

ING-A01-1-WU

Hardware Guide

Version : V1.1

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1 General Description

- The ING-A01 module is a 4G Android smart module based on the Qualcomm platform, integrating multiple wireless communication, 322PIN LCC+LGA, with dimensions of 44.2mm * 41.2mm * 3mm.
- ING-A01-1: SM6225, 64-bit octa-core processors (4xA73@ 2.4GHz + 4xA53@ 1.9GHz).
- Built-in Adreno™ 610 GPU.
- 2/3/4GB LPDDR4X RAM+ 16/32/64GB eMMC Flash.
- Support /GPRS/EDGE, WCDMA/HSPA+, LTE (Cat4).
- Support WIFI 802.11a/b/g/n/ac, BT5.0 (BR/EDR+BLE).
- Support GPS/GLONASS/BDS/Galileo.
- Android 14 OS.
- 1x MIPI DSI, 4-Lanes, support up to FHD+ (1080 × 2520) display.
- 3x MIPI CSI, 4/4/4 Lanes, support up to 64MP camera.
- Multiple audio inputs and outputs, support stereo headphones.
- Support USB3.1, SD 3.0, ADC, UART, SPI, I2C, I3C, PWM, GPIO.

2 Product Overview

2.1 Summary of Features

Application Processor	
CPU	■ ING-A01-1: Qualcomm's SM6225 Quad Cortex-A73 @ 2.4GHz and Quad Cortex-A53 @ 1.9GHz
Memory	

RAM	2 / 3 / 4GB LPDDR4X RAM; 2 × 16 bit at 2133 MHz
ROM	16 / 32 / 64 GB eMMC Flash SDC2 can be used as external memory (TF card)
Multimedia	
LCD	1x 4-lane MIPI DSI, up to 1.5 Gbps/Lane Up to FHD+ (1080 × 2520) @90 Hz
Camera	3x 4-lane MIPI_CSI, up to 2.5 Gbps/lane Supports 3 concurrently working cameras (Triple ISP), supports up to (13 MP + 13 MP + 5 MP 30 fps @ ZSL) or up to (25 MP + 5 MP or 16 MP + 16 MP 30 fps @ ZSL) or up to 32 MP (30 fps @ ZSL) or 64 MP (no ZSL)
Video Encode & Decode	Encode: 1080p60 8-bit HEVC/H.264/H.265 Decode: 1080p60 8-bit HEVC/H.264/H.265/VP9 Concurrency: 1080p30 decode + 1080p30 encode
Graphics	Adreno™ 610 GPU OpenGL ES 3.2, Vulkan 1.1 OpenCL 2.0
Audio	Voice Codec: ■ EVS, EVRC, EVRC-B, EVRC-WB ■ G.711 and G.729A/AB ■ AMR-NB, AMR-WB Audio Codec: ■ MP3; AAC; HE AAC v1, v2; FLAC; APE; ALAC; AIFF
Audio input	Three analog microphone inputs

Audio output	Stereo headphone output Differential earpiece output Differential AUX output without internal audio PA
Peripheral	
UART	Up to five groups of UART interface. Two of them are configured by default; three of them are multiplexed from other interfaces Debug UART: 2-wire UART interface, dedicated for debugging by default UART5: 4-wire UART with the speed rate up to 4 Mbps, which supports RTS and CTS hardware flow control
I2C	Up to eight groups of I2C interfaces. Five of them are dedicated I2C interfaces used for cameras, sensors and TPs. One of them is generic I2C interface used for other peripherals, two of them are multiplexed from other interfaces. I2C data rate up to 400Kbps
SPI	Up to five groups of SPI interface. One of them is default configuration. The other four of them are multiplexed from other interfaces Only support master mode, clock up to 50Mbps
UIM	Two – dual voltages (1.8 V and 2.95 V)
USB	Complies with USB 3.1 Gen 1 or 2.0 specifications Supports USB OTG and USB 3.1 Type-C interface, compatible with USB 2.0
SD	4-bit port SDC2, support SD3.0
2G/3G/4G	
	GSM B2/B3/B5/B8

ING-A01-1-WU bands	WCDMA B1/B2/B4/B5/B8
	LTE-FDD B1/B2/B3/B4/B5/B7/B8/B12/B17/B20/B28/B66;
	LTE-TDD B38/B40/B41
Power Class	GPRS B5/B8: Power Class 4 (33dBm±2dB) GPRS B2/B3: Power Class 1 (30dBm±2dB) EDGE B5/B8: Power Class E2 (27dBm±3dB) EDGE B2/B3: Power Class E2 (26dBm±3dB) WCDMA/HSPA+: Power Class 3 (24dBm+1/-3dB) LTE: Power Class 3 (23dBm±2dB)
Wireless connectivity	
WLAN	2.4GHz/5GHz dual-band, support 802.11a/b/g/n/ac Support AP and STA mode
Bluetooth	BT5.0 (BR/EDR+BLE)
GNSS	
GNSS	GPS/GLONASS/BDS/Galileo/SBAS
Antenna	
Impedence	50Ω

3 Function Description

3.1 Power Supply

3.1.1 VBAT

The module provides three VBAT pins dedicated to connecting with the external power supply.

The power supply range of the module is 3.5~4.4V, and the recommended value is 3.9V. The power source is critical to the module's performance. The power supply of the module should be able to provide sufficient current of 4A at least, otherwise it may cause exceptions such as restart or shutdown.

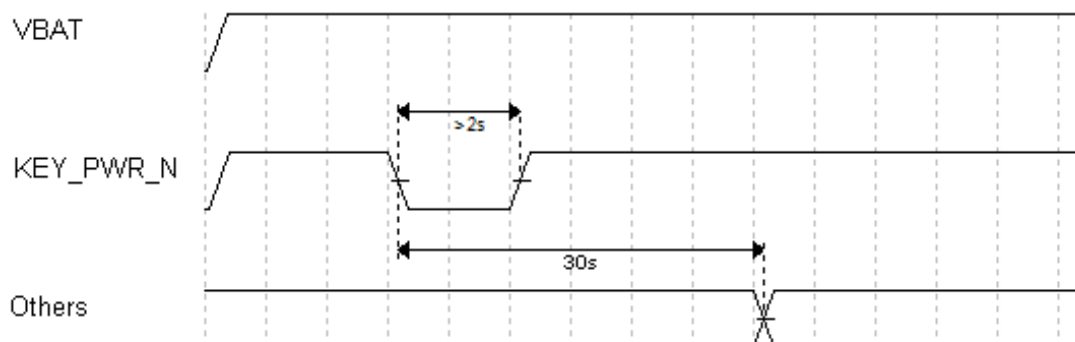
3.1.2 VRTC

The RTC of the module can be powered by an external power supply pin VRTC. When VBAT is disconnected and you need to reserve RTC function, then VRTC cannot be kept unconnected. The RTC can be powered by an external power source when the module is powered down and there is no power supply for the VBAT. The power source can be an external battery or capacitor according to application demands. The power supply range of VRTC is 2~3.25V, and the recommended value is 3V.

3.2 Power On and Power Off

3.2.1 Power On

The module can be turned on by driving the KEY_PWR_N pin low for at least 2s. KEY_PWR_N is pulled up to 1.8V internally.

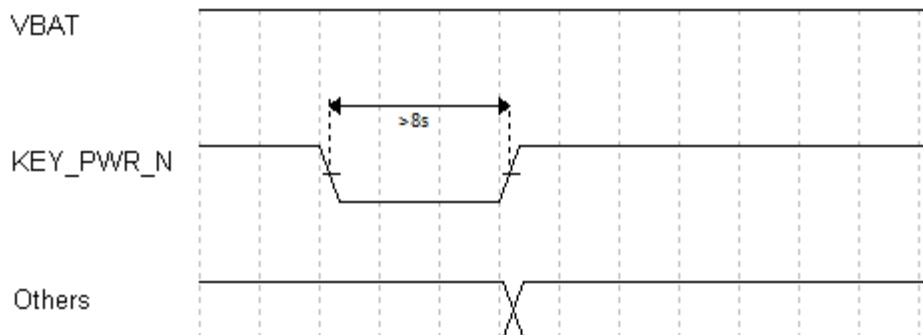


The module can also turn on automatically when driving the CBL_PWR_N Pin low.

3.2.2 Restart/Power Off

The module can be turned off by driving the KEY_PWR_N pin low for at least 0.6 s. Choose whether to turn off the module when the prompt window comes up.

The other way to turn off the module is to drive KEY_PWR_N low for at least 8 s. The module will execute the forced shut-down.



3.3 Display & Camera

3.3.1 LCD Interface

The module provides one LCM interface, which is MIPI_DSI standard compliant. The interface supports one group of 4-lane high-speed differential data transmission with maximum speed rate of 1.5 Gbps/lane and supports FHD + (1080 × 2520 @ 90 fps)

3.3.2 Camera Interface

Based on MIPI_CSI standard, the maximum data rate is up to 2.5 Gbps/lane. The module supports up to four cameras and supports 3 concurrently working cameras. It supports up to (13 MP + 13 MP + 5 MP 30 fps @ ZSL) or up to (25 MP + 5 MP or 16 MP + 16 MP 30 fps @ ZSL) or up to 32 MP (30 fps @ ZSL) or 64 MP (no ZSL). The video and photo quality are determined by various factors such as the camera sensor, camera lens.

3.4 Audio Interfaces

The module provides 3 analog input channels and 3 analog output channels.

The module offers three audio input channels, including two differential input channels and one single-ended input channel.

The earpiece interface uses differential output.

The loudspeaker interface uses the differential output.

The headset interface features stereo left and right channel output, and headset insert detection function is supported.

3.5 Peripheral Interface

3.5.1 USB Interface

The module provides one USB interface which complies with USB 3.1 Gen 1 and USB 2.0 specifications and supports USB OTG. It supports USB Type-C interface and Micro USB interface. It also supports SuperSpeed mode (5 Gbps) for USB 3.1 Gen 1, high-speed (480 Mbps) and full-speed (12 Mbps) modes for USB 2.0. The USB interface is used for AT command transmission, data transmission, software debugging and firmware upgrade.

3.5.2 SIM Interface

The module has two (U)SIM interfaces. The (U)SIM interface meets ETSI and IMT-2000 requirements. Dual SIM Dual Standby function is supported by default. Either 1.8 V or 2.95 V (U)SIM card is supported, and the (U)SIM card is powered by the internal power supply of the module.

3.5.3 SD Card Interface

The SD card interface of the module complies with SD 3.0 specifications.

3.5.4 UART Interface

The module provides up to five groups of UART interface. Two of them are configured by default; three of them are multiplexed from other interfaces.

Two UART:

- UART5: 4-wire UART, supports RTS and CTS hardware flow control, up to 4 Mbps.
- Debug UART: 2-wire UART, used for debugging only.

3.5.5 SPI Interface

The module provides five groups of SPI which only support master mode. One of them is default configuration. It can be used for fingerprint recognition. The other four of them are multiplexed from other interfaces.

3.5.6 I2C Interface

The module provides eight groups of I2C interfaces. Five of them are dedicated I2C interfaces used for cameras, sensors and TPs. One of them is a generic I2C interface used for other peripherals, two of them are multiplexed from other interfaces.

Six I2C:

- TS_I2C: Used for TP.
- CAM0_I2C/CAM1_I2C: Used for camera.
- SEN0_I2C/SEN1_I2C: Used for sensor.

- APPS_I2C: Used for other peripherals like power IC/MF/Charger.

All I2C interfaces are open drain signals and therefore you must pull them up externally. The reference power domain is 1.8 V. The SEN_I2C interface only supports sensors of aDSP architecture. CAM_I2C signals are controlled by Linux Kernel code and support connection to video-output-related devices

3.5.7 I3C Interface

The module provides three groups of I3C interfaces. All of them are multiplexed from other interfaces. The sensor I3C interface only supports sensors of aDSP architecture.

3.5.8 UART/SPI/I2C/I3C Multiplexing Relationship

The module supports up to 5 groups of configurable interfaces, which can be configured as UART, SPI, I2C interfaces.

3.6 ADC Interface

The module provides one ADC interface which supports up to 15-bit resolution.

3.7 Antenna Interface

There are four antenna interfaces, including the main antenna, diversity antenna, WIFI/BT antenna, and GNSS antenna. The impedance of the antenna interface is 50 ohms.

4 Electrical Characteristics and Reliability

4.1 Recommended Operating conditions

	Min	Typ	Max
VBAT	3.5V	3.9V	4.4V
VRTC	2.0V	3.0V	3.25V

4.2 Operating and Storage Temperatures

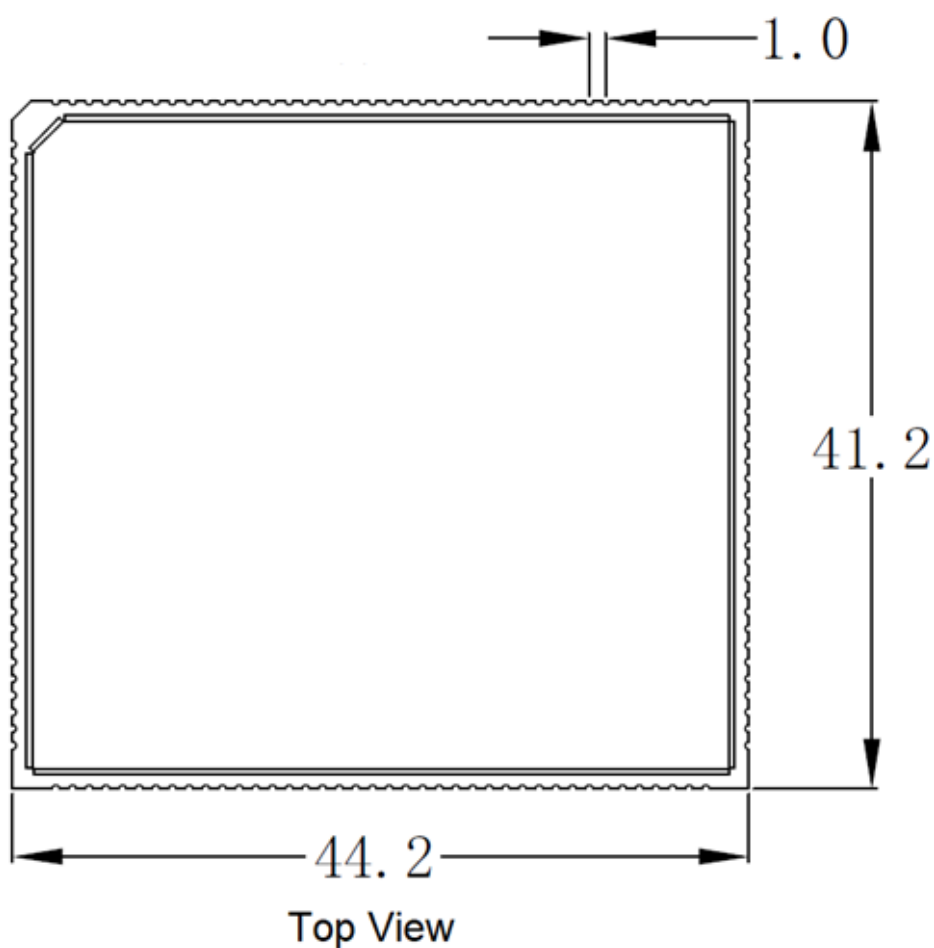
	Min.	Typ.	Max
Operating	-25°C	25°C	75°C
Storage	-40°C		85°C

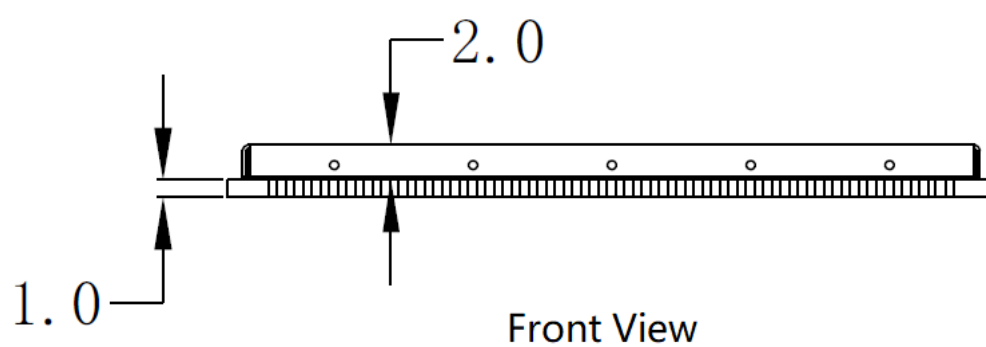
5 Mechanical Information

5.1 Mechanical Information

Dimensions	44.2mm*41.2mm*3mm (dimensional tolerances of length: $\pm 0.15\text{mm}$; dimensional tolerances of height: $\pm 0.2\text{mm}$)
Weight	TBD
Form factor	322PIN LCC+LGA

5.2 Three-View Drawing





6 Storage Conditions

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 4. The storage requirements are shown below.

1. Recommended Storage Condition: the temperature should be 23 ± 5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours in a factory where the temperature is 23 ± 5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 72 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

- The module is not stored in Recommended Storage Condition;
- Violation of the third requirement mentioned above;
- Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
- Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

- The module should be baked for 8 hours at 120 ± 5 °C;
- The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

7. Standard

CE MARKING

The CE marking indicates ING-A01-1-WU complies with the requirements of European Directive 2014/53/EU on Radio Equipment for:

- The protection of the health and the safety of the user and any other person.
- The protection requirements with respect to electromagnetic compatibility.

And complies with harmonized standards.

Operating Frequency Band (RF)

Frequency	Uplink	Downlink
GSM B2	1850-1910MHz	1930-1990MHz
GSM B3	1710-1785MHz	1805-1880MHz
GSM B5	824-849MHz	869-894MHz
GSM B8	880-915MHz	925-960MHz
WCDMA B1	1920-1980MHz	2110-2170MHz
WCDMA B2	1850-1910MHz	1930-1990MHz
WCDMA B4	1710-1755MHz	2110-2155MHz
WCDMA B5	824-849MHz	869-894MHz
WCDMA B8	880-915MHz	925-960MHz
LTE-FDD B1	1920-1980MHz	2110-2170MHz
LTE-FDD B2	1850-1910MHz	1930-1990MHz
LTE-FDD B3	1710-1785MHz	1805-1880MHz
LTE-FDD B4	1710-1755MHz	2110-2155MHz

Frequency	Uplink	Downlink
LTE-FDD B5	824-849MHz	869-894MHz
LTE-FDD B7	2500-2570MHz	2620-2690MHz
LTE-FDD B8	880-915MHz	925-960MHz
LTE-FDD B12	699-716MHz	729-746MHz
LTE-FDD B17	704-716MHz	734-746MHz
LTE-FDD B20	832-862MHz	791-821MHz
LTE-FDD B28	703-748MHz	758-803MHz
LTE-FDD B66	1710-1780MHz	2110-2200MHz
LTE-TDD B38	2570-2620MHz	
LTE-TDD B40	2300-2400MHz	
LTE-TDD B41	2496-2690MHz	
2.4GHz WIFI	2412-2472MHz (For CE only); 2412-2462MHz (For FCC only);	
5GHz WIFI	5150-5850MHz	
BT5.0 (BR/EDR+BLE)	2402-2480MHz	
GPS	1575.42MHz±1.023MHz (RX only)	
GLONASS	1597.5MHz~1605.8MHz (RX only)	
BDS	1561.098MHz±2.046MHz (RX only)	
Galileo	1575.42MHz ±2.046MHz (RX only)	

Max Of Transmit Power (For EU Compliance)

EGSM900: 33dBm, DCS1800: 30dBm

WCDMA BAND I, V, VIII: 24dBm

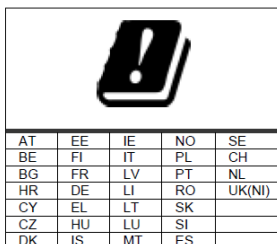
LTE BAND 1, 3, 5, 7, 8, 20, 28, 38, 40, 41: 25dBm

BT: 9.86dBm; BLE: 7.72dBm; 2.4G Wi-Fi: 17.46dBm; 5G Wi-Fi: 17.36dBm; 5.8GHz Wi-Fi: 13.91dBm

Restrictions in the 5GHz band:

According to Article 10(10) of Directive 2014/53/EU, the packaging shows that this terminal will be subject to some restrictions when placed on the market.

In all EU member states, operation of 5150-5350MHz is restricted to indoor use only.

**FCC WARNING**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure compliance statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users.
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Antenna Change Notice to Host manufacturer

Recommend using antenna which certified with this module mentioned in this manual.

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application, based on the new emissions testing. Please perform testing on frequency bands where the antenna gain is highest, worst-case band-edges based on original filing, and only on frequency bands where the antenna gain is highest.

Summarize the specific operational use conditions

This module has been tested to meet the requirement of mobile application (20cm away from human body), any certain situation should be considered if the end product/host change the application, such as spurious emission, SAR.etc.

Limited module procedures

Not applicable

Trace antenna designs

Not applicable

List of applicable FCC rules

This modular transmitter complies with FCC Rules Part 15C, Part 15E, Part 2, Part 22, Part 24, Part 27

This module is tested with the following antenna

Antenna Type	Max. Antenna Gain
Dipole Antenna	BT/BLE/2.4G Wi-Fi: 1.92dBi U-NII-1/2A:0dBi, U-NII-2C:0.49dBi, U-NII-3:0.3dBi GSM 850: -3.29dBi; PCS 1900MHz: 1dBi WCDMA B2: 2.86dBi, B4:1.24dBi, B5:-3.29dBi LTE B2:2.86dBi, B4:1.24dBi, B5:-3.29dBi, B7:0.39dBi, B12: -1.23Bi, B17:-1.23Bi, B38:-0.57dBi, B41:0.97dBi, B66: 1.24dBi,

Labelling and compliance statement instruction for host product manufacturer

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains FCC ID: XKB-INGA01WU” any similar wording that expresses the same meaning may be used.

§ 15.19 Labelling requirements shall be complied on end user device.

Labelling rules for special device, please refer to §2.925, § 15.19 (a)(5) and relevant KDB publications. For E-label, please refer to §2.935.

FCC regulatory Compliance Statement mentioned in this manual shall be properly included in host product manual per FCC Rules.

The host product manufacturer shall be aware not to provide information to the end user on how to install or remove this module in your host product manual.

Guide on test modes and additional testing requirements

Host product manufacturer is ultimately responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, additional transmitter(s) in the host, etc.).

Test software access to different test modes:

For engineering test mode, please contact original module manufacturer for technical support

Disclaimer on additional testing, Part 15 Subpart B compliance of Host Product

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product

manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in §15.105 *Information to the user* or such similar statement and place it in a prominent location of host product manual. Original texts from FCC Rules are as following you may refer to:

For Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.*
- Increase the separation between the equipment and receiver.*
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- Consult the dealer or an experienced radio/TV technician for help.*

For Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WWW.ingenico.com

13-17 Rue Pages, 92150 Suresnes , Hauts-de-Seine, FRANCE / (T)+33(0)1 58 01 80 00 / (F)+33 (0)1 58 01 91 35

Ingenico-SA au capital de 47 656 332 / 317 218 758 RCS Nanterre.