

Nokia AV Hardware Interface Specification

Version 1.0; April 16, 2008

Interfaces

NOKIA

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Contents

1	Introduction	5
2	System specification	6
2.1	General information.....	6
2.2	Principle of terminal block diagram.....	6
2.3	Principle of accessory block diagram.....	7
2.4	Accessory detection flow.....	8
2.5	Accessory removal flow.....	8
3	Interfaces	10
3.1	Electrical interface.....	10
3.1.1	Interface signals.....	10
3.2	Electrical characteristics.....	10
3.2.1	Terminal electrical characteristics.....	10
3.2.2	Accessory electrical characteristics.....	12
3.3	Accessory detection voltages.....	13
3.3.1	Detection point 1.....	13
3.3.2	Detection point 2 (video cable/headphone detection).....	14
3.3.3	Detection point 3 (open cable/accessory detection).....	14
3.3.4	Detection point 4 (basic headset detection).....	14
3.4	Video formats.....	15
3.5	Grounding.....	15
4	Functional description	16
4.1	Accessory detection.....	16
4.1.1	Basic headset.....	16
4.1.2	Headphones.....	17
4.1.3	Video cable.....	17
4.1.4	Adapter.....	18
4.1.5	Unsupported headsets.....	19
4.2	FM-radio antenna.....	19
5	Terms and abbreviations	20
6	Evaluate this resource	21

Change history

April 16, 2008	Version 1.0	Initial document release.

1 Introduction

This document gives the required technical information concerning the Nokia AV connector 2.5mm/3.5mm (Audio/Video) interface. The Nokia AV interface is fully compliant with [OMTP](#) (Open Mobile Terminal Platform) [Wired Analog Audio specification](#). The OMTP specification defines the 4-pin pin out, hands-free functionality, and the 3.5mm/2.5mm sizes for analog audio connectivity. The Nokia AV Connector is used in Nokia devices for GSM (Global System for Mobile communications) and WCDMA (Wideband Code Division Multiple Access) market areas. Nokia CDMA (Code division multiple access) devices do not support Nokia AV.

This document specifies the electrical AV interface between Nokia mobile terminal and accessories, for example headset and video cables. It also defines the accessory hardware level identification process of the mobile terminal. Product related details are not included, which means that product level requirements cannot be directly taken from this document, for example from audio quality point of view.

All products using the Nokia AV connector must comply with this interface specification.

Control data and advanced accessories are proprietary of Nokia and are not covered in this document.

2 System specification

2.1 General information

Nokia AV connector consists of mono or stereo audio output, mono audio input, and optional features such as control data over microphone line, stereo audio line input, and video output.

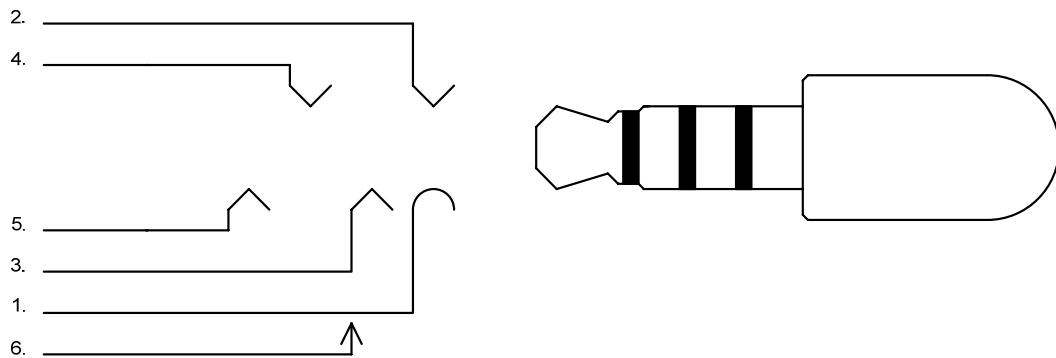


Figure 1: Nokia AV connector pin layout

2.5mm/3.5mm Pin #	Signal name	Direction	Description
6	PLUGDET	In	Terminal internal connection, plug detection
5	HSEARL	Out	Audio output left channel
4	HSEARR	Out	Audio output right channel
3	HSMIC	In / Out	Multiplexed microphone audio and control data, C-video out
1, 2	GND	-	Ground contacts

Table 1: Nokia AV Interface signals

2.2 Principle of terminal block diagram

Figure 2 gives an overview of the terminal implementation.

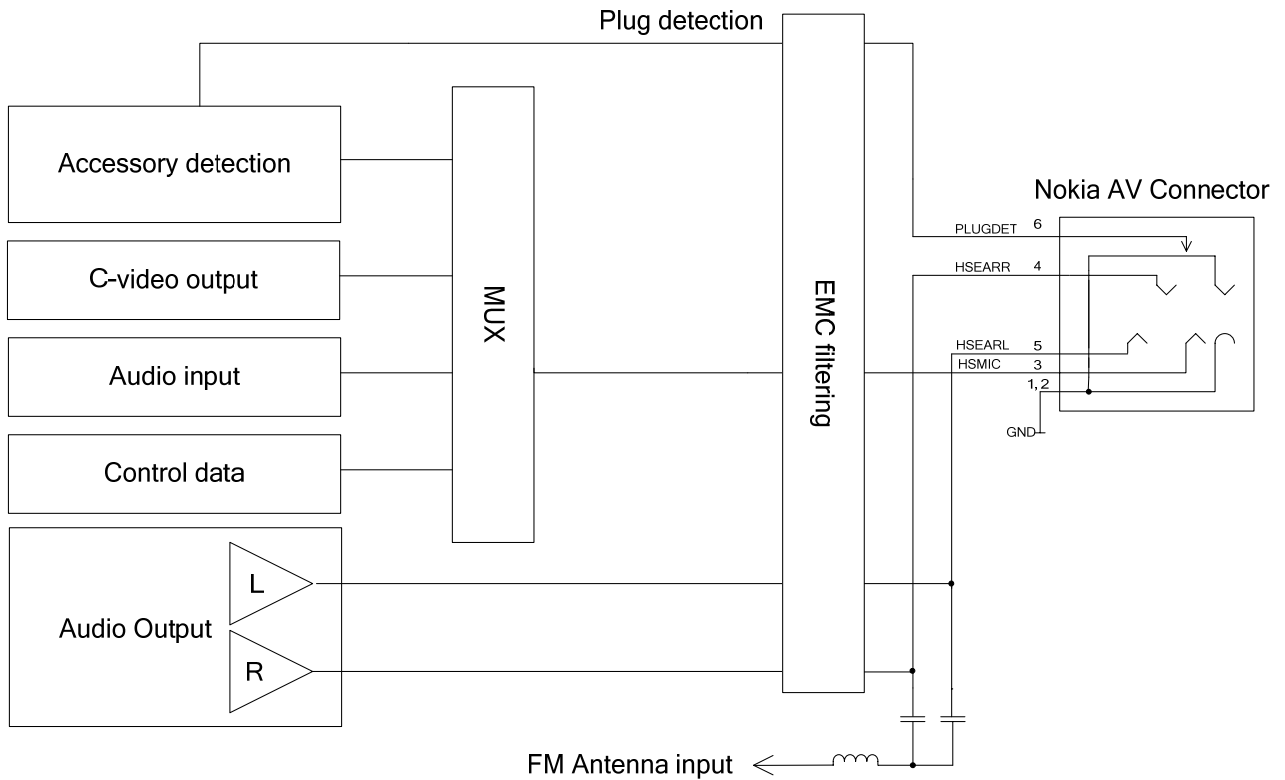


Figure 2: Terminal block diagram

2.3 Principle of accessory block diagram

Figure 3 gives an overview of basic headset implementation. Basic headset consists of a microphone, an earpiece, and a send/end button. It does not include any active parts, and the terminal cannot differentiate them from each other. For example, the terminal cannot detect whether the headset is mono or stereo. Block diagram does not include any EMC (Electromagnetic compatibility) components.

All basic headsets use same audio parameters.

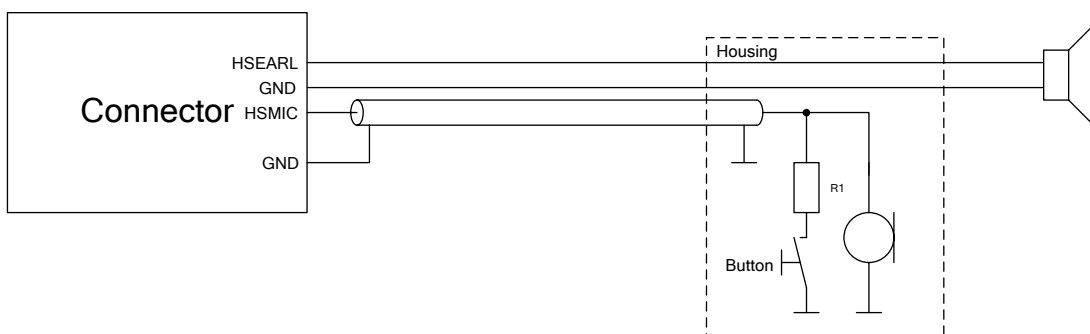


Figure 3: Basic mono headset block diagram

2.4 Accessory detection flow

Figure 4 describes the principle of the accessory detection flow. Detailed accessory detection voltage characteristics are described in Section 3.3, and a functional description in Section 4.1.

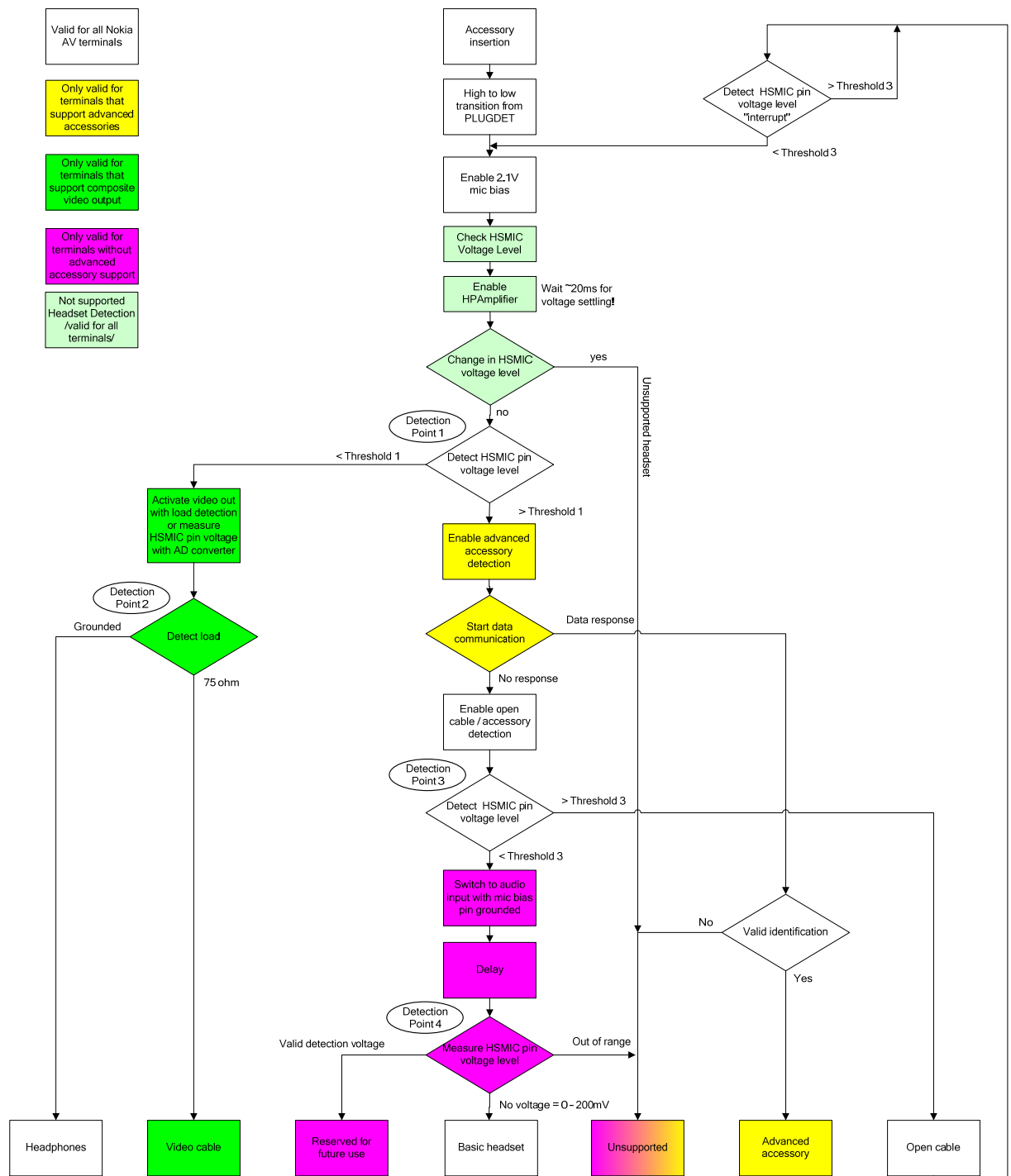


Figure 4: Detection flow chart

2.5 Accessory removal flow

This section describes the principle of accessory removal flow.

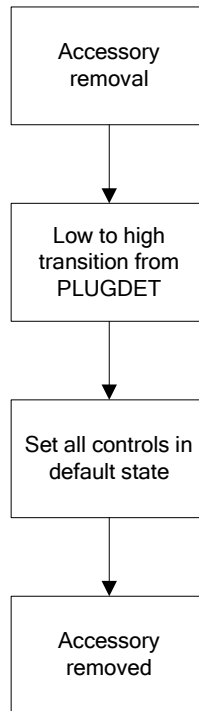


Figure 5: Removal flow chart

3 Interfaces

3.1 Electrical interface

3.1.1 Interface signals

Nokia AV interface supports mono/stereo audio output, microphone input, control data bus, and video output.

Signal name	Function	Notes
HSEARL	Audio output	
HSEARR	Audio output	
HSMIC	Audio input	
	Control data	Optional
	Composite video	Optional
GND	Common ground	

Table 2: Multiplexed functions of Nokia AV connector interface

3.2 Electrical characteristics

3.2.1 Terminal electrical characteristics

Table 3: Terminal electrical characteristics

Signal name	Function / Parameter	Min	Typ	Max	Unit	Notes
GND	Common ground					
	Impedance		20	60	mΩ	Connector contact DC and audio frequency resistance up to 20kHz. Measured from male connector to PWB analog GND
				1	Ω	Video frequency resistance, up to 5MHz
HSEARL & HSEARR	Audio output for entertainment audio See note 8 below					
	DC		0		V	
	Maximum output signal to 32 ohm for EN50332-2 compliant terminals			948	mVpp	EN50332-2: SW limited See note 11 below
	Serial resistance		16		Ω	Terminal source resistance
	Terminal line capacitance	1	2	5	nF	EMC filtering
	Earpiece load impedance	16	32	600	Ω	

Signal name	Function / Parameter	Min	Typ	Max	Unit	Notes	
	Line out load	10			k Ω		
				100	nF		
	Frequency range	20		20000	Hz	See note 1 below	
	Distortion			0.5	%	THD, See note 2 and note 3 below	
				0.1	%	THD, See note 2 and note 4 below	
	SNR	75			dB	See note 3 and note 9 below	
		93			dB	See note 4 and note 9 below	
	Channel separation	50			dB	See note 3 and note 10 below	
		56			dB	See note 4 and note 10 below	
	Audio output for cellular telephone audio						
		DC		0		V	
		Maximum output signal			2	Vpp	
		Serial resistance		16		Ω	$\pm 10\%$, terminal source resistance
		Line capacitance	1	2	5	nF	EMC filtering
HSMIC	Audio input						
	Mic bias	2.00	2.1	2.25	V	V bias	
	Mic bias current capability	1.2			mA	To short circuit, see note 12 below	
	Bias resistance	2.09	2.2	2.31	k Ω		
	Input signal negative peak level	0.7			V		
	Maximum input signal			1.3	Vpp		
	Narrowband frequency range	300		3400	Hz	See note 1 below	
	Wideband frequency range	150		6800	Hz	See note 1 and note 6 below	
	Extended band frequency range	150		10000	Hz	Optional, see note 1 below. Codec limited bandwidth	
	Cross talk			-50	dB	Note 7, Note 10	
Composite video							

Signal name	Function / Parameter	Min	Typ	Max	Unit	Notes
	Video signal		1		Vpp	± 3dB
	Source impedance		75		Ω	
	Serial resistance			4	Ω	
	Source capacitance			40	pF	
	Band width		10		MHz	
PLUGDET	Contact resistance			10	Ω	Grounded when plug inserted.

Note 1: Maximum attenuation -3 dB referred to 1 kHz.

Note 2: With 0.5 Vpp output level to 32 ohm load.

Note 3: For mainstream products.

Note 4: For music products.

Note 5: Input sampled 5ms interval, two consecutive samples need to be low for interrupt.

Note 6: In case the terminal supports wideband call, voice clips, multimedia messages or similar, wideband frequency ranges are used, otherwise narrowband values.

Note 7: Electrical cross talk between audio output and audio input, caused by common ground resistance.

Note 8: Entertainment audio, for example mp3-audio, FM-radio. Excluding cellular telephone audio.

Note 9: SNR specified with 948mVpp limited output (EN50332-2).

Note 10: Applicable with specified impedance values for headset and common ground impedances.

Note 11: EN50332-2 standard specifies maximum of 150mV long term RMS to 32 ohm load using test signal with 10dB crest factor.

$$150\text{mV}_{\text{rms}} + 10\text{dB} = 474\text{mVp} = 948\text{mVpp}$$

Terminal tolerances need to be taken into account to meet 948mVpp max signal level.

Note 12: Mic bias must be capable to supply enough current in case microphone line is short circuited to GND during accessory detection. Worst case occurs with max bias voltage together with min bias resistance.

3.2.2 Accessory electrical characteristics

Signal name	Function	Min	Typ	Max	Unit	Notes
GND	Common ground					
	Resistance				mΩ	See Table 3: Terminal electrical characteristics"

HSEARL & HSEARR	Audio output					
	Earpiece load impedance				Ω	See Table 3: Terminal electrical characteristics"
	Sensitivity	Max sensitivity is specified according to EN50332-2 specification, where the headset input wide band characteristic voltage VBCV shall be $\geq 75\text{mV}$ when SPL reaches 94 dB SPL. See EN50332-2 specification for details.				
HSMIC	Audio input					
	Bias load	100		500	μA	Standard headset / TTY
	Send/End button					
	Resistance to GND		22	100	Ω	R1 in Figure 3
	Microphone / audio level					
	Usage sensitivity	-62	-57	-45	dBV	Standard headset. See note 1 below
HSMIC	Composite video					
	Cable impedance		75		Ω	$\pm 5 \Omega$, see note 2 below

Table 4: Accessory electrical characteristics

Note 1: With nominal input signal -4.7dBPa in MRP.

Note 2: Additional 470uF – 2200uF serial capacitance recommended in Japanese market. Capacitor decreases current consumption but initial detection is more complicated without the DC component.

3.3 Accessory detection voltages

This section describes voltage thresholds used in Nokia AV connector's accessory detection.

Nokia AV accessory detection is based on voltage measurement from microphone line in different types of biasing and impedance loading cases. Voltage detection is made by using comparators and/or ADCs. Accessory detection flow diagram is shown in Figure 4.

3.3.1 Detection point 1

Table 5 gives voltage threshold limit for Detection point 1. Detection point 1 separates video cable or headphone from other accessories. See also Figure 4.

Device	Min	Typ	Max	Unit	Notes
MicBias enabled					
Detection threshold 1	0.4	0.6	0.7	V	Valid also for button detection

Table 5: Detection Point 1 detection

Note: < Detection threshold 1 ---> video cable or headphone
> Detection threshold 1 ---> other accessory

3.3.2 Detection point 2 (video cable/headphone detection)

Table 6 gives voltage threshold limits for Detection point 2. Detection point 2 separates video cable from headphone. For more information, see Figure 4.

Device	Min	Typ	Max	Unit	Notes
MicBias enabled					
Headphones	0		40	mV	
Video cable (connected to TV)	40		90	mV	

Table 6: Video cable/headphone detection

3.3.3 Detection point 3 (open cable/accessory detection)

Detection point 3 separates open cable from other accessories. In Detection point 3 microphone load 100uA-500uA has to be separated from the open cable. Therefore pull-up and threshold voltage have to fulfill following equation:

$$\frac{V_{\text{pull-up}_{\text{max}}} - V_{\text{threshold}}}{R_{\text{pull-up}_{\text{min}}}} \leq 100 \mu A$$

If the detection result is “open cable” then phone gets to an open cable loop, where open cable/accessory detection starts over. Therefore open cable pull up current consumption needs to be taken into account in design phase.

For example, two commonly used pull up scenarios are described in Table 7

Device	Min	Typ	Max	Unit	Notes
Pull-up scenario 1					
Detection threshold 3	1.75			V	
Pull-up voltage		2.5	2.6	V	
Pull-up resistance	9			kΩ	
Pull-up scenario 2					
Detection threshold 3	1.75			V	
Pull-up voltage		2.1	2.25	V	
Pull-up resistance	5.5			kΩ	

Table 7: Open cable detection

Note:	< Detection threshold 3 ---> accessory
	> Detection threshold 3 ---> open cable

3.3.4 Detection point 4 (basic headset detection)

Table 8 gives voltage threshold limits for Detection Point 4. Detection Point 4 is used to detect basic headset. See also Figure 4.

Device	Min	Typ	Max	Unit	Notes
Mic line grounded					
Basic headset	0		0.2	V	
Reserved for future use	0.2	0.3	0.4	V	
Reserved for future use	0.5	0.6	0.7	V	
Reserved for future use	0.8	0.9	1.0	V	
Reserved for future use	1.1	1.2	1.3	V	

Table 8: Detection point 4 detection

3.4 Video formats

Table 9 gives an overview of different video formats. Picture aspect ratios can be 4:3 or 16:9.

Region	Frame rate	Color subcarrier	Cable insertion 75 Ω load detection
PAL: Europe	50.00 Hz	4.43361875 MHz	Detection can be done with DC or AC measurement method.
PAL: Argentina	50.00 Hz	3.58205625 MHz	
PAL: Brazil	59.94 Hz	3.57561149 MHz	
NTSC: US	59.94 Hz	3.579545 MHz	
NTSC: Japan	59.94 Hz	3.579545 MHz	Video signal DC bias < 0.15 V expects serial capacitor in the, cable and so cable insertion load detection requires AC measurement.

Table 9: Video formats

3.5 Grounding

It is important to keep common ground resistance low in the terminal and accessories to avoid electrical echo through common ground from ear to microphone input. In accessories common ground needs to be designed so that the ear to mic path resistance is minimized, and therefore microphone and earpieces must have separate ground lines. Also, in stereo headsets common ground for earpieces is related to headset performance.

4 Functional description

In the initial state, only PLUGDET is active; all other pins are not active.

4.1 Accessory detection

Accessory detection begins with plug detection. Plug detection is based on voltage transition in PLUGDET line, which is pulled up to 1.8V with 100kOhm resistor. When the plug is inserted, it shorts PLUGDET line to ground, which initiates the accessory detection.

The accessory detection is shown in Figure 4. The detection is based on different states of microphone line, and decisions are made based on different DC-levels on the microphone line. Accessory removal is detected in all cases from the PLUGDET signal transition when the plug is removed. If there is an adapter between terminal and accessory, the terminal cannot detect removal of accessory, and only adapter removal is detected.

In order to provide reliable accessory detection, the “minimum of two retries” logic is used. Once the detection routine ends in a decision about the detected accessory, detection routine is executed again from the beginning to verify that it ends with the same decision as the first time. If the same decision is done twice, accessory detection is valid.

The following sections define the detection step by step with different types of accessories.

4.1.1 Basic headset

This section describes the basic headset detection. For reference see Figure 2 and Figure 3.

Indicative detection time with minimum of two retries: ~1600ms

4.1.1.1 Insertion

Note: The time values in this section are only for guidance.

- Falling edge from PLUGDET
- Activate mic bias 2.1V and VCC for switches, wait 20ms for settling
- Check HSMIC voltage level
- Enable HP amplifier, wait ~20ms for settling
- HSMIC voltage level decreased? --> no
- Read Detection point 1 comparator output --> 1 (level above Threshold 1)
- Enable open cable detection
- Read Detection point 3 comparator output --> 0 (level below Threshold 3)
- Set mic bias pin to '0' (grounded)
- Measure HSMIC line voltage with AD converter after delay --> No voltage = 0 – 200mV
- Activate button detection
- Accessory is basic headset

Note: Mic bias is activated constantly only when uplink audio is used.

4.1.1.2 Removal

- Rising edge from PLUGDET
- Set all controls in default state
- Accessory removed

4.1.1.3 Send/end button detection

The send/end button detection is made with Comparator (See Figure 2: Terminal block diagram). When the mic bias is activated, a button press draws the microphone line below the comparator's threshold and this generates an interrupt. There is a digital filter of 62ms to filter out short spikes.

In sleep mode button detection can be made with polling, or by hardware with periodic headset button detection feature.

4.1.2 Headphones

This section describes headphones (earpieces only, no microphone) detection. For reference see Figure 2: Terminal block diagram.

Indicative detection time with minimum of 2 retries: ~600ms

4.1.2.1 Insertion

- Falling edge from PLUGDET
- Activate mic bias 2.1V and VCC for switches, wait 20ms for settling
- Check HSMIC voltage level
- Enable HP amplifier, wait ~20ms for settling
- HSMIC voltage level decreased? --> no
- Read Detection point 1 comparator output --> 0 (level below Threshold 1)
- Measure HSMIC line voltage with AD converter --> level below 40mV
- Deactivate mic bias 2.1V
- Accessory is headphones

4.1.2.2 Removal

- Rising edge from PLUGDET
- Set all controls in default state
- Accessory removed

4.1.3 Video cable

This section describes video cable detection based on DC measurement. If a cable with DC blocking capacitor is used, this method cannot be used and the user should activate video out through MENU. TV out circuits with video load detection can also detect DC blocked loads.

Indicative detection time with minimum of 2 retries: ~600ms

4.1.3.1 Insertion

- Falling edge from PLUGDET
- Activate mic bias 2.1V and VCC for switches, wait 20ms for settling
- Check HSMIC voltage level
- Enable HP amplifier, wait ~20ms for settling
- HSMIC voltage level decreased? --> no
- Read Detection point 1 comparator output --> 0 (level below Threshold 1)
- Measure HSMIC line voltage with AD converter --> level above 40mV and below 90mV
- Deactivate mic bias 2.1V
- Accessory is video cable

4.1.3.2 Removal

- Rising edge from PLUGDET
- Set all controls in default state
- Accessory removed

4.1.4 Adapter

This section describes 3-pole and 4-pole adapter detection. 3-pole adapter follows the same detection sequence as headphones. For reference see Section 4.1.2 on headphones detection.

Following section defines adapter insertion sequence when the adapter is connected first and then accessory to adapter.

4.1.4.1 Insertion

Adapter to terminal:

- Falling edge from PLUGDET
- Activate mic bias 2.1V and VCC for switches, wait 20ms for settling
- Check HSMIC voltage level
- Enable HP amplifier, wait ~20ms for settling
- HSMIC voltage level decreased? --> no
- Read Detection point 1 comparator output --> 1 (level above Threshold 1)
- Enable open cable detection (thus 10kOhm pull-up to 2.5V)
- Read Detection point 3 comparator output --> 1 (level above Threshold 3)
- Accessory is adapter or open cable

Accessory to adapter:

- Interrupt from Comp 2
- Continue accessory detection based on the detection flowchart Figure 4 and Section 4.1.

4.1.4.2 Removal

Adapter to terminal:

- Rising edge from PLUGDET
- Set all controls in default state
- Accessory removed

Accessory to adapter:

Removal of headphones from adapter only generates an interrupt. With other accessories there is no interrupt generated from HW. The only way to detect removal of other accessories is to poll the microphone line with SW.

4.1.5 Unsupported headsets

This section describes unsupported headsets detection. Headsets using differential signaling have a different pin order compared to Nokia AV connector and are not supported. Unsupported headsets should be detected and avoided in accessory detection.

Headset with a differential signaling, such as the old 2.5mm Nokia audio accessory connector, connects Nokia AV connector HSMIC and HSEARL lines together through the headset earpiece. Unsupported headsets can then be detected by measuring the state of the HSMIC line with different impedance loads on the HSEARL line.

When the loading on the HSEARL line is changed, the change can be measured from HSMIC line by ADC. Loading of the HSEARL can be controlled, for example, by changing the state of HP amplifier from ON to OFF.

The detection method can be different if HP amplifier does not behave accordingly.

4.1.5.1 Insertion

- Falling edge from PLUGDET
- Activate mic bias 2.1V and VCC for switches, wait 20ms for settling
- Check HSMIC voltage level
- Enable HP amplifier, wait ~20ms for settling
- Check HSMIC voltage level again
- HSMIC voltage level decreased? --> Yes
- Not supported headset

4.2 FM-radio antenna

The HS EAR lines are used for FM antenna reception. Nokia 5300 and Nokia 7390 are the reference phones in FM performance. Nokia HS-47 shall be used as the reference headset for FM performance tuning and testing.

5 Terms and abbreviations

Term or abbreviation	Meaning
ASIC	Application Specific Integrated Circuit
AV	Audio/Video
BB	Base Band
CDMA	Code Division Multiple Access
EMC	Electromagnetic compatibility
FM	Frequency Modulation
GND	Ground
GSM	Global System for Mobile communication
HW	Hardware
IF	Interface
MRP	Mouth Reference Point
OMTP	Open Mobile Terminal Platform (http://www.omtp.org/)
SPR	Standard Product Requirements
SPL	Sound Pressure Level
WCDMA	Wideband Code Division Multiple Access

6 Evaluate this resource

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