



NOKIA 12 GSM MODULE HARDWARE INTEGRATION MANUAL

NOKIA



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RX-9:

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Your device may cause TV or radio interference (for example, when using a telephone in close proximity to receiving equipment). The FCC or Industry Canada can require you to stop using your telephone if such interference cannot be eliminated. If you require assistance, contact your local service facility. This device complies with part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference.



ACRONYMS AND TERMS

Acronym/term	Description
A	Ampere
AC	Alternating Current
A/D	Analog-to-Digital
AM	Application Module
API	Application Programming Interface
AT	ATtention (command language)
°C	Celcius
CE	Mark for a product that fulfils the EU safety and R&TTE requirements
CORBA	Common Object Request Broker Architecture
CMOS	Complementary Metal-Oxide Semiconductor
CSD	Circuit Switched Data
CTS	Clear To Send
dB	Decibel
dBi	Antenna Gain
DC	Direct Current
DCD	Data Carrier Detect
DCE	Data Circuit Terminating Equipment
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EARN	Earphone Amplifier Inverting Input Pin
EARP	Earphone Amplifier Non-Inverting Input Pin
EDGE	Enhanced Data Rates for Global Evolution
EGSM	Extended GSM
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
F	Farad
°F	Fahrenheit
FCC	Federal Communications Commission
GGSN	Gateway GPRS Support Node

Acronym/term	Description
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communication
HBM	Human Body Model
Hi-Z	High Impedance
HSCSD	High Speed Circuit Switched Data
HW	Hardware
Hz	Hertz
IC	Integrated Circuit
IP	Internet Protocol
M2M	Machine-to-machine
MICN	Microphone amplifier inverting input pin
MICP	Microphone amplifier non-inverting input pin
MMCX	Miniature Microax
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
RF	Radio Frequency
RI	Ring Indicator
RS-232	Interface, standardised by the Electronic Industries Alliance (EIA), for communication between computers, terminals, and modems
RTS	Request to Send
RX-2	Type designation for the Nokia 12 GSM module (EGSM 900/GSM 1800 MHz bands)
RX-9	Type designation for the Nokia 12 GSM module (GSM 850/GSM 1900 MHz bands)
SIM	Subscriber Identity Module
SMS	Short Message Service
SW	Software
TCP	Transmission Control Protocol
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
V	Volt
W	Watt



1. ABOUT THIS DOCUMENT

This document provides instructions for the Nokia 12 GSM module (hereafter Nokia 12 module) hardware integration. The document is intended to help the system integrator to integrate the Nokia 12 module into a remote end hardware application and to gain the necessary type approvals.

The document describes the mechanical, electrical and radio frequency (RF) integration as well as antenna installation.



Note: For more information on the Nokia 12 module usage and software integration, see the *Nokia 12 GSM Module Product Specification*, *Nokia 12 GSM Module Software Developer's Guide*, *Nokia 12 GSM Module Java™ IMlet Programming Guide* and *Nokia 12 GSM Module Test Board Product Specification*.



2. INTRODUCTION

The Nokia 12 module has been designed for M2M (machine-to-machine) applications and other wireless solutions. There are two versions of the Nokia 12 module:

- RX-2 dual-band GSM device supporting EDGE, GPRS, HSCSD, CSD, and SMS in EGSM 900/GSM 1800 MHz bands



Note: An enhanced version of the RX-2, Nokia 12i module, includes GPRS class 10, EDGE class 6, AMR voice codec, and RoHS-free hardware.

- RX-9 dual band GSM device supporting EDGE, GPRS, CSD, SMS in GSM 850/GSM 1900 MHz bands.

The Nokia 12 module can be used in several applications due to its three different operating modes. Simple I/O applications can be easily implemented by using the Nokia 12 module in the User control mode that offers message personalising, secure messaging, and timing functionality for SMS controlled I/O applications. In the AT command mode, the Nokia 12 module can be used as a GSM modem. In modem use, all supported bearers are available. The Nokia 12 module is Nokia M2M Platform compatible. In the M2M system mode, the Nokia 12 module communicates with the server application through the Nokia M2M Gateway, and all the compatible features of the Nokia 12 module are available for developing a wide range of M2M applications.

In addition to the different operating modes, the Nokia 12 module has an integrated TCP/IP stack which enables direct GPRS or GSM data connection between a remote end application and a server application. Due to the integrated TCP/IP stack, the HTTP and Socket APIs of the Nokia 12 are available for application development.

In addition to the bearers and operating modes listed above, the Nokia 12 supports several Java™ APIs, location service for external GPS module integration, reliability features like AutoPIN, GSM encryption and security codes, reset mechanism and Nokia M2M Platform authentication. Java technology support enables upgrading the application software over-the-air, and smart messaging makes the installation flexible. GSM phase 2+ supplementary services enable voice application development.




Note: All data bearers as well as TCP/IP are dependent on network support.



3. MECHANICAL INTEGRATION

The Nokia 12 module contains two holes for mounting screws. The screws can be used in mounting, but are not compulsory.



Note: If you are going to use the Nokia 12 module in a rough environment, the use of screws (or plastic PCB support) is recommended.

3.1 DIMENSIONS

The general dimensions and overall area of the Nokia 12 module are listed in Table 1 and Table 2.

Table 1. General dimensions of the Nokia 12 GSM module (in millimetres and inches)

Height	36 mm	1.41 inch
Width	45 mm	1.77 inch
Thickness	9 mm	0.35 inch

Table 2. Overall area of the Nokia 12 GSM module (in square centimetres and square inches)

Area	16.2 cm ²	2.48 inch ²
------	----------------------	------------------------

The detailed physical dimensions (in millimeters) of the Nokia 12 module are shown in Figure 1.



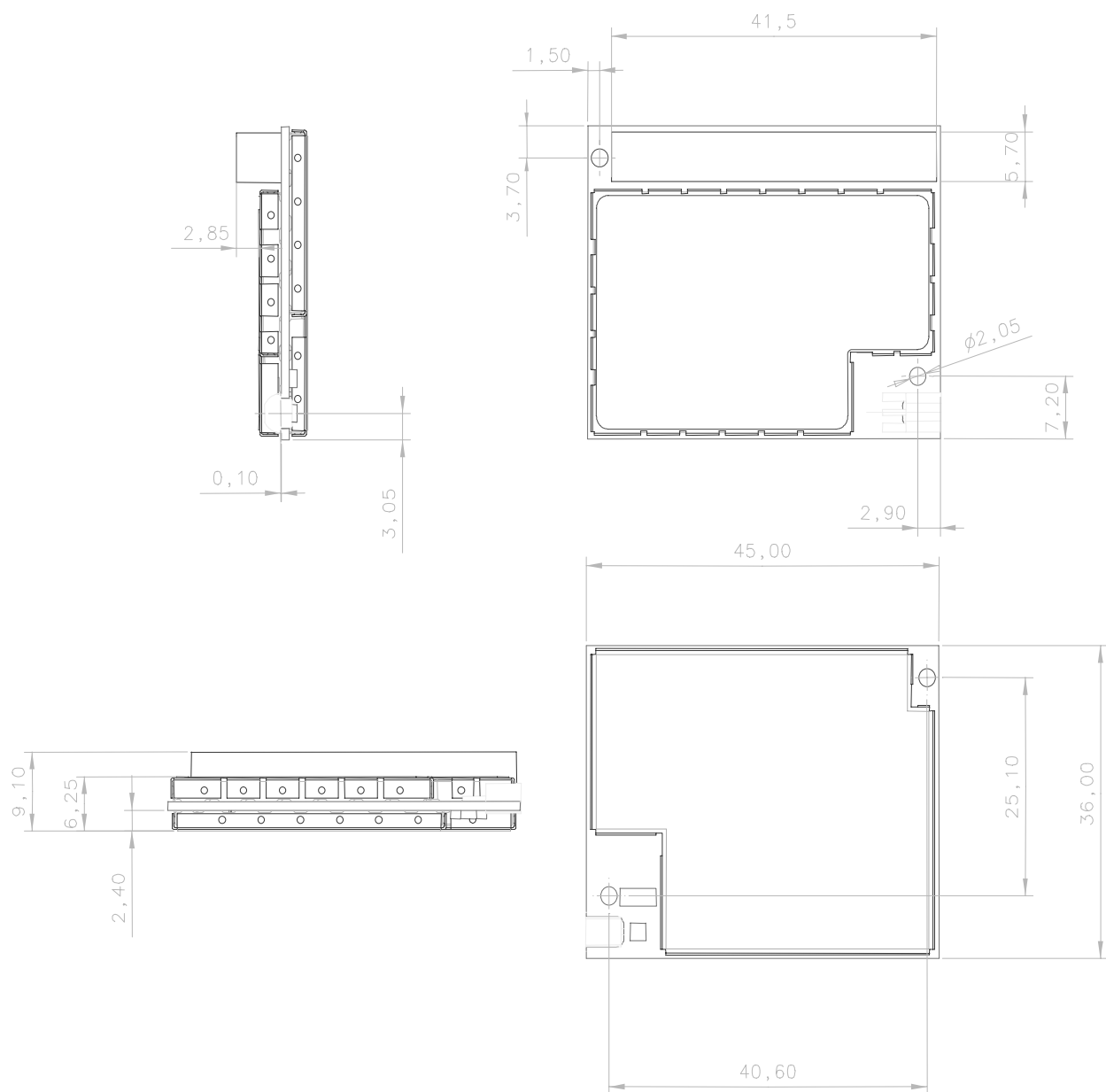


Figure 1. Detailed physical dimensions of the Nokia 12 GSM module (in millimetres)

4. ELECTRICAL INTEGRATION

4.1 M2M SYSTEM CONNECTOR

All signals are routed through the M2M System Connector, except the antenna, which is routed through the miniature microax (MMCX) RF connector.

The M2M System Connector is a 60-pin (2 rows, 30 pins per row), 1.27 mm/0.05 inch pitch pin header connector. It has a frame that helps in the physical integration and also holds the Nokia 12 module firmly in position.

The possible mating connector is described in Table 3.

Table 3. Possible mating connectors for the Nokia 12 module

Supplier	Part number	Description
SAMTEC	SFMC-130-02-S-D	Female connector. Board-to-board
SAMTEC	SFM-130-02-S-D	Female connector. Board-to-board. With alignment mark.

Table 4 defines the recommended operating conditions for the actual device and/or interface operation, and Table 5 defines the absolute maximum ratings.

Table 4. Recommended operating conditions

Parameter	Value	Note
Supply Voltage (V_{BB})	3.6...4.0 V (3.8 V typical)	Voltage must never drop below the low limit.
Logic voltage (I/O voltage)	1.8...5.0 V	
DC output source or sink current (any I/O pin, user adjustable)	0...5 V	Upper limit depending on I/O voltage.
Operating temperature range	-10...+55 °C +14...+131 °F	

Table 5. Absolute maximum ratings

Parameter	Value
Supply voltage	+4.2 V
DC input voltage (any signal pin)	-0.5...5.5 V



Parameter	Value
Operating temperature range	-25...+55 °C -13...+131 °F
Storage temperature range	-40...+85 °C -40...+185 °F

4.1.1 Electrical characteristics

All digital outputs (1-9) are open drain outputs, and all pins have a 10 kohm pull-up resistor to I/O voltage.

Table 6. Digital output characteristics

Parameter	Value
Application load resistance	>100 kohm
Application load capacitance	<100 pF
High level output voltage minimum ($I_o = -20\mu A$)	0.67*I/O voltage
Low level output voltage maximum ($I_o = 1mA$)	0.4 V

The analog inputs (AD1-3) have an input range of 2.7 V. All analog inputs have a 100 kohm pull-down resistor inside the Nokia 12 module. The AD channels are calibrated in production and the calibrated range is from 0.03 V to 2.77 V.



Note: Accuracy is not guaranteed outside the calibrated range.

Table 7. Analog input characteristics

Parameter	Nominal
Input impedance	100 kohm
Input voltage range	0 - 2.8 V
Resolution	10 bits
Integral non-linearity	+/-6 mV
Differential non-linearity	+/-9 mV
Temperature drift	< 5 mV

All digital inputs (4-11) are complementary metal-oxide semiconductor (CMOS) inputs, and all pins have a 10 kohm pull-up resistor to I/O voltage.





Table 8. Digital input characteristics

Parameter	Value
Application driving impedance	<100 ohm
Low level input voltage (IO VOLTAGE/pin 52 1.8 - 5V)	0.15 V maximum
High level input voltage ((IO VOLTAGE/pin 52 1.8 - 5V)	1.6 V minimum

Table 9. Microphone input characteristics

Parameter	Nominal	Note
Differential input voltage range for microphone input (MICP & MICN)	0.316 V _{PP}	2.0 V _{PP} maximum
Microphone amplifier input resistor	50 kohm	30 kohm minimum

Table 10. Earphone output characteristics

Parameter	Nominal	Note
Differential output voltage for earphone output (EARP&EARN)	0.316 V _{PP}	2.0 V _{PP} maximum
Load resistance	1 kohm	30 ohm minimum

The IO VOLTAGE (pin 52) selects the logic level of all digital outputs/inputs. The specifications of the digital audio interface are the same as the digital inputs and outputs specifications.

All the M2M System Connector pins can handle 4 kV electrostatic discharge (ESD), classified according to the human body model (HBM).

4.1.2 Connector pin-out

The odd number pins (1, 3, 5, 7...) are on one side of the connector and the even number pins (2, 4, 6, 8...) on the other side. Figure 2 illustrates the pin numbering of the M2M System Connector.



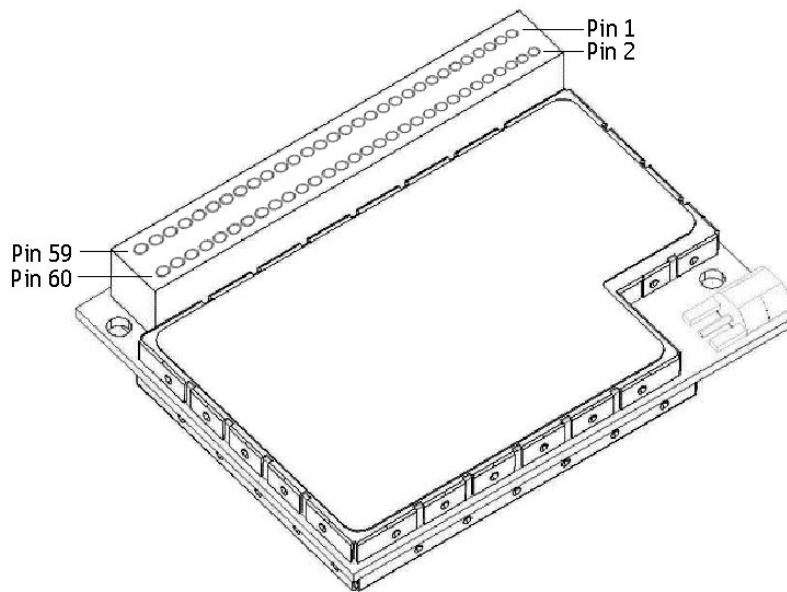


Figure 2. Pin numbering of the Nokia 12 M2M System Connector

The pin-out of the M2M System Connector is shown in Table 11.

Table 11. M2M System Connector pin-out

Pin	Name	Pin	Name
1	VBB	2	GND
3	VBB	4	GND
5	VBB	6	GND
7	VBB	8	GND
9	VBB	10	GND
11	NC	12	NC
13	NC	14	NC
15	MICP	16	EARP
17	MICN	18	EARN
19	AD3	20	AD2
21	PCMDCLK	22	PCMSCLK
23	PCMTX	24	PCMRX
25	RESET T	26	RESET A
27	PORT1RX	28	NC
29	PORT1TX	30	OUTPUT2
31	OUTPUT3	32	OUTPUT4

Pin	Name		Pin	Name
33	OUTPUT5		34	INPUT6
35	INPUT5		36	AD1
37	BSI		38	PORT2RX
39	PORT2TX		40	PORT2RTS
41	PORT2CTS		42	OUTPUT8
43	INPUT8		44	OUTPUT9
45	SLEEPX		46	INPUT11
47	VSIM		48	SIMRST
49	SIMCLK		50	SIMDATA
51	SIMDET		52	IO VOLTAGE
53	OUTPUT1/P3RX		54	INPUT4/P3TX
55	INPUT10		56	INPUT7
57	OUTPUT6		58	OUTPUT7
59	INPUT9		60	NC

The pin functions are described in Table 12.

Table 12. M2M System Connector pin descriptions

Pin	Name	Description
1	VBB	<p>Device power. Voltage nominal 3.8 V, 3.6 V – 4.0 V, maximum current 2A peak. Regulated power input for the Nokia 12 module.</p> <p>All V_{BB} pins must be connected together at the application end. The device end is not fuse-protected, so the application should provide sufficient overload protection.</p> <p>Current consumption can be as high as 2 A when transmitting at full power. When the Nokia 12 module is transmitting data, there is a current peak (max. 2A) at 4.6 ms intervals that lasts 0.577ms (1 TX slot) or 1.154 ms (2 TX slots). Average power consumption is about 500 mA. The power supply should be designed according to this.</p> <p>If the operating voltage falls below 3.4 V, the Nokia 12 module automatically shuts down. For more information on the power supply, see Chapter 4.3.</p>
2	GND	<p>Return ground for device power. These pins are used for device power (V_{BB}) return ground. Connect to common ground. All GND pins must be connected at</p>

Pin	Name	Description
		the application end. For more information on grounding, see Chapter 4.2.
3	VBB	See PIN 1
4	GND	See PIN 2
5	VBB	See PIN 1
6	GND	See PIN 2
7	VBB	See PIN 1
8	GND	See PIN 2
9	VBB	See PIN 1
10	GND	See PIN 2
11	NC	Not used
12	NC	Not used
13	NC	Not used
14	NC	Not used
15	MICP	MICP is used with analog audio as differential positive input. The line is AC coupled at the device end. Frequency response is 300 - 3400 Hz. For more information on the analog audio, see chapter 4.6.1.
16	EARP	EARP is used with analog audio as differential positive output. Frequency response is 300 - 3400 Hz. For more information on the analog audio, see Chapter 4.6.1.
17	MICN	MICN is used with analog audio as differential negative input. The line is AC coupled at the device end. Frequency response is 300 - 3400 Hz. For more information on the analog audio, see chapter 4.6.1.
18	EARN	EARN is used with analog audio as differential negative output. Frequency response is 300 - 3400 Hz. For more information on the analog audio, see chapter 4.6.1.
19	AD3	Input for 10 bit analog-to-digital (A/D) converter. The application end must scale voltage level between 0 - 2.8 V.
20	AD2	See PIN 19
21	PCMDCLK	PCMDCLK is a 512 kHz digital audio clock from the application module. Logic level is set by the IO VOLTAGE pin (pin 52). For more information on the digital audio, see Chapter 4.6.2.
22	PCMSCLK	PCMSCLK is one PCMDCLK cycle that repeats itself every 64 PCMDCLK cycles. Frame sync frequency is thus is 8 kHz. The logic level is set by the IO

Pin	Name	Description
		VOLTAGE pin (pin 52). For more information on the digital audio, see Chapter 4.6.2.
23	PCMTX	Digital audio, transmits data from the device to the application. Logic level is set by the IO VOLTAGE pin (pin 52). For more information on the digital audio, see Chapter 4.6.2.
24	PCMRX	Digital audio, receives data from the application to the device. Logic level is set by the IO VOLTAGE pin (pin 52). For more information on the digital audio, see Chapter 4.6.2.
25	RESET T	Reset input for the Nokia 12 module, active low. The Nokia 12 module is reset when this line is low. Logic level is set by the IO VOLTAGE pin (pin 52). Minimum duration is approximately 500 ms.
26	RESET A	The M2M System Protocol 2 reserves this pin when a link is being established between an Application Module (AM) and the Nokia 12 module. If the link is not established, the pin resets the AM automatically at 60-second intervals.
27	PORT1RX	PORT1 receive. PORT1RX is an asynchronous serial channel receive pin. Functionality otherwise as in pin 29, PORT1TX. Logic level is set by the IO VOLTAGE pin (pin 52).
28	NC	Not used
29	PORT1TX	PORT1 transmit. PORT1TX is an asynchronous serial channel transmit pin that can be used with pin 27 (PORT1RX) to form a full duplex serial link. Pins 30-35 can be used to provide handshaking functions. Logic level is set by the IO VOLTAGE pin (pin52)
30	OUTPUT2	Digital output from device. Logic level is set by the IO VOLTAGE pin (pin 52). If the AT command mode is active, this pin is used as a Data Carrier Detect (DCD) output for Port 1.
31	OUTPUT3	Digital output from module. Logic level is set by the IO VOLTAGE pin (pin 52). If the AT command mode is active, this pin is used as Data Set Ready (DSR) output for Port 1.
32	OUTPUT4	Digital output from module. Logic level is set by the I/O voltage pin (pin 52). If the AT command mode is active, this pin is used as Clear To Send (CTS) output for Port 1.
33	OUTPUT5	Digital output from module. Logic level is set by the IO VOLTAGE pin (pin 52). If the AT command mode is active, this pin is used as Ring Indicator (RI) output for Port 1.
34	INPUT6	Digital input to module. Logic level is set by the IO

Pin	Name	Description
		VOLTAGE pin (pin 52). If the AT command mode is active, this pin is used as Request To Send (RTS) input for Port 1.
35	INPUT5	Digital input to module. Logic level is set by the IO VOLTAGE pin (pin 52). If the AT command mode is active, this pin is used as Data Terminal Ready (DTR) input for Port 1
36	AD1	Input for 10 bit A/D converter. The application end must scale voltage level between 0 to 2.8 V.
37	BSI	Input for 10 bit A/D converter. The application end must scale voltage level between 0 to 2.8 V.
38	PORT2RX	PORT2 receive. PORT2RX is an asynchronous serial channel receive pin and it is used with pin 39. Logic level is set by the IO VOLTAGE pin (pin 52).
39	PORT2TX	PORT2 Transmit. PORT2RX is an asynchronous serial channel transmit pin that is used with pin 38. Logic level is set by the IO VOLTAGE pin (pin 52).
40	PORT2RTS	RTS for PORT2. PORT2RTS provides handshaking signal for asynchronous communication between the Nokia 12 module and the application when using PORT2. Works together with pin 41. Logic level is set by the IO VOLTAGE pin (pin 52).
41	PORT2CTS	CTS for PORT2. PORT2CTS provides handshaking signal for asynchronous communication between the Nokia 12 module and the application when using PORT2. Works together with pin 40. Logic level is set by the IO VOLTAGE pin (pin 52).
42	OUTPUT8	Digital output from the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
43	INPUT8	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
44	OUTPUT9	Digital output from the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
45	SLEEPX	Sleep indicator of the Nokia 12 module. When the Nokia 12 module is in the sleep mode, the level of this output pin is low, otherwise high. The sleep mode is automatic. Logic level is set by the IO VOLTAGE pin (pin 52).
46	INPUT11	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
47	VSIM	Operating voltage for the SIM card, generated by the Nokia 12 module. For more information on the SIM interface, see Chapter 4.5.
48	SIMRST	Reset signal for the SIM card, generated by the Nokia 12 module. For more information on the SIM

Pin	Name	Description
		interface, see Chapter 4.5.
49	SIMCLK	Clock signal for the SIM card, generated by the Nokia 12 module. For more information on the SIM interface, see Chapter 4.5.
50	SIMDATA	Data line between the SIM card and the Nokia 12 module. For more information on the SIM interface, see Chapter 4.5.
51	SIMDET	SIM card detection signal. For more information on the SIM interface, see Chapter 4.5.
52	IO VOLTAGE	This pin sets logic level for the application. Voltage must be 1.8 V - 5.0 V. For more information on the power supply, see Chapter 4.3.
53	OUTPUT1 / PORT3RX	Digital output from the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52). If PORT3 is configured for serial communication, this is a receive (input) signal. Note! Direction changes if pin 53 is configured for serial communication.
54	INPUT4 / PORT3TX	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52). If PORT3 is configured for serial communication, this is a transmitter (output) signal. Note! Direction changes if pin 54 is configured for serial communication.
55	INPUT10	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
56	INPUT7	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
57	OUTPUT6	Digital output from the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
58	OUTPUT7	Digital output from the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
59	INPUT9	Digital input to the Nokia 12 module. Logic level is set by the IO VOLTAGE pin (pin 52).
60	NC	Not used



4.2 GROUNDING

There is only one common ground for the power supply and I/Os in the Nokia 12 module. That is, there are no separate analog/digital ground pins in the M2M System Connector.

All ground pins must be connected together at the application end. Grounding through screws is not allowed. The mounting screws must be isolated from the application ground.

4.3 POWER SUPPLY

The Nokia 12 module is powered by the hardware application to which it is integrated. The operating voltage must not fall below the specification limit under any circumstances. The recommended operation conditions are shown in Table 4. For example, at full power, the TX can be up to 2 A, when current is drawn from the power supply. There are no capacitors on the power supply line of the Nokia 12 module, so the application must provide sufficient filtering.

The power supply must be capable of supplying at least 3 W average power, but it is recommended that the power supply also provides the peak current. Otherwise a large capacitor bank is needed to compensate the voltage drop during transmit bursts.

The Nokia 12 module does not have protection for over-voltage of current, so the hardware application must be equipped with one if there is a possibility for over-voltage. The hardware application should at least include a fuse.

The ripple on the operating voltage must not exceed 100 mV and the voltage must never drop below 3.6 V during operation.

The application must also produce I/O voltage. The logic levels of digital inputs and outputs correspond to this I/O voltage. I/O voltage can be supplied from a linear regulator.

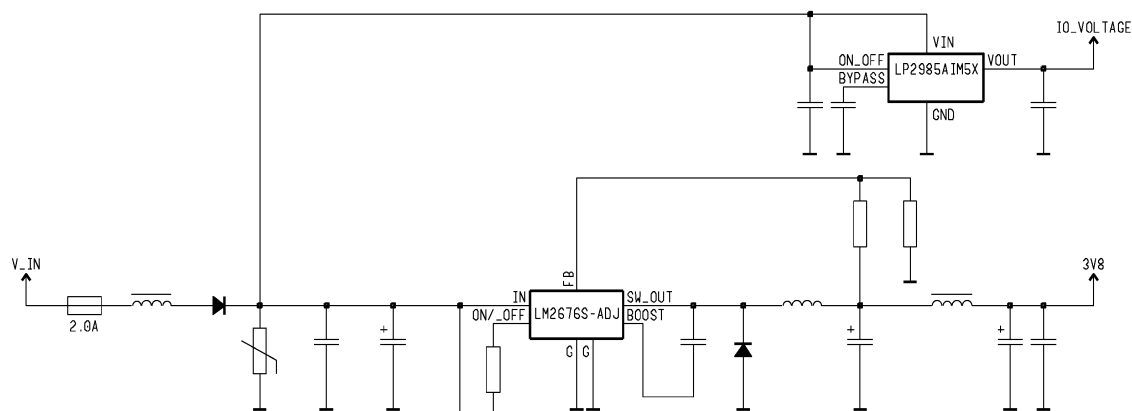


Figure 3. Example powering with simple DC/DC converter and linear regulator

4.4 SERIAL COMMUNICATION

The Nokia 12 module is accessible through three different asynchronous serial interfaces with different protocols. The pins provide one asynchronous channel with a simple handshaking capability. The usage of the 3 ports can be configured with the Nokia 12 Configurator software. The Nokia 12 Configurator is downloadable at www.forum.nokia.com/m2m free of charge.

The Nokia 12 module supports the industry standard DB9 RS-232C connection, but an external level converter is required. For more information on the available handshake signals for different ports, see Chapters 4.4.1, 4.4.2 and 4.4.3.

The Nokia 12 module is a DCE (Data Communication Equipment) and the hardware application to which it is integrated is a DTE (Data Terminal Equipment). One possible method of implementing the level conversions is to use a MAX3237 transceiver or an equivalent integrated circuit (IC) level converter.



Note: When port settings are changed, the new settings will not become valid until the Nokia 12 module is restarted.

4.4.1 PORT1

PORT1 provides the first asynchronous channel. This port can be used with full 8 signal RS-232 handshaking signals. The baud rate for PORT1 can be between 1200 and 230400 bit/s.



Note: Baud rate 230400 bit/s can be used only with AT command mode and autobauding.

There are several settings for PORT1. The default setting for PORT1 is 'HW Detection'. This means that when a 68 kohm resistor is set between the BSI (pin 37) and the ground, the Nokia 12 module enters the AT command mode when it is started. It is also possible to set the AT command mode on by using the Nokia 12 Configurator (the connection type is set to 'AT').

The Nokia 12 module provides all signals for the industry standard DB9 RS-232C connection, but an external level converter is required.

4.4.2 PORT2

PORT2 provides the second asynchronous channel with a simple handshaking capability (only RTS and CTS). The baud rate for PORT2 can be set to 9600, 19200, 38400, 57600 or 115200 bit/s. PORT2 is the default port for using the M2M System Protocol. However, if PORT1 is configured to use the M2M System Protocol, PORT2 cannot be used.

4.4.3 PORT3

PORT3 provides the third asynchronous channel with no hardware handshakes. The baud rate for PORT3 can be set between 1200 and 115200 bit/s.

4.5 SIM INTERFACE

All leads from the M2M System Connector to the SIM card reader must be shorter than 15 cm/5.9 inches, because the voltage drop and increasing capacitance will affect timing. Furthermore, it is recommended that a 100 nF bypass capacitor is placed as close as possible to the SIM reader on the VSIM (pin47) line.

The leads between the M2M System Connector and the SIM card reader must be protected against interferences, and that is why the striplines must always be placed within the interlayers of the printed circuit board (PCB).



Note: The striplines must never be placed to the overlayer of the PCB.

A possible SIM card reader supplier is listed in Table 13.

Table 13. Possible SIM card reader supplier

Supplier	Part Number	Description
Amphenol	M-C707_10M006_522_2	SIM reader with a lid open indication switch.

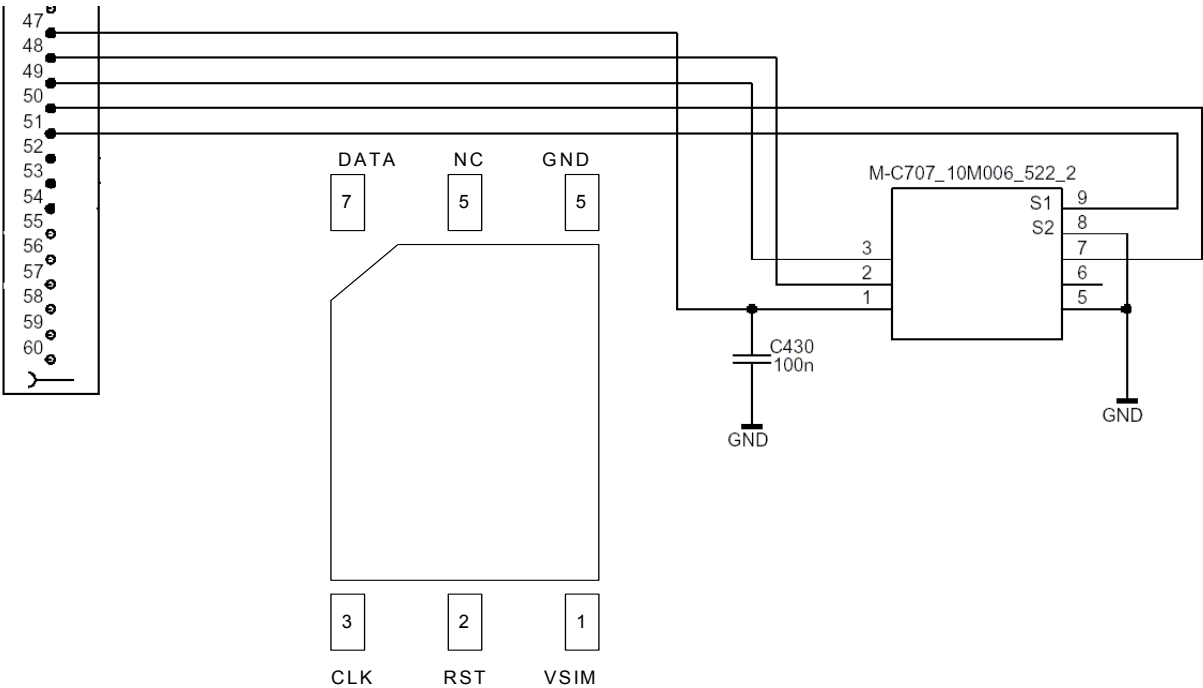



Figure 4. SIM card connections (using Amphenol)

The Nokia 12 module supports 1.8 V and 3 V SIM cards, and it automatically sets the correct voltage according to the SIM card that is used.



Note: The SIM card reader must have a switch that indicates when the SIM card is being removed, so that the Nokia 12 module can shut it down correctly. The switch must open when the card is removed or the lid is open. The Nokia 12 module has a pull-up in the SIM detection line, so the hardware application must connect the other end of the switch to the ground.

4.6 AUDIO INTERFACE

4.6.1 Analog audio

The M2M System Connector provides possibilities to build different kind of audio applications around the Nokia 12 module.

The analog TX path (from the external application to the Nokia 12 module) has a DC isolation inside the Nokia 12 module with 100 nF capacitors, and these capacitors together with the microphone preamplifier input impedance form a 1st order high pass filter with 32 Hz roll-off (-3 dB).

Table 14. Microphone audio characteristics

Name	Symbol	Min	Type	Max	Units
Differential input voltage range for microphone input (MICP & MICN)			0.316	2.0	V _{PP}
Microphone amplifier input resistor	RMIC	30	50		kohm
Common mode voltage level	VCM	1.3	1.35	1.4	V

The earphone lines from the Nokia 12 module are driven differentially to achieve the best possible audio quality, free of radio frequency noise. In the differential mode, positive output is driven from EARP and negative signal from EARN output.

Table 15. Earphone audio characteristics

Name	Test condition	Min	Type	Max	Units
Output voltage swing in fully differential mode	EARP to EARN		0.316	2	V _{PP}
Output resistance				1	ohm
Load resistance	EARP to EARN (with dynamic transducer)	30		45	ohm
Load resistance	EARP to EARN (with external audio circuitry)	1			kohm
Load capacitance	EARP to EARN (with external audio circuitry)			10	nF
Common voltage level for Earphone output	VCMEar	0.75	0.8	0.85	V
Offset voltage		-50		50	mV

The following chapter gives an example of using the audio properties of the Nokia 12 module for voice communication purposes. The circuits presented in the example illustrate the connection methods.

There are also other possibilities for using the Nokia 12 audio interface. The presented component values are examples only; the customer can adjust the application-specific values to achieve the best performance for the application in question.

4.6.1.1 Analog audio example

Analog TX path: Due to the small audio signal level of the electret microphone, it is recommended to use a preamplifier for the microphone before connecting it to the Nokia 12 module. It is strongly recommended to protect the differential connection against RF noise. A microphone preamplifier with 20 dB input gain is recommended for reasonable uplink audio levels.

Microphone input: See Figure 5.

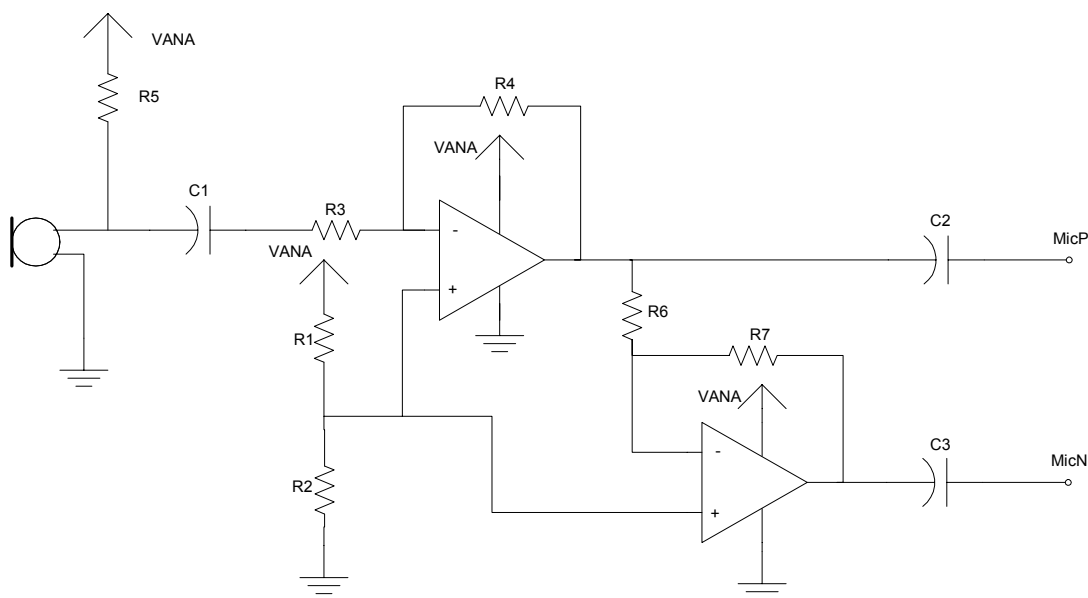


Figure 5. Single-ended microphone pre-amplifier

Analog RX path: In voice applications, the Nokia 12 module is able to drive an earphone application without external electronics. However, it is also possible to build a high-volume loudspeaker application by using an external power amplifier with a high sensitivity loudspeaker. The following paragraphs show example circuits for both cases.

Earphone application: An earphone can be connected to the Nokia 12 module without external components. In Figure 6 external components are used for EMC purposes to optimise audio quality and reliability.

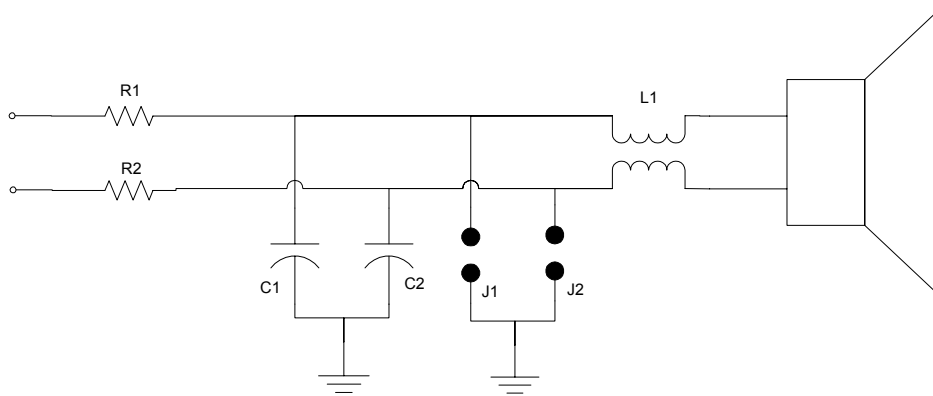


Figure 6. Earphone application circuit

The recommended earphone type is dynamic. The maximum allowed load for this application is 32 ohm. In the example circuit, L1 is the common mode choke for the suppression of common mode disturbance in the earphone lines.

J1 and J2 are surge protector gaps for ESD protection. These can be replaced with varistor or any other state-of-the-art ESD protection component. C1 and C2 are used for RF noise filtering.

R1 and R2 are used as an attenuator if the signal level from the Nokia 12 module is too high for the application. These resistors can be replaced with linear potentiometers and thus get adjustable volume control for the earphone application. The following component list gives example values for the circuit:

- L1= 1000ohm@100MHz
- C1=C2=27pF
- R1=R2= Must be defined together with the sensitivity of the earphone

External Audio Power amplifier: External audio power must be used if there is a need to drive low impedance load as loudspeaker. Figure 7 shows an example connection circuit for differential audio boomer. In this application only the connection interface to the Nokia 12 module is presented. For more detailed information on the boomer connections and specification, see the boomer manufacturer application note.

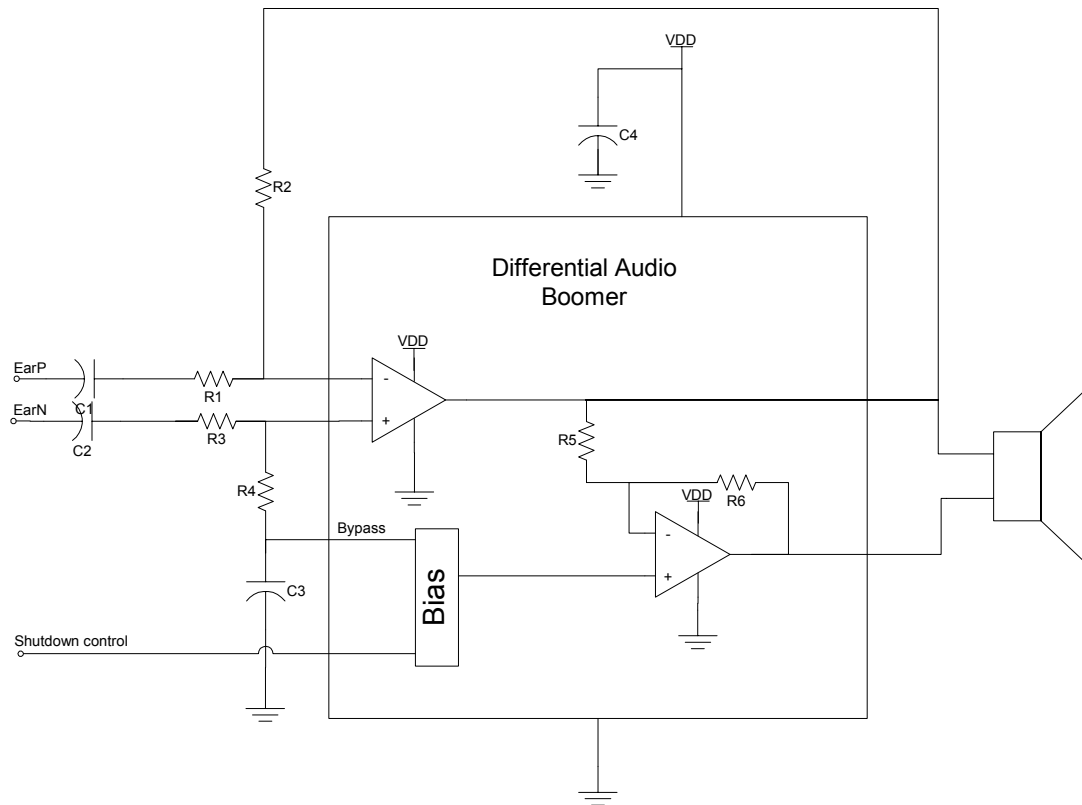


Figure 7. Differential external power amplifier connection

Refer to the audio boomer manufacturer and loudspeaker application notes for information on maximum safe ratings for the selected components. Also keep in mind the limitation of V_{DD} to avoid overdriving the audio boomer and thus distorting the output signal unnecessarily.

4.6.1.2 Acoustic echo

Because in a GSM voice call the uplink and downlink audios are activated at the same time, it is recommended to use common sense when evaluating a suitable distance between the loudspeaker and the microphone. The acoustic echo canceller inside the Nokia 12 module is tuned so that the optimum result is achieved with 20 cm or longer distance between the microphone and the speaker. It is also advisable to locate the microphone and the loudspeaker so that they are pointed away from each other to achieve the best possible double-talk performance.

4.6.2 Digital audio

There is a pulse code modulation (PCM) codec interface in the Nokia 12 module for digital audio support. The digital audio interface supports sign-extended 13-bit linear code (total 16 bits are transmitted).

4.6.2.1 Sign-extended linear code

PCM digital audio data transmission between the Nokia 12 module and the application is handled with four signals: PCMDCLK, PCMSCLK, PCMTX, and PCMRX. The format of the data transmission is sign-extended 13-bit linear code. A total of 16 bits are transmitted, and higher order bits must be sign-extended. Transmission of data commences after frame sync (PCMSCLK) rises high for one PCMDCLK clock cycle. After returning low, each data bit is transmitted on the falling edge of PCMDCLK.

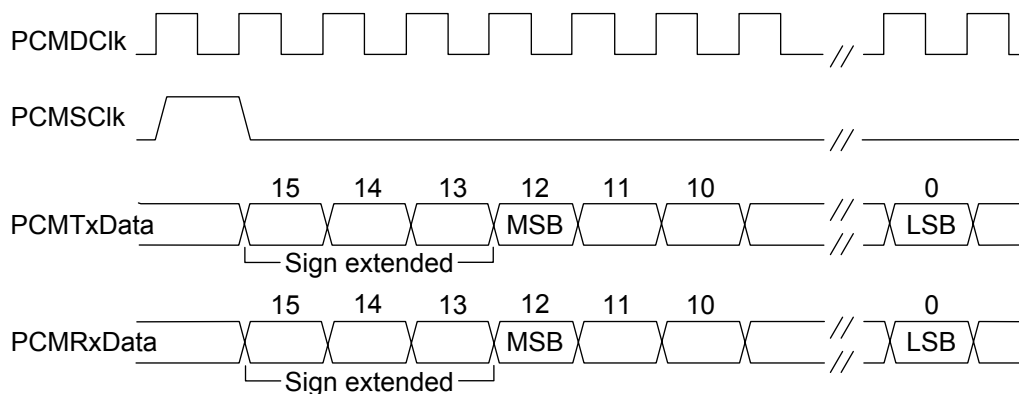


Figure 8. Timing of clock and transmission signals

The application must provide both the PCMDCLK and PCMSCLK. PCMDCLK frequency is 512 kHz and PCMSCLK is repeated at 8 kHz, that is, at every 64th clock cycle. All bits but the 16 data bits following the frame sync are discarded. PCMDCLK has a typical 50 % duty-cycle; a variation of 5 % can be tolerated. For detailed timing, refer to Figure 9 and Table 16. Tcyc is the cycle time (1.953 microseconds) of the 512 kHz clock. The PCMSCLK rising edge must occur at the maximum of 8 ns after the PCMSCLK rising edge.

The pulse width of the frame sync pulse should be one data clock cycle.

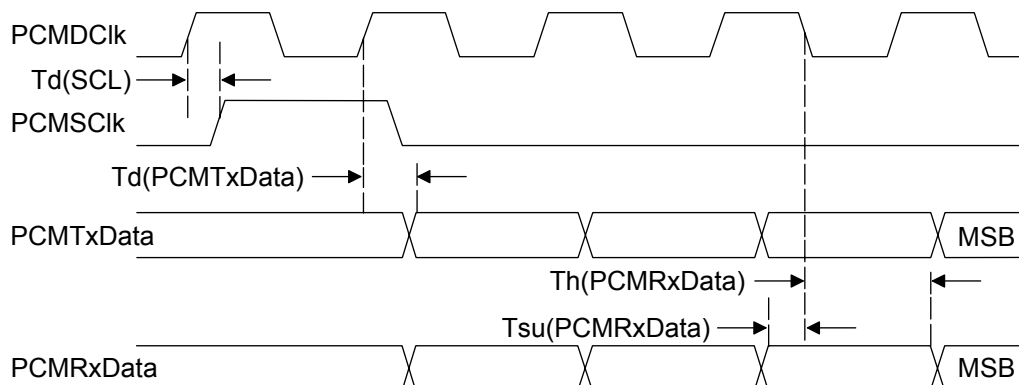


Figure 9. PCM timing diagram

PCM timing characteristics are described in Table 16. The coding format presented in Table 16 is supported, for example, by the Motorola type MC145483 codec.

Table 16. PCM timing characteristics

Parameter	Symbol	Min	Max	Unit
Delay time (PCMSClk valid after PCMDClk rising)	Td(SClk)	0	8	ns
Delay time (PCMTxData valid after PCMDClk rising)	Td(TxData)	5	25	ns
PCMRxData setup time before PCMDClk falling edge	Tsu(RxData)	20	Tcyc-20	ns
PCMRxData hold time after PCMDClk falling edge	Th(RxData)	20	Tcyc-20	ns

5. RF AND ANTENNA INTEGRATION

The RF requirements for the Nokia 12 module are type-dependent:

- RF requirements for the RX-2 type follow the ETSI EGSM900/GSM1800 phase2+ specifications.
- RF requirements for the RX-9 type follow the ETSI GSM850/GSM1900 phase2+ specifications.

Table 17. RF specifications for the Nokia 12 GSM module

Parameter	Value	Description
RF impedance	50 ohm	
RF power	2W (class 4)	EGSM900 & GSM 850
	1W (class 1)	GSM1800 & GSM 1900

The RF signal from the Nokia 12 module to an external antenna goes through the MMCX connector.

An adapter cable between the MMCX connector and the antenna may be needed. Suitable connectors and cables are available, for example, from Amphenol, TYCO, and IMS Connector Systems.

The Nokia 12 module is certified with a Smarteq dual-band antenna (art no: 1140.26 for 900/1800MHz and 1140.27 for 850/1900MHz). Suitable antennas are available, for example, from Smarteq and Hirschmann.

For more information on the RF exposure, see Chapter 6.2.5.


5.1 ANTENNA INSTALLATION

The antenna must be placed within a good RF field; a location where the signal strength is adequate. A hand-portable phone can be used to check the best location for the antenna.



Note: Electronic devices can cause interference, which affects the performance of the Nokia 12 module. Do not place the antenna close to electronic devices or other antennas.

If an additional cable is needed between the antenna and the Nokia 12 module, use low-loss cables (for example RG-58, Amphenol, Suhner, etc.) and connectors. Every additional cable, adapter, and connector increases the loss of signal power.



When designing the hardware application to which the Nokia 12 module is integrated into, it is important to take care of RF emissions. Do not place any sensitive components or striplines near the antenna or the antenna connector.

For more information on the RF exposure, see Chapter 6.2.5.



6. CERTIFICATIONS

The test house requires the following documentation from the application integrator for type approval tests:

- Hardware description
- Schematics
- Block diagram
- PWB/component layout
- Bill of materials
- HW/SW versions used in tests.
- Summary of application
- User's guide

If the application HW or SW changes, the integrator is responsible for verifying the effect, and if needed, to perform all required tests again in an accredited laboratory.

6.1.1 RX-2

The Nokia 12 module (RX-2) is a CE marked device. In order to show compliance to R&TTE requirements, the integrator has to show that all the instructions in this document have been followed in the integration, and a declaration of conformity has been written.

The final product must carry CE marking to show compliance with all the directives that are applicable to it. The numbers of all the Notified Bodies involved in every aspect of the conformity assessment must be shown next to the CE marking with any additional markings that can be needed (for example, Alert symbol for WLAN). The technical documentation explains the role of each Notified Body. If external elements are designed according to this document, only the following tests must be carried out in an accredited laboratory:

- EMC tests in all working modes (EN 301 489-1/7, 3GPP TS 51.010)
- Safety (Europe: EN/IEC 60950)

6.1.2 RX-9

The Nokia 12 module (RX-9) is an FCC equipment authorized device (47CFR 15, 22, 24). If external elements are designed according to this document, only the following tests must be carried out in an accredited laboratory:

- FCC equipment authorization (all applicable parts of 47CFR15)

6.2 TECHNICAL REQUIREMENTS

6.2.1 SIM testing

SIM testing is not needed, because the SIM card reader is a passive component. In the implementation, SIM presence must follow the type approval conditions of the Nokia 12 module. 6- or 8-pin SIM card readers can be used. For more information on the SIM interface, see Chapter 4.5.

6.2.2 Power supply

The power supply must be designed as advised in Chapter 4.3. If this specification is exactly followed and fulfilled, the number of required RF tests is minimized in the type approval process.



Note: If the power supply specification is not followed, the Nokia 12 module type approval is not valid.

6.2.3 EMC/ESD and safety tests

EMC and safety tests according to GSM standards (EN 301 489-1/7, 3GPP TS 51.010 and EN 60 950) are mandatory and must be completed by the application integrator. The integrator should guarantee overall ESD protection in the integrated application (EN 301 489).



Note: The Nokia 12 test board is an ESD supersensitive device.

6.2.4 RF testing

The antenna must be connected to the Nokia 12 module as this document instructs. The antenna impedance has to be as specified in Chapter 5. Further passive RF testing for the type approval is not required. Radiation performance is always the responsibility of the integrator.



Note: If the antenna specification is not followed, the Nokia 12 type approval is not valid.



6.2.5 RF exposure

In order to comply with the RF exposure requirements, install the antenna so that a minimum separation distance of 20 cm/7.9 inch can be maintained between the antenna and all persons.

If some other antenna than the one in the sales package is used, it must be ensured that the maximum antenna gain of 3 dBi is not exceeded.

RX-2

If the application does not provide a separation distance of at least 20 cm/7.9 inch, the integrator must carry out all needed certifications.

RX-9

The Nokia 12 module cannot be used in applications that allow the separation distance between antenna and all persons to be less than 20 cm/7.9 inch.

6.2.6 Additional type approval notes

Changes in the application software have no effect on type approval issues.

If the Nokia 12 module software is updated, no type approval actions are required from the application integrator. All Nokia products are officially type approved.

Any changes to the RF path are not allowed. Power supply instructions must be followed.

RX-9

The Nokia 12 module (RX-9) type label has the FCC ID number to indicate that it is FCC equipment authorized. If the application prevents the label from being visible, the application must be labeled so that it contains the text: "Contains FCC ID LJPRX-9".



REFERENCES

Nokia M2M customer documents

The following Nokia M2M customer documents are available at <http://www.forum.nokia.com/m2m> or <http://www.americas.forum.nokia.com>.

/1/ Nokia 12 GSM Module Software Developer's Guide

/2/ Nokia 12 GSM Module Java™ IMlet Programming Guide

/3/ Nokia 12 GSM Module Product Specification

/4/ Nokia 12 GSM Module Test Board Product Specification

General standards and specifications

*/1/ 3GPP TS 51.010, Digital cellular telecommunication system (Phase 2+)
Mobile Station (MS) conformance specification
/ 3rd Generation Partnership Project (3GPP)*

*/2/ 47CFR 15, 22, 24, Code of Federal Regulations, 47: Telecommunication
Part 15: Radio frequency devices
Part 22: Public mobile services
Part 24: Personal communications services
/ Federal Communications Commission (FCC)*

*/3/ DIN 72300-3 Electrical and electronic equipment for road vehicles -
Environmental conditions - Part 3: Mechanical loads
/ Deutsches Institut für Normung (DIN)*

*/4/ EN 301 489-1/7 Electromagnetic compatibility and Radio spectrum Matters
(ERM); Electro-Magnetic Compatibility (EMC) standard for radio
equipment and services
Part 1: Common technical requirements
Part 7: Specific conditions for mobile and portable radio and ancillary
equipment of digital cellular radio telecommunications systems (GSM and DCS)
/ European Telecommunications Standards Institute (ETSI)*

*/5/ EN/IEC 60950 Safety of Information technology equipment
/ European Committee for Electrotechnical Standardization (Cenelec)*