0.363$$

$$Headset\ \ without\ \ MIC:\ \ Mic\_detect < Bias\ \ * \frac{11}{100} + Ref = 3.3 * \frac{11}{100} + 0 = 0.363$$

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

$$No\ \ botton\ \ push:\ \ Mic\_detect > Bias\ \ * \frac{11}{100} + Ref = 3.3 * \frac{11}{100} + 0 = 0.363$$

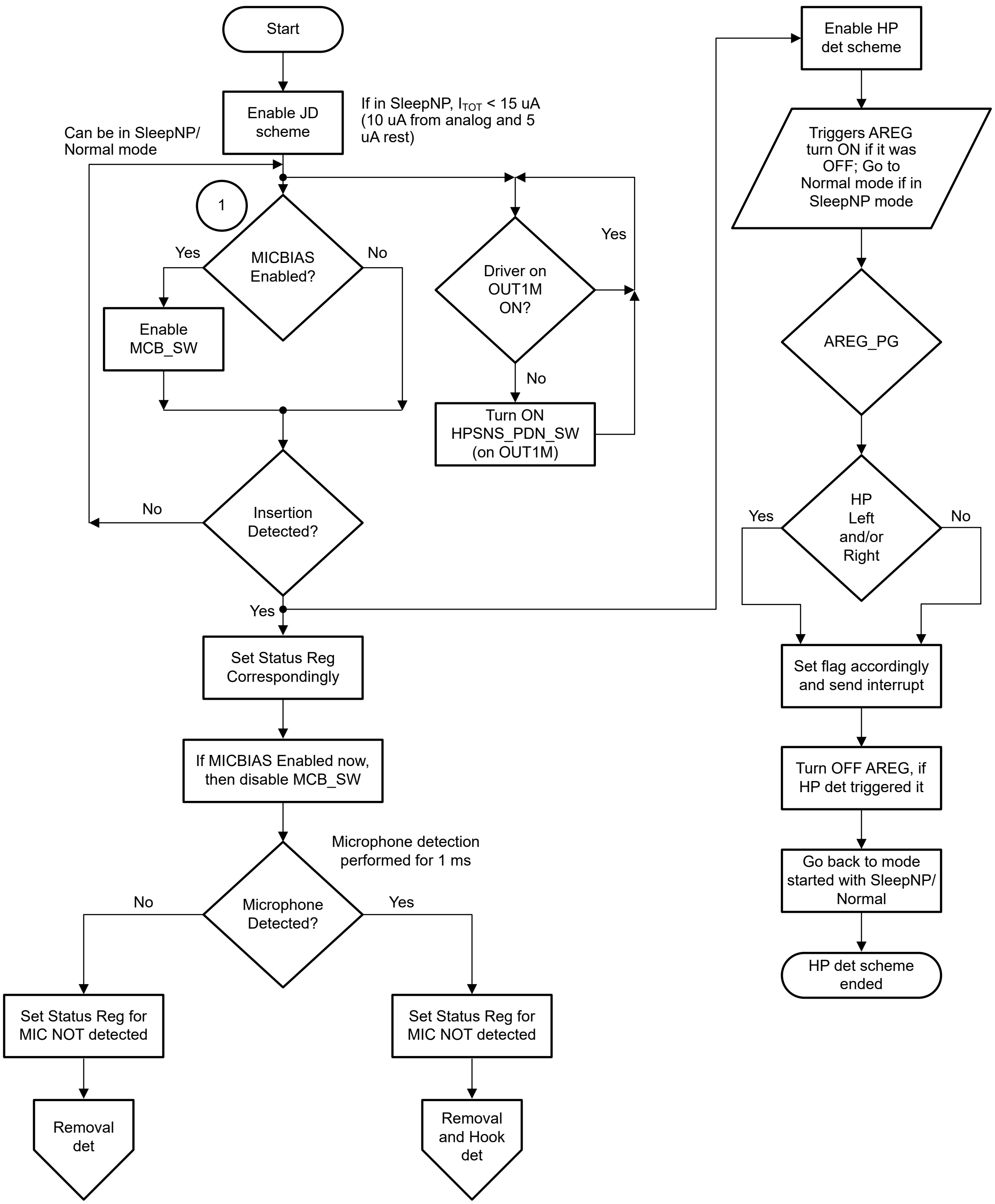
$$Push\ \ botton\ \ detected:\ \ Mic\_detect\ \ < Bias\ \ * \frac{11}{100} + Ref = 3.3 * \frac{11}{100} + 0 = 0.363$$

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

$$Headset\ \ \ removed\ \ :\ \ Mic\_detect > Bias\ \ * \frac{22}{25} + Ref = 3.3 * \frac{22}{25} + 0 = 2.904$$

$$Insertion\ \ deteced\ \ :\ \ Mic\_detect < Bias\ \ * \frac{22}{25} + Ref = 3.3 * \frac{22}{25} + 0 = 2.904$$

# 4 Flowchart for Pseudo-Differential (Capacitor-less) Output Configuration



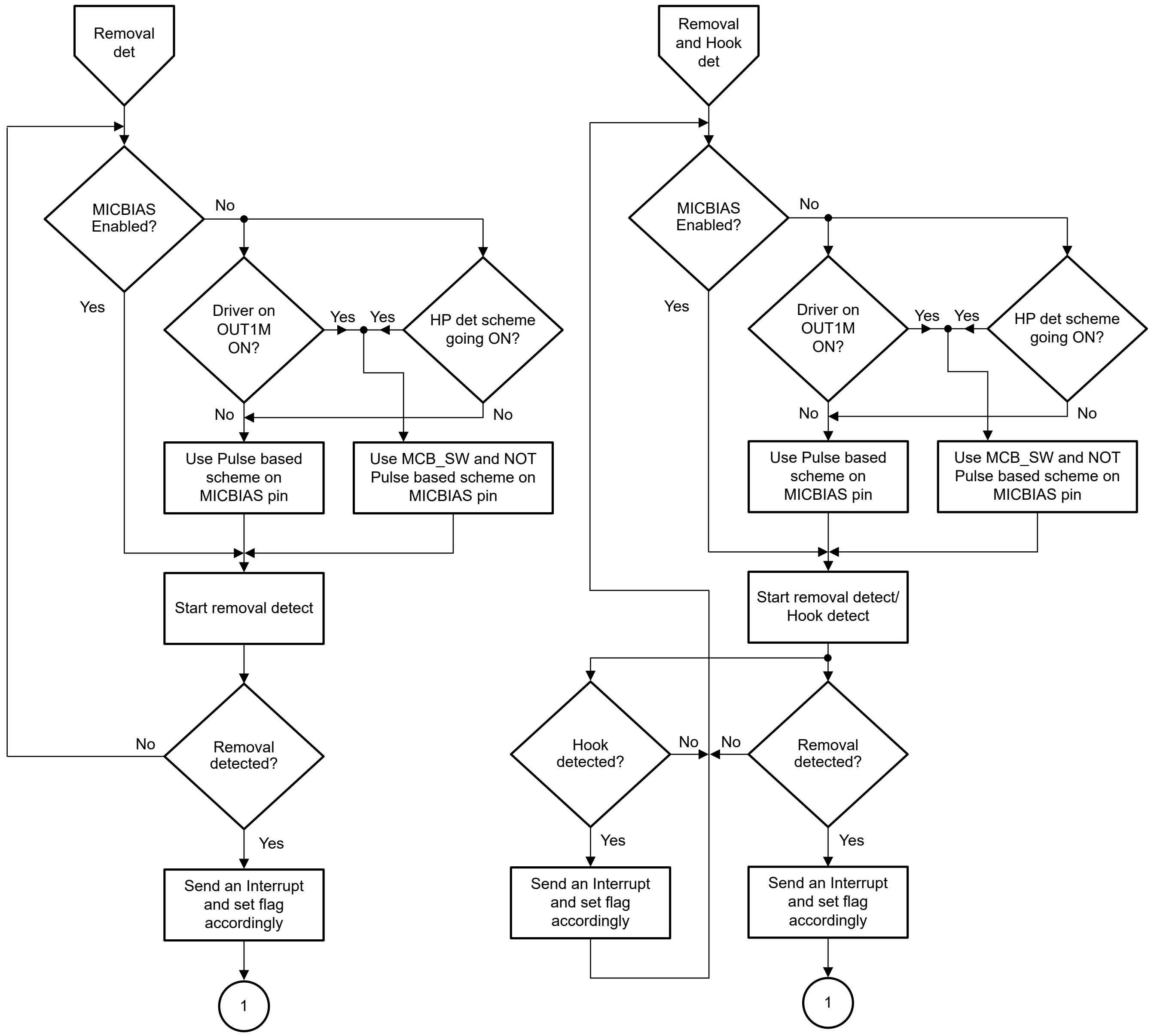



**Figure 4-1. Flowchart for Insertion Detection and Headset-Type Detection**

The insertion detection and the headset-type detection are evaluated in Figure 4-1

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.

If Dvgnd (VGND driver) is on, Micbias is switched on 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.

# 5 Flowchart for AC-Coupled (Capacitor) Output Configuration

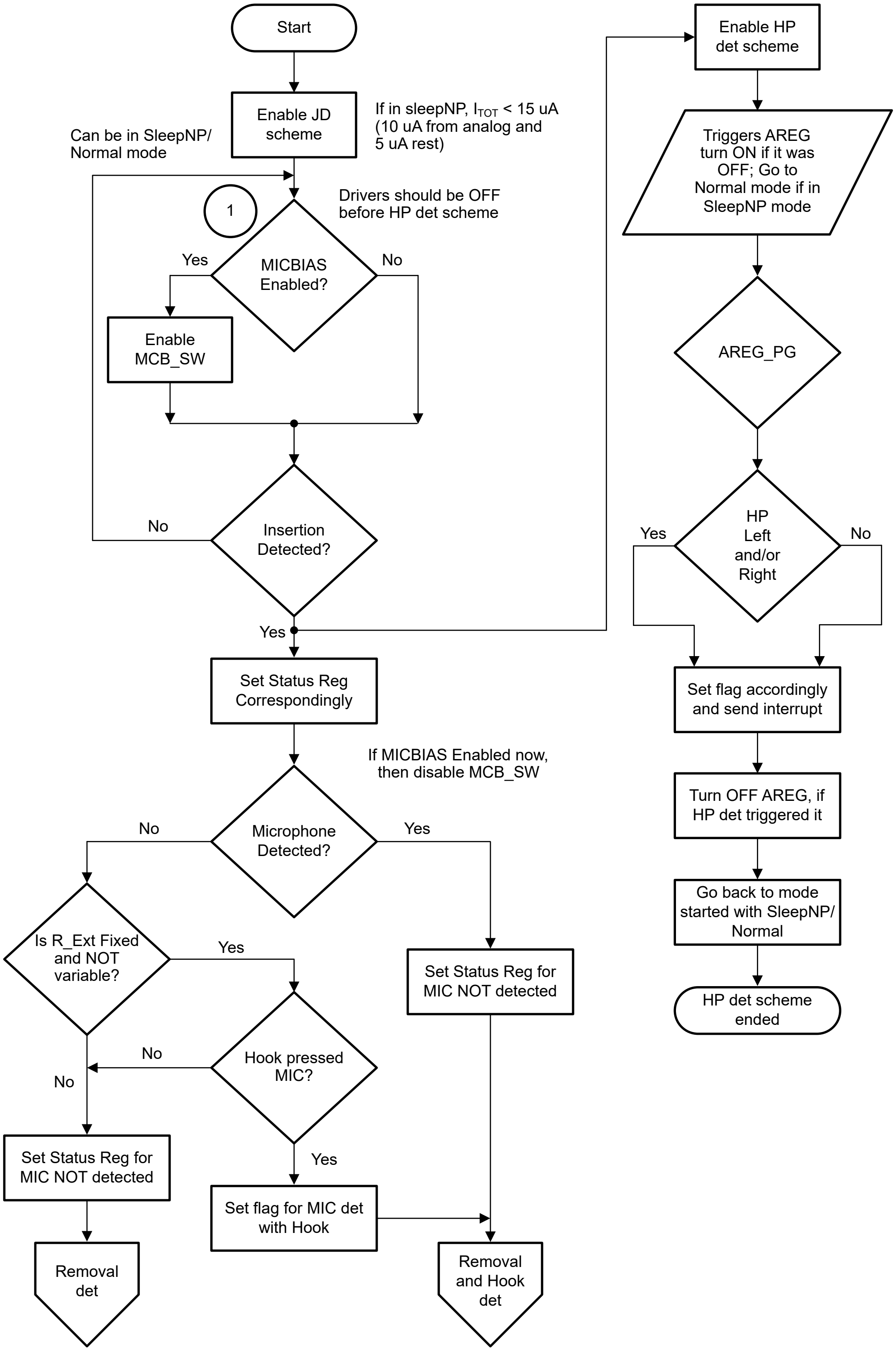



**Figure 5-1. Flowchart for Insertion Detection and Headset-Type Detection**

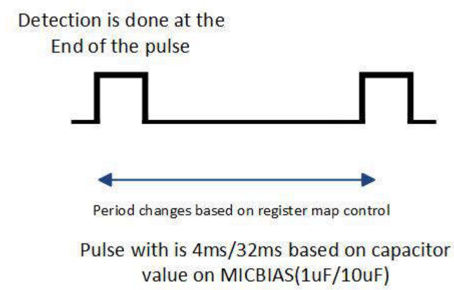



**Figure 5-2. Pulse Scheme**

DET_PULSE, which is generated using an internal oscillator, is used for hook button detection. DET_PULSE frequency is 0.5HZ,1Hz,7.5HZ or 15Hz based on reg map control with the high time of 4 or 32 ms based on capacitor value on MICBIAS.

## 6 Summary

The family of TAx5x1x devices include dedicated logic circuitry for detecting the presence of an accessory, and the type of accessory connected.

This application note discusses the headset detection schemes for two different headset output configurations: pseudo-differential (capacitor-less) output, and ac-coupled output. Two examples of the used cases are also presented.

## 7 References


1. Texas Instruments, *TAD5112-Q1 Stereo Audio DAC With 106dB Dynamic Range*, data sheet.
2. Texas Instruments, *TAC5242 High-Performance Pin Controlled Stereo Audio Codec With 118dB Dynamic Range ADC and 120dB Dynamic Range DAC*, data sheet.

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