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LEON-G100/G200

quad-band GSM/GPRS Data and Voice Modules

Data Sheet

Abstract

Technical data sheet describing the LEON-G100/G200 quad-band GSM/GPRS data and voice modules.
The LEON-G100/G200 are complete and cost efficient solutions, bringing full feature quad-band GSM/GPRS data and voice transmission technology in a compact form factor.

29.5 x 18.9 x 3.0 mm

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Document status information	
Objective Specification	This document contains target values. Revised and supplementary data will be published later.
Advance Information	This document contains data based on early testing. Revised and supplementary data will be published later.
Preliminary	This document contains data from product verification. Revised and supplementary data may be published later.
Released	This document contains the final product specification.

This document applies to the following products:

Name	Type number	Firmware version	PCN / IN
LEON-G100	LEON-G100-06S-00	07.60.00	GSM.G1-SW-10012
	LEON-G100-06A-00	07.60.00	GSM.G1-SW-10012
LEON-G200	LEON-G200-06S-00	07.60.00	GSM.G1-SW-10012

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Contents

1 Functional description

1.1 Overview

LEON-G100/G200 modules are cost efficient solutions offering full quad-band GSM / GPRS data and voice functionality in a compact LCC (Leadless Chip Carrier) form factor. Featuring low power consumption and GSM/GPRS class 10 data transmission with voice capability, LEON-G100/G200 combine baseband, RF transceiver, power management unit, and power amplifier in a single, easy-to-integrate solution.

LEON-G100/G200 are fully qualified and certified solutions, reducing cost and enabling short time to market. These modules are ideally suited for M2M and automotive applications such as: Automatic Meter Reading (AMR), Remote Monitoring Automation and Control (RMAC), surveillance and security, eCall, road pricing, asset tracking, fleet management, anti theft systems and Point of Sales (PoS) terminals.

LEON-G100/G200 support full access to u-blox GPS receivers via the GSM modem. GSM and GPS can be controlled through a single serial port from any host processor. LEON-G100/G200's compact form factor and SMT pads allow fully automated assembly with standard pick & place and reflow soldering equipment for cost-efficient, high-volume production.

LEON-G100 is available in standard and automotive grade versions.

1.2 Product features

Module	Bands	Interface					Audio		Functions												
	GSM/GPRS quad-band	UART	SPI	USB	DDC for u-blox GPS	GPIO	Analog Audio	Digital Audio	Network indication	Antenna Supervisor	Jamming detection	Embedded TCP/UDP stack	FTP, HTTP, SMTP	SSL	GPS via Modem	Embedded Assist**Now** Software	FW update via serial interface	FOTA	In-band modem	Battery charging
LEON-G100	•	1			1	5	2	1	•	•	•	•	•		•	•	•	A	A	
LEON-G200	•	1			1	5	2	1	•	•	•	•	•		•	•	•	•		•

A = available upon request with LEON-G100 Automotive module

Table 1: Features of the LEON-G100/G200 modules

1.3 Block diagram

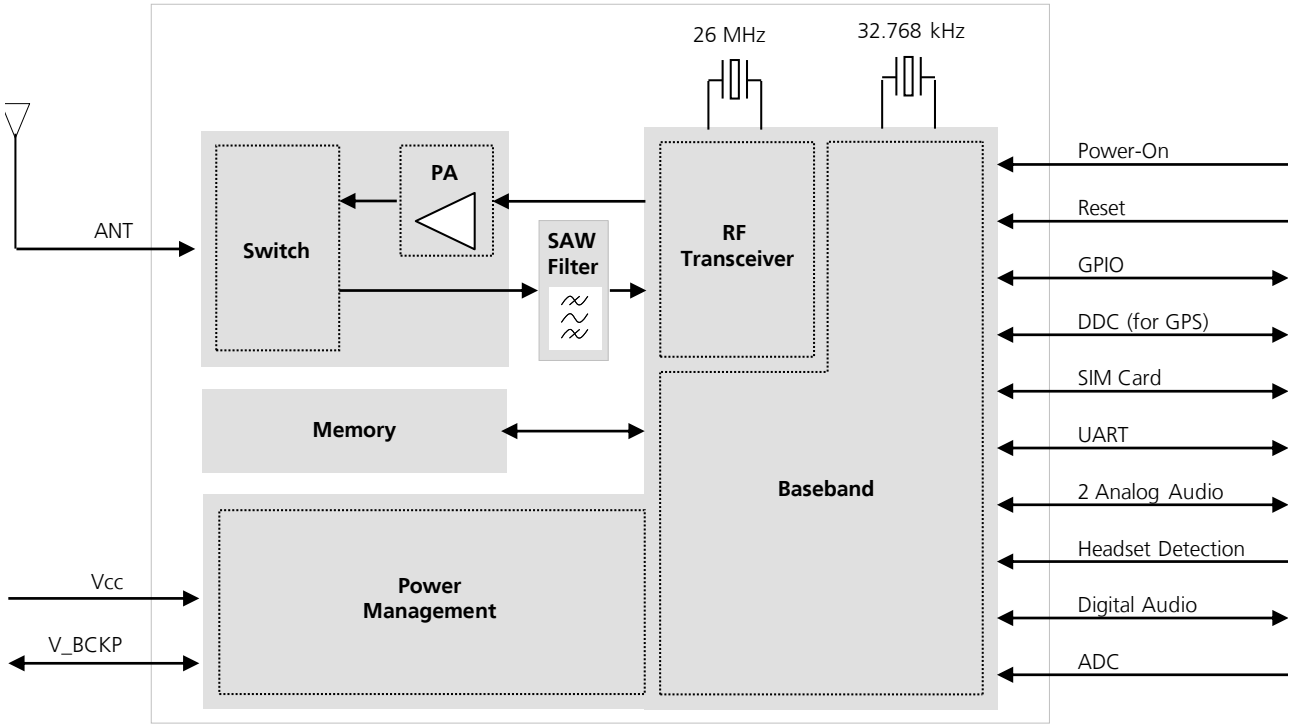

Figure 1: LEON-G100 block diagram

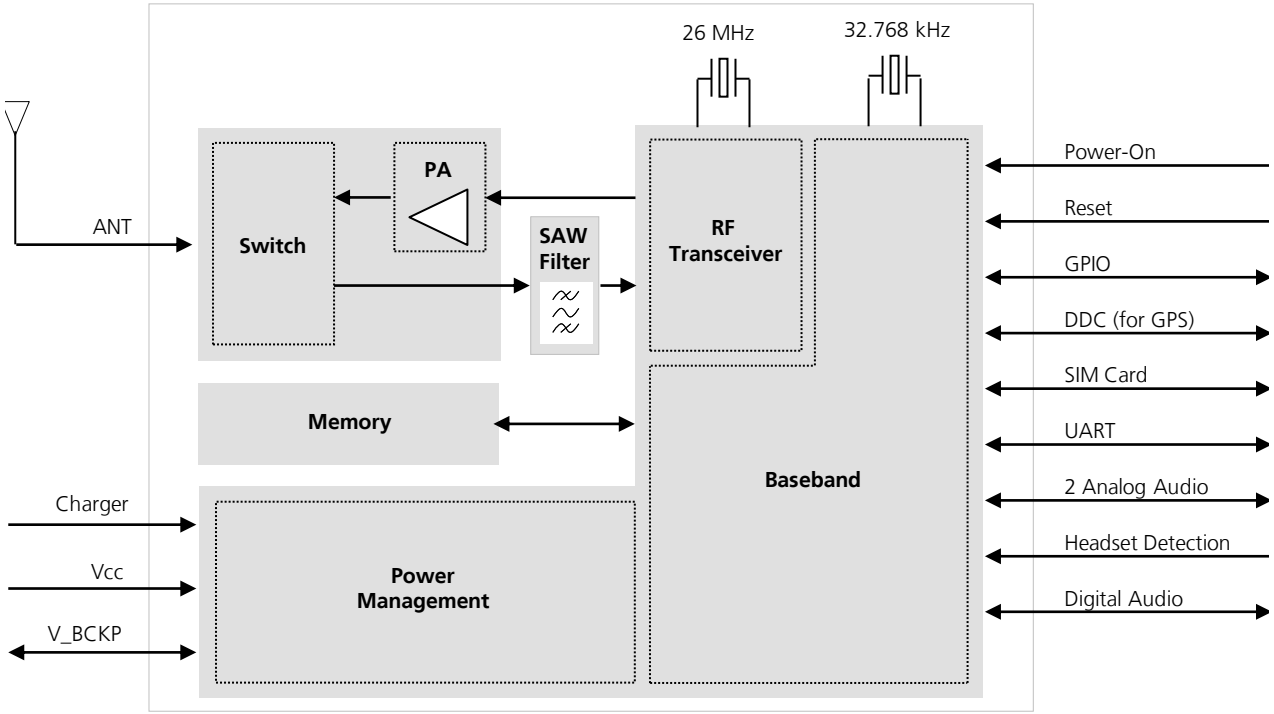

Figure 2: LEON-G200 block diagram

1.4 Product description

LEON-G100/G200 modules integrate a full-feature Release 99 GSM-GPRS protocol stack:

- Quad-band support: GSM 850 MHz, EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz
- Power Class 4 (33 dBm nominal maximum output power) for GSM/EGSM bands
- Power Class 1 (30 dBm nominal maximum output power) for DCS/PCS bands
- GPRS multislot class 10
- All GPRS coding schemes from CS1 to CS4 are supported
- GPRS bit rate: 85.6 kb/s (max.), 53.6 kb/s (typ.) in down-link; 42.8 kb/s (max.), 26.8 kb/s (typ.) in up-link
- CS (Circuit Switched) Data calls are supported in transparent/non transparent mode up to 9.6 kb/s
- Encryption algorithms A5/1 for GSM and GPRS are supported
- Bearer service fax Group 3 Class 2.0 is supported

GPRS modem is a Class B Mobile Station; this means that the module can be attached to both GPRS and GSM services, using one service at a time. Network operation modes I to III are supported, with user-definable preferred service selectable from GSM to GPRS.

LEON-G100/G200 modules function as GPRS multislot class 10 for data transfer

- 4 time-slots in downlink direction, 1 time-slot in uplink direction, or
- 3 time-slots in downlink direction, 2 time-slots in uplink direction

With correct configuration via AT commands the module can also function as GPRS multislot class 8 device.

The network will automatically configure the number of timeslots available for usage by the module.

The network configures automatically the channel encoding used by the module, depending on the conditions of the quality of the radio link between cell phone and base station. If the channel is very noisy, the network may use the most robust coding scheme (CS-1) to ensure higher reliability. If the channel is providing a good condition, the network could use the least robust but fastest coding scheme (CS-4) to obtain optimum speed.

The maximum GPRS bit rate of the module depends on the current network settings.

Direct Link mode is supported for TCP sockets.

1.5 Supplementary services

- Call Hold/Resume (CH)
- Call Waiting (CW)
- Multi-Party (MTPY)
- Call Forwarding (CF)
- Call Divert
- Explicit Call Transfer (ECT)
- Call Barring (CB)
- Call Completion to Busy Subscriber (CCBS)
- Advice of Charge Charging (AOCC)
- Calling Line Identification Presentation (CLIP)
- Calling Line Identification Restriction (CLIR)
- Connected Line Identification Presentation (COLP)
- Connected Line Identification Restriction (COLR)
- Unstructured Supplementary Services Data (USSD)
- Network Identify and Time Zone (NITZ)

1.6 Short Message Service (SMS)

- Mobile-Originating SMS (MO SMS)
- Mobile-Terminating SMS (MT SMS)
- SMS Cell Broadcast (SMS CB)
- Concatenated SMS
- Text and PDU mode supported
- Reception of SMS during circuit-switched calls
- Reception of SMS via GSM or GPRS
- SMS storage (customizable & configurable) provided

1.7 AT Command support

The module supports the following AT commands standards:

- AT commands according to the 3GPP TS 27.007 Technical Specification [1]
- AT commands according to the 3GPP TS 27.005 Technical Specification [2]
- AT commands according to the 3GPP TS 27.010 Technical Specification [3]
- u-blox AT command extension

☞ For the complete list of the supported AT commands and their syntax refer to the document u-blox AT Commands Manual [4].

1.8 Other basic features

- Display of Called Number
- Indication of Call Progress Signals
- Country/PLMN Indication
- International Access Function
- Service Indicator
- Dual Tone Multi Frequency (DTMF)
- Subscription Identity Management
- Service Provider Indication
- Abbreviated Dialing
- SIM Toolkit

1.9 AssistNow clients and GPS integration

For customers using u-blox GPS receivers, LEON-G100/G200 modules feature embedded AssistNow Online and AssistNow Offline clients. AssistNow A-GPS provides better GPS performance and faster Time-to-First-Fix. The clients can be enabled / disabled with an AT command. LEON-G100/G200 modules act as a stand-alone AssistNow client, making AssistNow available with no additional requirements for resources or software integration on an external host micro controller.

Full access to u-blox GPS receivers is available via LEON-G100/G200 modules through a dedicated DDC (I^2C) interface. This means that GSM/EDGE and GPS can be controlled through a single serial port from any host processor. For more details see the GPS Implementation Application Note [7].

1.10 In-Band modem

LEON-G100 Automotive grade version implements the in-Band modem functionality as standardized in the 3GPP TS 26.267 specification [9].

According to the eCall (Pan-European automatic in-vehicle emergency call system) specification, an eCall must be generated automatically or manually following an car accident using GSM cellular service "112". When activated, the in-vehicle eCall system (IVS) creates an emergency call carrying both voice and data (e.g. vehicle GPS position) directly to the nearest 112 Public Safety Answering Point (PSAP) to quickly decide upon detaching rescue services to the known position.

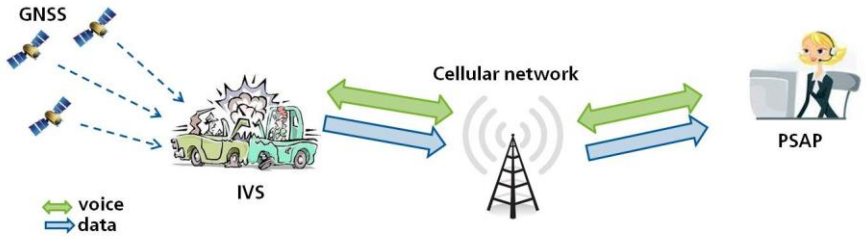

Figure 3: In-Band modem diagram flow

In-band modem allows the fast and reliable transmission of vehicle Minimum Set of Data (MSD - 140 bytes) and the establishment of a voice emergency call using the same physical channel (voice channel) without any modifications of the existing cellular network architecture.

In-Band modem is a mandatory feature to meet the eCall requirements and to develop in vehicle devices fully supporting eCall.

The in-Band modem functionality is delivered upon request.

1.11 Smart Temperature Supervisor

An internal sensor is used to constantly monitor the board temperature of LEON-G100/G200 modules. The measured value is compared with internally predefined thresholds and it proceeds accordingly.

A warning notification is reported by the module when the temperature value is still inside the valid range (i.e. the module is still in a valid and good working condition) but approaches an upper or lower limit.

A shutdown is notified and automatically forced by the module when the temperature value is outside the specified range (i.e. the module is in a dangerous working condition). For security reasons the shutdown is suspended in case an emergency call is in progress: in this case the device will switch off at call termination.

The Smart Temperature Supervisor feature can be enabled or disabled through an AT command (for more details please refer to u-blox AT commands manual [4], +USTS AT command). If the feature is disabled there is no embedded protection against disallowed temperature working conditions.

☞ The sensor measures board temperature, which can differ from ambient temperature.

2 Interfaces

2.1 Power management

2.1.1 Module supply (VCC)

LEON-G100/G200 modules must be supplied through the **VCC** pin by a DC power supply. Voltages must be stable: during operation, the current drawn from **VCC** can vary by some order of magnitude, especially due to the surging consumption profile of the GSM system (described in the LEON-G100/G200 System Integration Manual [6]). It is important that the system power supply circuit is able to support peak power.

2.1.2 Battery charger (LEON-G200 only)

For battery charging functions, the module is provided with integrated circuitry and software. Two pins are available to connect the positive pole of the external DC supply used as the charger.

The **V_CHARGE** pin is the charger supply input: it sinks the charge current that is typically in the order of several hundred mA. The **CHARGE_SENSE** pin is connected to an internal ADC converter to measure the charging voltage: it senses the charger voltage and sinks a few µA.

2.1.3 RTC Supply (V_BCKP)

V_BCKP is the Real Time Clock (RTC) supply. When **VCC** voltage is within the valid operating range, the internal Power Management Unit (PMU) supplies the RTC and the same supply voltage will be available on **V_BCKP** pin. If the **VCC** voltage is under the minimum operating limit (e.g. during not powered mode), the RTC can be externally supplied via **V_BCKP** pin.

2.2 RF antenna interface

The **ANT** pad has an impedance of 50 Ω and provides the RF antenna interface.

2.3 System functions

2.3.1 Module Power-On (PWR_ON)

Shorting **PWR_ON** pin to ground is used to switch on the module. The **PWR_ON** pin requires an external pull-up resistor to set its value to logic high and must not be left floating. Internal circuitry is low level sensitive.

The module can also be switched on by a rising edge on the **VCC** pin to a valid voltage as module supply, by RTC alarm, or by charger detection on the **V_CHARGE** and **CHARGE_SENSE** pins (LEON-G200 only).

2.3.2 Module Reset (RESET_N)

To reset LEON-G100/G200 modules the **RESET_N** pin must be shorted to ground. Driving **RESET_N** pin low causes an asynchronous reset of the entire module (except for the RTC block).

RESET_N is pulled low by the module itself when the module is in power-off mode or an internal reset occurs.

2.4 SIM interface

An SIM card interface is provided on the **VSIM**, **SIM_IO**, **SIM_CLK**, **SIM_RST** pins of the LEON-G100/G200 modules: the high-speed SIM/ME interface is implemented as well as the automatic detection of the required SIM supporting voltage.

Both 1.8 V and 3 V SIM types are supported: activation and deactivation with automatic voltage switch from 1.8 V to 3 V are implemented, according to ISO-IEC 7816-3 Specifications. The SIM driver supports the PPS (Protocol and Parameter Selection) procedure for baud-rate selection, according to the values proposed by the SIM Card.

2.5 Asynchronous serial interface (UART)

The UART interface is a 9-wire unbalanced asynchronous serial interface provided for all communications with LEON-G100/G200 modules: AT commands interface, GPRS data and CSD data, software upgrades.

UART features are:

- Complete serial port with RS-232 functionality conforming to the ITU-T V.24 Recommendation [5], with CMOS compatible signal levels (0 V for low data bit or ON state and 2.85 V for high data bit or OFF state)
- Data lines (**RxD** as output, **TxD** as input), hardware flow control lines (**CTS** as output, **RTS** as input), modem status and control lines (**DTR** as input, **DSR** as output, **DCD** as output, **RI** as output) are provided
- Hardware flow control (default value), software flow control, or none flow control are supported
- Power saving indication available on the hardware flow control output (**CTS** line): the line is driven to the OFF state when the module is not prepared to accept data signals
- 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400 b/s baud rates are supported for the AT interface; note that 1200 and 230400 b/s are available in conjunction only with autobauding
- Auto baud rate detection (autobauding) is the default configuration
- Frame format can be: 8N2 (8 data bits, No parity, 2 stop bits) or 8E1 (8 data bits, even parity, 1 stop bit) or 8O1 (8 data bits, odd parity, 1 stop bit) or 8N1 (8 data bits, No parity, 1 stop bit) or 7E1 (7 data bits, even parity, 1 stop bit) or 7O1 (7 data bits, odd parity, 1 stop bit)
- Default frame configuration is 8N1 where there are eight (8), no (N) parity bit, and one (1) stop bit
- Automatic frame recognition is supported: this feature is enabled in conjunction with the auto baud rate detection only

2.5.1 MUX protocol

LEON-G100/G200 modules have a software layer with MUX functionality, 3GPP TS 27.010 multiplexer protocol [3]. It is a data link protocol (layer 2 of OSI model) which uses HDLC-like framing and operates between the module (DCE) and the application processor (DTE), and allows a number of simultaneous sessions over the physical link (UART). This permits, for example, an SMS to be transferred to the DTE when a data connection is in progress.

The following channels are defined:

- Channel 0: control channel
- Channel 1 – 5: AT commands /data connection
- Channel 6: GPS tunnelling

For more details please refer to the GSM Mux Implementation Application Note [8].

2.6 DDC (I^2C compatible) bus interface

LEON-G100/G200 modules provide an I^2C compatible DDC interface on the **SCL** and **SDA** pins exclusively for communication with u-blox GPS devices.

2.7 Audio

LEON-G100/G200 modules provide four analog and one digital audio interfaces:

- Two microphone inputs:
  - First microphone input (**MIC_BIAS1**, **MIC_GND1**): it can be used for direct connection of the electret condenser microphone of an handset. This audio input is used when audio uplink path is set as "Handset Microphone" (for more details please refer to u-blox AT Commands Manual [4], AT+USPM command)
  - Second microphone input (**MIC_BIAS2**, **MIC_GND2**): it can be used for direct connection of the electret condenser microphone of an headset. This audio input is used when audio uplink path is set as "Headset Microphone" (for more details please refer to u-blox AT Commands Manual [4], AT+USPM command).
- Two speaker outputs:
  - First speaker output (**HS_P**): a single ended low power audio output can be used to directly connect the receiver (earpiece) of an handset or an headset. This audio output is used when audio downlink path is "Normal earpiece" or "Mono headset" (for more details please refer to u-blox AT Commands Manual [4]; AT+USPM command). These two downlink path profiles use the same physical output but have different sets of audio parameters (for more details please refer to u-blox AT Commands Manual [4], AT+USGC, +UDBF, +USTN commands).
  - Second speaker output (**SPK_P**, **SPK_N**): a differential high power audio output, can be used to directly connect a speaker or a loud speaker used for ring-tones or for speech in hands-free mode. This audio output is used when audio downlink path is "Loudspeaker" (for more details please refer to u-blox AT Commands Manual [4], AT+USPM command , <main_downlink> and <alert_sound> parameters).
- Headset detection input (**HS_DET**):
  - The headset detection, if enabled, causes the automatic switch of the uplink audio path to "Headset Microphone" and downlink audio path to "Mono headset". Enabling / disabling of detection can be controlled by parameter <headset_indication> in AT+USPM command (for more details please refer to u-blox AT Commands Manual [4]).
- I^2S digital audio interface (**I2S_TX**, **I2S_RX**, **I2S_CLK**, **I2S_WA**)
  - This audio path is selected when parameters <main_uplink> and <main_downlink> in +USPM command (for more details please refer to u-blox AT Commands Manual [4]) are respectively "I^2S input line" and "I^2S output line".

☞ Not all the Input-Output audio path combinations are allowed. Please check audio command +USPM in u-blox AT Commands Manual [4] for allowed combinations of audio path and for their switching during different use cases (speech/alert tones).

☞ The default values for audio parameters tuning commands (for more details please refer to u-blox AT Commands Manual [4]; +UMGC,+UUBF, +UHFP, +USGC, +UDBF, +USTN AT commands) are tuned for audio device connected as suggested above (i.e. Handset microphone connected on first microphone input, headset microphone on second microphone input). For a different use case (i.e. connection of a Hands Free microphone) these parameters should be changed on the audio path corresponding to the connection chosen.

☞ For the default values related to the uplink, downlink path and headset detection please refer to u-blox AT Commands Manual [4].

2.8 ADC input (LEON-G100 only)

One Analog to Digital Converter input (**ADC1**) is available with the LEON-G100 and can be configured via u-blox AT commands. The ADC resolution is 11-bit, single ended input range of 0-2.0 V. For more details, please refer to the u-blox AT Commands Manual [4], +UADC AT command.

2.9 GPIO

LEON-G100/G200 modules provide some pins which can be configured as general purpose input or output, or to provide special functions via u-blox AT commands (for further details please refer to the LEON-G100/G200 System Integration Manual [6] and to u-blox AT Commands Manual [4], +UGPIOC, +UGPIOR, +UGPIOW, +UGPS, +UGPRF, +USPM).

LEON-G100/G200 modules provide five general purpose input/output pins: **GPIO1**, **GPIO2**, **GPIO3**, **GPIO4** and **HS_DET**, with the available functions described below:

- **GPS supply enable**: the **GPIO2** pin is by default configured to enable or disable the supply of the u-blox GPS receiver connected to the LEON-G100/G200 module
- **GPS data ready**: the **GPIO3** pin is by default configured to sense when the u-blox GPS receiver connected to the LEON-G100/G200 module is ready to send data by the DDC (I^2C) interface
- **GPS RTC sharing**: the **GPIO4** pin is by default configured to provide a RTC (Real Time Clock) synchronization signal to the u-blox GPS receiver connected to the LEON-G100/G200 module
- **Headset detection**: the **HS_DET** pin is by default configured to sense headset presence
- **Network status indication**: all the 5 pins (**GPIO1**, **GPIO2**, **GPIO3**, **GPIO4** and **HS_DET**) can be configured to indicate network status (registered home network, registered roaming, data transmission, no service)
- **General purpose input**: all the 5 pins (**GPIO1**, **GPIO2**, **GPIO3**, **GPIO4** and **HS_DET**) can be configured as input, sensing high or low digital level
- **General purpose output**: all the 5 pins (**GPIO1**, **GPIO2**, **GPIO3**, **GPIO4** and **HS_DET**) can be configured as output, set in the high or low digital level.
- **Pad disabled**: all the 5 pins (**GPIO1**, **GPIO2**, **GPIO3**, **GPIO4** and **HS_DET**) can be configured in tri-state, with an internal active pull-down enabled

3 Pin definition

3.1 Pin assignment

Figure 4: LEON-G100/G200 modules pin assignment

No	Module	Name	Power domain	I/O	Description	Remarks
1	All	GND		N/A	Ground	All GND pads must be connected to ground.
2	All	V_BCKP		I/O	Real Time Clock supply	V_BCKP = 2.0 V (typical) generated by the module to supply the Real Time Clock when VCC supply voltage is within valid operating range. See section 4.2.3 for detailed electrical specs.
3	All	GND		N/A	Ground	All GND pads must be connected to ground.
4	LEON-G100	Reserved		N/A	Reserved	Leave unconnected.
	LEON-G200	V_CHARGE		I	Charger supply input	See section 4.2.3 for detailed electrical specs.
5	LEON-G100	ADC1	ADC	I	ADC input	Resolution: 11 bits Input operating voltage range: 0 V – 2.0 V See section 4.2.12 for detailed electrical specs.
	LEON-G200	CHARGE_SENSE		I	Charger sense input	See section 4.2.3 for detailed electrical specs.
6	All	GND		N/A	Ground	All GND pads must be connected to ground.
7	All	GND		N/A	Ground	All GND pads must be connected to ground.
8	All	GND		N/A	Ground	All GND pads must be connected to ground.
9	All	DSR	GDI	O	UART data set ready	Circuit 107 (DSR) in ITU-T V.24. Output driver class B slow. PU/PD class A. Value at reset: T/PU. See section 4.2.9 for detailed electrical specs.

No	Module	Name	Power domain	I/O	Description	Remarks
10	All	RI	GDI	O	UART ring indicator	Circuit 125 (RI) in ITU-T V.24. Output driver class D. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
11	All	DCD	GDI	O	UART data carrier detect	Circuit 109 (DCD) in ITU-T V.24. Output driver class B. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
12	All	DTR	GDI	I	UART data terminal ready	Circuit 108/2 (DTR) in ITU-T V.24. Internal active pull-up to 2.85 V enabled. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
13	All	RTS	GDI	I	UART ready to send	Circuit 105 (RTS) in ITU-T V.24. Internal active pull-up to 2.85 V enabled. PU/PD class C. Value at reset: T/PU. See section 4.2.9 for detailed electrical specs.
14	All	CTS	GDI	O	UART clear to send	Circuit 106 (CTS) in ITU-T V.24. Output driver class E. PU/PD class C. Value at reset: T. See section 4.2.9 for detailed electrical specs.
15	All	TxD	GDI	I	UART transmitted data	Circuit 103 (TxD) in ITU-T V.24. Internal active pull-up to 2.85 V enabled. PU/PD class C. Value at reset: T. See section 4.2.9 for detailed electrical specs.
16	All	RxD	GDI	O	UART received data	Circuit 104 (RxD) in ITU-T V.24. Output driver class E. PU/PD class C. Value at reset: T. See section 4.2.9 for detailed electrical specs.
17	All	GND		N/A	Ground	All GND pads must be connected to ground.
18	All	HS_DET	GDI	I	GPIO	By default, the pin is configured to provide the headset detection function. Internal active pull-up to 2.85 V enabled when the pin is configured for headset detection. Output driver class E. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
19	All	PWR_ON	POS	I	Power-on input	The PWR_ON pin has high input impedance: don't leave it floating in noisy environment (an external pull-up resistor is required). See section 4.2.6 for detailed electrical specs.
20	All	GPIO1	GDI	I/O	GPIO	The pin can be configured to provide the network status indication function. Output driver class C. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
21	All	GPIO2	GDI	I/O	GPIO	By default, the pin is configured to provide the GPS Supply Enable function. Output driver class C. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
22	All	RESET_N	ERS	I/O	External reset signal	A series Schottky diode is integrated in the module as protection. An internal 12.6 kΩ pull-up resistor pulls the line to 1.88 V when the module is not in the reset state. An internal open drain FET pulls the line low when an internal reset occurs and when the module is in power down mode. See section 4.2.7 for detailed electrical specs. For more details regarding module reset, see [6].
23	All	GPIO3	GDI	I/O	GPIO	By default, the pin is configured to provide the GPS data ready function. Output driver class F. PU/PD class B. Value at reset: T. See section 4.2.9 for detailed electrical specs.

No	Module	Name	Power domain	I/O	Description	Remarks
24	All	GPIO4	GDI	I/O	GPIO	By default, the pin is configured to provide the GPS RTC sharing function. Output driver class F. PU/PD class B. Value at reset: T/PD. See section 4.2.9 for detailed electrical specs.
25	All	GND		N/A	Ground	All GND pads must be connected to ground.
26	All	I2S_WA	GDI	O	I^2S word alignment	Output driver class D. PU/PD class B. Value at reset: T. See section 4.2.9 for detailed electrical specs.
27	All	I2S_TXD	GDI	O	I^2S transmit data	Output driver class D. PU/PD class B. Value at reset: T. See section 4.2.9 for detailed electrical specs.
28	All	I2S_CLK	GDI	O	I^2S clock	Output driver class D. PU/PD class B. Value at reset: T. See section 4.2.9 for detailed electrical specs.
29	All	I2S_RXD	GDI	I	I^2S receive data	Internal active pull-up to 2.85 V enabled. PU/PD class B. Value at reset: T. See section 4.2.9 for detailed electrical specs.
30	All	SCL	DDC	O	I^2C bus clock line	Fixed open drain. No internal pull-up. Value at reset: T/OD. See section 4.2.10 for detailed electrical specs.
31	All	SDA	DDC	I/O	I^2C bus data line	Fixed open drain. No internal pull-up. Value at reset: T/OD. See section 4.2.10 for detailed electrical specs.
32	All	SIM_CLK	SIM	O	SIM clock	Output driver class E. Value at reset: L. See section 4.2.8 for detailed electrical specs.
33	All	SIM_IO	SIM	I/O	SIM data	Internal 4.7k pull-up to VSIM. Output driver class E. Value at reset: OD/L. See section 4.2.8 for detailed electrical specs.
34	All	SIM_RST	SIM	O	SIM reset	Output driver class E. Value at reset: L. See section 4.2.8 for detailed electrical specs.
35	All	VSIM		O	SIM supply output	VSIM = 1.80 V typical if SIM card = 1.8V type or VSIM = 2.85 V typical if SIM card = 3.0V type See section 4.2.3 for detailed electrical specs.
36	All	GND		N/A	Ground	All GND pads must be connected to ground.
37	All	HS_P	AUDIO	O	First speaker output with low power single-ended analog audio	This audio output is used when audio downlink path is “Normal earpiece” or “Mono headset” See section 4.2.11 for detailed electrical specs.
38	All	SPK_P	AUDIO	O	Second speaker output with high power differential analog audio	This audio output is used when audio downlink path is “Loudspeaker” See section 4.2.11 for detailed electrical specs.
39	All	SPK_N	AUDIO	O	Second speaker output with power differential analog audio output	This audio output is used when audio downlink path is “Loudspeaker” See section 4.2.11 for detailed electrical specs.
40	All	Reserved		N/A	Reserved	Leave unconnected.
41	All	MIC_BIAS2	AUDIO	I	Second microphone analog signal input and bias output	This audio input is used when audio uplink path is set as “Headset Microphone” See section 4.2.11 for detailed electrical specs.
42	All	MIC_GND2	AUDIO	I	Second microphone analog reference	Local ground of the second microphone See section 4.2.11 for detailed electrical specs.
43	All	MIC_GND1	AUDIO	I	First microphone analog reference	Local ground of the first microphone See section 4.2.11 for detailed electrical specs.
44	All	MIC_BIAS1	AUDIO	I	First microphone analog signal input and bias output	This audio input is used when audio uplink path is set as “Handset Microphone” See section 4.2.11 for detailed electrical specs.
45	All	GND		N/A	Ground	All GND pads must be connected to ground.

No	Module	Name	Power domain	I/O	Description	Remarks
46	All	GND		N/A	Ground	All GND pads must be connected to ground.
47	All	ANT		I/O	RF antenna	50 Ω nominal impedance See section 4.2.5 for detailed electrical specs.
48	All	GND		N/A	Ground	All GND pads must be connected to ground.
49	All	GND		N/A	Ground	All GND pads must be connected to ground.
50	All	VCC		I	Module supply input	See section 4.2.3 for detailed electrical specs.

Table 2: Pinout

Pins designated Reserved should not be used. For more information about Pinout see the LEON-G100/G200 System Integration Manual [6].

Explanation of abbreviations and terms used is reported in Appendix A.

4 Electrical specifications

Stressing the device above one or more of the ratings listed in the Absolute Maximum Rating section may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating Conditions sections (chapter 4.2) of the specification should be avoided. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Operating conditions ranges define those limits within which the functionality of the device is guaranteed.

Where application information is given, it is advisory only and does not form part of the specification.

4.1 Absolute maximum rating

Limiting values given below are in accordance with the Absolute Maximum Rating System (IEC 134).

Symbol	Description	Condition	Min.	Max.	Unit
VCC	Module supply voltage	Input DC voltage at VCC pin	-0.30	5.5	V
ICC	Module supply current	Input DC current at VCC pin		2.5	A
V_CHARGE	Module charge voltage	Input DC voltage at V_CHARGE and CHARGE_SENSE pins		15.0	V
I_CHARGE	Module charge current	Input DC current at V_CHARGE and CHARGE_SENSE pins		1000	mA
V_BCKP	RTC supply voltage	Input DC voltage at V_BCKP pin	-0.15	2.50	V
GDI	Generic digital interfaces	Input DC voltage at Generic digital interfaces pins	-0.30	3.60	V
DDC	DDC interface	Input DC voltage at DDC interface pins	-0.30	3.60	V
SIM	SIM interface	Input DC voltage at SIM interface pin	-0.30	3.60	V
ERS	External reset signal	Input DC voltage at External reset signal pin	-0.15	5.50	V
POS	Power-on input	Input DC voltage at Power-on signal pin	-0.15	5.50	V
AUDIO	Audio input pins	Input DC voltage at Audio pins	-0.15	3.00	V
ADC	ADC pins	Input DC voltage at ADC pin	-0.15	3.00	V
V_ANT	Antenna voltage	Input DC voltage at ANT pin	-0.15	3.00	V
P_ANT	Antenna power	Input RF power at ANT pin		10	dBm
Rho_ANT	Antenna ruggedness	Output RF load mismatch ruggedness at ANT pin		20:1	VSWR
Tstg	Storage temperature range		-40	+85	°C

Table 3: Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection devices.

4.1.1 Maximum ESD

Parameter	Min.	Typ.	Max.	Unit	Remarks
ESD for all pins except ANT pin			1000	V	HBM according MIL-Std 883D, method 3015.7, EOS/ESD Standard S5.1-1993
ESD for ANT pin			4000	V	According to IEC 61000-4-2.

Table 4: Maximum ESD ratings

GSM modules are Electrostatic Sensitive Devices (ESD) and require special precautions when handling.

4.2 Operating conditions

Unless otherwise specified, all operating condition specifications are at an ambient temperature of 25°C.

Operation beyond the operating conditions is not recommended and extended exposure beyond them may affect device reliability

4.2.1 Operating temperature range

Symbol	Parameter	Module	Min.	Typ.	Max.	Units	Remarks
Topr	Operating temperature range	All	-40	+25	+85	°C	
		All	-30		+85	°C	Normal operating range see chapter 4.2.1.1
		All	-40		-30	°C	Extended operating range see chapter 4.2.1.2
Tcharge	Operating temperature range for charging mode	LEON-G200	0		+40	°C	5°C hysteresis to prevent rapid enabling/disabling of charging mode

Table 5: Environmental conditions

4.2.1.1 Normal operating temperature range

LEON-G100/G200 modules are fully functional and meet ETSI specification across the specified temperature range.

4.2.1.2 Extended operating temperature range

LEON-G100/G200 modules are fully functional across the specified temperature range. Occasional deviations from the ETSI specification may occur.

4.2.2 Case-to-Ambient thermal resistance

Symbol	Parameter	Module	Min.	Typ.	Max.	Units	Remarks
$R_{th, C-A}$	Case-to-Ambient thermal resistance	All		14		°C/W	Module mounted on a 130 mm x 110 mm x 1.6 mm FR4 PCB with a high coverage of copper in still air conditions

Table 6: Case-to-Ambient thermal resistance

4.2.3 Supply/Power pins

Symbol	Parameter	Min.	Typ.	Max.	Unit
VCC	Module supply normal operating voltage[1]	3.35	3.8	4.50	V
	Module supply extended operating voltage[2]	3.00		4.50	V
ICC_PEAK[3]	Module Supply Peak Current: peak of module current consumption through the VCC pad during a GSM transmit burst, with a matched antenna (typ. value) or with a mismatched antenna (max. value)		2.00	2.50	A
V_CHARGE	Open circuit voltage of the external charger applied to the module V_CHARGE and CHARGE_SENSE pads for valid charger detection. Charging voltage must be limited by the external charger to a value less or equal the maximum specified rate.	5.6	6.0	15.0	V
I_CHARGE	Charging current provided by the external charger connected to the module V_CHARGE and CHARGE_SENSE pads. Charging current must be limited by the external charger to a value less or equal the maximum specified rate.	400[4]	500[4]	1000	mA
V_BATT	Li-Ion Battery overcharge detection voltage[5]	4.30			V
V_BCKP	Real Time Clock Supply input voltage	1.00	2.00	2.25	V
I_BCKP	Real Time Clock Supply average current consumption, at V_BCKP = 2.0 V		2.00		µA

Table 7: Input characteristics of Supply/Power pins

Symbol	Parameter	Min.	Typ.	Max.	Unit
VSIM	SIM Supply	1.75	1.80	1.85	V
		2.76	2.85	2.94	V
V_BCKP	Real Time Clock Supply output voltage	1.86	2.00	2.14	V
I_BCKP	Real Time Clock Supply output current capability			3	mA

Table 8: Output characteristics of Supply/Power pins

[1] Input voltage at VCC must be above the normal operating range minimum limit to switch-on module. Complete functionality of the module is only guaranteed within the specified range.
[2] Ensure that input voltage at VCC never drops below the extended operating range minimum limit during module operation. Module switches off when the VCC voltage value drops below the extended operating range minimum limit.
[3] Use this figure to dimension maximum current capability of power supply.
[4] The value is just suggested in case that only the LEON module is supplied by the battery, to allow battery charging during connected mode
[5] If a Li-Ion battery pack with an integrated protection circuit is used and the charging process is managed by the LEON-G200 module, the overcharge detection voltage of the battery pack, which enables battery protection, must be greater than the minimum value indicated in this table, to be charged by the LEON-G200 module.

4.2.4 Power consumption

Status	Current Consumption[6]
Power Off Mode	< 90 µA
GSM/GPRS Power Saving (Idle) Mode @ DRX = 5[7]	< 1.60 mA
GSM/GPRS Power Saving (Idle) Mode @ DRX = 9[8]	< 0.99 mA
GSM Talk (Connected) Mode @ 850 / 900 MHz (P = 32.2 dBm typ.)[9]	< 300 mA
GSM Talk (Connected) Mode @ 1800 / 1900 MHz (P = 29.2 dBm typ.)[9]	< 250 mA
GPRS 2 Tx + 3 Rx slots TBF (Connected) Mode @ 850 MHz (P = 30.5 dBm typ.)[9]	< 410 mA
GPRS 2 Tx + 3 Rx slots TBF (Connected) Mode @ 900 MHz (P = 30.5 dBm typ.)[9]	< 350 mA
GPRS 2 Tx + 3 Rx slots TBF (Connected) Mode @ 1800 MHz (P = 27.5 dBm typ.)[9]	< 330 mA
GPRS 2 Tx + 3 Rx slots TBF (Connected) Mode @ 1900 MHz (P = 27.5 dBm typ.)[9]	< 340 mA

Table 9: Power consumption

4.2.5 RF Performance

Parameter		Min.	Max.	Unit	Remarks
Frequency range GSM 850	Uplink	824	849	MHz	Module transmit
	Downlink	869	894	MHz	Module receive
Frequency range E-GSM 900	Uplink	880	915	MHz	Module transmit
	Downlink	925	960	MHz	Module receive
Frequency range DCS 1800	Uplink	1710	1785	MHz	Module transmit
	Downlink	1805	1880	MHz	Module receive
Frequency range PCS 1900	Uplink	1850	1910	MHz	Module transmit
	Downlink	1930	1990	MHz	Module receive

Table 10: Operating RF frequency bands

Parameter	Min.	Typ.	Max.	Unit	Remarks
Receiver input sensitivity GSM 850	-102	-110		dBm	Downlink RF level @ ARP BER Class II < 2.4 % Condition: 50 Ω source
Receiver input sensitivity E-GSM 900	-102	-110		dBm	Downlink RF level @ ARP BER Class II < 2.4 % Condition: 50 Ω source
Receiver input sensitivity DCS 1800	-102	-109		dBm	Downlink RF level @ ARP BER Class II < 2.4 % Condition: 50 Ω source
Receiver input sensitivity PCS 1900	-102	-109		dBm	Downlink RF level @ ARP BER Class II < 2.4 % Condition: 50 Ω source

Table 11: Receiver sensitivity performance

[6] Maximum values for module average current consumption through the VCC pad in the listed status/conditions, at 25°C, with VCC = 3.8 V, with a matched antenna.
[7] Module is registered in the network, with a paging period of 1177 ms (GSM network DRX setting of 5) with 16 neighbour cells.
[8] Module is registered in the network, with a paging period of 2118 ms (GSM network DRX setting of 9) with none neighbour cell.
[9] Module transmits at the maximum power level.

Parameter	Min.	Typ.	Max.	Unit	Remarks
Maximum output power GSM 850	31.0	32.2	34.0	dBm	Uplink burst RF power for Single slot TCH at maximum output power control level (PCL 5) Condition: 50 Ω output load
Maximum output power E-GSM 900	31.0	32.2	34.0	dBm	Uplink burst RF power for Single slot TCH at maximum output power control level (PCL 5) Condition: 50 Ω output load
Maximum output power DCS 1800	28.0	29.2	32.0	dBm	Uplink burst RF power for Single slot TCH at maximum output power control level (PCL 0) Condition: 50 Ω output load
Maximum output power PCS 1900	28.0	29.2	32.0	dBm	Uplink burst RF power for Single slot TCH at maximum output power control level (PCL 0) Condition: 50 Ω output load

Table 12: Transmitter maximum output power

4.2.6 PWR_ON pin

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
PWR_ON	Internal supply for Power-On Input Signal	1.86	2.00	2.14	V	Real Time Clock supply (V_BCKP)
	L-level input	-0.10	0.00	0.86	V	High input impedance (no internal pull-up)
	H-level input	1.60	2.00	4.50	V	High input impedance (no internal pull-up)
	L-level input current		-6		µA	
	Minimal low time required to perform a proper power-on	5			ms	

Table 13: PWR_ON pin characteristics

4.2.7 RESET_N pin

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
RESET_N	Internal supply for External Reset Signal	1.86	2.00	2.14	V	Real Time Clock supply (V_BCKP)
	L-level input	-0.10	0.00	0.15	V	A series Schottky diode is integrated in the module as protection: the module senses a low level when the RESET_N pin is forced low.
	H-level input	1.60	2.00	4.50	V	A series Schottky diode is integrated in the module as protection: the module senses a low level when the RESET_N pin is forced low.
	L-level output		0.00		V	The module has an internal open drain FET which pulls the RESET_N line low when an internal reset occurs and when the module is in power down mode.
	H-level output		1.88		V	The module has an internal pull-up resistor (12.6 kΩ typical) which pulls the level to 1.88 V (typical) when the module is not in the reset state.
	L-level input current		-150		µA	
	Minimal low time required to perform a proper reset	50			ms	

Table 14: RESET_N pin characteristics

4.2.8 SIM pins

Parameter	Min.	Typ.	Max.	Unit	Remarks
Low-level input		0.00	0.36	V	VSIM = 1.80 V
		0.00	0.57	V	VSIM = 2.85 V
High-level input	1.26	1.80	3.30	V	VSIM = 1.80 V
	2.00	2.85	3.30	V	VSIM = 2.85 V
Low-level output		0.00	0.20	V	VSIM = 1.80 V, Max value at I_{OL} = +1.0 mA
		0.00	0.35	V	VSIM = 1.80 V, Max value at I_{OL} = +1.5 mA
		0.00	0.20	V	VSIM = 2.85 V, Max value at I_{OL} = +1.0 mA
		0.00	0.35	V	VSIM = 2.85 V, Max value at I_{OL} = +1.5 mA
High-level output	1.60	1.80		V	VSIM = 1.80 V, Min value at I_{OH} = -1.0 mA
	1.45	1.80		V	VSIM = 1.80 V, Min value at I_{OH} = -1.5 mA
	2.65	2.85		V	VSIM = 2.85 V, Min value at I_{OH} = -1.0 mA
	2.50	2.85		V	VSIM = 2.85 V, Min value at I_{OH} = -1.5 mA
Input/Output leakage current			0.7	µA	0.2 V < V_{IN} < 3.3 V
Internal pull-up resistor on SIM_IO to VSIM		4.7		kΩ	
Clock frequency on SIM_CLK		3.25		MHz	
Pad resistance: Rising edge			130	Ω	1.0-1.5 mA load
Pad resistance: Falling edge			120	Ω	1.0-1.5 mA load

Table 15: SIM pins characteristics

4.2.9 Generic Digital Interfaces pins

Parameter	Min.	Typ.	Max.	Unit	Remarks
Internal supply for GDI domain	2.76	2.85	2.94	V	
Input characteristic: L-level input	-0.20	0.00	0.57	V	
Input characteristic: H-level input	2.00	2.85	3.30	V	
Output characteristics: L-level output		0.00	0.40	V	Max value at I_{OL} = +10.0 mA for Driver Class B slow
		0.00	0.80	V	Max value at I_{OL} = +15.0 mA for Driver Class B slow
		0.00	0.20	V	Max value at I_{OL} = +2.5 mA for Driver Class B
		0.00	0.35	V	Max value at I_{OL} = +5.0 mA for Driver Class B
		0.00	0.20	V	Max value at I_{OL} = +2.0 mA for Driver Class C
		0.00	0.35	V	Max value at I_{OL} = +4.0 mA for Driver Class C
		0.00	0.20	V	Max value at I_{OL} = +1.0 mA for Driver Class D
		0.00	0.35	V	Max value at I_{OL} = +2.0 mA for Driver Class D
		0.00	0.20	V	Max value at I_{OL} = +1.0 mA for Driver Class E and F
		0.00	0.35	V	Max value at I_{OL} = +1.5 mA for Driver Class E and F
Output characteristics: H-level output	2.65	2.85		V	Min value at I_{OH} = -10.0 mA for Driver Class B slow
	2.50	2.85		V	Min value at I_{OH} = -15.0 mA for Driver Class B slow
	2.65	2.85		V	Min value at I_{OH} = -2.5 mA for Driver Class B
	2.50	2.85		V	Min value at I_{OH} = -5.0 mA for Driver Class B
	2.65	2.85		V	Min value at I_{OH} = -2.0 mA for Driver Class C
	2.50	2.85		V	Min value at I_{OH} = -4.0 mA for Driver Class C
	2.65	2.85		V	Min value at I_{OH} = -1.0 mA for Driver Class D
	2.50	2.85		V	Min value at I_{OH} = -2.0 mA for Driver Class D
	2.65	2.85		V	Min value at I_{OH} = -1.0 mA for Driver Class E and F
	2.50	2.85		V	Min value at I_{OH} = -1.5 mA for Driver Class E and F
Input/Output leakage current			0.7	µA	0.2 V < V_{IN} < 3.3 V
Pad resistance: Rising edge			50	Ω	2.5-5.0 mA load for Driver Class B slow
			70	Ω	2.5-5.0 mA load for Driver Class B
			70	Ω	2.0-4.0 mA load for Driver Class C
			115	Ω	1.0-2.0 mA load for Driver Class D
			130	Ω	1.0-1.5 mA load for Driver Class E
			180	Ω	1.0-1.5 mA load for Driver Class F
Pad resistance: Falling edge			50	Ω	2.5-5.0 mA load for Driver Class B slow
			70	Ω	2.5-5.0 mA load for Driver Class B
			70	Ω	2.0-4.0 mA load for Driver Class C
			115	Ω	1.0-2.0 mA load for Driver Class D
			120	Ω	1.0-1.5 mA load for Driver Class E
			180	Ω	1.0-1.5 mA load for Driver Class F
Pull-up input current			-450	µA	PU/PD Class A
			-100	µA	PU/PD Class B
			-30	µA	PU/PD Class C
Pull-down input current			450	µA	PU/PD Class A
			100	µA	PU/PD Class B
			30	µA	PU/PD Class C

Table 16: GDI pins characteristics

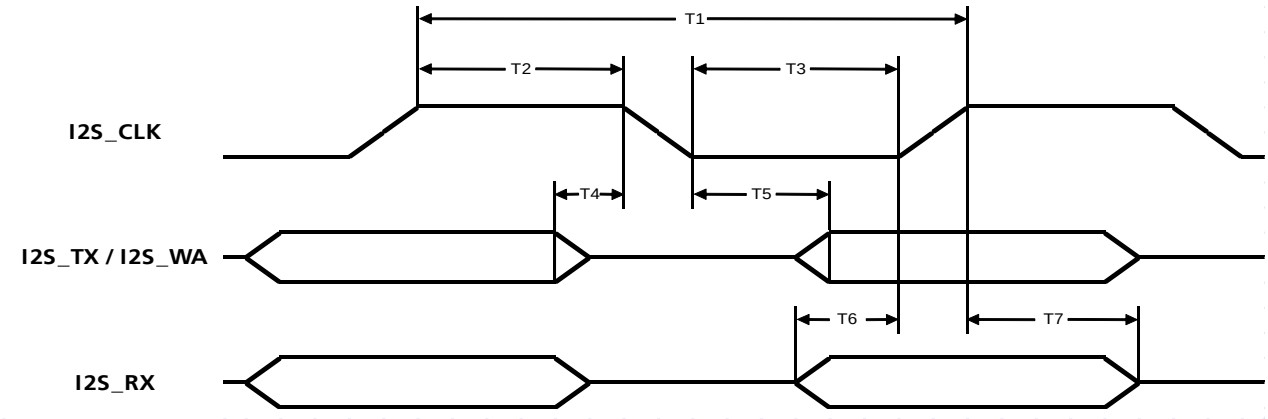

Figure 5: AC characteristics of digital audio interface in normal I2S mode (<I2S_mode> = 2,4,6,8,10,12)

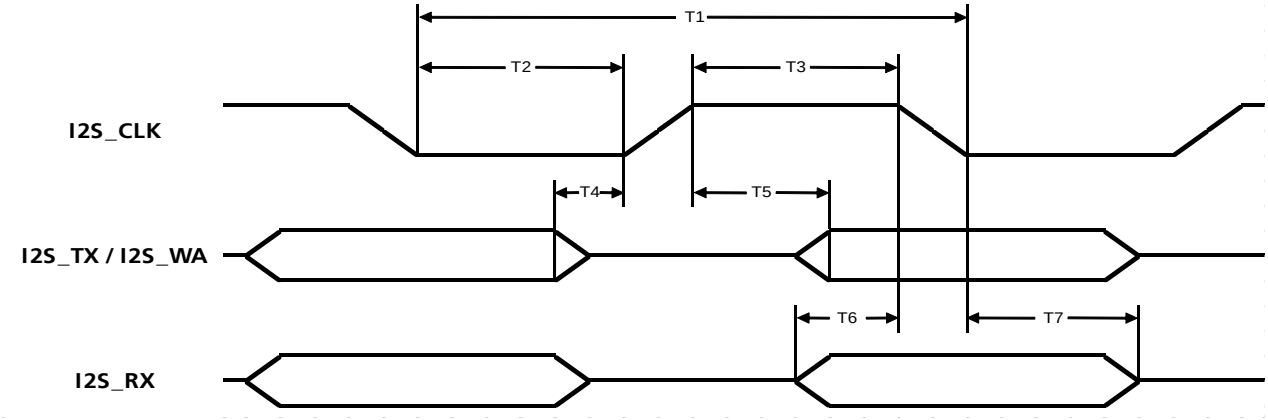

Figure 6: AC characteristics of digital audio interface in normal I2S mode (<I2S_mode> = 3,5,7,9,11,13)

Parameter	Description	Min.	Typ.	Max.	Unit	Remarks
T1	I2S_CLK period		3.906		µs	<I2S_mode> = 2,4,6,8,10,12
			3.906		µs	<I2S_mode> = 3,5,7,9,11,13
1/T1	I2S_CLK frequency		256		kHz	<I2S_mode> = 2,4,6,8,10,12
			256		kHz	<I2S_mode> = 3,5,7,9,11,13
T2	I2S_CLK high time		1.953		µs	<I2S_mode> = 2,4,6,8,10,12
			1.953		µs	<I2S_mode> = 3,5,7,9,11,13
T3	I2S_CLK low time		1.953		µs	<I2S_mode> = 2,4,6,8,10,12
			1.953		µs	<I2S_mode> = 3,5,7,9,11,13
	I2S_WA period		125.0		µs	<I2S_mode> = 2,4,6,8,10,12
			125.0		µs	<I2S_mode> = 3,5,7,9,11,13
	I2S_WA frequency		8		kHz	<I2S_mode> = 2,4,6,8,10,12
			8		kHz	<I2S_mode> = 3,5,7,9,11,13
T4	I2S_TX invalid before I2S_CLK low end			24	ns	<I2S_mode> = 2,4,6,8,10,12
	I2S_TX invalid before I2S_CLK high end			24	ns	<I2S_mode> = 3,5,7,9,11,13
T5	I2S_TX valid after I2S_CLK high begin			24	ns	<I2S_mode> = 2,4,6,8,10,12
	I2S_TX valid after I2S_CLK low begin			24	ns	<I2S_mode> = 3,5,7,9,11,13
T6	I2S_RX setup time before I2S_CLK high end	27			ns	<I2S_mode> = 2,4,6,8,10,12
	I2S_RX setup time before I2S_CLK low end	27			ns	<I2S_mode> = 3,5,7,9,11,13
T7	I2S_RX hold time after I2S_CLK low begin	0			ns	<I2S_mode> = 2,4,6,8,10,12
	I2S_RX hold time after I2S_CLK high begin	0			ns	<I2S_mode> = 3,5,7,9,11,13

Table 17: AC characteristics of digital audio interface in normal I2S mode (<I2S_mode> = 2,3,4,5,6,7,8,9,10,11,12,13)

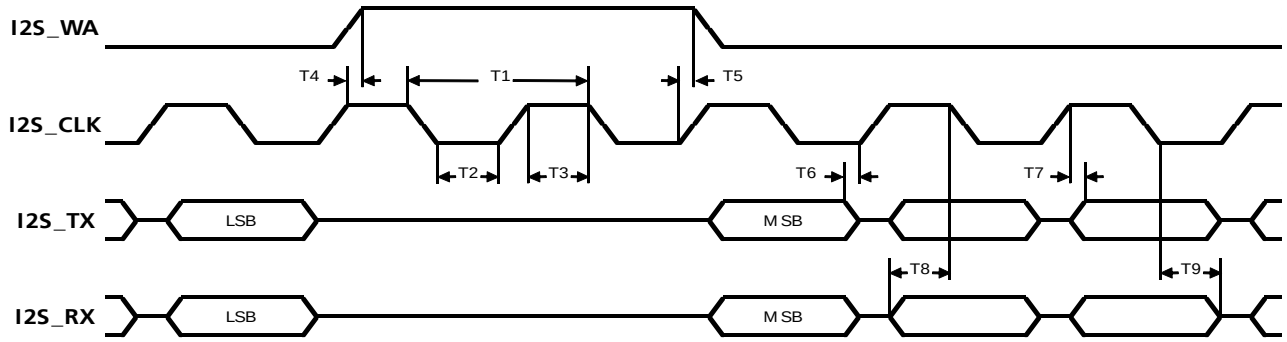

Figure 7: AC characteristics of digital audio interface in PCM mode (<I2S_mode> = 0)

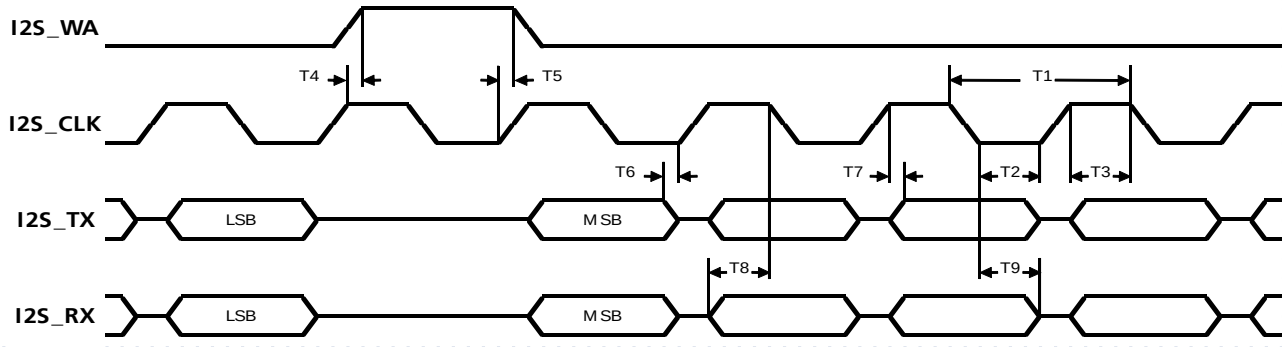

Figure 8: AC characteristics of digital audio interface in PCM mode (<I2S_mode> = 1)

Parameter	Description	Min.	Typ.	Max.	Unit	Remarks
T1	I2S_CLK period		6.944		µs	<I2S_mode> = 0
			7.353		µs	<I2S_mode> = 1
1/T1	I2S_CLK frequency		144		kHz	<I2S_mode> = 0
			136		kHz	<I2S_mode> = 1
T2	I2S_CLK low time		3.472		µs	<I2S_mode> = 0
			3.676		µs	<I2S_mode> = 1
T3	I2S_CLK high time		3.472		µs	<I2S_mode> = 0
			3.676		µs	<I2S_mode> = 1
	I2S_WA period		125.0		µs	<I2S_mode> = 0
			125.0		µs	<I2S_mode> = 1
	I2S_WA frequency		8		kHz	<I2S_mode> = 0
			8		kHz	<I2S_mode> = 1
T4	I2S_CLK high begin to I2S_WA high begin	0		48	ns	<I2S_mode> = 0
		0		48	ns	<I2S_mode> = 1
T5	I2S_CLK low end to I2S_WA high end	0		48	ns	<I2S_mode> = 0
		0		48	ns	<I2S_mode> = 1
T6	I2S_TX invalid before I2S_CLK low end			24	ns	<I2S_mode> = 0
				24	ns	<I2S_mode> = 1
T7	I2S_TX valid after I2S_CLK high begin			24	ns	<I2S_mode> = 0
				24	ns	<I2S_mode> = 1
T8	I2S_RX setup time before I2S_CLK high end	27			ns	<I2S_mode> = 0
		27			ns	<I2S_mode> = 1
T9	I2S_RX hold time after I2S_CLK low begin	0			ns	<I2S_mode> = 0
		0			ns	<I2S_mode> = 1

Table 18: AC characteristics of digital audio interface in PCM mode (<I2S_mode> = 0,1)

4.2.10 DDC (I^2C) pins

Parameter	Min.	Typ.	Max.	Unit	Remarks
Internal supply for DDC domain	2.76	2.85	2.94	V	
L-level input	-0.30	0.00	0.86	V	In accordance with I^2C bus specification
H-level input	2.00	2.85	3.30	V	In accordance with I^2C bus specification
Hysteresis	0.14			V	In accordance with I^2C bus specification
L-level output		0.00	0.40	V	Max value at I_{OL} = +3.0 mA
Input/Output leakage current			0.7	µA	0.2 V < V_{IN} < 3.3 V
Clock frequency on SCL		100		kHz	

Table 19: DDC pins characteristics

4.2.11 Audio pins

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
MIC_BIAS1/2	Microphone supply open circuit voltage output		2.20		V	Open circuit single-ended voltage. Provided by MIC_BIAS1 with MIC_GND1 as reference, or provided by MIC_BIAS2 with MIC_GND2 as reference.
	Microphone supply current			2.0	mA	Provided by MIC_BIAS1 with MIC_GND1 as reference, or provided by MIC_BIAS2 with MIC_GND2 as reference.
	Microphone supply output resistance	2.85	3.00	3.15	kΩ	Series resistance of the microphone voltage supply MIC_BIAS1 or MIC_BIAS2
MIC_GND1/2	Microphone ground		0		V	MIC_GND1 and MIC_GND2 pins are internally connected to GND

Table 20: Microphone supply characteristics

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
MIC_BIAS1/2	Input level range			1.03	Vpp	Full scale single-ended voltage. Signal applied to MIC_BIAS1 with MIC_GND1 as reference, or applied to MIC_BIAS2 with MIC_GND2 as reference.
	Input impedance		1.5		kΩ	At 1 kHz. Impedance between MIC_BIAS1 and MIC_GND1 pins, or between MIC_BIAS2 and MIC_GND2 pins.
	Internal discrete high-pass -3dB cutoff frequency		70		Hz	
If not specified otherwise, all parameters are measured with a bandwidth of 20 Hz,...,20 kHz.						

Table 21: Microphone dynamic characteristics

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks[10]
HS_P	Maximum single-ended output voltage	1.65	1.85	2.05	Vpp	Full scale single-ended open circuit voltage.
	Common mode output voltage		1.25		V	
	Internal output resistance		1.7	4	Ω	
	Output load resistance		16		Ω	
	Single-ended output load capacitance			10	nF	
	Signal to noise	70	80		dB	Load = 16 Ω, Gain stage = +0 dB, Input signal = 0 dBFS, Code 0, A-weighted
	Signal to distortion (THD)	60	70		dB	Load = 16 Ω, Gain stage = +0 dB, Input signal = 0 dBFS
		60	70		dB	Load = 16 Ω, Gain stage = +0 dB, Input signal = -1 dBFS
		60			dB	Load = 16 Ω, Gain stage = +0 dB, Input signal = -6 dBFS
	Power supply rejection	60	66		dB	Gain stage = +0 dB, $U_{VDD}(t)$ = 2.5 V+0.15 V•sin(2π•1 kHz•t)
	Passband ripple			0.5	dB	f < 0.45 f_s
	Stopband attenuation	50			dB	f > 0.55 f_s
	Absolute gain drift			±2	%	Variation due to change in supply, temperature and life time.
If not specified otherwise, all parameters are measured with a bandwidth of 20 Hz,...,20 kHz.						

Table 22: Low power single-ended audio receive path (HS_P) output characteristics

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks [10]
SPK_P/SPK_N	Maximum differential output voltage		7.8		Vpp	Overdrive Gain stage = +9 dB
	Common mode output voltage		1.6		V	
	Output load resistance		8		Ω	
	Single-ended output load capacitance			10	nF	
	Inductive load			400	µH	Between output pins and GND with series resistance
	Signal to noise	70	80		dB	Load = 16 Ω, Gain stage = +0 dB, Input signal = 0 dBFS, Code 0, A-weighted
	Signal to distortion (THD)	50			dB	Load = 8 Ω, 350 mW
	Power supply rejection	60			dB	1 kHz
If not specified otherwise, all parameters are measured with a bandwidth of 20 Hz,...,20 kHz.						

Table 23: High power differential audio receive path (SPK_P, SPK_N) output characteristics

[10] If not specified otherwise, all parameters are measured with a bandwidth of 20 Hz,...,20 kHz and gain setting gs = 0 dB.

4.2.12 ADC pin (LEON-G100 only)

Pin Name	Parameter	Min.	Typ.	Max.	Unit	Remarks
ADC1	Resolution		11		Bits	
	Differential linearity error			±0.5	LSB	
	Integral linearity error			±4	LSB	
	Offset error			±10	LSB	ADC input = 0 V
	Absolute gain drift			±2	%	Variation due to change in supply, temperature and life time.
	Input voltage span	0		2.00	V	
	Throughput rate	0.2	2	4	Hz	
	Input resistance	1.1			MΩ	With respect to GND. If mode OFF is selected.
	Input resistance in measurement mode	387	580	773	kΩ	With respect to GND. Variation due to process tolerances and change in supply, temperature, and life time.
	Internal voltage	0.46	0.48	0.50	V	With respect to GND. Variation due to process tolerances and change in supply, temperature, and life time.
	Input leakage current			0.1	µA	

Table 24: ADC pin characteristics

5 Mechanical specifications

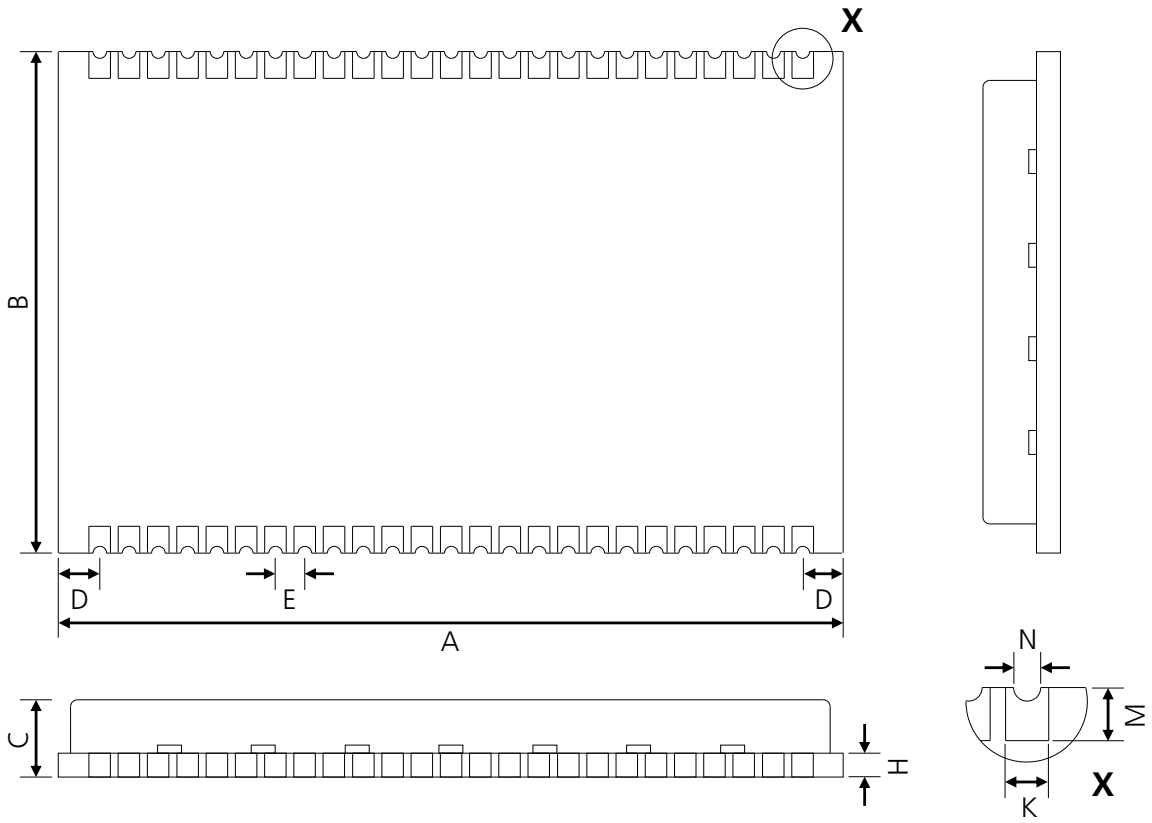

Figure 9: Dimensions (LEON bottom and sides views)

Parameter	Description	Min.		Typ.		Max.	
A	Height (mm)	29.4	[1157.5 mil]	29.5	[1161.4 mil]	30.1	[1185.0 mil]
B	Width (mm)	18.8	[740.2 mil]	18.9	[744.1 mil]	19.0	[748.0 mil]
C	Total Thickness (mm)	2.8	[110.2 mil]	3.0	[118.1 mil]	3.3	[129.9 mil]
D	Edge to Pin Pitch (mm)	1.4	[55.1 mil]	1.5	[59.1 mil]	1.8	[70.9 mil]
E	Pin to Pin Pitch (mm)	1.0	[39.4 mil]	1.1	[43.3 mil]	1.2	[47.2 mil]
H	PCB Thickness (mm)	0.8	[3.1 mil]	0.9	[3.6 mil]	1.0	[4.0 mil]
N	Half-moon Diameter (mm)	0.4	[1.6 mil]	0.5	[2.0 mil]	0.6	[2.4 mil]
M	Pin Height (mm)	0.9	[3.5 mil]	1.0	[3.9 mil]	1.1	[4.3 mil]
K	Pin Width (mm)	0.7	[2.8 mil]	0.8	[3.1 mil]	0.9	[3.5 mil]
Weight	(g)			< 5			

Table 25: Dimensions

For information regarding the Paste Mask and Footprint see the LEON-G100/G200 System Integration Manual [6].

6 Qualification and approvals

6.1 Reliability tests

Tests for product family qualifications according to ISO 16750 "Road vehicles - Environmental conditions and testing for electrical and electronic equipment", and appropriate standards (see Table 26).

Test	Reference	Test Conditions
Temperature step test	ISO16750-4 IEC60068-2-1 IEC60068-2-2	Function tests at stable temperature. The temperature must decrease in 5K steps from RT to -40°C followed by increase to +85°C in 5K steps.
Temperature cycling	IEC60068-2-14 Na	-40°C / +125°C, 100 cycles, air to air No function
Damp heat in function	IEC60068-2-3	+85°C / 85%rH VCCmax, 1000 hours, in function
High Temp.Operating Life (Life span) in function	IEC60068-2-2	1000 hrs @ 85°C Ta Toper max, VCCmax
Dry heat no function	IEC60068-2-2	+125°C, 1000 hours, no function
Electrical test at Umin, Unom, Umax	ISO16750-4 IEC60068-2-1 IEC60068-2-2	Function test at Umin, Unom, Umax 1 hour / voltage level Test at -40°C, RT, +85°C, Function tests at stable temperature
Damp heat cyclic	IEC60068-2-30 Db Variation 1	+25°C...+55°C; >90% rH 6 cycles of 24 hrs
Vibration in function	IEC60068-2-6	5-500 Hz; 5g 2.5 hrs/axis at –40°C 2.5 hrs/axis at +85°C 3 hrs/axis at RT Total: 24 hrs, function supervision
Mechanical Shock	IEC60068-2-27 Ea	30 g / 11 ms (halfsine), 3 Shocks/axis, no function
Robustness of terminations of Surface Mounted Devices	IEC60068-2-21 Ue1	1 mm/s +/- 0.5 mm/s D>2 mm 1 Bending cycle Duration on Dmax: 20s +/- 1 s

Table 26: Qualification tests

6.2 Approvals

Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" RoHS).

LEON-G100/G200 GSM/GPRS modules are RoHS compliant.

No natural rubbers, hygroscopic materials, or materials containing asbestos are employed.

LEON-G100/G200 modules are approved under the schemes reported in Table 27.

Country	Scope	LEON-G100	LEON-G200
EU	R&TTE	YES	YES
EU	CE (NB ID: 0682)	YES	YES
US	FCC	XPYLEONG100	XPYLEONG200
US	PTCRB	YES	YES
Independent	GCF – CC plus field trials	YES	YES
Canada	Industry Canada (IC)	8595A-LEONG100	8595A-LEONG200

Table 27: LEON-G100 / G200 certification approvals

For more details on all country certification and network operators please refer to our website www.u-blox.com.

7 Product handling

7.1 Packaging

LEON-G100/G200 modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down.

Figure 10: Reeled LEON-G100/G200 modules

7.1.1 Reels

LEON-G100/G200 modules are deliverable in quantities of 250 pcs on a reel. The dimension of the reel is shown in Figure 11.

☞ Quantities of less than 250 pieces are also available. Contact u-blox for more information.

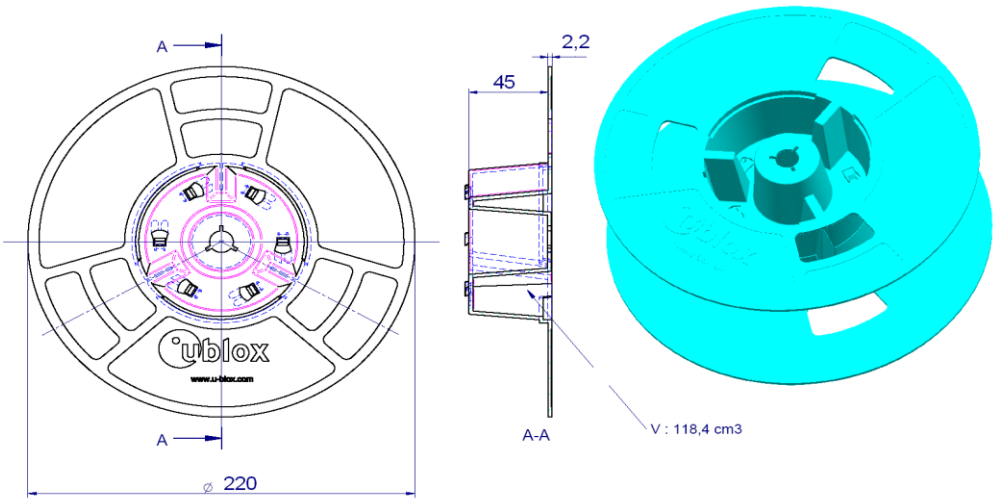

Figure 11: Dimensions of reel (measurements are in mm, unless otherwise specified)

7.1.2 Tapes

The dimensions and orientations of the tapes for LEON-G100/G200 modules are specified in Figure 12.

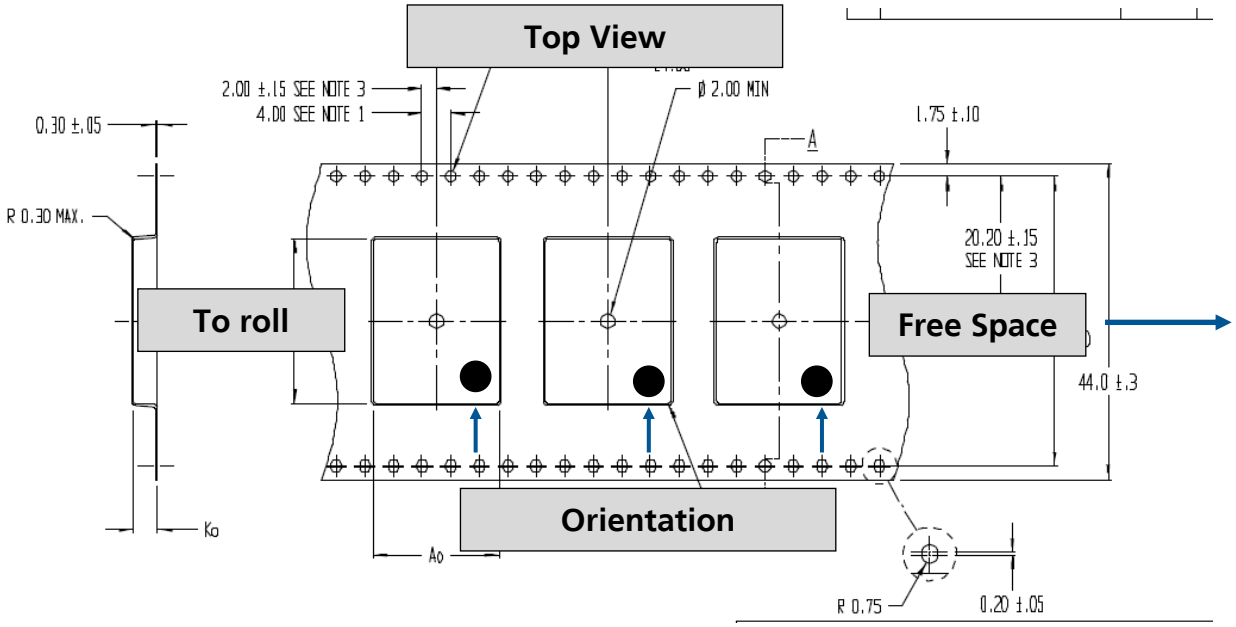

Figure 12: Dimensions for LEON-G100/G200 on tape

7.2 Shipment, storage and handling

LEON-G100/G200 modules are designed and packaged to be processed in an automatic assembly line, and are shipped in Tape-and-Reel.

LEON-G100/G200 modules are Moisture Sensitive Devices (MSD) in accordance to the IPC/JEDEC specification. Appropriate MSD handling instructions and precautions are summarized in Sections 7.2.1 to 7.2.4. Read them carefully to prevent permanent damage due to moisture intake.

LEON-G100/G200 modules contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling LEON-G100/G200 modules without proper ESD protection may destroy or damage them permanently. See Section 7.2.6 for ESD handling instructions.

7.2.1 Moisture sensitivity levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. LEON-G100/G200 modules are rated at MSL level 4.

For MSL standard see IPC/JEDEC J-STD-020 (can be downloaded from www.jedec.org).

7.2.2 Shipment

Table 28 summarizes the dry pack requirements for different MSL levels in the IPC/JEDEC specification.

MSL Level	Dry Pack Requirement
1	Optional
2	Required
2a	Required
3	Required
4	Required

Table 28: JEDEC specification of dry pack requirements

According to IPC/JEDEC specification J-STD-020, if a device passes MSL level 1, it is classified as not moisture sensitive and does not require dry pack. If a device fails level 1 but passes a higher numerical level, it is classified as moisture sensitive and must be dry packed in accordance with J-STD-033.

LEON-G100/G200 modules are delivered on Tape-and-Reels in a hermetically sealed package ("dry bag") to prevent moisture intake and protect against electrostatic discharge. For protection from physical damage, the reels are individually packed in cartons.

Carrier materials such as trays, tubes, reels, etc., that are placed in the Moisture Barrier Bag (MBB) can affect the moisture level within the MBB. Therefore, the effect of these materials is compensated by adding additional desiccant in the MBB to ensure the shelf life of the SMD packages.

The dry bag provides an IPC/JEDEC compliant MSD label describing the handling requirements to prevent humidity intake. IPC/JEDEC specifications require that MSD sensitive devices be packaged together with a Humidity Indicator Card (HIC) and desiccant to absorb humidity. If no moisture has been absorbed, the three fields in the HIC indicate blue color. Figure 13 shows examples of an MSD label and HIC.

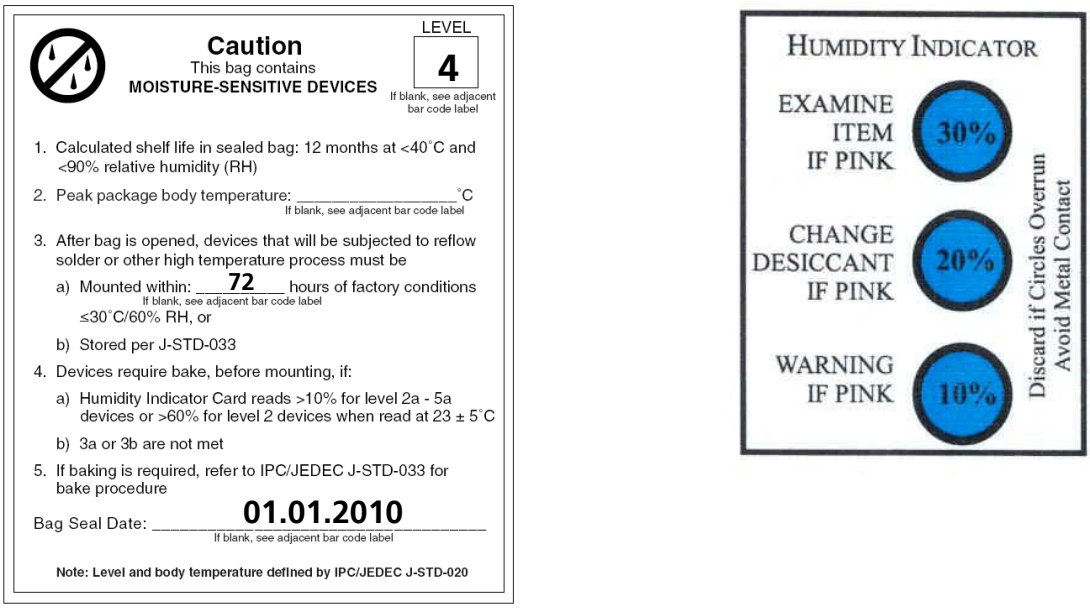

Figure 13: Examples of MSD Label and Humidity Indicator Card

7.2.3 Storage and floor life

The calculated shelf life for dry packed SMD packages is a minimum of 12 months from the bag seal date, when stored in a noncondensing atmospheric environment of <40°C/90% RH.

Table 29 lists floor life for different MSL levels in the IPC/JEDEC specification.

MSL Level	Floor life (out of bag) at factory ambient ≤30°C/60% RH or as stated
1	Unlimited at ≤30°C/85% RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours

Table 29: JEDEC specification of floor life

The parts must be processed and soldered within the time specified for the MSL level. If this time is exceeded, or the humidity indicator card in the sealed package indicates that they have been exposed to moisture, the devices need to be pre-baked before the reflow solder process (see Section 7.2.4).

7.2.4 Drying

Both encapsulant and substrate materials absorb moisture. IPC/JEDEC specification J-STD-020 must be observed to prevent cracking and delamination associated with the "popcorn" effect during reflow soldering. The popcorn effect can be described as miniature explosions of evaporating moisture. Baking before processing is required in the following cases:

- Humidity indicator card: At least one circular indicator is no longer blue
- Floor life or environmental requirements after opening the seal have been exceeded, e.g. exposure to excessive seasonal humidity.

Refer to Section 4 of IPC/JEDEC J-STD-033 for recommended baking procedures. Table 4-1 of the specification lists the required bake times and conditions for drying. For example, a LEON-G100 that has exceeded its floor life by >72 hours shall be baked at 125°C for 9 hours. (Floor life begins counting at time = 0 after bake).

Do not attempt to bake LEON-G100/G200 modules while contained in tape and rolled up in reels. For baking, place parts individually onto oven tray.

Oxidation risk: Baking SMD packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive can result in soldering problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solderability considerations. The cumulative bake time at a temperature greater than 90°C and up to 125°C shall not exceed 96 hours. If the bake temperature is not greater than 90°C, there is no limit on bake time. Bake temperatures higher than 125°C are not allowed.

7.2.5 Reflow soldering

Reflow profiles are to be selected according to IPC/JEDEC J-STD-020.

7.2.6 ESD precautions

LEON-G100/G200 modules are Electrostatic Sensitive Devices (ESD) and require special ESD precautions typically applied to ESD sensitive components.

Maximum ESD ratings of the LEON-G100/G200 modules are reported in Table 7.

Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates LEON-G100/G200 modules.

ESD precautions should be implemented on the application board where the module is mounted, as described in the LEON-G100/G200 System Integration Manual [6].

Failure to observe these precautions can result in severe damage to the device!

8 Default settings

Interface	Settings	Comments
AT interface		Frame: 8 bits, no parity, 1 stop bit
		Flow control: hardware
Autobauding	AT+IPR=0	Enabled
UART interface	AT&S1	DSR line sets to ON in connected mode (GPRS data transfer only) and to OFF in command mode
	AT&D1	Upon an ON-to-OFF transition of DTR, the DCE enters online command state and issues an OK result code
	AT&C1	DCD changes in accordance with the underlying DCE, which may include functions other than the physical layer functions
	AT&K3	HW flow control enabled
Power Saving	AT+UPSV=0	Disabled
Network registration	AT+COPS=0	Self network registration

Table 30: Available Protocols

9 Labeling and ordering information

9.1 Product labeling

The labeling LEON-G100/G200 modules include important product information. The location of the product type number is shown in Figure 14.

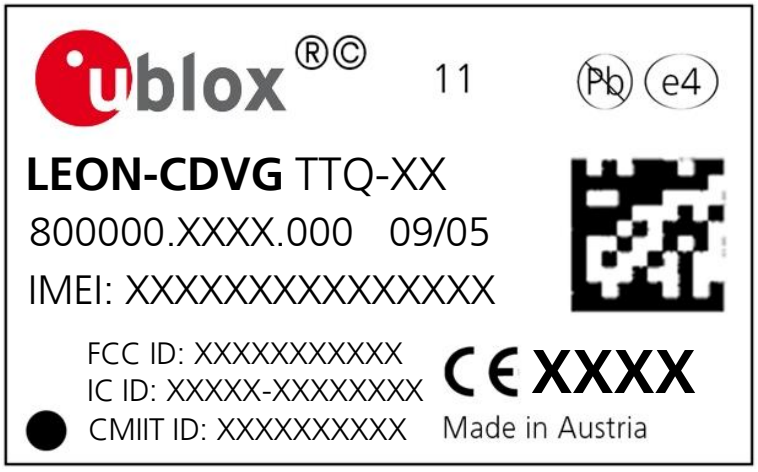

Figure 14: Location of product type number on LEON-G100 module label

☞ About approval code please refer to chapter 6.2.

9.2 IMEI

TAC (Type Allocation Code)

- For LEON-G100: 35785203.
- For LEON-G200: 35785303.
- For LEON-G100 (Brazilian market): 35717604

The first 8 digits of IMEI are the TAC number.

9.3 Explanation of codes

3 different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox products, independent of packaging and quality grade. The **Ordering Code** includes options and quality, while the **Type Number** includes the hardware and firmware versions. Table 31 below details these 3 different formats:

Format	Structure
Product Name	LEON-CDVG
Ordering Code	LEON-CDVG-TTQ
Type Number	LEON-CDVG-TTQ-XX

Table 31: Product Code Formats

The parts of the product code are explained in Table 32.

Code	Meaning	Example
C	Cellular standard (i.e. G: GSM; E: EDGE; W: WEDGE; H: HSDPA; U:HSUPA, P: HSPA+, L: LTE; C: CDMA)	G: GSM
D	Generation, e.g. chip or function set; range: [0…9]	1
V	Variant based on the same cellular chip	
G	GPS generation (if GPS functionality available)	5: u-blox 5, 0: no GPS functionality
TT	Major Product Version	00
Q	Quality grade/production site • S = standard / made in Austria • A = automotive / made in Austria • B = standard / made in Brazil	S
XX	HW version plus GPS SW (not relevant for certification)	00

Table 32: Part identification code

9.4 Ordering information

Ordering No.	Product
LEON-G100-06S	Quad-band GSM/GPRS Module, 29.5 x 18.9 x 3.00 mm, 250 pcs/reel
LEON-G100-06A	Automotive quad-band GSM/GPRS Module, 29.5 x 18.9 x 3.00 mm, 250 pcs/reel
LEON-G200-06S	Quad-band GSM/GPRS module with extended feature set, 29.5 x 18.9 x 3.00 mm, 250 pcs/reel

Table 33: Product ordering codes

Appendix

A Glossary

Name	Definition
ADC	Analog/Digital Converter, ADC Pins (power domain)
AUDIO	Audio Pins (power domain)
DDC	DDC Interface (power domain)
Driver Class	Output Driver Class: see Table 16 for definition
EOS	Electrical Overstress
ERS	External Reset Signal
GDI	Generic Digital Interfaces (power domain)
H	High
HBM	Human Body Model
L	Low
OD	Open Drain
PD	Pull-Down
POS	Power-On Input Signal
PU	Pull-Up
PU/PD Class	Pull Class: see Table 16 for definition
SIM	SIM Interface (power domain)
T	Tristate
TBF	Temporary Block Flow

Table 34: Explanation of abbreviations and terms used

Related documents

[1] 3GPP TS 27.007 Technical Specification Group Core Network and Terminals; AT command set for User Equipment (UE)

[2] 3GPP TS 27.005 - Technical Specification Group Terminals; Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE-DCE) interface for Short Message Services (SMS) and Cell Broadcast Service (CBS)

[3] 3GPP TS 27.010 - Terminal Equipment to User Equipment (TE-UE) multiplexer protocol (Release 1999)

[4] u-blox AT Commands Manual, Docu. No WLS. SW-11000

[5] ITU-T Recommendation V24, 02-2000. List of definitions for interchange circuits between Data Terminal Equipment (DTE) and Data Connection Equipment (DCE)

[6] LEON-G100/G200 System Integration Manual, Docu. No GSM.G1-HW-09002

[7] GPS Implementation Application Note, Docu. No GSM.G1-CS-09007

[8] GSM Mux Implementation Application Note for LEON-G100/G200 Docu. No GSM.G1-CS-10002

[9] 3GPP TS 26.267 - Technical Specification Group Services and System Aspects; eCall Data Transfer; In-band modem solution; General description (Release 9)

☞ For regular updates to u-blox documentation and to receive product change notifications please register on our homepage.

Revision history

Revision	Date	Name	Status / Comments
-	02/05/2011	lpah	Initial release
1	06/06/2011	lpah	Added Qualification tests

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