DM-15/25

Integrator's Manual

Figures

Revision History

RELEASE	DATE	SUMMARY OF CHANGES
A	2/14/02	Initial Release- MCH
P1B	2/27/02	Added FCC warning in 4.3.3
P2B	4/02/02	Removed Developer's Kit and AT Commands. Added FCC and Safety section. Added I/O Description

1 Introduction to the Integrator's Manual

1.1 Overview

This manual is for use as a guide to the setup, installation, and use of the DM-15/25 module into your application. The module may be tested using the Developer's Kit which is supplied together with the a DM-15/25 module and all the necessary tools.
The DM-15/25 module is intended for mounting into an application developer's chassis to provide wireless communication capability for the product. The target chassis could be in a wide variety of forms such as a residential electric meter, a point of sale terminal, an alarm panel, or an automobile console. All initial configuration, mode control, and operational commands are issued to the module over an RS-232 serial port using a flexible AT command format. The module circuitry has been designed to meet the environmental requirements of a large range of commercial and industrial users.

1.2 How to read the manual

This manual is divided into four chapters. **Chapter 2** is Safety & FCC Requirements. **Chapter 3** gives a general overview of the integrator's manual and the intended use of the DM-15/25 module. A list of related documents as well as a list of abbreviations used all through the manual is also included. Information concerning Service and Support is also presented. The description of the DM-15/25 module is presented in **Chapter 4**, including explanation on how to integrate the DM-15/25 with the customer application and the DM-15/25 technical data. **Chapter 5** describes the function of the Signal and data pins. **Chapter 6** describes the recommended circuitry, with reference designs.

Information on the Developer Kit in described in the **Developers Kit Manual**

The full set of *AT* commands available in the DM-15/25 are described in the **AT Command Set Manual.**

1.3 Service and Support

1.3.1 Web Pages

For more information about where you can buy our modules or for recommendations of accessories and components, look at our Web Pages.
The address is:
http://www.sonyericsson.com/m2m/
To register for product news and announcements or for product questions, contact the Sony Ericsson modules Technical Support group:

- **Telephone**: 919-472-1122 (staffed Monday-Friday 8:00 AM – 5:00 PM EST).
- **Email**: modules.supportusa@sonyericssonmobile.com

1.3.2 Component Suppliers

Description	Part #	Additional Information
System Connector	515.569.035.030.xxx	http://www.oduusa.com
Antenna Connector and cabling	Various	http://www.amp.com Amphenol 908-22101

1.4 Related Documents

The DM-15/25 is based upon the following mobile standards:

- Aeris Microburst™ RF Module, Requirements, rev 19.0 (DM-15A, DM-25)
- TIA/EIA/IS-91 – Mobile Station - Base Station Compatibility Standard for 800 MHz Analog Cellular
- TIA/EIA-136-270-A Mobile Station Minimum Performance Standard, August 1999
- FCC Part 15, 22, Radiated Emissions Limits, Public Mobiles Services

These standards define the requirements for a Cellular System mobile station using AMPS analog and TDMA technology.

1.5 Abbreviations

AGND	Analog Ground
AT	Attention command
BMI	Base Mobile Interworking
CLI	Calling Line Identification
CSD	Circuit Switched Data
CTS	Clear To Send
DCCH	Digital Control Channel
DCD	Data Carrier Detect
DFMS	Data From Mobile Station
DTMS	Data To Mobile Station
DTR	Data Terminal Ready
EDB	External Data Bus
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
FCC	Federal Communications Commission
GND	Chassis Ground
IRA	International Reference Alphabet
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
LED	Light-Emitting Diode
LSB	Least Significant Bit
ME	Mobile Equipment
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
NAM	Number Assignment Module
NVM	Non-Volatile Memory
OEM	Original Equipment Manufacturer
PAD	Protocol Adapter
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PIN	Personal Identification Number
RD	Receive Data, also known as DFMS
RF	Radio Frequency
RLP	Radio Link Protocol
RTS	Request To Send
SID	System Identifier
SMS	Short Message Service
TA	Terminal Adapter
TD	Transmit Data, also known as DTMS
TE	Terminal Equipment

2 Safety & FCC Requirements

2.1 Warning: FCC RF Exposure Requirements

This module is approved for mobile operations only with respect to CFR 47 part 2.1091.
If this module is intended to be used as a portable device, the OEM integrators should investigate separate approval to satisfy SAR requirements of 2.1093.

2.2 Warning: Antenna Installation

- At no time is the antenna to be located closer than **27 centimeters** to a normally occupied location or person.
- At no time should an antenna system with greater than 1.0 dB gain be used with this module in any normally occupied area. In an automotive configuration, an antenna with a 2.5dB gain and a minimum 1.5 dB of cable loss should be used.

2.3 Module Operation

Safe and efficient use of this module requires a properly terminated antenna. DO NOT operate the module with a damaged or missing antenna, replace a damaged or missing antenna immediately otherwise damage to the module may result and could violate FCC regulations. DO NOT operate this device within **27 centimeters** of a person unless proper shielding from the antenna is installed.

2.4 OEM Labeling

A label must be affixed to the outside of the end product into which the authorized module is incorporated, with a statement similar to the following:
This device contains TX FCC ID: XXXXXX (where "XXXXXX" is the FCC ID of the module).

2.5 Posted Facilities

Do not operate this device where posted notices require wireless devices to be turned off.

2.6 Electronic Devices

Most electronic equipment is shielded from RF signals. However, certain electronic equipment may not be shielded properly against RF signals.

Pacemakers
The Health Industries Manufacturers Association recommends that a minimum separation of six (6) inches be maintained between a wireless transmitter and a pacemaker to avoid potential interference with the pacemaker. These recommendations are consistent with the independent research and recommendations of Wireless Technology Research. Persons with Pacemakers should always keep the antenna/module more than **27 centimeters** from their pacemaker when the module is on; if you have a reason to suspect that interference is taking place, turn off the module immediately.

Hearing Aids
Some digital wireless devices may interfere with some hearing aids.

Other Medical Devices
If you use any other type of personal medical device in the presence of this transceiver, consult the manufacturer of your device to determine if it is adequately shielded from external RF energy. Your physician may be able to assist you in obtaining this information.

2.7 Blasting Areas

To avoid interfering with blasting operations, turn your module off when in a "blasting area" or in areas posted: "Turn off two-way radio". Obey all signs and instructions.

2.8 Potentially Explosive Atmospheres

Turn your module off when in any area with a potentially explosive atmosphere and obey all signs and instructions. Sparks in such areas could cause an explosion or fire resulting in bodily injury or even death. Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include such areas as gasoline stations; below deck on boats; fuel or chemical storage or transfer facilities; vehicles using liquefied petroleum gas (such as propane or butane); areas where the air contains chemicals or particles, such as grain dust or metal powders; and any other area where you would normally be advised to turn off your vehicle engine.

2.9 Vehicles

RF signals may affect improperly installed or inadequately shielded electronic systems in motor vehicles. Check with the manufacturer or its representative regarding your vehicle. You should also consult the manufacturer of any equipment that has been added to your vehicle.

2.10 For Vehicles Equipped with an Airbag

An airbag inflates with a great force. Do not place objects including both installed or portable wireless equipment in the area over the airbag or in the airbag deployment area. If in-vehicle wireless equipment is improperly installed and the airbag inflates, serious injury could result.

2.11 Responsible Use

OEM Manufacturers providing telematic devices for vehicular use are encouraged to incorporate the following CTIA guidance for safe and responsible wireless communication device use into their user's manuals:

2.11.1.1 A Guide to Safe and Responsible Wireless Communication Device Use

TENS OF MILLIONS OF PEOPLE IN THE U.S. TODAY TAKE ADVANTAGE OF THE UNIQUE COMBINATION OF CONVENIENCE, SAFETY AND VALUE DELIVERED BY THE WIRELESS COMMUNICATION DEVICE. QUITE SIMPLY, THE WIRELESS COMMUNICATION DEVICE GIVES PEOPLE THE POWERFUL ABILITY TO COMMUNICATE BY VOICE—ALMOST ANYWHERE, ANYTIME—WITH THE BOSS, WITH A CLIENT, WITH THE KIDS, WITH EMERGENCY PERSONNEL OR EVEN WITH THE POLICE. EACH YEAR, AMERICANS MAKE BILLIONS OF CALLS FROM THEIR WIRELESS PHONES, AND THE NUMBERS ARE RAPIDLY GROWING.

3 Overview of the DM-15/25 Modules

3.1 Overview

The DM-25 is an 800MHz AMPS/TDMA, and 1900MHz TDMA transceiver module. At 1900 MHz it is a Class IV module. At 800MHz it can be configured to be either a Class I or Class II module. The DM15 has the same functionality as the DM25, it however is 800MHz only. Both are designed for consumer and OEM industrial data applications.

The DM-15/25 module is intended for mounting into an application developer's chassis to provide wireless communication capability for the product. The target chassis may take a wide variety of forms such as a residential electric meter, a point of sale terminal, an alarm panel, or an automobile console. All initial configuration, mode control, and operational commands are issued to the DM-15/25 module over an RS-232 serial port using a flexible AT command format, as described in the AT Command section of this document. A single system connector provides serial communications, power, and I/O signaling.

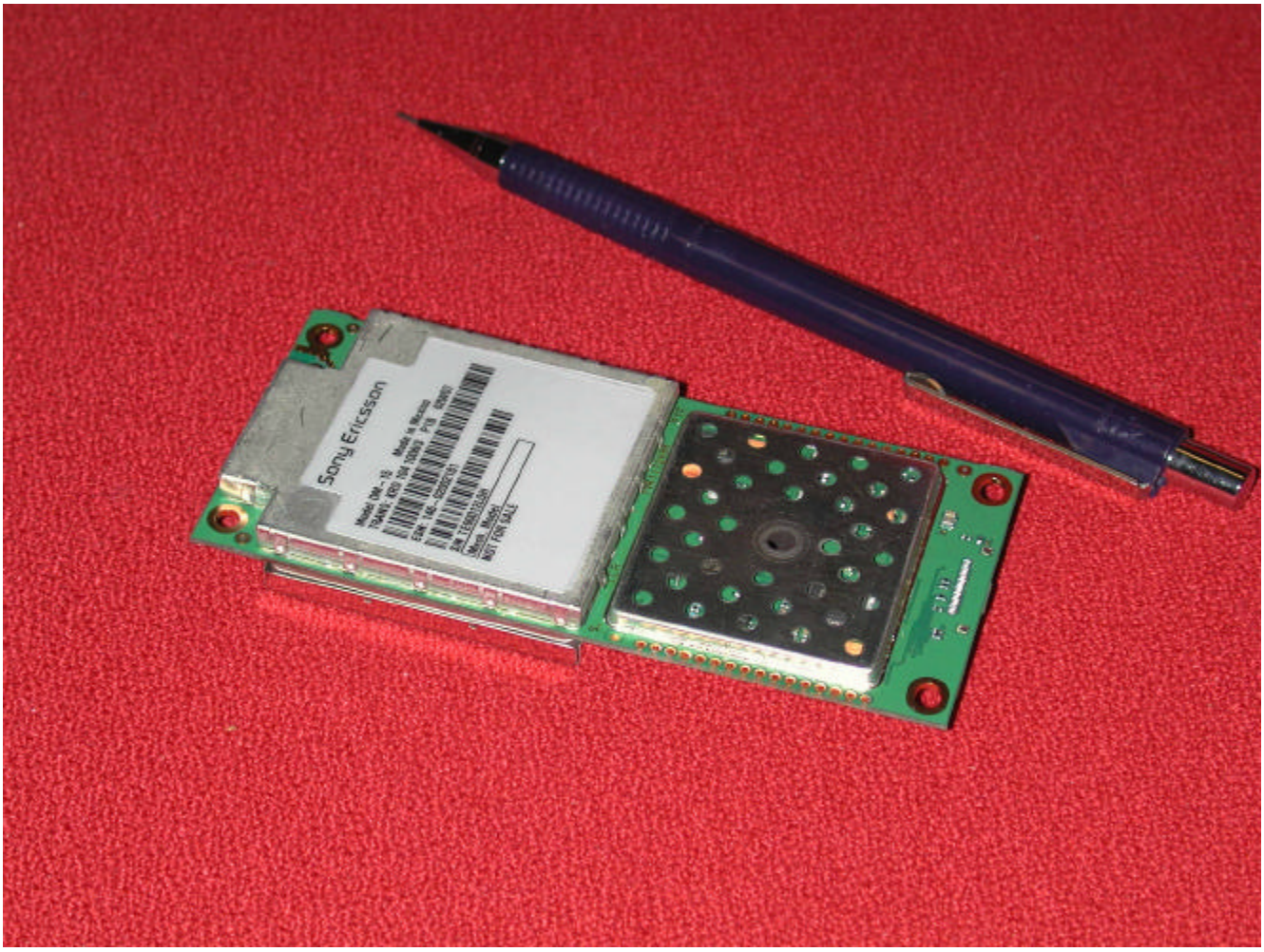


Figure 1: DM-15/25 Module

4 Integrating The DM-15/25 Module

4.1 Mechanical Description

The DM-15/25 has no mechanical elements other than the main PCB assembly. All critical electronic components are shielded using sheet metal cans to prevent internal and external electromagnetic interference from degrading the module's performance and to prevent the module from interfering with other nearby devices. The module is plugged into the fixed mating connector and secured with 4 screws to the standoff posts.
The module has no keypad, display, microphone, speaker or battery. The physical dimensions of the DM-15/25 module are as indicated in the figure shown below.

Note! All the measurements are in millimeters.

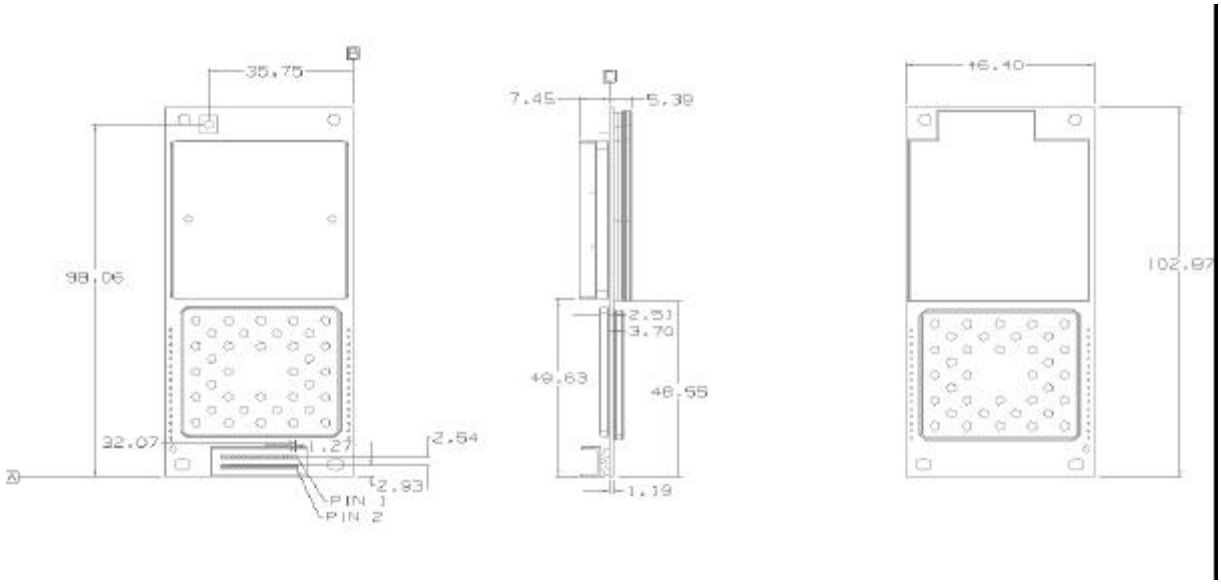


Figure 3: Physical Dimensions of the DM-15/25

The following shows the allowed contact area to the module. Contact to areas other than the areas shown below should be avoided due to the possibility that electrical components or pc-board connectors may be exposed.

Note also a "Heat Sink" area is shown. This contact point can be used for contacting a heat sink if needed when operation within the user's enclosure restricts air flow.

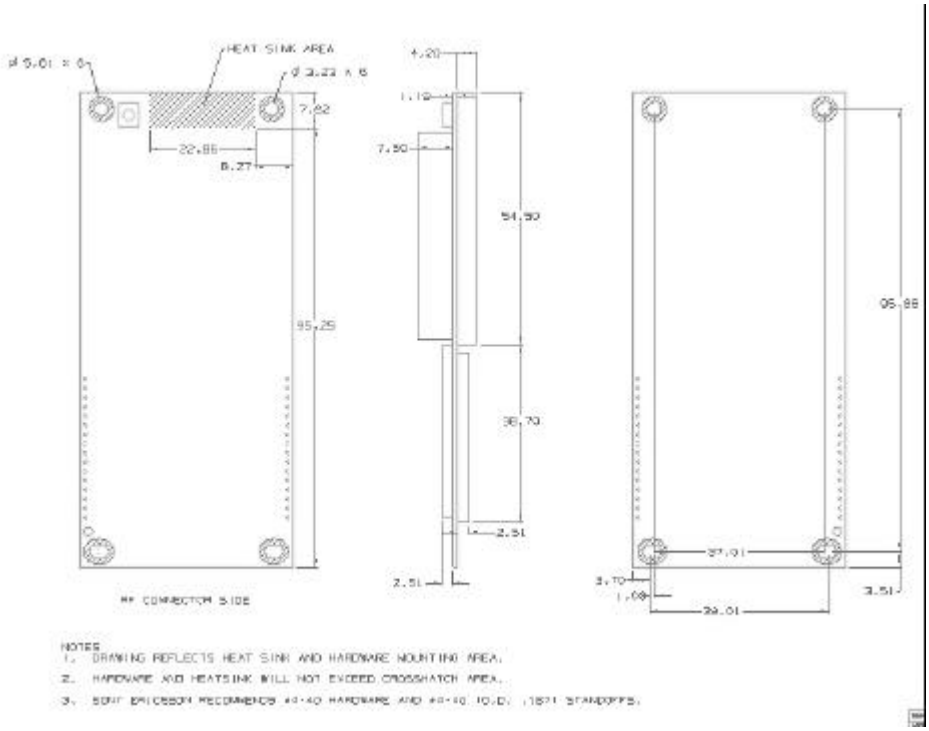
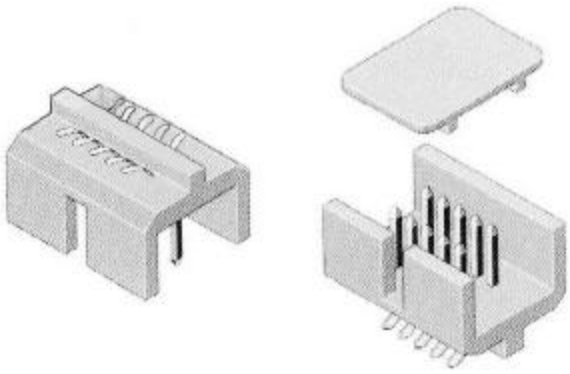


Figure 4 Contact Areas for the DM-15/25

4.1.1 Connector Overview

External interfaces to the module are made primarily through a 30-pin, standard 0.050-inch pitch, ODU header shown below.

SMT-Header Series 515, Straight
for surface mounting
2-Row, Grid 1,27 x 2,54 mm



Features

- With vacuum adapter plate
- SMT version

Figure 2: 30-pin system connector

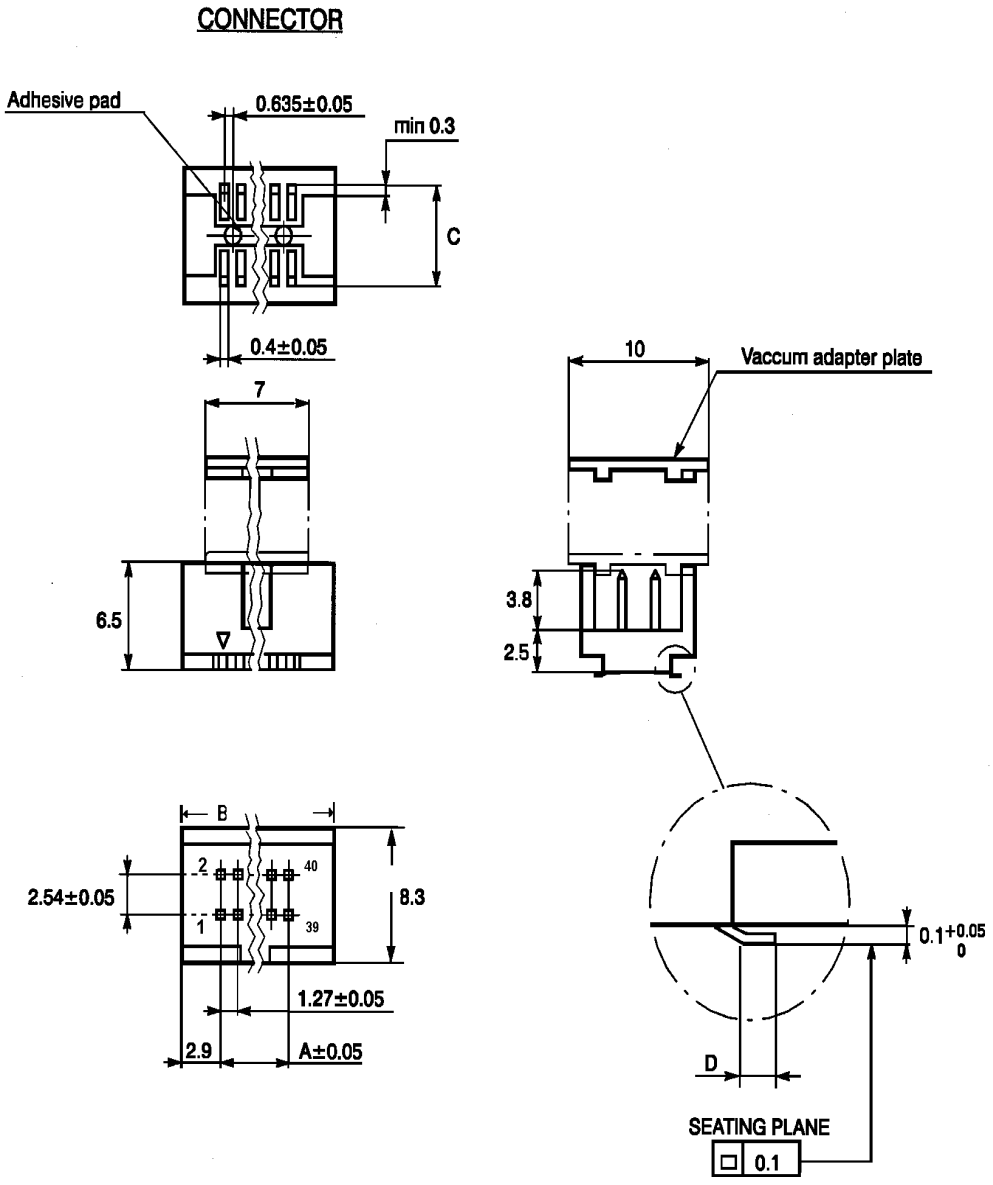


Figure 3: 30-pin system connector footprint

Section 4.1.3.2 shows the PIN-connection of the different signals connected to the interface as well as a short description of the signals.

4.1.2 General Electrical and Logical Characteristics

Many of the signals present in the interface are CMOS signals where the following levels apply.

CMOS Output / Input electrical characteristics

Parameters	**Test conditions**	**Limits**			**Units**
		Min.	**Typ.**	**Max.**	
High level output voltage (I_{OH}= 800 mA)	V_{OH}	0.9 * VDD		VDD	Volts
Low level output voltage (I_{OL}= 800 mA)	V_{OL}	0		0.1* VDD	Volts
High-Level Input Voltage (V_{IH})	V_{IH}	0.8 * VDD		VDD	Volts
Low-Level Input Voltage (V_{IL})	V_{IL}	0		0.2 * VDD	Volts

Logic Voltage	Min	Nominal	Max	Units
VDD	3.3	3.4	3.5	Volts

4.1.3 Power Interface

The module is able to operate in several modes and different output power levels. Typical applications require output power levels similar to those in a handheld cellular phone, which is considered a power class IV unit for dual mode operation. It is possible to increase the output power level to that of a class I unit (4 W nominal) during the 5 second analog burst data mode. Table 1 below shows the nominal output power levels (Effective Radiated Power, assuming an antenna system gain of 1 dBd (2.5 dBd antenna gain with 1.5 dB cable loss)).

	Mobile Station Power Level (dBW)										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Class I, AMPS	6	2	-2	-6	-10	-14	-18	-22	-22	-22	-22
Class II, AMPS	2	2	-2	-6	-10	-14	-18	-22	-22	-22	-22
Class II TDMA	2	2	-2	-6	-10	-14	-18	-22	-22	-22	-22
Class IV, TDMA	-2	-2	-2	-6	-10	-14	-18	-22	-27±3	-32±4	-37±5
Class IV, PCS	-2	-2	-2	-6	-10	-14	-18	-22	-28±3	-33±4	-38±5

Table 1. Mobile Station Nominal Power Levels

***Note: Output power levels maintained within range of +2 / -4 dB for PL0-7**
Power levels 8-10 are valid for digital mode only, maintained within range of +2 / -6 dB

4.1.3.1 Power Consumption

4.1.3.1.1 Transmit Mode

Power class selection	VCC_5V (peak)	VCC_12V (peak)	Heat Sink
Busrt Mode Class I AMPS Class II TDMA Class II	600-ma	1,300-ma	9^{o} C/watt recommended
Busrt Mode Class I AMPS Class IV TDMA Class IV	1,000-ma	1,300-ma	Not required

Table 2 Power Consumption in Transmit/talk mode

4.1.3.1.2 Standby Mode

DC current in mA	AMPS Mode	TDMA Mode	PCS Mode
Average	45	45	35

Table 3 Power Consumption in Standby Mode

4.1.3.1.3 Sleep Mode (Minimum DC Power consumption)

A power down or "sleep mode" is available in which the module is placed in a low power consumption state under control of the host application. In this mode, the unit consumes approximately 30 uA of current as measured from the VCC_5V supply input on pins 29 and 30 of the system connector. The MODULE_PWR_EN_B (WAKE) signal, on pin 8 of the system connector is tied to VCC_5V through a 330kΩ resistor and therefore needs to be driven low by an external open collector transistor in order to turn the module off. Turning off the external open collector transistor causes the MODULE_PWR_EN_B (WAKE) signal to float, which returns the unit to full operation, although there may be some delay (3-4 seconds) while the module reestablishes cellular service with the cellular network.

4.1.3.2 Power Supply, Ground and Signal Pins

The signals related to the power supply are: **VCC_12**, 13.8 V ± 20%, 1.3A max power supply, connected to the pin numbers 25, 27 and 28 and needed for 3 Watt burst applications and **VCC_5,** 5 volt ± 13.3% regulated, 1A max (1A peak during TDMA burst) regulated power supply connected to pin numbers 29 and 30.

Following is a list of the power supply requirements and signal pinout`:

MODEL	Description
DM15	800 MHz, Class 4 TDMA/AMPS, Single 5-V supply +/-10%
DM-15A,	800 MHz, Class 4 TDMA/AMPS; Class 1 Burst Data; Dual Supply required (+5v +/-10%, 13.8v +/- 20%) Selectable mode for Class 2 TDMA/AMPS; Class 1 Burst Data , Dual Supply required (+5v +/-10%, 12v +/- 10%)
DM-25	800/1900 MHz, Class 4 TDMA/AMPS, Class 1 Burst Data, Dual Supply required (+5v +/-10%, 13.8v +/- 20%) Selectable mode for Class 2 TDMA-800/AMPS, Class 1 Burst Data , Dual Supply required (+5v +/-10%, 12v +/- 10%) Note: Use of Class 2 AMPS **requires** heat sink of 9 deg C/Watt for full temperature range operation.

The ground signals in DM-15/DM-25 are Analog Ground, **AGND,** connected to pin number 5, and chassis Ground, **GND**, connected to the system connector interface through pin numbers 1, 2, 4, 17 and 18.

Following is a list of the ground pins:

Pin	DM-15/DM-25	Description
1	GND	Chassis Ground
4	GND	Digital Ground
5	AGND	Analog Ground
17	GND	Digital Ground
18	GND	Digital Ground

Analog Ground (AGND)

The AGND lead is the analog audio reference ground. It is the return signal for *Audio To Mobile Station* (**ATMS**), *Audio From Mobile Station* (**AFMS**).

Electrical characteristics: $I_{max} < 45$ mA (peak)

The AGND is connected to the chassis Ground (GND) in the ME, and *only* there. The application should not be connected to neither GND nor AGND.

Chassis Ground (GND)

GND is the logical reference of all digital signals in the System Interface as well as the DC return of the power supply signal, VCC_5V and VCC_12V (used for AMPS burst modes).

Electrical characteristics: $I_{average} < 0.7$ A

$I_{peak} < 2$ A

Note! That no GND pin can withstand over 0.5 A.

4.1.3.3 MODULE_PWR_EN_B (WAKE)

The MODULE_PWR_EN_B (*WAKE*) signal is a TTL compatible active high input. This signal (pin 8 on the system connector), is tied to VCC_5V through 330kΩ resistor, recommend open collector/drain transistor; short this pin to GND to power down the module.

4.1.4 Audio interface

The audio-related signals are: the analog audio signals **ATMS** (Audio To Mobile Station), and **AFMS** (Audio From Mobile Station), and the Pulse Code Modulation (**PCM**) signals (**PCMULD**, **PCMDLD**, **PCMCLK**, and **PCMSYNC**).

Pin	DM-15/DM-25	Description
3	AFMS	Audio Output From Module
6	ATMS	Audio Input to Module
13	PCMCLK	External PCM Clock Output
14	PCMSYNC	External PCM frame Sync
15	EXTPCMULD	External PCM Voice Input
16	PCMDLD	External PCM Voice Input

4.1.4.1 Analog Audio

ATMS (pin 6 on the system connector) is the analog audio input to the module. When it is active, it is connected to the radio via the audio processing stages in the module.

ATMS is also used as the microphone input from the portable Handsfree. When enable via the AT*NAUD command, a DC bias is provided from the **ATMS**.

The **AFMS** (pin 3 on the system connector) is the analog audio output from the module. When it is active it is connected to the radio via the audio processing stages in the module. The audio signal then comes out of the output AFMS.
It is also used as a earpiece driver for the Portable Handsfree accessory.

Pin	DM-15/DM-25	Description
3	AFMS	Audio Output From Module
6	ATMS	Audio Input to Module

The factory default audio settings are presented in the following table. Refer to AT*NAUD

AFMS	**Module audio output** **Output Impedance (active state)** **Output Impedance (inactive state)** **Output Impedance (pwr down state)** **Drive capacity into 50** W **Drive capacity into 5 k**W	(0.3 – 3.5 kHz) Zout < 10 Ω in series with ≥3.3 uF (-20%) Zout < 10 Ω to VDD/2 Zout > 30 kΩ 1.1 V_{P-P} min. 2.0 V_{P-P} min./ 4.0 V_{P-P} max.
	External Device audio input Input Impedance	Zin > 50 Ω
	Volume control	± 12 dB from nominal > - 40 dB (mute)
	Levels to external audio input at mid volume	28 mVrms nominal 450 mVrms max.
ATMS	**All sources must be AC coupled except for a microphone device. MIC should be DC coupled in order for module to supply DC power to microphone.**	
	External audio source **Output impedance (active state)** **Output impedance (inactive state)**	 Zout ≤ 100 Ω Zout > 10 k
	Module audio input **Input impedance** **Output DC level unloaded for external MIC**	 Zin > 2 kΩ 2.0 V min.
	Levels from external audio source (default)	45 mVrms nominal 340 mVrms max.
	Audio input signal is amplified an additional 32 db and a DC bias is provided to the microphone when using the AT*NAUD command for HF mode.	1.5 mVrms nominal

4.1.4.2 Digital Audio

The DM-15/DM-25 provides digital audio capability over the system connector. The digital audio signals enable the connection of a digital audio source. The receiver is bypassing the analog audio processing functions performed within the ME. The digital audio interface includes the following PCM signals:

Pin	DM-15/DM-25	Description
13	PCMCLK	External PCM Clock Output
14	PCMSYNC	External PCM frame Sync
15	PCMULD	External PCM Voice Input
16	PCMDLD	External PCM Voice Input

Already defined CMOS output/input electrical characteristics apply (see Section 4.1.2 General Electrical and Logical Characteristics). The voltage levels at the PCM interface are in accordance with the 3.3 V DC CMOS technology.

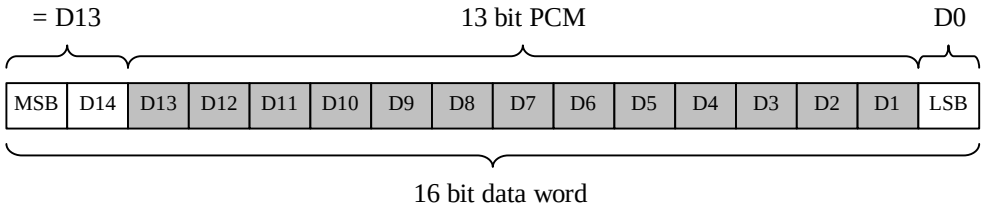
The PCM format (for **PCMULD and PCMDLD**) follows a linear PCM data format with 13-bit data embedded in a 16-bit word. The data bits in **PCMULD** (input) and **PCMDLD** (output) are aligned so that the MSB in each word occurs on the same clock edge. See timing diagram in Figure 4.

4.1.4.2.1 Data Format

The DM-15/DM-25 module implements a 13-bit PCM with the 13-bit data embedded in a 16-bit word as follows. The output data is compatible with the linear PCM data I/O of an industry standard Texas Instrument DSP.

Each PCM word shall contain 16-bits D0 - D15. D13 - D1 is the 2´s complement value of the 13-bit PCM, with D13 as the sign bit. D14 and D15 are always set to be equivalent with D13, and D0 can contain an optional LSB if a 14-bit word is used. D13 is the MSB while D1 is the LSB if a 14-bit word is not used. Note that the MSB is sent in first place.

Bit	Contents
D15 - D14	Equal to D13
D13 – D1	Two complement of the 13-bit PCM
D0	Optional additional data



4.1.4.2.2 Timing

Timing shall be according to the following diagram (see Figure 4). The signals in the diagram shall be interpreted according to the following relation.

DM-15/DM-25 signal	**Diagram name**
PCMCLK	PCMCLK (output)
PCMSYNC	PCMSYN (output)
PCMULD	PCMI (input)
PCMDLD	PCMO (output)

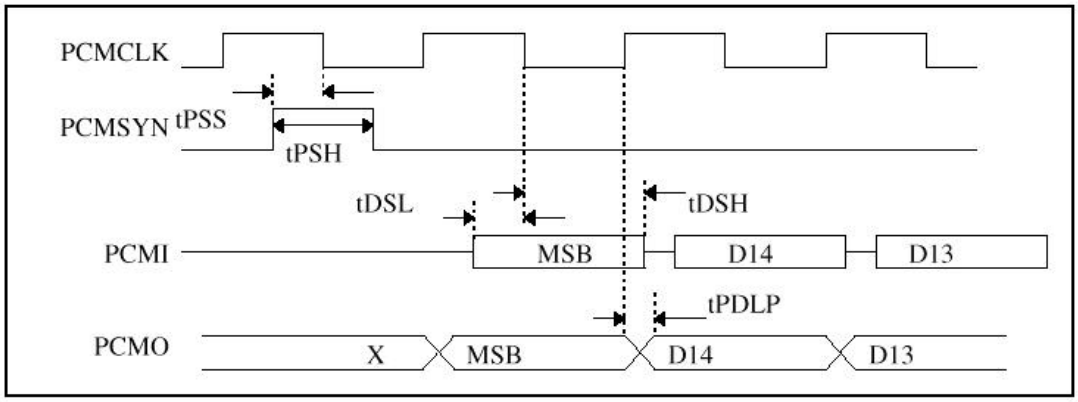


Figure 4 PCM timing diagram for DM-15/DM-25

The meaning and value of the timing parameters are described in Table 4.

Name	**Description**	**Min**	**Typ**	**Max**	**Unit**
fPCMCLK	clock frequency		200		kHz
fPCMSYN	PCM clock frequency		8		kHz
tPSS	PCMSYN (setup) to PCMCLK (fall)	10			ns
tPSH	PCMSYN pulse length	20			ns
tDSL	PCMI (setup) to PCMCLK (fall)	10			ns
tDSH	PCMI (hold) from PCMCLK (fall)	10			ns
tPDLP	PCMO valid from PCMCLK (rise)			25	ns

Table 4 PCM timing parameters for DM-15/DM-25

4.1.5 Serial Data Interface

The serial channels are used as asynchronous communication links between the application system and the module. The following table shows the serial data channels related signals:

Pin	DM-15/DM-25	Description	Dir
19	DCD	Data Carrier Detect	O
21	CTS	Clear To Send	O
22	DTR	Data Terminal Ready	I
23	TD	Serial Data To Module (DTMS)	I
24	RTS	Request To Send	I
26	RD	Serial Data From Module (DFMS)	O

All the serial-channel-related signals have the same electrical characteristics. In the following table you can see some of these characteristics.

The common CMOS electrical specifications defined in Section 4.1.2 General Electrical and Logical Characteristics are valid for all these signals.

The standard character format is 1 start bit, 8 data bits, non-parity and 1 stop bit. In all, there are 10 bits per character.

Note! That the signal levels do not match the standard RS232 (V.28).

4.1.6 General Purpose Signals

The module provides two general purpose binary inputs and two general purpose binary outputs on the system connector.

The AT*EGPI command described in section, allows an application to query the states of the two general purpose binary inputs.

The AT*EGPO command described in section, allows an application to query or set the states of the two general purpose binary output inputs.

Pin	DM-15/DM-25	Description
7	OUTPUT 2	General Purpose Binary Output # 2
9	INPUT 2	General Purpose Binary Input # 2
10	OUTPUT 1	General Purpose Binary Output # 1
12	INPUT 1	General Purpose Binary Input # 1

The general purpose output signals OUTPUT 1 and OUTPUT 2 are CMOS open drain outputs with 1 mA drive.

The general purpose input signals INPUT 1 and INPUT 2 are CMOS bi-directional, tri-state output with 2mA drive.

5 Application IO description

5.1 General

This section describes the IO functionality, and recommended implementation.

5.2 System connector IO functionality

Note 1: The application IO can be one of the following listed types:

- I Logic input (no pull up or pull down resistors required).
- IOC Logic open-collector input.
- O Logic output (no pull up or pull down resistors required).
- OOC Logic open-collector output.
- I/O Logic I/O.

The pin direction in this table is seen from the application's point of view.

Group	Pin No.	Name	Application Requirements	App I/O_1
Data	**HW flow control is by default enabled in the phone module.**			
	23	TD (DTMS)	Logic output to phone module. The application shall set this output active high upon startup.	O
	26	RD (DFMS)	Logic input from phone module.	I
	24	RTS	Logic output to phone module. Pulled down by the phone module (R > 20k). The application shall set this pin active low when ready to receive data.	O
	21	CTS	Logic input from phone module. This signal is initially set high, indicating that the phone module is not ready to receive data. It is set low when the phone module is ready to receive data.	I
	22	DTR	Logic output to phone module. This signal is pulled up in the phone module (R > 20k). This signal should be set high by the application during a data call. A high to low transition will terminate the data call. This signal is asserted (logic high) by the application when it wishes to open a communications channel. The phone module then prepares the modem to be connected to the telephone circuit, and, once connected, maintains the connection. When DTR is de-asserted (logic low), the phone module is switched to "on-hook" to terminate the connection.	O
Data	19	VPPFLASH/DCD	**DCD:** Logic input from phone module. This signal is set default high. It goes low indicating that a data or fax call is established, (CONNECT) received from remote modem. The signal goes high when data connection is disconnected. **Sent from the phone module (DCE) to the application (DTE) to indicate that it has received a basic carrier signal from a (remote) DCE.** **VPPFLASH:** The application shall not apply a voltage to this pin unless they intend to use it as VPPFLASH in which case it becomes a power output.	I/O
PCM	15	PCMULD	Logic output to phone module.	O
	16	PCMDLD	Logic input from phone module.	I
	14	PCMSYNC	Logic input from phone module.	I
	15	PCMCLK	Logic input from phone module.	I

Analog Audio	5	AGND	Analog reference. This signal is an analog reference output by the phone module. This signal is connected to GND in one place in the phone module. Under no circumstances shall it be connected to any ground or be used as ground in the application. See 3.4 for more detailed information.	I
	6	ATMS	Single ended audio output to phone module.	O
	3	AFMS	Single ended audio input from phone module.	I
Status	8	MODULE_PWR_EN_B	Logic open collector output that is set low by the application to enable power to the phone module. The pull-up resistor resides in the phone module.	OOC
	2420	RINGER	Pulse Modulated logic input from phone module. The application must provide power amplification if the current draw is expected to exceed 1mA.	I
Unused				
	40	USB_D-	No termination. Leave open.	
Reserved	9	RESERVED	No termination. Leave open.	I
	12	RESERVED	Terminate with a ~100k resistor to DGND.	O
	7	RESERVED	Terminate with a ~100k resistor to DGND.	O
	10	RESERVED	No termination. Leave open.	I
	11	RESERVED	Terminate with a ~100k resistor to DGND.	NC

6 Recommended Circuitry

Abbreviations:

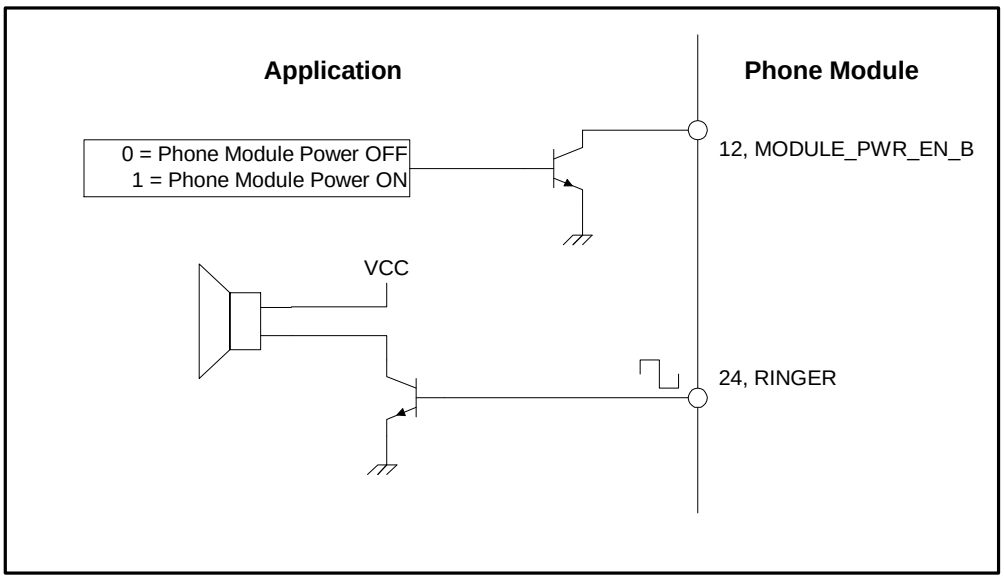
- VCC Represents the logic supply voltage used by the application.
- VREF Represents the logic supply voltage used by the phone module.

Component proposals:

- Transistors not showing a base resistor should be interpreted as a BRT (Built in Resistor Transistor) i.e. Toshiba RN1308.
- The inverting buffers should preferably be Schmitt-Triggered, i.e. Toshiba TC7S14 or similar.

6.1 Status

The status group contains four signals, one output signal from the application and three input signals to the application.

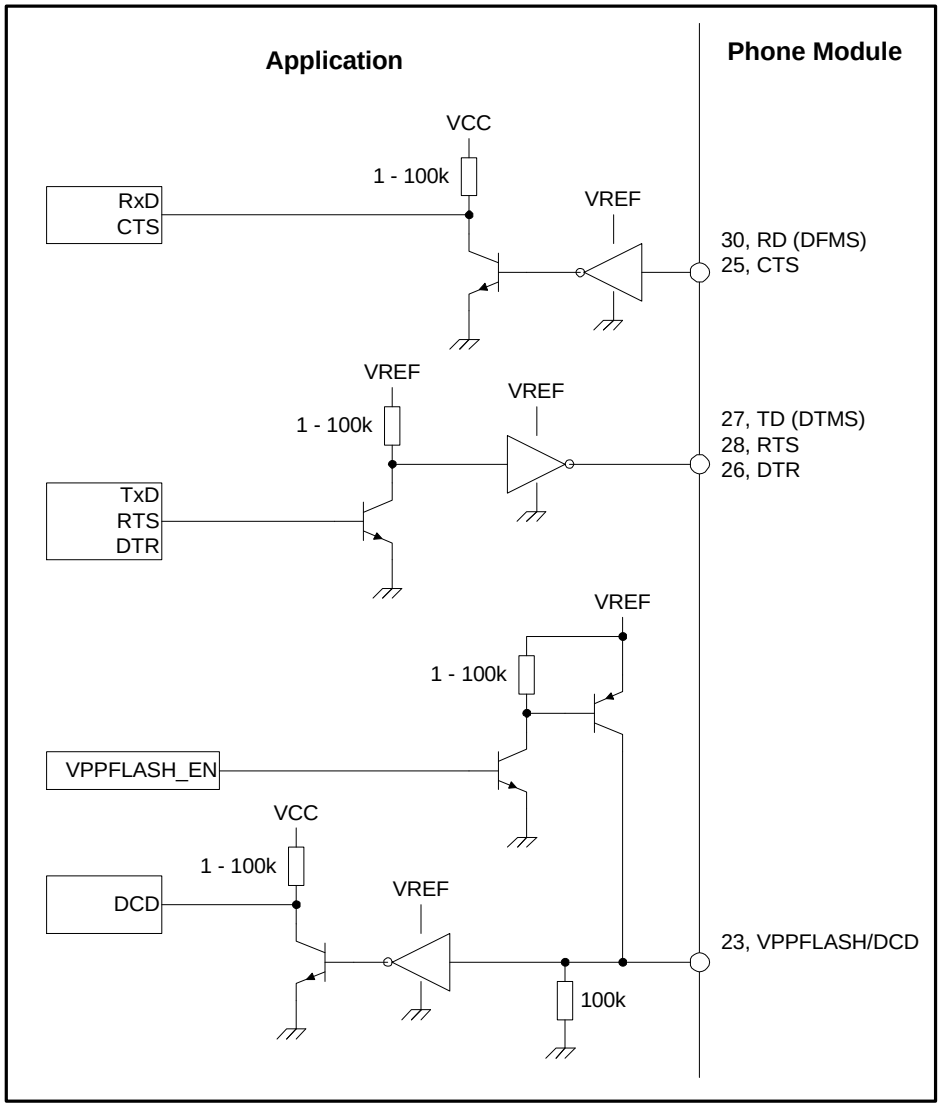


6.1.1 MODULE_PWR_EN_B (*Wake*)

This signal, located on pin 12 in the system connector, enables the main 5V supply in the phone module so that it powers on. This is an open collector input to the phone module. Its reference voltage is the main 5V supply.

6.2 Data

The data group contains six signals, three output signals from application, two input signals to application, and one I/O signal.

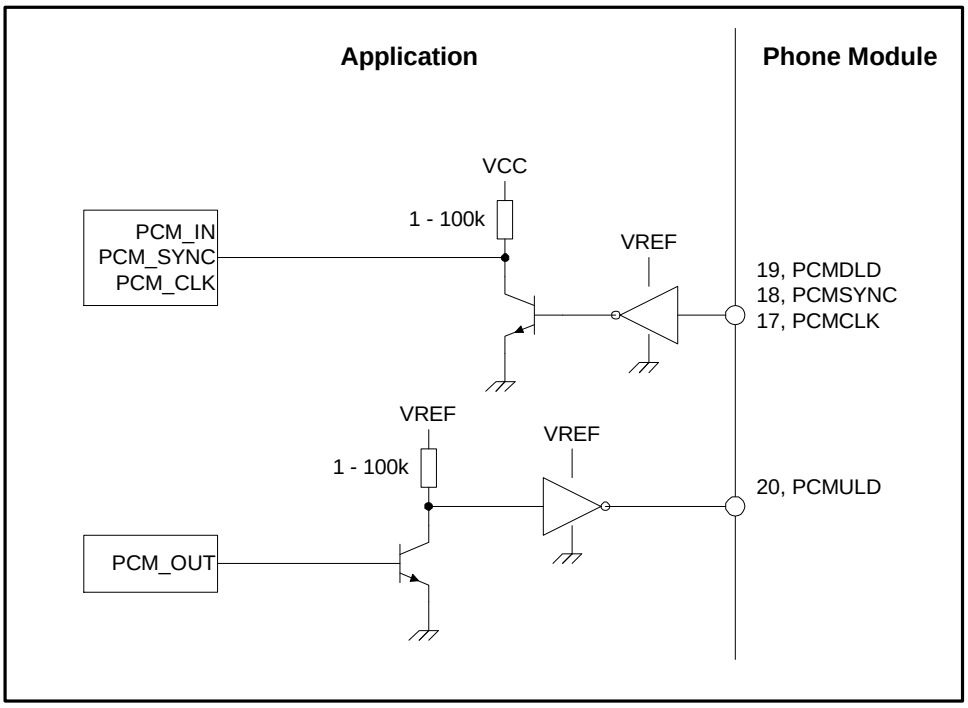


6.2.1 VPPFLASH/DCD

This signal, located on pin 23 in the system connector, can be used by the application to enable flashing of the phone module. To enter flash-mode, the application shall set VPPFLASH_EN active high, then enable the MODULE_PWR_EN_B pin. The circuitry above ensures that a high enough signal is input on VPPFLASH without overloading the DCD input buffer.

6.3 PCM

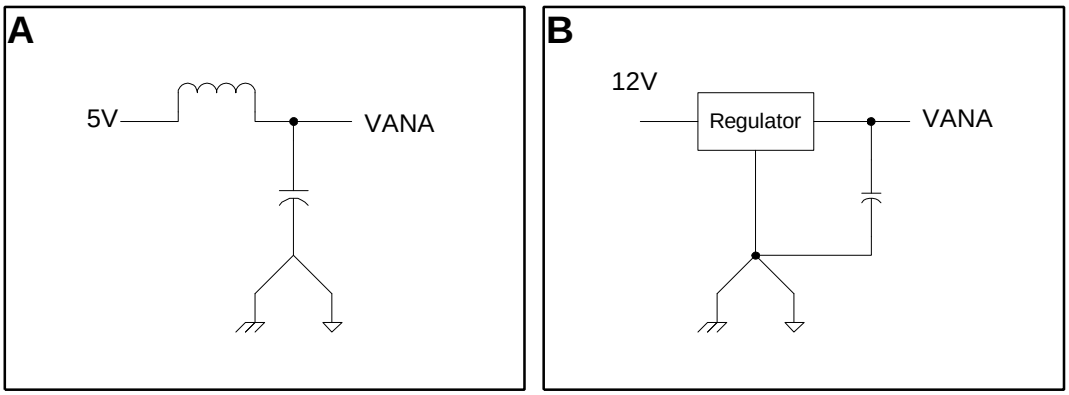
The PCM group contains four signals, three input signals to the application, and one output signal from the application.



6.4 Analog Audio

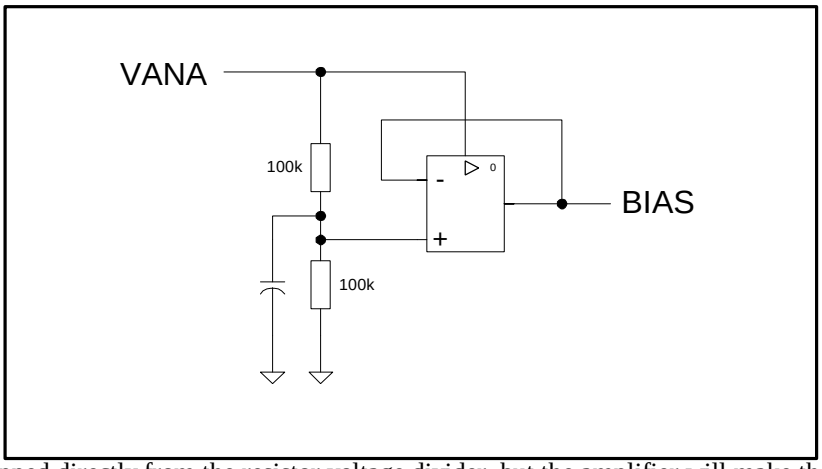
6.4.1 Creating an analog ground

An analog ground plane should be generated, which connects to GND in one point so that high frequency digital current is not floating through the analog ground. Connecting the analog ground in only one point avoids ground currents from power supplies and other high current circuitry from creating noise in the analog circuitry. This common point should be located where the analog supply voltage (VANA) is generated (at filter (A), or regulator (B) depending on implementation).



6.4.2 Creating an analog reference voltage (BIAS)

The BIAS reference should be generated from the analog supply voltage (VANA) and be referenced to the analog ground. This reference shall be used to bias all analog circuitry in the application.



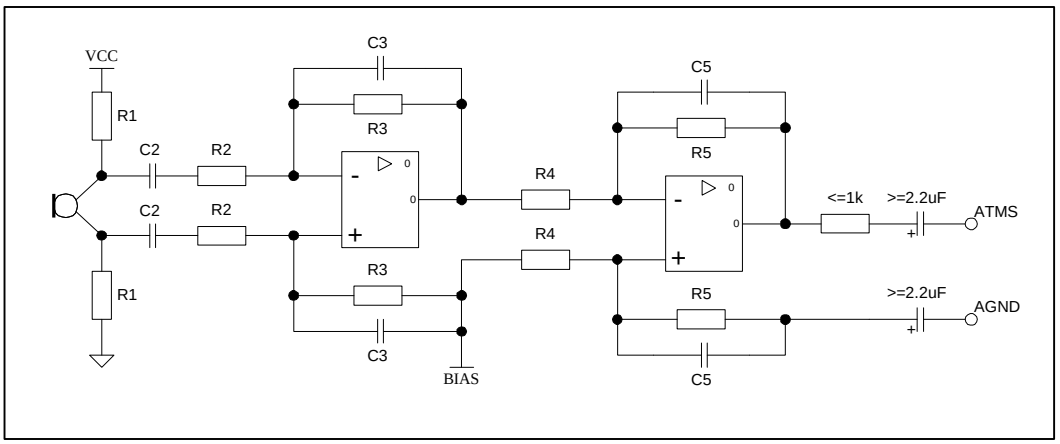
The bias can be tapped directly from the resistor voltage divider, but the amplifier will make the bias more stable and less susceptible to noise.

6.4.3 Analog ground vs. AGND

The AGND signal output from the module is not a ground. It is an analog reference, which is connected to the main ground used by the module in one place inside the module. It should not under any circumstances be used as a ground or connected to a ground in the application. AGND must be treated as a signal. Together with ATMS and AFMS it creates a semi differential interface.
The analog ground shall be used as ground plane for the analog circuitry of the application. It should not be connected to the AGND signal output from the phone module.

6.4.4 Microphone path

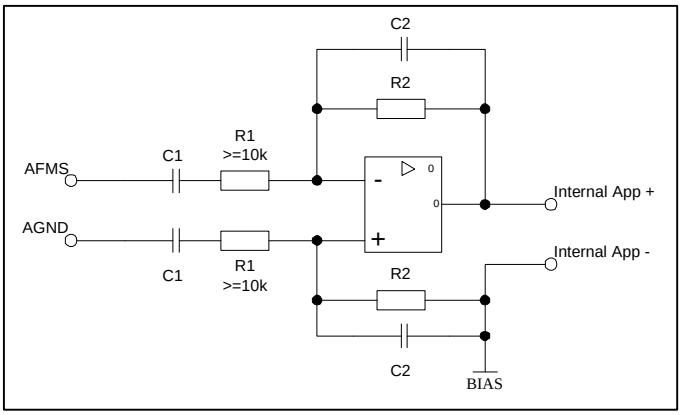
An application using the analog audio interface must re-reference the signal from its own internal BIAS to AGND received from the module.
The figure below shows an example of a microphone implementation.



The microphone should preferably be connected to its pre-amplifier differentially, which will minimize noise picked up along the way from the microphone to its amplifier. If the impedance is the same on both microphone lines, and the lines are run in parallel, the same amount of noise is picked up on both lines. This noise is then removed in the differential amplifier stage.

6.4.5 Loudspeaker path

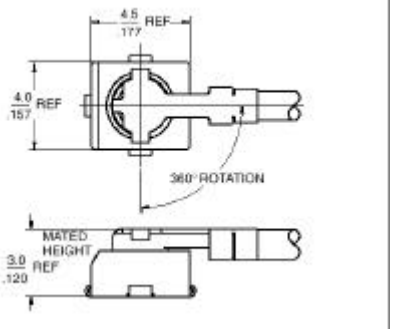
An application using the analog audio interface must re-reference the AFMS-signal from AGND to its own internal BIAS. The figure shows a differential implementation. C1 is chosen to create the correct HP frequency response. R1 and R2 determine the gain, and C2 and R2 determine the LP frequency response.



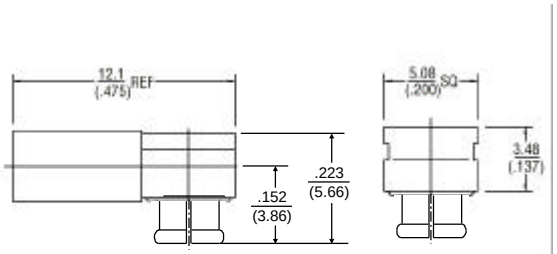
6.4.6 Antenna connector

The antenna connector is the hub for transmission of the Radio Frequency (RF) signals from the DM-15/DM-25 module to the external antenna. The antenna connector of the module is surface mounted, micro miniature snap-on MA/-COM connector (P/N 2367-5002-54). A wide variety of compatible mating connectors are available. Pigtail assembly (P/N 9960-2100-24), and the inter-series cable assembly (P/N 9960-4100-XX) from M/A-COM are two options using pre-assembled cables. Another mating option is a right angle crimp jack from M/A-COM that uses standard RG-type coaxial cable. Custom cables assemblies can be manufactured to individual requirements using standard off-the-shelf coaxial cable and mating connectors (TNC, SMA, etc.) with either RG-178 or RG-316 size M/A-COM connectors. Since the mating connector can rotate through 360°, the application developer has maximum flexibility for routing the RF coax assembly. The total height of the mated pair using M/A-COM pre-assembled RF connectors is 0.12 inches. The mated pair height using the right angle crimp jack is approximately 0.290 inches. Physical dimensions of the two module connector types are shown below. The pigtail and the right angle crimp.

The physical dimensions of the connector are shown in the drawing below.



Pigtail **Assembly**



Right Angle Crimp **Jack**

Electrical performance parameters are valid only when the terminating impedance at the output of the antenna connector exhibits a VSWR of less than 2:1 for all phase angles in the frequency band of operation. High VSWR loads at the antenna connector adversely affect current consumption, linearity, and power efficiency of the module and may prevent operation or cause internal damage.

The RF performance of the DM-15/DM-25 meets the requirements of the TIA/EIA-136-270-B specification.

Electrical characteristics at the antenna interface		
Nominal impedance	**50 Ω (better than 2:1)**	
Output Power	3 Watt peak (Class 1)	Burst Modem, AMPS
	2 Watt peak (Class 2)	AMPS, DAMPS
	0.6 Watt peak (Class 4)	AMPS, DAMPS, PCS
Static Sensitivity	Better than - 116 dBm	12 dB SINAD, AMPS
	Better than - 110 dBm	<3% BER, DAMPS
	Better than –110 dBm	<3% BER, PCS

6.5 Functional Description

This chapter describes the functionality of the DM-15/DM-25 module. The module performs a set of telecom services according to TIA/EIA-136. The functions of the display and keypad, usually used to make calls, are implemented by issuing AT Commands over the serial interface. To find out how to send SMS messages, make data calls, use the burst mode services and handle the Phone Book.

6.5.1 Speech Calls

The module offers the following telecom services:

- **Telephony** according to EIA/TIA-136.
- **Emergency** according to EIA/TIA-136.

An incoming call is indicated by an AT unsolicited result code (RING indicator).
The audio input and output signals in the interface (AFMS and ATMS) will carry analog speech in full duplex (transmitting and receiving simultaneously). The module supports both Full-Rate speech coding and Enhanced Full-Rate (EFR), if EFR is available in the network. For EFR to be usable, changes must be made in the module's internal parameters.

6.5.2 Value Carrier Services

The module supports the following value carrier services:

- **Calling Line Identification Presentation (CLIP).** Enables the called module to get the CLI (phone number) of the calling party.
- **Calling Line Identification Restriction (CLIR).** Allows the calling module to enable or disable the presentation of the CLI (phone number) to the called party when originating a call (dialling).
- **Call Forwarding.** Permits the called module to have the network send incoming calls to a desired phone number.
- **Call Waiting.** Permits the module to be notified of an incoming call, for example, if the module is engaged in an active call. The module can either accept, reject or ignore the incoming call.

- **Conference Calls (Multiparty).** Permits the module to maintain simultaneous communication with more than one party.
- **Call Barring.** Allows the module to bar certain categories of outgoing or incoming calls. The categories are determined by one or more barring programs.

Note! **Some value carrier services as Call Forwarding and Call Waiting may vary depending on your service provider's network.**
Value carrier services are activated/deactivated via the ATD command using a specific code. This code might vary depending on the service provider. *Consult your service provider for further information.*

6.5.3 Short Message Services

The DM-15/DM-25 module provides the functional capability to create and send text messages across the air interface. These messages are transported on the air interface via the layer-3 R-DATA message.
The key management attribute of a short message is the folder in which it resides. Folders are convenient groupings of similar messages. For example, common folders are in-box, out-box and hold-box. This pool of folders use a common set of indices (internally controlled) to reference each message location. The incoming messages are stored in non-volatile memory until deleted by the host application using the AT+CSDM command .
The module supports the following SMS services in TDMA:

- **Sending** *:* Mobile-originated (MO) according to EIA/TIA 136-350.
- **Receiving***:* Mobile Terminated (MT) according to EIA/TIA 136-350.

The maximum length of an SMS message is 201 bytes.

6.5.3.1 Services for Short Message Control

The services provided by the DM-15/DM-25 module for short message control are the followings:

- Message formatting – The module formats short messages for transmitting over the air interface.
- Message storage – The module stores messages received over the air interface in an in-box; it queues messages for transmission over the air interfce in an out-box.
- Default information element storage – The module stores default information elements for use in formatting short messages.
- Message reference assigment – The module assigns message reference numbers to new short messages that are transmitted over the air interface.
- Message index assigment – The module assigns message index numbers to messages received over the air interface.
- Privacy Management – The module supports privacy criteria.
- Message reporting – The module reports incoming messages received over the air interface.

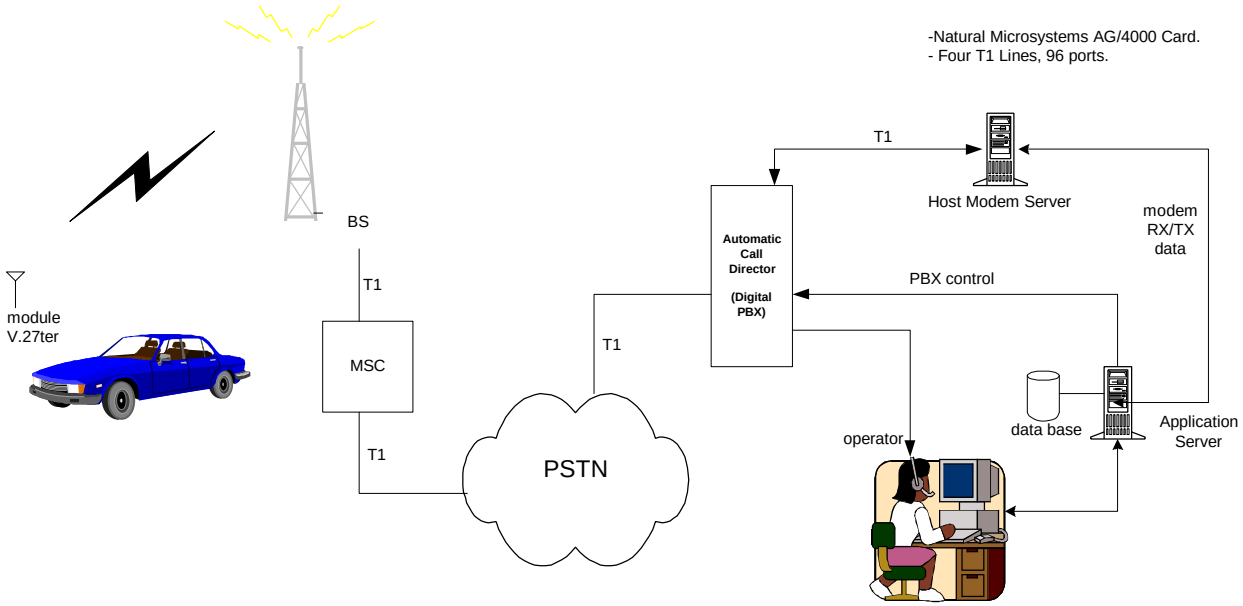
6.5.4 Data Functionality

6.5.4.1 TDMA

- **Asynchronous Circuit Switch Data** (CSD) according to EIA/TIA 136-350. AMPS

- **AMPS Data** over the voice channel. In this case an external modem connected to the analog audio signals (ATMS, AFMS) is needed.
- **Microburst/Vburst mode** (by Aeris).
- The DM-15/DM-25 module supports Aeris Microburst and Vburst protocols. These protocols enable applications to send either short messages or 1045 byte data-grams to the Aeris data center. The short messages in Microburst mode are sent using dialed digits inside a feature request. Feature requests are pages with a '*' character followed by 15 digits. In Microburst/Vburst mode the DM-15/DM-25 module does not use either IRDB or WIN4 list.
- The Microburst and Vburst service is detected by listening for pages to area code 175 or area code 180 respectively.
- Application providers that use Aeris Microburst/Vburst protocols must obtain Microburst and Vburst documentation from Aeris (see section 1.4)
- **Sony Ericsson Burst Modem.**
- The Sony Ericsson Burst Modem protocol enables applications to send 250-byte messages on an AMPS voice channel.
- In order to have a complete solution customers must develop an application to control the module, obtain service with a cellular provider, and develop a call center to process incoming data packets or voice calls.
- The DM-15/DM-25 module supports several control channel selection modes. The Sony Ericsson Burst Modem protocol may use a standard IRDB lookup mode or a GTE Win4 scanning mode..

Burst modem application



The 250 Byte Message Protocol

The key feature of the 250-byte protocol is that it allows applications to send up to 250 bytes of data during a voice call. The voice conversation is suspended while data is transferred.

The 250-byte protocol utilizes powerful error detection and correction algorithms to maximize the chance of delivering error free data. The data in each packet is duplicated three times to enable majority logic correction, the data is encoded with a convolution encoder that allows multiple bit error correction, and each ten data bytes are protected by a 16 bit CRC. If a first attempt to send the data packet fails then it is retransmitted up to two more times. The time to send 250 bytes varies between 5 and 15.5 seconds depending on the number of retransmissions.

6.5.5 Telematics capability

Sony Ericsson DM-15/DM-25 modules can be used in two different modes. The two modes are called NAM-1 and NAM-2. In NAM-1 mode the module is a TDMA dual mode phone. Applications can use NAM-1 mode to place analog or digital calls. NAM-1 also supports digital data modes such as short message service. In NAM-2 mode, also called "telematics" mode, the module behaves similar to an AMPS-only phone. Applications can use telematics mode to send short data packets on an analog voice channel.

In order to switch between NAM-1 and NAM-2 modes the module must be reset, therefore applications that desire to use both modes are necessarily more complex. The NAM-1 and NAM-2 modes share the same ESN as well as most of the configuration settings. The important exceptions are MIN, band order, SID and SOC. These parameters can be set independently for telematics

mode. This means that applications that want to use both modes may choose a different carrier for NAM-2. Using different carriers raises some complications with IRDB settings.

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6.5.6 Over the air activation (OTA)

The DM-15/DM-25 supports Over the Air Programming as defined in EIA/TIA 136 Rev. B

6.5.7 Hints for integrating the module

This chapter, which gives you advice and helpful hints on how to integrate the DM-15/DM-25 with the application, should be taken as a guide.

Note! The circuits on the test board are not shielded. Thus take proper precautions for avoiding ESD and EMI.

6.5.8 Precautions

Here is a list of preparations that you should make before beginning the integration work that is described in this chapter.

- Where to install the module.
- Safety Standards.
- Network and subscription.
- Antenna.

6.5.9 Where to install the module

Make sure that the module is installed so that the environmental conditions, such as temperature, humidity, vibration, etc., are not beyond the limits specified for it. See also section 7 **Technical Data**.

Make sure that the signal strength is sufficient. To improve signal strength, move the antenna to another position. Signal strength may depend on how close the module is to a radio base station. Degradation in signal strength could be a result of disturbance from another source, for example, an electronic device nearby.

You can verify signal strength by issuing the AT command AT+CSQ.

Tip! Before installing the module, use an ordinary mobile telephone to check a possible location for it. Consider signal strength as well as cable length in determining the location for the module and antenna. That way, you will find out if it is practical to install the module where you intended.

6.5.10 Network and subscription

Make sure that the AMPS/TDMA network provides the necessary telecommunication services. Contact your service provider. Make sure that the location at which you intend to use the module is within the network coverage.

If you intend to use SMS for the application, make sure that this is included in your (voice) subscription.

6.5.10.1 Possible communication disturbances

- **Noise** can be caused by electronic devices and radio transmitters.
- **Path-loss** occurs as the strength of the received signal steadily decreases with the distance from the transmitter.
- **Shadowing** is a form of environmental attenuation of radio signals that is caused by hills, buildings, trees or even vehicles. Inside buildings this can cause problems, especially if the walls are thick and reinforced.
- **Multi-path fading** is a sudden decrease or increase in the signal strength. This is the result of interference caused when direct and reflected signals reach the mobile phone simultaneously. Flat surfaces such as buildings, streets, vehicles, etc, can reflect signals.
- **Hand-over** occurs when you move from one cell to another in the AMPS/TDMA network. It transfers your present mobile phone call from one cell to another. Hand-over will interfere briefly with communication and could cause a delay, or at worst, a disruption.

7 Technical Data

Mechanical specifications	
Maximum length:	4.050 in
Maximum width:	1.827 in
Maximum thickness:	0.50 in
Weight:	44 g

Power supply voltage, normal operation	VCC_5V	VCC_12V
Nominal Voltage:	5.00 Volts	13.8 Volts Class I 12.0 Voltts Class II
Voltage range:	4.5 – 5.5 Volts	11.1 – 16.6 Volts Class I 10.8 – 13.2 Volts Class II
Power Consumption (Maximum):	1 Amps (1A Peak during TDMA Burst)	1.3 Amps

Radio specifications	**DM-15**	**DM-25**
Frequency range:	TX: 824 – 849 RX: 869 – 894	TX: 824 – 849; 1850-1910 RX: 869 – 894; 1930-1990
Maximum RF output power:	2 W TDMA 3 W Analog Burst Only	2 W TDMA 3 W Analog Burst Only
Antenna impedance:	50 Ω	50 Ω
VSWR (Maximum):	2:1	2:1

Environmental specifications	
Operating temperature range:	-30°C to +70°C: TIA/EIA 136-270A Specification -40°C to –30°C: –3dB Degradation beyond –30°C Spec +70°C to +85°C: –3dB Degradation beyond +70°C Spec
Storage temperature range:	-40 ^{0}C to +85 ^{0}C
Maximum relative humidity:	95% ± 3% at +40 ^{0}C
Stationary vibration, sinusoidal:	Displacement: 7.5 mm Acceleration amplitude: 20 m/s^2 40 m/s^2 Frequency range: 2-8 Hz 8-200 Hz 200-500 Hz

Stationary vibration, random	Acceleration spectral density (m^2/s^2): 0.96 2.88 0.96 Frequency range: 5-10 10-200 200-500 60 min per/axis
Non-stationary vibration, including shock	Shock response spectrum I, peak acceleration: - 3 shocks in each axis and direction: 300 m/s^2, 11 ms Shock response spectrum II, peak acceleration: - 3 shocks in each axis and direction: 1000 m/s^2, 6 ms
Bump:	Acceleration 250 m/s^2
Free fall transportation:	1.2 m
Rolling pitching transportation:	Angle: 35 degrees, period: 8s
Static load:	10 kPa
Low air pressure/high air pressure:	70 kPa / 106 kPa

Phone memory	
Maximum number of entries stored in the phone book.	200
Maximum number of SMS messages.	100 entries or a total of 2 kBytes of data.