

TECHNICAL CODE

DIGITAL TERRESTRIAL TELEVISION (DTT) - ACTIVE INDOOR ANTENNA

Developed by



Registered by



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Development of technical codes

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Committee representation

Multimedia Terminal Working Group (MMT WG) under the Malaysian Technical Standards Forum Bhd (MTSFB) which supervised this technical code consists of representatives from the following organisations:

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Eastool Solution Sdn Bhd
Fraunhofer IIS
LG Electronics (M) Sdn Bhd
Media Prima Berhad
MyTV Broadcasting Sdn Bhd
Panasonic AVC Networks Kuala Lumpur Malaysia Sdn Bhd
Radio Television Malaysia
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Indoor Digital Terrestrial Television Antenna Task Force of the Multimedia Terminal Working Group (MMT WG) which developed this technical code consists of representatives from the following organisations:

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Foreword

This technical code for the Digital Terrestrial Television (DTT) - Active indoor antenna ('this Technical Code') was developed pursuant to section 185 of the Act 588 by the Malaysian Technical Standards Forum Bhd ('MTSFB') via its Indoor Digital Terrestrial Television Antenna Task Force of the Multimedia Terminal Working Group (MMT WG).

This Technical Code was developed for the purpose of certifying communications equipment under the Communications and Multimedia (Technical Standards) Regulations 2000.

This Technical Code shall continue to be valid and effective until reviewed or cancelled.

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DIGITAL TERRESTRIAL TELEVISION (DTT) - ACTIVE INDOOR ANTENNA

1. Scope

This Technical Code specifies the minimum requirements for active indoor Digital Terrestrial Television (DTT) antennas. DTT reception quality depends on several antenna parameters which play a crucial role in delivering the DTT signal to the connected DTT receiver in conjunction with DTT systems operating in the frequency range of 470 MHz - 742 MHz, Ultra High Frequency (UHF) during pre-Analogue Switch Off (ASO) and in the frequency range of 470 MHz - 694 MHz (UHF) during post-ASO.

An active antenna is an antenna that contains active electronic components such as transistors, as opposed to most antennas which only consist of passive components such as metal rods, capacitors and inductors. Active antenna designs allow antennas of limited size to have a wider frequency range (bandwidth) than passive antennas, and are primarily used in situations where a larger passive antenna is either impractical (inside a portable radio) or impossible (suburban residential area that disallows use of large outdoor low frequency antennas).

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

See Annex A.

3. Abbreviation

For the purposes of this Technical Code, the following abbreviation applies.

AC	Alternating Current
ASO	Analogue Switch Off
AUT	Antenna Under Test
dB	decibel
dBi	decibels relative to an isotropic radiator
dBm	Decibel-milliwatts
DTT	Digital Terrestrial Television
DUT	Device Under Test
ESD	Electrostatic Discharge
Gp	Passive antenna gain
Gt	Total antenna gain
IM	Intermodulation
IEC	International Electrotechnical Commission
IUT	Implementation Under Test
NF	Noise Figure

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OIP ₃	3rd Order Intercept Point
RF	Radio Frequency
S/N	Signal-To-Noise
STB	Set Top Box
UHF	Ultra High Frequency

4. Requirements

4.1 General requirements

Device of indoor DTT antenna shall be designed not to cause interference with other authorised radiocommunication services, and be able to tolerate any interference caused by other radiocommunication services, electrical or electronic equipment.

The antenna shall be tested to comply with the applicable requirements stipulated in Clause 4 which the parameters are profiled in Table 1. The Antenna Under Test (AUT) shall comply to the test method specified in Annex B and parameters in Table 1.

4.1.1 Power supply

The equipment may be Alternating Current (AC) or Direct Current (DC) powered. For AC powered equipment, the operating voltage shall be 240 V + 5 %, - 10 % and frequency 50 Hz ± 1 % in according to MS 406 or 230 V ± 10 % and frequency 50 Hz ± 1 % in according to MS IEC 60038 whichever is current.

If an external power supply is used (e.g. AC adaptor), it shall not affect the capability of the equipment to meet this Technical Code. Adaptor shall be pre-approved by the relevant regulatory body before to be used with the equipment.

Alternatively, the power supply may be integrated in the Set Top Box (STB).

4.1.2 Power supply cord and mains plug

The equipment shall be fitted with a suitable and appropriate approved power supply cord and mains plug. The power supply cord and mains plug are regulated products and it shall be pre-approved by the relevant regulatory body with the following requirements before to be used with the equipment.

- a) The power supply cord shall be certified in according to either:
 - i) BS 6500;
 - ii) IEC 60227-5; or
 - iii) IEC 60245-4.
- b) The main plug shall be certified in according to:
 - i) MS 589: Part 1 or BS 1363: Part 1 (for 13 A fused plugs); or
 - ii) MS 1578 or BS EN 50075 (for 2.5 A, 250 V, flat non-rewirable two-pole plugs).

4.1.3 Radio Frequency (RF) input connector

The RF input connector shall be complied to IEC 61169-2.

4.1.4 Marking

The equipment shall be marked with the following information:

- a) supplier/manufacturer's name or identification mark;
- b) supplier/manufacturer's model or type reference; and
- c) other markings as required by the relevant standards.

The markings shall be legible, indelible and readily visible. All information on the marking shall be either in Bahasa Melayu or English Language.

4.2 Technical requirements

In order to get the optimal DTT reception performance the following mentioned antenna parameters shall be complied. Each antenna model shall comply with the specified value range from each selected parameter as follows where the summary of technical requirements are listed in Table 1:

- a) passive antenna gain;
- b) total antenna gain;
- c) Noise Figure (NF);
- d) 3rd Order Intercept Point (OIP₃);
- e) return loss;
- f) directivity;
- g) temperature range;
- h) suppression of unwanted signals;
- i) power consumption; and
- j) Electrostatic Discharge (ESD).

4.2.1 Operating frequency range

The indoor antennas for DTT broadcast service receivers shall operate in the frequency range 470 MHz - 742 MHz (UHF) during pre-ASO and in the frequency range of 470 MHz - 694 MHz (UHF) during post-ASO.

4.2.2 Passive antenna gain

Passive gain is one of the most important antenna factors, the more passive gain the better the Signal-To-Noise (S/N) ratio on the antenna output port.

The passive antenna gain is a relative measure of an antenna's ability to focus radio frequency energy. The measurement is typically measured in dBi (decibels relative to an isotropic radiator) or in dBd (decibels relative to a dipole radiator).

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The passive gain of an antenna is the gain obtained by the antenna structure itself without any active components. An antenna with high passive gain will perform better within areas with relative low field strengths.

The indoor antenna shall have a passive gain of ≥ 0 dBi.

4.2.3 Total antenna gain

The total antenna gain (G_t) is the sum of the passive antenna gain (G_p) and the gain of the integrated amplifier (G_a).

$$G_t = G_p + G_a$$

G_p is measured in dBi while G_a is measured in dB.

The amplifier in an active antenna is primarily designed to overcome the coaxial loss by cable and should provide a sufficient gain margin of the total system gain. Deploying an active antenna allows placing an antenna remotely (with relatively long cable) as the antenna is powered conveniently over the same cable.

The RF levels at the output of the antenna shall not exceed the maximum input RF level of the STB receiver to avoid any deterioration of the STB receiving signal.

The antenna gain shall be stable over the operating frequency range at ± 2 dB.

The indoor antenna shall have a total antenna gain of $18 \text{ dB} \pm 2 \text{ dB}$.

4.2.4 Noise figure (NF)

The low Noise Figure (NF) is an important performance characteristic of the antenna amplifier which in general, it is better than the front end of the STB to ensure the ability to receive weak stations is greatly improved.

NF is a measure of degradation of the S/N caused by noise contributed by components in the RF signal chain. Less noise contribution will produce a better S/N ratio at the output of RF signal chain.

The total noise figure (F) in a system is defined as:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \frac{F_4 - 1}{G_1 G_2 G_3} + \dots + \frac{F_n - 1}{G_1 G_2 G_3 \dots G_{n-1}}$$

where,

F_n is the noise figure of the n-th device.

This is the case when several devices are cascaded.

The illustration of an antenna with integrated amplifier connected to a STB is shown in Figure 1.

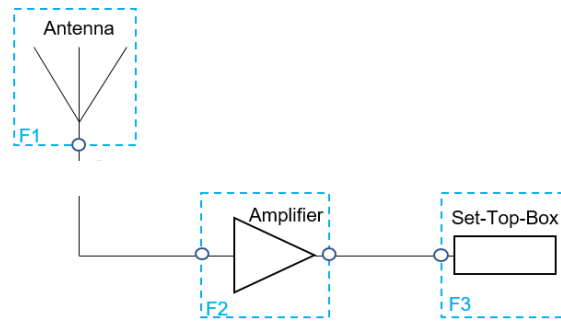


Figure 1. System setup of the installation diagram

The indoor antenna shall have a typical noise figure of ≤ 1.5 dB.

4.2.5 Output 3rd order Intercept Point (OIP₃)

Output 3rd Order Intercept Points (OIP₃) specifications provide a useful figure for determining the degree of linearity exhibited by RF electronic devices/systems. The linearity of the system will be getting better when the OIP₃ produce higher value, thus the RF domain will have better performance in regarding of spectral purity.

The OIP₃ is the theoretical output level at which the third-order two-tone distortion products are equal in power to the desired (wanted) signals. The calculation is based on the following equation.

$$IM_3 = 3P_{out} - 2OIP_3$$

where,

IM₃ is third order intermodulation level (dBm);

P_{out} is single tone power at output (dBm); and

OIP₃ is output third-order intercept point (dBm).

The intermodulation (IM) products created in active components like amplifiers shall be kept as low as possible.

In order to achieve low IM products (- 60 dBc), amplifiers with high OIP₃ are needed. Figures 2 and 3 show the result of two carriers when it applied to the amplifier. In Figure 2, each 1 dB increment at the input will increase the output carrier by 1 dB as well but the IM product will be increased by 3 dB. Figure 3 shows its measurement on a spectrum analyser. The distance between the wanted carriers and the IM products is called IMA should be as high as possible.

The UHF spectrum is more occupied by high RF level mobile telecom signals, thus more demands on linearity (OIP₃) of the antenna amplifier.

The amplifier shall be capable of handling signals with 0 dBm output level, and assuming that IM products are at - 60 dBc.

$$OIP_3 = (3P_{out} - IM_3)/2$$

$$OIP_3 = (3 \times 0 - (- 60))/2$$

$$OIP_3 = 30 \text{ dBm}$$

The indoor antenna shall have a OIP₃ level of ≥ 30 dBm.

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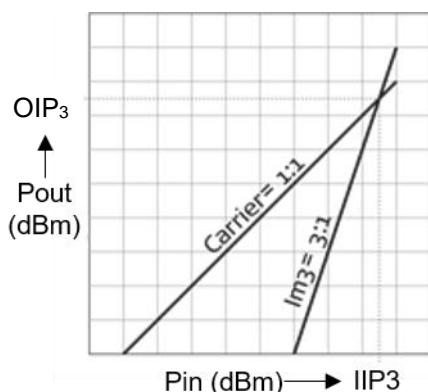


Figure 2. OIP₃ table

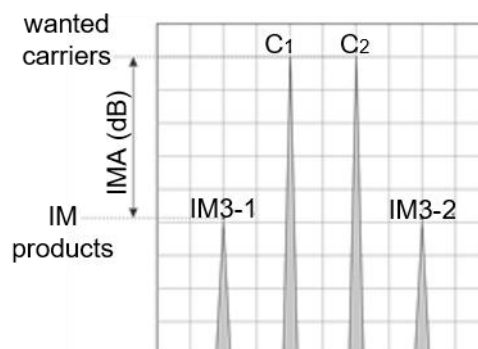


Figure 3. OIP₃ analysing

4.2.6 Return loss

Antenna impedance and the quality of the impedance match are most commonly characterised as return loss. These impedance parameters are to measure value of the RF power supplied to the STB receiver reflects back to the antenna terminals.

For efficient transfer of DTT RF signals between an antenna and STB receiver the return loss should be ≤ -10 dB for 75 Ω system impedance.

The indoor antenna shall have a return loss of ≤ -10 dB.

4.2.7 Directivity

An antenna is a physical device that radiates or receives energy, almost always with some directional dependence. Theoretically, for efficient transfer of energy between two antennas, their respective radiation patterns shall be optimised in the correct direction and the antenna shall be polarised with the same orientation. However, in the real world, where Line of Sight (LOS) between two antennas rarely exists, and at frequencies above about 500 MHz, objects in the path between the antennas (walls, structures, people, terrain, etc.) may substantially alter both the effective radiation patterns and the polarisation.

Even if a device is located in a fixed position, polarisation will typically change with time due to movement of nearby objects. As a result, while some general attention shall be paid to radiation pattern shape and antenna polarisation, these parameters can be optimised for a particular situation in only a general way. Since indoor reception is commonly multipath reception (Rayleigh), an omni-directional or slight directivity is recommended.

The antenna directivity shall be measured as a minimum at the lowest, middle and highest frequency of the declared frequency band(s).

The indoor antenna shall have as near to omni-directivity pattern as shown in Figure 4.

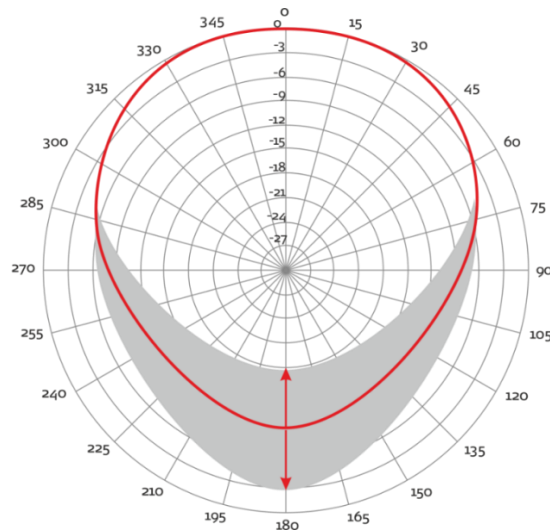


Figure 4. Directivity antenna pattern

4.2.8 Temperature range

Operating temperature range for consumer indoor antenna shall be within -20°C to 70°C .

An operating temperature is the temperature at which an electrical or mechanical device operates. The device will operate effectively within a specified temperature range which varies based on the device function and application context, and ranges from the minimum to the maximum operating temperature.

The indoor antenna shall have a temperature range between -20°C to 70°C

4.2.9 Suppression of unwanted signals

Wireless devices such as Global System for Mobile (GSM), Wireless Local Area Network (WLAN) and other systems often have multiple transceivers, operating in various bands and act as a local or nearby interferer. Interference may also cause by the following wireless devices:

- a) amateur radio;
- b) shortwave broadcast;
- c) Frequency Module (FM) radio broadcast; and
- d) Long Term Evolution (LTE).

To prevent DTT interference, suppression filtering of the interfering frequency band from the wireless devices is required.

The indoor antenna shall have a suppression of unwanted signals of $\geq 20\text{ dB}$.

4.2.10 Power consumption

Typical STB receivers are capable of delivering $+5\text{ V}$ at a maximum current of 50 mA , the maximum current of the active antenna shall not exceed 50 mA .

The indoor antenna shall have power consumption $\leq 250\text{ mW}$.

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4.2.11 Electrostatic Discharge (ESD)

The discharge of ESD can affect the correct functioning of equipment. The charge is created by the friction of two materials, one of which is non-conductive. ESD interference derives its strength from the very short rise time (up to less than 1 ns), and the short duration (typically less than 100 ns) of a pulse in combination with a large current or voltage.

The device shall be protected with special components which leads the charge to ground to avoid component damaged by ESD. Mostly the components are assembled to the input and output of the device.

The device shall withstand contact discharges of 2 kV and 4 kV and air discharges of 2 kV, 4 kV and 8 kV with both polarities plus (+) and minus (-).

The ESD of indoor antenna shall withstand contact discharges of 2 kV and 4 kV and air discharges of 2 kV, 4 kV and 8 kV with both polarities plus (+) and minus (-).

Table 1. Summary of technical requirements for indoor DTT antenna

No.	Parameter	Value/range
1.	Operating frequency range	470 MHz - 742 MHz (UHF) during pre-ASO and 470 MHz - 694 MHz (UHF) during post-ASO
2.	Passive antenna gain, Gp	≥ 0 dBi
3.	Total antenna gain, Gt	18 dB ± 2 dB
4.	Noise figure	≤ 1.5 dB
5.	Output 3 rd order intercept point, OIP ₃	≥ 30 dBm
6.	Return loss	≤ - 10 dB
7.	Directivity	The indoor antenna shall have as near to omnidirectivity pattern as shown in Figure 4.
8.	Temperature range	- 20 °C to 70 °C
9.	Suppression of unwanted signal	≥ 20 dB
10.	Power consumption	≤ 250 mW
11.	Electrostatic discharge	The ESD of indoor antenna shall withstand contact discharges of 2 kV and 4 kV and air discharges of 2 kV, 4 kV and 8 kV with both polarities plus (+) and minus (-).

Annex A
(normative)

Normative references

MS 406, *Specification for voltages and frequency for alternating current transmission and distribution systems (Second revision)*

MS 589-1, *13 A plugs, socket-outlets, adaptors and connection units - Part 1: Specification for rewirable and non-rewirable 13A fused plugs (Third revision)*

MS 1578, *Specification for flat non-rewirable two-pole plugs, 2.5 A, 250 V, with cord, for the connection of class II-Equipment for household and similar purposes*

MS IEC 60038, *IEC standard voltages*

IEC 60227-5, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V - Part 5: Flexible cables (cords)*

IEC 60245-4, *Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 4: Cords and flexible cables*

IEC 61169-2, *Radio-frequency connectors - Part 2: Sectional specification - Radio frequency coaxial connectors of type 9,52*

BS 1363: Part 1, *13 A plugs, socket-outlets, adaptors and connection units - Part 1: Specification for rewirable and non-rewirable 13 A fused plugs*

BS 6500, *Electric cables. Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments*

BS EN 50075, *Specification for flat non-wirable two-pole plugs 2.5 A 250 V, with cord, for the connection of Class II-equipment for household and similar purposes*

Annex B
(normative)

Testing procedures

B1. Passive antenna gain

The passive antenna gain should be measured in a homogeneous field. For the testing purposes, the AUT without the built-in amplifier, calibrated reference antenna, transmit antenna, attenuator 10 dB and network analyser are required.

In order to measure the field strength of the calibrated reference antenna, the following steps shall be followed:

- a) Arranged all devices as illustrated in Figure B1.
- b) Connect 10 dB attenuator to the reference antenna to avoid mismatches with the coaxial cable.
- c) Both signal shall be connected to the network analyser which generates a sweep in the frequency range the AUT is specified.
- d) The transmit antenna will transmit the signal to the reference antenna.
- e) Values of the received signal which measured by the reference antenna shall be recorded.
- f) Replace the reference antenna with the AUT then repeat steps specified in a) until e). The passive gain of the AUT is calculated by taking the calibrated reference gain values of the reference antenna into account.

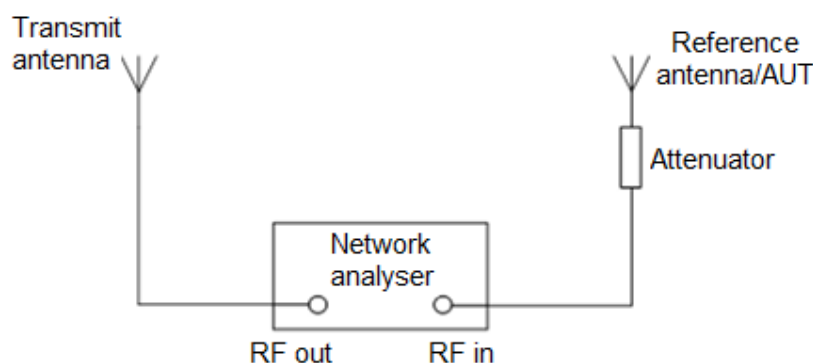


Figure B1. Antenna gain measurement

B2. Total antenna gain

To determine the total antenna gain, the antenna with built-in amplifier is connected to the input of the network analyser through a 10 dB attenuator. The setup and measurement procedures are the same as specified in Clause B1. The gain flatness can be determined after gain measurement is completed.

B2.1 Amplifier gain

To measure the amplifier gain, the amplifier is separated from the antenna. The amplifier input is connected to the network analyser's output and the amplifier output is connected to the network analyser's input (see Figure B2). The analyser's output is set to a certain level so that the amplifier works in linear region. The sweep frequency range is set to 1 MHz - 1 000 MHz . The amplifier gain can be read out and saved in the analyser's memory.

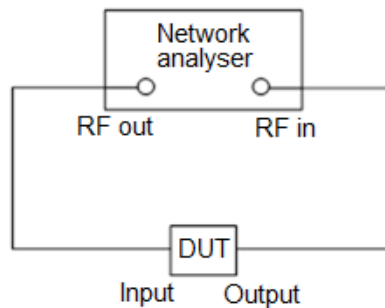


Figure B2. Amplifier gain measurement

B3. Noise figure (amplifier)

To determine the noise figure of the amplifier a measurement setup which consist of spectrum analyser and noise source as illustrated in Figure B3 shall be arranged.

In order to measure the noise figure, the following steps shall be followed (steps e) and f) are for noise measurement of the amplifier):

- a) Calibrate the measurement setup.
- b) Connect a noise source with a calibrated noise figure to the spectrum analyser.
- c) The frequency shall be set in the operating frequency range of the antenna.
- d) Measure the noise level.
- e) The noise source shall be connected to the input of the amplifier.
- f) A sweep shall be made in the same frequency range as in step c).
Note. The added noise in the circuit is the noise level of the amplifier Device Under Test (DUT).
- g) All measurements shall be recorded.

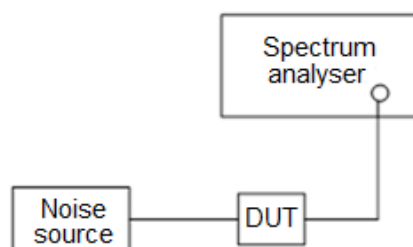


Figure B3. Noise measurement

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B4. Output 3rd Order Intercept Point (OIP₃)

To determine the OIP₃ of the amplifier, a measurement setup which consist of 2 units of signal generator, 2 units of 10 dB attenuator, a 20 dB attenuator, combiner and spectrum analyser as illustrated in Figure B4 shall be arranged.

In order to measure the noise figure, the following steps shall be followed:

- a) Connect the outputs of two RF signal generators with a combiner after passing through a 10 dB attenuator. The attenuator is necessary to avoid coupling between the RF signal generators.
- b) The combiner's output shall be connected to the amplifier's DUT input.
- c) The DUT shall be connected to the spectrum analyser through a 20 dB attenuator to protect the spectrum analyser against overloading.
- d) Set the RF signal generators to 1 MHz spacing (i.e. if signal generator 1 is at 500 MHz, then signal generator 2 shall be set at 501 MHz).
- e) The amplified carriers with the IM products will be displayed on the analyser's screen.
- f) The software in the equipment will provide the value of OIP₃ on the screen.

To get an overview of the OIP₃ for the whole frequency band, it shall be measured in steps of 50 MHz.

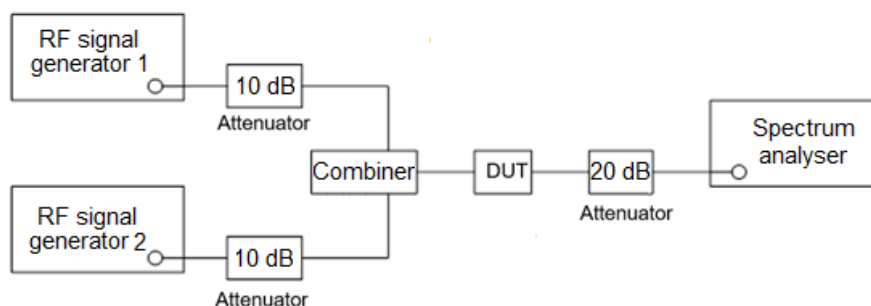


Figure B4. OIP₃ measurement

B5. Return loss

In order to measure the return loss, the following steps shall be followed:

- a) Connect the antenna to a network analyser with built-in voltage/Vertical Standing Wave Ratio (VSWR) bridge.
- b) The measuring port shall be first calibrated.
- c) It shall be set to "Open", "Short" and a "Load".
- d) The impedance of the load shall be matched with the impedance of the AUT.
- e) Measure the return loss of AUT after calibrating the setup.

B6. Directivity (Antenna diagram)

To determine the antenna diagram, a measurement setup which consist of network analyser with readout interface, transmit antenna, attenuator, rotator, motor controller and personal computer or laptop as illustrated in Figure B5 shall be arranged.

In order to measure the antenna diagram, the following steps shall be followed:

- a) Connect 10 dB attenuator to the AUT to avoid mismatches with the coaxial cable.
- b) The analyser generates sweeps in the frequency range the AUT is specified.
- c) The transmit antenna will transmit the signal to the reference antenna.
- d) Activate the rotator during transmission which will make full rotation of 360°.
- e) For all the frequencies of interest, measurements shall be made for some specific angles for all interested frequencies.
- f) All data that recorded in PC or laptop shall be saved in order to plot the antenna diagram.

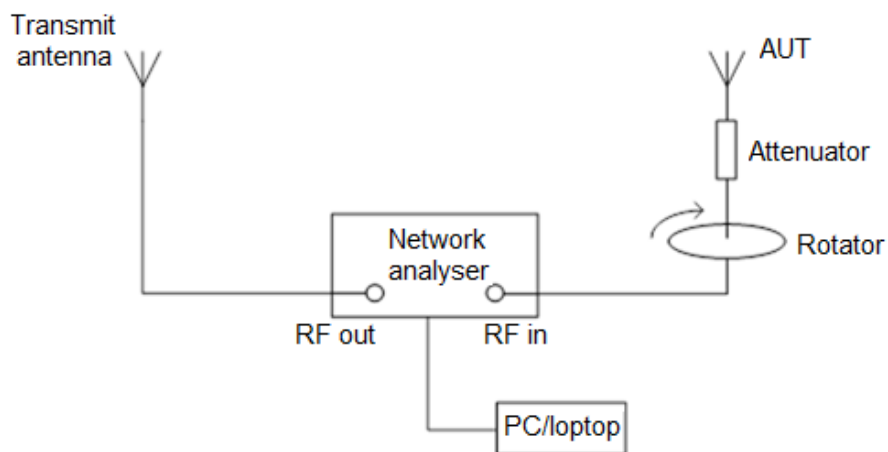


Figure B5. Antenna diagram measurement

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