

/Załącznik nr 1/ APPENDIX NO. 1

EMS equipment for ALSE

Polish version of specification will be provided on request

Introduction

The following statement of work (SOW) is for the construction and delivery of automated test system (“turnkey solution”) for CISPR25 EMC ALSE Chamber for Radiated Immunity (RI ALSE, RI Portable Transmitters) testing. Quotation shall assume no existing hardware is available on site to meet the requirements listed in this statement of work. After quotation is received, further hardware evaluation will be considered. All hardware must be compatible with Rohde & Schwarz EMC32 (control and monitoring). The supplier shall act as system integrator and shall supply all hardware, software, and controls logic to support all types of EMC testing as outlined in this statement of work. The supplier shall ensure that all components of the proposed equipment comply with this statement of work, all referenced standards, polish health & safety requirements and applicable legal regulations.

1. Standards

In this chapter required specification and standards that the chamber and associated equipment have to fulfilled and have to be built up accordance with, are provided.

1.1. Standard accessibility

The supplier is responsible to obtain all required specifications and standards referred in this document on his own.

1.2. Required standards and specification

In this section standards are listed which the system is required to fulfil in order to meet the requirements. This is critical for product validation with accordance to listed standards. In section additional requirements are specified that extend the national standards

1.3. Radiated immunity (RI)

National reference standards

- ISO11452-1
- ISO11452-2
- ISO11452-9

Frequency limitation from lower frequency band:

1GHz – 18GHz @ 200V/m

1.15GHz–1.45GHz (L-band) & 2.7GHz–3.1GHz (S-band) Radar pulses @ 600V/m
5.2GHz–5.9GHz (C-band) & 8.2-12.4GHz (X-band) @ 200V/m

Extended range

1.2GHz–1.4GHz (L-band) & 2.7GHz–3.1GHz (S-band) Radar pulses @ 1200V/m; distance between antenna and DUT can be reduced from 1m to 0.6m with condition that the DUT remains in the far field and remains covered by the antenna lobe; max DUT size is 0.4x0.4x0.4m

8.5GHz–10.5GHz Radar pulses @ 600V/m; distance between antenna and DUT can be reduced from 1m to 0.6m with condition that the DUT remains in the far field and remains covered by the antenna lobe; max DUT size is 0.4x0.4x0.4m

15.7GHz–17.7GHz Radar pulses @ 300V/m; distance between antenna and DUT can be reduced from 1m to 0.6m with condition that the DUT remains in the far field and remains covered by the antenna lobe; max DUT size is 0.4x0.4x0.4m

- RI Handheld Transceiver: ISO11452-9
1GHz–6GHz @ max.25W

Delivered system has to be built in two separate racks:

1. First rack: the EMS system has to be equipped with the necessary switching units to ensure the continued frequency range 1GHz -6GHz with two independent and equivalent outputs, one for EMS and Radar pulses testing (up to 600V/m) and one for ISO11452-9 testing. The rack has to be installed in amplifier room.
2. Second rack: for radar pulses (L-band, S-band @1200V/m) and for EMS tests in continued frequency range 6 GHz -18 GHz.. The rack has to be mobile and need to be able to operate in both SAC3 and ALSE chambers.

2. Equipment requirement

2.1. Computer requirement

The computer is already part of existing system and is not part of the SOW.

2.2. Hardware integration

Hardware shall be compatible with existing SAC3 and also ALSE 1m chamber equipment (supplier on site visit prior offering is recommended).

The Radiated EMS system have to be built with the discrete, independent devices, like signal generators, power meters, power amplifiers, switching units.

The Radiated EMS system devices have to be fully compatible to devices installed in existing systems (supplier on site visit prior offering is recommended) to allow easy exchange (without software's test templates and hardware

setups modification) in case of malfunction, damage, periodic calibration. The mast driver shall be compatible with Maturo system Multiple Control Unit MCU / FCU3.0.

2.3. Hardware requirements

2.3.1. General

Hardware quoted must meet all of the test specifications listed in this documents. All standards which cannot be met with the system configuration quoted, or are met with certain conditions shall be clearly denoted.

It is required that EMS rack up to 6GHz and field strength up to 600V/m shall be placed in amplifier room and shall be able to operate in hole power and frequency ranges, providing the proper signals for EMS / Radar Pulses / Portable Receiver tests.

Equipment for radar pulses rated for 1200V/m and EMS test 6GHz-18GHz shall be built in one rack that is mobile and can operate in SAC3 and ALSE 1m chamber interchangeably.

Remote optical control shall be provided.

2.3.2. Signal generators

Each EMS rack has to be equipped with own signal generator. Here are the minimum technical requirements for signal generators listed:

Signal generator of EMS 1-6 GHz rack:

- Frequency range 8 kHz to 6 GHz
- SSB at 20 kHz offset: ≤ -126 dBc/Hz @ 1 GHz and ≤ -110 dBc/Hz @ 6 GHz
- Output power min. +18 dBm for $f > 1$ MHz, software upgradeable for min. +20 dBm for $f > 1$ MHz
- Modulation: AM, Pulse, programmable pulse sequences
- Internal modulation source for sinus and pulse (min. pulse width ≤ 10 ns)

Signal generator of EMS 6-18 GHz rack:

- Frequency range max. 100 kHz – min. 18 GHz
- SSB at 20 kHz offset: ≤ -122 dBc/Hz @ 1 GHz and ≤ -106 dBc/Hz @ 6 GHz and ≤ -96 dBc/Hz @ 18 GHz
- Output power min. +11 dBm for $f > 1$ GHz, upgradeable for min. +16 dBm for $f > 1$ GHz
- Modulation: AM, Pulse, programmable pulse sequences
- Internal modulation source for sinus and pulse (min. pulse width ≤ 10 ns)

2.3.3. Amplifiers

Amplifiers/field generating systems to capable of creating and controlling up to the 1200V/m and down to 1 V/m and 0.1 watts required in these specifications. This system shall be optimized in order to keep the required amplifier powers to a minimum by using high gain antennas, low loss cabling/switching systems, and keeping lead length to a minimum by strategically positioning the amplifiers close to the antenna placements.

Relating to required frequencies and field levels defined in section 1.3 the amplifiers might be divided into a few frequency ranges.

Amplifiers have to ensure the full compatibility and 1:1 interchangeability to amplifiers existing in the SAC systems.

The following minimum technical requirements have to be fulfilled for offered amplifiers:

For 1-6 GHz rack:

- Frequency range max. 1 GHz – min. 6 GHz
- Mixed (CW and Pulse) operating mode in range min. 1 GHz – 3.2 GHz and 5.2GHz–5.9GHz
- Output power: CW mode min. 400 W (1dB definition) in range up to 3.2GHz and min. 180W (1dB definition) in range up to 6 GHz. Pulse mode min. 600 W in range of L-Band and min. 500W in S-Band
- Harmonics ≤ -20 dBc for $f \geq 1.8$ GHz at 1dB output power
- Compact construction – max. 16 HU
- Gain adjustment range: min. 15 dB
- Power supply – single phase (N, L and PE)
- Internet browser based remote control (web GUI) and remote service check (web Service GUI)
- Optionally upgradeable for TTL fast mute (switching off / on $< 8 \mu\text{s}$)
- Solid state construction
- Built-in monitor outputs for forward and reflected power, optionally upgradeable for DC voltage outputs proportional to forward and reflected power
- The built-in interlock system has to ensure two operating modes after Interlock circuit is opened: standard – the output power is switched on immediately when Interlock is closed again, and extended – the output power is switched on when the Interlock is closed again and when user confirms with additional signal
- If amplifier has to be divided to smaller bands, the automatic switching for input signal, monitor outputs and for power outputs has to be ensured

For 6-18 GHz rack:

- Frequency range: max. 6 – min. 18 GHz plus L-band, S-Band and X-band
- Output power: min. 1800 W in range L-Band, min. 2000 W in S-Band, min. 300W in range 6-18GHz
- TWT technology is allowed in frequency range 6-18GHz only. In this case the internal harmonic filter needs to be provided, with functionality to switch / bypass locally (from amplifier GUI) and remotely, harmonics ≤ -21 dBc
- Compact construction – max. 12 HU
- Built-in monitor outputs for forward and reflected power
- The built-in interlock system to operate independently and to be controlled by the Interlock system of 1-6 GHz rack (see above) and by Interlock system of EMS racks existing in SAC3

- If amplifier has to be divided to smaller bands, the automatic switching for input signal and monitor outputs has to be ensured in the full frequency range, and the automatic switching for power outputs has to be ensured for frequency range 6-18 GHz

The offered solution shall be discussed with APTIV before offer.

2.3.4. Power meters

- Two channel power meter has to be offered for each EMS rack. Each power meter has to be equipped with two wide-band power probes
- Frequency range of each power probe: 50 MHz to 18 GHz
- Power range of each power probe: – 60 dBm to +20 dBm
- Video Bandwidth of each power probe: min. 30 MHz

2.3.5. Antennas

- All antennas including Log-periodic and Horn shell be susceptible to ESD events caused by the operators or customers.
- Full complement of antennas required to cover all test requirements listed in section 1.2 shall be provided
- For RI Portable Transmitter tests following antenna requirement are given:
 - Two antennas with flat elements for frequency range: 360MHz to 2.7GHz@20W and 800MHz to 6GHz@20W
 - Fixture/holder for antenna fixation over the DUT is required
 - External bidirectional couplers to cover the frequency range 360 MHz -6 GHz

2.3.6. Antennas masts

- The supplier shall provide antennas mast.
- Automatic antenna polarization change (pneumatic drive) shall be realized. This shall be controlled by software that is compatible with R&S EMC32. This requirement is mandatory.
- Antenna polarization change shall keep the same antenna height above the chamber floor.
- Tolerance for antenna positioning is max. +/- 1cm.
- The mast must be equipped with adapters for attachment of antennas
- The supplier shall provide the driver of the mast with the necessary cables and software, if any.
- Control the mast shall provide automation of measurements.
- Connection with control room shall be done over fiberoptics.
- Additional mast / tripod must be delivered for antennas or field probes
- There shall be separate masts for horn antennas intended for immunity and Radar Pulses
- Antenna for radar pulses 1.2GHz–1.4GHz (L-band) is already existing and is not a part of the SOW.

2.3.7. RF Cables

- All necessary RF cables shall be offered.

- Auto switching networks and automation to minimize cable disconnects and maximize system efficiency and test repeatability
- RF cables shall be double shielded, rated to power requirements needed to meet test specification and low loss.
- Connectors for RF cables shall be crimped at manufacturer site.
- RF cables (except mounted in fixed locations i.e. under chamber floor) should be flexible as much possible to avoid inconveniences during test setup preparation.
- RF cables routing shall be done with care to avoid cables damages on sharp edges or to avoid unintentional breakage by lab personnel. Sections of RF cables susceptible for damage (e.g. near to bulkhead) shall be protected by additional armor.
- All cables shall marked with an identification number as well as a description of source and target connection.

2.3.8. Electric field probes

- The transmission lines from the probes shall be fibre-optic.
- Laser powered field probes are preferred.
- Filed probes shall cover entire required frequency bands (to 18GHz) and immunity levels, CW measurement.
- It is required to be capable for directional axis calibration. Calibration for vertical or horizontal polarization shall be relevant to the specific axis, not the vector resultant (e.g. Etot). For vertical polarization, the field calibration shall be relative to the vertically aligned field probe sensor (i.e. Z axis sensor). For horizontal polarization, the field calibration shall be relative to the horizontally aligned field probe sensor (i.e. X axis sensor). Using this method requires the field probe facilitate separate field axis readings. Field probes that produce only a vector summation of the measured field shall not be used.

2.3.9. Others

- All hardware needs to be rackable (standard 19" racks). Space needs to be given for other external items not included in turnkey system. Each rack shall have emergency switch complying to polish health and safety requirements
- Radiated immunity test repeatability shall be in control to meet the measurement accuracy defined in ISO11452-1:2015.

3. Software requirements

Software for the system has to be provided. The test system shall be configured to operate compatibly with Rohde & Schwarz EMC32 test software. All test hardware shall be configured to work and be controlled via software that is compatible with EMC32. The test software / software driver key shall contain all necessary options to meet all aspects of the requirements listed in this statement of work (i.e. Data reporting and Test Sequencing). The software shall be able to cooperate with Aptiv monitoring application (EMC32 server).

It's required to have possibility within the software to block RF equipment operation if ALSE chamber interlock system detects safety risk (in. example chamber doors are open).

IMPORTANT

The software shall contain all relevant component that allow for performing tests defined in section 1.2.

4. Verification and approval

4.1. Verification

Following verification shall be reported to APTIV:

- Verification of meeting immunity conditions listed in the specifications found in this document
- Verification of meeting monitoring conditions listed in the specification found in this document
- Verification of all immunity test levels

4.2. Approval

Final approval of the project will come from the following items:

- Automation design plans given in block diagram format
- Agreement of design plans with equipment listings
- Timing Charts based around the completion of the construction schedule

5. Documentation requirement

Measurements shall be provided electronically.

5.1. Drawings requirements

Prints for manufacturing equipment shall meet Aptiv standards for equipment drawings. Sufficient mechanical and electrical drawings should be provided for ease of repairs or improvements. These should include assemblies and tooling drawings.

5.2. Equipment

- The documentation concerning the control and measurement equipment must be written in Polish or in English, with the exception that operating instructions and safety instructions must be written in Polish, according to Polish law.
- In addition to standard user manuals of delivered devices, the Supplier shall provide whole system documentation in Polish, especially as follows:
 - descriptions of the supplied devices, including safety operation instructions and procedures,
 - devices' configuration details in the software, including input level limitation, transducer factors, necessary settings for proper calculating of measurement results,
 - block diagrams, the lists of used elements, e.g. cables
 - description of the software configurations to each offered measurement setup including screenshots

- description how to operate via the software, example measurements like conducted emission, radiated emission, conducted immunity, radiated immunity, radar pulses and transmitter test

5.3. Spare parts

A list of recommended spare parts with the Original Item Manufacturer's (OIM) part name and part number cross referenced to the Original Equipment Manufacturer's (OEM) part name and number should be provided. This applies to any mechanical and electrical parts. Supplier shall offer (as separate line in the offer) spare parts suggested for 5 years of operation.

6. Products and existing equipment involved

The quoted equipment has to be compatible with SAC3 and ALSE 1m chamber and amplifier room that is existing onsite.

7. Shipping information

Materials and Equipment should be shipped to the following address:

Aptiv Services Poland S.A.

Attn: Szymon Porwolik

ul. Podgórk Tynieckie 2

30-399 Kraków, Poland

+48.728.441.788 Mobile

+48.12.252.2923 Office

8. Installation and integration

Integration will be performed by the supplier.

ALL HARDWARE NEEDS TO BE RECEIVED, INSTALLED and CONFIRMED to MEET SOW requirements – 6 months after signing the contract– this shall be targeted end of installation and certification measurements.

9. Training, support and warranty

9.1. Training

- The supplier needs to provide a written training plan for the equipment being supplied. It is in the supplier's own interest to make a good plan to ensure success of their equipment in Aptiv facilities.
- Onsite training shall be done for engineering, maintenance personnel and test technicians once the system is operational. The training must be comprehensive enough to allow personnel to maintain and operate equipment safely and effectively
- The supplier should provide training manuals as well as any additional training materials available (i.e. checklists or training aids)

9.2. Support

The supplier needs to provide a written support plan for the equipment being supplied. It is in the supplier's best interest to make a good plan to ensure success of their equipment in all Aptiv facilities. The supplier is responsible to support the whole system and is the single point of contact for all issues. If the question is beyond the supplier's knowledge about a component, they are responsible for contacting the component maker for help.

9.3. Warranty

The supplier shall warrant the equipment for two years. The warranty period will start on the date the equipment is placed into service unless otherwise negotiated by the purchasing department. Option to extend warranty period shall be quoted as the separate line.

10. Quote requirements

The cost requirements are as follows:

- Quotation shall cover all tests listed in section 1.2.
Each item shall be quoted separately. This includes hardware, engineering cost items, installation, and travel.
Additional training should be stated as an optional charge.
- Pricing breakdown is also required to determine additional expenses items. Such items may be handled using a separate Purchase Order(s).
- Shipping and Receiving Dates shall be provided
- Submission of concept sketches with the quotation shall be provided
- Items that are to be quoted as options or separately itemized (This may include such items as quick change tooling, documentation on USB flash drive, special software, etc.)
- A Gantt chart illustrating major milestone dates



- Utility requirements (including anticipated electrical needs (voltage and current), air pressure (PSI and CFM), vacuum exhaust, etc.)
- Cost of consumable supplies used by the equipment shall be provided
- Non-compliance with the statement of work or Standards. The supplier should outline here any paragraphs from the statement of work or listed standards with which the supplier will not comply and the reasons for the non-compliance. For semi-standard or off the shelf equipment, it may make sense to request the supplier state any additional costs attributable to compliance with the statement of work
- Special training costs such as: onsite training for engineers, operators and maintenance (1, 2 or 3 shifts), cost to return for training sessions at a later date, bilingual manuals or training videos shall be quoted separately