User Manual for 2AHDZ-ACTIVAC4G

Antenna Requirements

The antenna connection and board layout design are the most important aspect in the full product design as they strongly affect the product overall performances, hence read carefully and follow the requirements and the guidelines for a proper design. The antenna and antenna transmission line on PCB for a Telit ME910C1 device shall fulfil the following requirements:

ME910C1-WW

Item	Value
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth	250 MHz in LTE Band 1 140 MHz in LTE Band B2, PCS1900 170 MHz in LTE Band 3, DCS1800 445 MHz in LTE Band 4 70 MHz in LTE Band 5, GSM850 60 MHz in LTE Band 18 60 MHz in LTE Band 19 80 MHz in LTE Band 26 80 MHz in LTE Band 8, GSM900 71 MHz in LTE Band 20 110 MHz in LTE Band 28
Impedance	50 ohm
Input power	> 24dBm Average power
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfill all regulatory requirements)

PCB Design guidelines

When using the ME910C1, since there's no antenna connector on the module, the antenna must be connected to the ME910C1 antenna pad (K1) by means of a transmission line implemented on the PCB. This transmission line shall fulfil the following requirements:

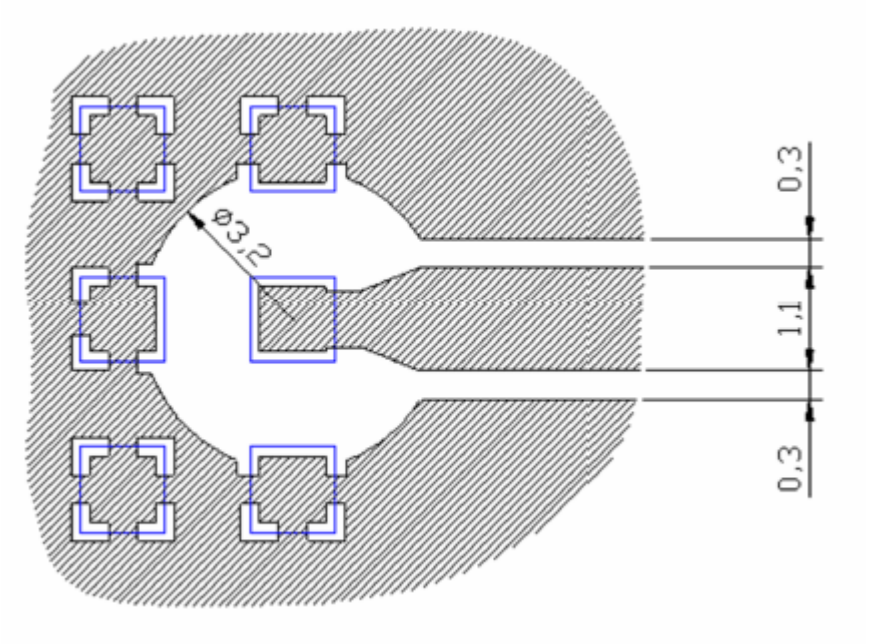
Item	Value
Characteristic Impedance	50 ohm (+-10%)
Max Attenuation	0,3 dB
Coupling	Coupling with other signals shall be avoided
Ground Plane	Cold End (Ground Plane) of antenna shall be equipotential to the ME910C1 ground pins

The transmission line should be designed according to the following guidelines:

- Make sure that the transmission line's characteristic impedance is 50ohm ;
- Keep line on the PCB as short as possible, since the antenna line loss shall be less than about 0,3 dB;
- Line geometry should have uniform characteristics, constant cross section, avoid meanders and abrupt curves;
- Any kind of suitable geometry / structure (Microstrip, Stripline, Coplanar, Grounded Coplanar Waveguide...) can be used for implementing the printed transmission line afferent the antenna;
- If a Ground plane is required in line geometry, that plane has to be continuous and sufficiently extended, so the geometry can be as similar as possible to the related canonical model;
- Keep, if possible, at least one layer of the PCB used only for the Ground plane; If possible, use this layer as reference Ground plane for the transmission line;
- It is wise to surround (on both sides) the PCB transmission line with Ground, avoid having other signal tracks facing directly the antenna line track.
- Avoid crossing any un-shielded transmission line footprint with other signal tracks on different layers;
- The ground surrounding the antenna line on PCB has to be strictly connected to the main Ground Plane by means of via holes (once per 2mm at least), placed close to the ground edges facing line track;
- Place EM noisy devices as far as possible from ME910C1 antenna line;
- Keep the antenna line far away from the ME910C1 power supply lines;
- If EM noisy devices (such as fast switching ICs, LCD and so on) are present on the PCB hosting the ME910, take care of the shielding of the antenna line by burying it in an inner layer of PCB and surround it with Ground planes, or shield it with a metal frame cover.

- If EM noisy devices are not present around the line, the use of geometries like Microstrip or Grounded Coplanar Waveguide has to be preferred, since they typically ensure less attenuation if compared to a Stripline having same length;

The following image is showing the suggested layout for the Antenna pad connection:

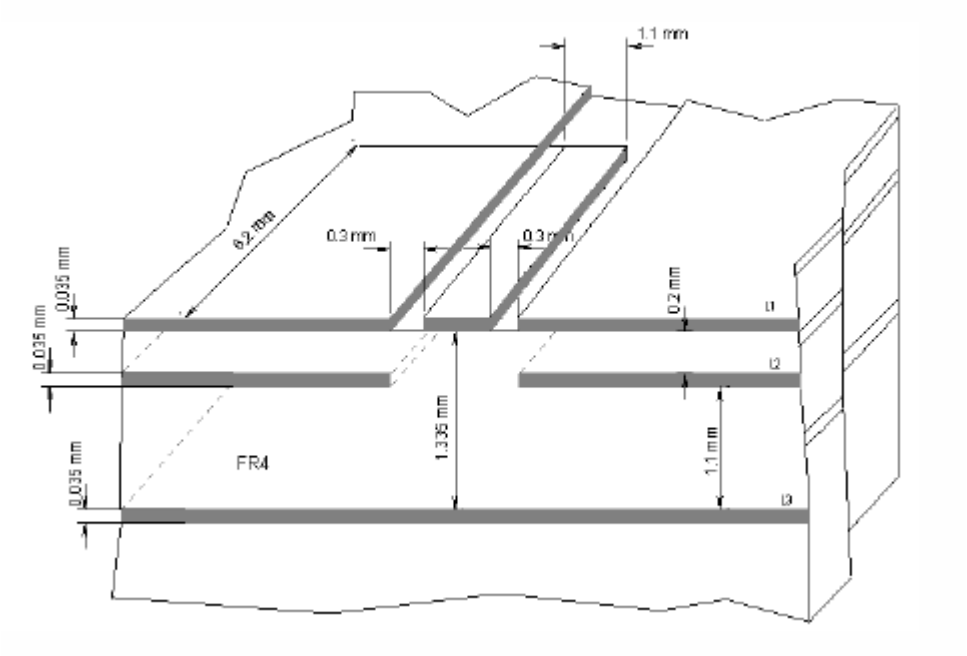


PCB Guidelines in case of FCC Certification

In the case FCC certification is required for an application using ME910C1, according to FCC KDB 996369 for modular approval requirements, the transmission line has to be similar to that implemented on ME910C1 interface board and described in the following chapter.

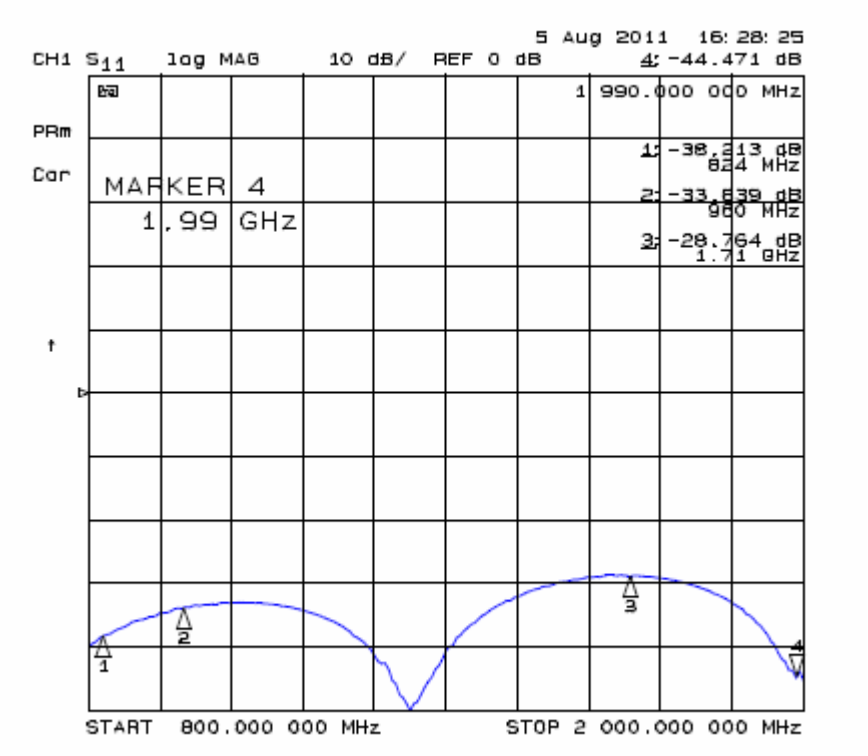
Transmission line design

During the design of the ME910C1 interface board, the placement of components has been chosen properly, in order to keep the line length as short as possible, thus leading to lowest power losses possible. A Grounded Coplanar Waveguide (G-CPW) line has been chosen, since this kind of transmission line ensures good impedance control and can be implemented in an outer PCB layer as needed in this case. A SMA female connector has been used to feed the line. The interface board is realized on a FR4, 4-layers PCB. Substrate material is characterized by relative permittivity εr = 4.6 ± 0.4 @ 1 GHz, TanD= 0.019 ÷ 0.026 @ 1 GHz. A characteristic impedance of nearly 50 Ω is achieved using trace width = 1.1 mm, clearance from coplanar ground plane = 0.3 mm each side. The line uses reference ground plane on layer 3, while copper is removed from layer 2 underneath the line. Height of trace above ground plane is 1.335 mm. Calculated characteristic impedance is 51.6 Ω, estimated line loss is less than 0.1 dB. The line geometry is shown below:

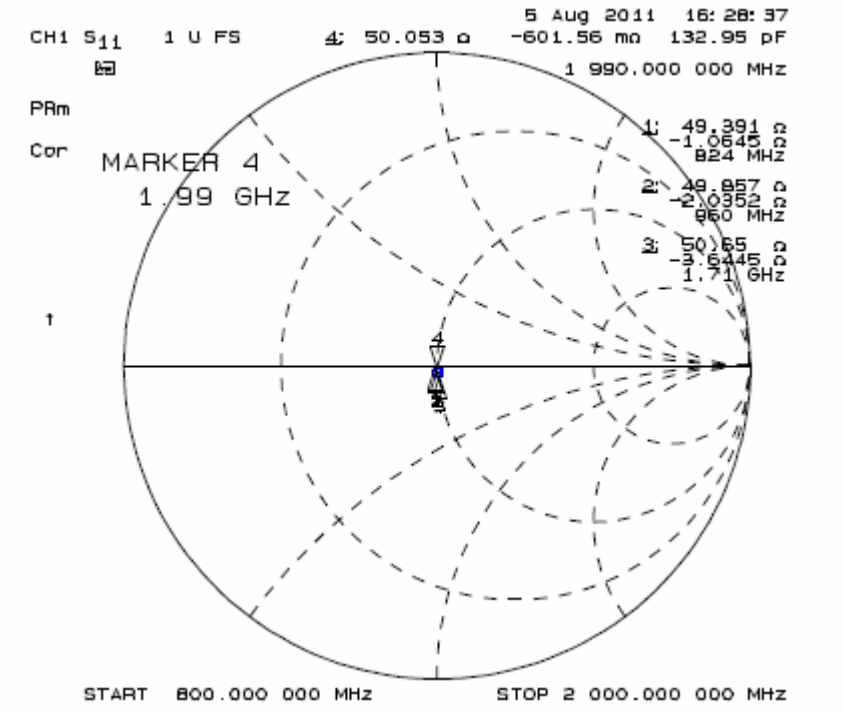


Transmission Line Measurements

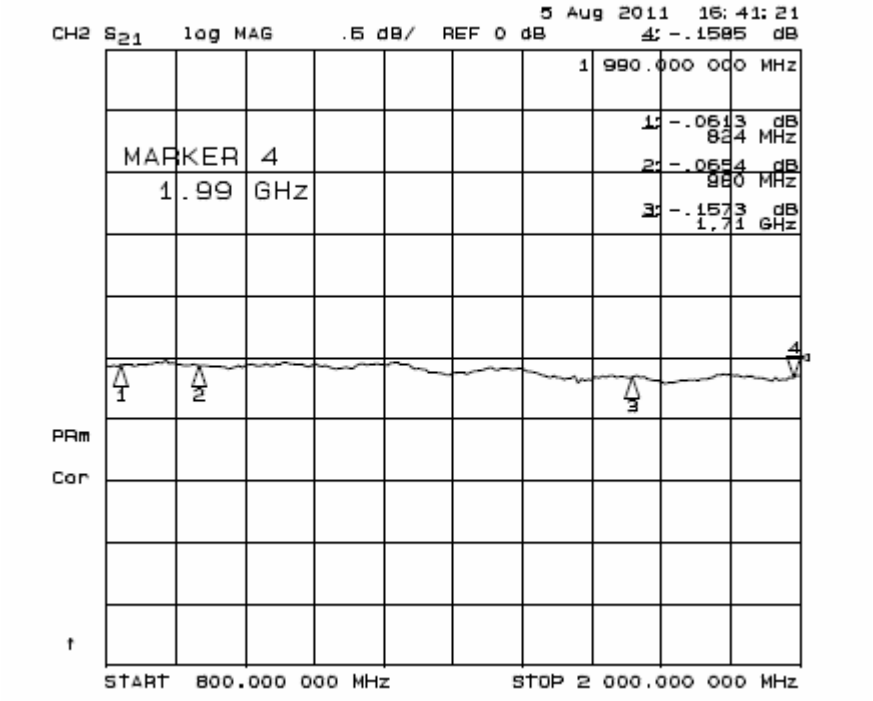
An HP8753E VNA (Full-2-port calibration) has been used in this measurement session. A calibrated coaxial cable has been soldered at the pad corresponding to RF output; a SMA connector has been soldered to the board in order to characterize the losses of the transmission line including the connector itself. During Return Loss / impedance measurements, the transmission line has been terminated to 50 Ω load. Return Loss plot of line under test is shown below:



Line input impedance (in Smith Chart format, once the line has been terminated to 50 Ω load) is shown in the following figure:



Insertion Loss of G-CPW line plus SMA connector is shown below:



Antenna Installation Guidelines

- Install the antenna in a place covered by the LTE signal with CAT-M1 support.
- Antenna must not be installed inside metal cases
- Antenna must not be installed according Antenna manufacturer instructions
- Antenna integration should optimize the Radiation Efficiency. Efficiency values > 50% are recommended on all frequency bands
- Antenna integration should not perturb the radiation pattern described in Antenna manufacturer documentation.
- It is preferable to get an omnidirectional radiation pattern to
- Antenna Gain must not exceed values indicated in regulatory requirements, where applicable, in order to meet related EIRP limitations. Typical antenna Gain in most M2M applications does not exceed 2dBi
- If the device antenna is located farther than 20cm from the human body and there are no co-located transmitter then the Telit FCC/IC approvals can be re-used by the end product
- If the device antenna is located closer than 20cm from the human body or there are co-located transmitter then the additional FCC/IC testing may be required for the end product (Telit FCC/IC approvals cannot be reused)

FCC/ISED Regulatory notices

Modification statement

Telit has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Telit n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Wireless notice

This device complies with FCC/ISED radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines and RSS‑102 of the ISED radio frequency (RF) Exposure rules.

Antenna gain must be below:

Band	ME910C1-NA	ME910C1-NV	ME910C1-WW	NE910C1-NA
FDD 1	--	--	--	--
FDD 2 / GSM1900	9,01 dBi	--	6,00 dBi	9,50 dBi
FDD 3	---	--	--	--
FDD 4	6,00 dBi	6,00 dBi	8,70 dBi	9,20 dBi
FDD 5 / GSM850	--	--	0,60 dBi	--
FDD 8	--	--	--	--
FDD 12	6,18 dBi	--	6,60 dBi	6,60 dBi
FDD 13	--	6,94 dBi	6,60 dBi	6,90 dBi
FDD 18	--	--	--	--
FDD 19	--	--	--	--
FDD 20	--	--	--	--
FDD 26	--	--	0,60 dBi	--
FDD 28	--	--	--	--

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Le présent appareil est conforme à l'exposition aux radiations FCC / ISED définies pour un environnement non contrôlé et répond aux directives d'exposition de la fréquence de la FCC radiofréquence (RF) et RSS‑102 de la fréquence radio (RF) ISED règles d'exposition. Gain de l'antenne doit être ci-dessous :

FCC Class B digital device notice

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.

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

Host Device Labeling Instructions

On the host device label, will need to include FCC ID information as shown.

Contains FCC ID: 2AHDZ-ACTIVAC4G