

JN-AN-1255

TIS-TRP Performance Test with RF Results

Rev. 1.1 — 22 April 2020

Application Note

Document information

Info	Content
Keywords	JN5189, K32W module
Abstract	Application note for TIS/TRP testing



Revision history

Rev	Date	Description
1.0	20200320	Initial release
1.1	20200422	Updated for K32W061

Zigbee have defined a test plan to evaluate a product's RF performances. This plan focuses on the Total Radiated Power (TRP) and on the Total Isotropic Sensitivity (TIS). Those tests assess the product radiated characteristics. This Application Note describes how to use the TIS-TRP-Tester tool and provides TIS/TRP RF test results.

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1. Introduction

TIS and TRP tests are performed in an anechoic chamber. The test procedure follows the “Zigbee RF Performance Test Plan & Spec” (doc 15-0161-25-cert-zigbee-rf-performance-test-plan-spec). The JN5189/K32W061 device features an integrated radio which is IEEE 802.15.4 compliant and supports this Zigbee standard.

This Application Note describes the RF performances of JN5169 as tested in 7-Layers

Item	Version	Description
JN-AN-1255-Zigbee_RF_Performance_Test_TISTRP	1v1	This application note with software
OM15069	Rev 2	NXP evaluation kit carrier board (DK6)
OM15076	Rev 3	NXP RF module embedding JN5189 (T10)

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2. TIS TRP Test setup

Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS) are handled within an anechoic chamber. The setup is depicted in the diagram below.

The Zigbee module under test is driven through Over The Air commands:

- Channel selection,
- RX or TX mode selection,
- Packet counting reporting.

For this purpose, a dedicated module is sending the relevant commands (IEEE802.15.4 formatted) and is reporting the results to EMQuest Test suite.

Over the air commands are defined in Zigbee Doc. 15-0161-25.

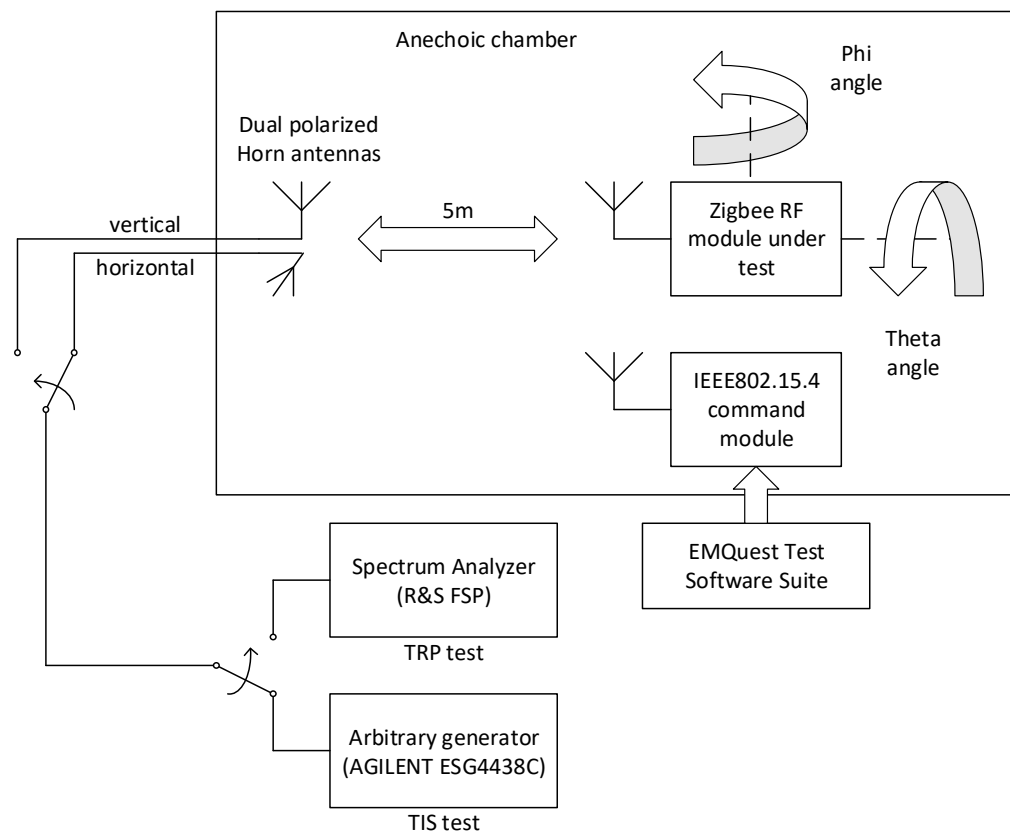


Figure 1: TIS and TRP setup.

The JN5189 module can be programmed with binaries included in the Zip using the JN5189 Production flash programmer. The binaries included are:

JN-AN-1255-Zigbee_RF_Performance_Test_TISTRP_CMD.bin: Command Module binary. Only need ed for development when the EMQuest software is not available.

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JN-AN-1255-Zigbee_RF_Performance_Test_TISTRP_DUT.bin: DUT module binary.
The binary that get programmed in the device under test.

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3. Using a Local CMD module

If the EMQuest software is not available, then a CMD module is provided that can be programmed into another JN5189 or K32W061 module.

Connect Teraterm to the CMD module @115200.

Type **Help** for the list of commands.

Both ends will default to channel 16.

- 1) You should be able to PING the DUT by typing

custom rping

the CMD module will respond with **NO ACK** or **Received ACK** if it gets a response

- 2) Set the channel at both end (if you want to change them) with

Custom setchannel 11

This sets both ends to channel 11

- 3) To run the test, you should do the following
 - a. Type **custom rstart** to tell the remote end to start.
 - b. Transmit the test packets from the ARB.
 - c. Type **custom rend** to tell the remote end to stop. It will then transmit the results. Remember the result will have one additional packet as it received the REND command. This is also a protocol packet, so you should expect the total packets to be 1 bigger than the number of packets sent by the ARB and the protocol packets to be 1.
 - d. The TotalLQI and totalRSSI packet is the sums of all the LQI and RSSI values received. You will have to divide this by the number of packets to find the average LQI and RSSI.

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```

Tera Term - [disconnected] VT
File Edit Setup Control Window Help
>custom rping
NO ACK
>help
>custom rping
custom lpingtimeout <timeout(ms)>
custom setchannel <channel>
custom lsetchannel <channel>
custom rsetchannel <channel>
custom lgetchannel
custom lsetpower <power>
custom rsetpower <power>
custom lgetpower
custom rgetpower
custom rstream <duration(ms)>
custom restart
custom reboot
custom lreboot
custom find <channel>
custom rhardwareversion
custom rsoftwareversion
>custom lsetchannel 16
Channel set to 16
>custom rping
Received ACK
>
>
>
>custom rping
Received ACK
>custom restart
>custom reboot
Report from DUT module
totalPackets : 1
Protocol Packets : 1
totalLQI : 115
totalRSSIMagnitude : 201
>

```

In addition, the CMD module support 2 additional commands that can be used instead of the ARB for functional testing. These are:

custom lsend <num>

This will transmit <num> 20-byte payload packets so **custom lsend 200** will send 200 packets

custom lpower <power>

This lets you set the power used in the LSEND command. It does not affect the power used to sending commands to the DUT. **custom lpower -30** will set the test to a power of -30. The MAC only support powers down to -30 so this is the lower limit

You can also put a terminal on the DUT end. Pressing a key will show you the current value of the counters and the current channel. You can also see incoming commands. The commands are defined as follows

```

E_CMD_ID_PING = 0x00,           //0
E_CMD_ID_ACK,                   //1
E_CMD_ID_SET_CHANNEL,          //2
E_CMD_ID_OBSOLETE1,            //3
E_CMD_ID_OBSOLETE2,            //4
E_CMD_ID_SET_POWER,            //5
E_CMD_ID_GET_POWER,            //6
E_CMD_ID_GET_POWER_RESPONSE,   //7
E_CMD_ID_DUMMY8,               //8
E_CMD_ID_STREAM,               //9
E_CMD_ID_START_RX_TEST,        //A

```

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```

E_CMD_ID_END_RX_TEST,           //B
E_CMD_ID_RX_REPORT,            //C
E_CMD_ID_REBOOT,               //D
E_CMD_ID_OBSOLETE3,           //E
E_CMD_ID_OBSOLETE4,           //F
E_CMD_ID_GET_REBOOT_BYTE_RESPONSE, //10
E_CMD_ID_GET_HW_VERSION,      //11
E_CMD_ID_GET_HW_VERSION_RESPONSE, //12
E_CMD_ID_GET_SW_VERSION,      //13
E_CMD_ID_GET_SW_VERSION_RESPONSE, //14

```

Example from DUT end shown below:

```

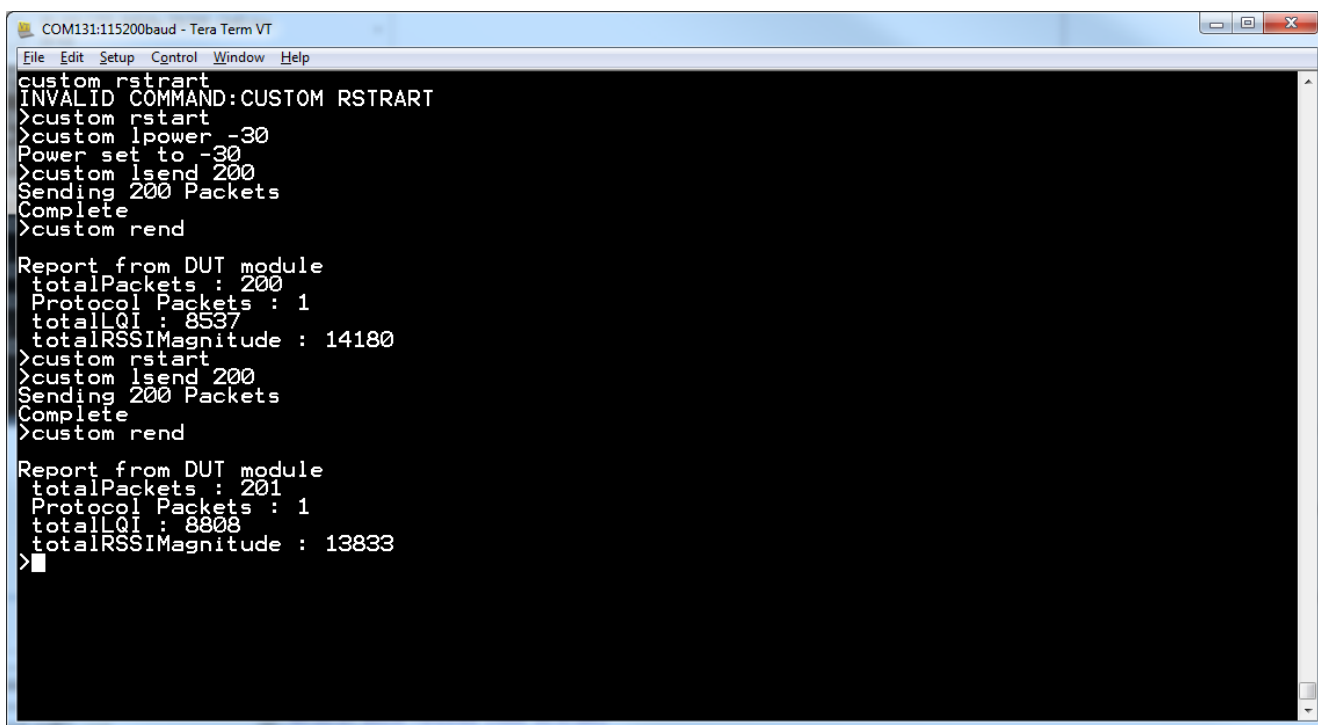
COM47:115200baud - Tera Term VT
File Edit Setup Control Window Help
>
Report from DUT module
totalPackets : 0
Protocol Packets : 0
totalLQI : 0
totalRSSIMagnitude : 0
Channel : 16
>
Report from DUT module
totalPackets : 0
Protocol Packets : 0
totalLQI : 0
totalRSSIMagnitude : 0
Channel : 16
>
Report from DUT module
totalPackets : 0
Protocol Packets : 0
totalLQI : 0
totalRSSIMagnitude : 0
Channel : 16
>
ID: 2 Len: 4Chan: 16 ChannelMask: 10000
ID: 0 Len: 0
ID: 2 Len: 4Chan: 16 ChannelMask: 10000
ID: 2 Len: 4Chan: 16 ChannelMask: 10000
ID: 0 Len: 0
ID: 2 Len: 4Chan: 16 ChannelMask: 10000

```

Here is a typical test. As you can see in the first test 1 packet was missed.

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```
COM131:115200baud - Tera Term VT
File Edit Setup Control Window Help
custom rstart
INVALID COMMAND:CUSTOM RSTART
>custom rstart
>custom lpower -30
Power set to -30
>custom lsend 200
Sending 200 Packets
Complete
>custom rend

Report from DUT module
totalPackets : 200
Protocol Packets : 1
totalLQI : 8537
totalRSSIMagnitude : 14180
>custom rstart
>custom lsend 200
Sending 200 Packets
Complete
>custom rend

Report from DUT module
totalPackets : 201
Protocol Packets : 1
totalLQI : 8808
totalRSSIMagnitude : 13833
>
```

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4. JN5169 Test results

Table 1. Total Radiated Power JN5169

Band	Ch.	Freq. (MHz)	Cond. PWR (dBm)	TRP (dBm)	NHPRP $\pm 45^\circ$ (dBm)	NHPRP $\pm 30^\circ$ (dBm)
				FS	FS	FS
ISM	15	2425	N/A*	8,80	6,97	4,78
ISM	19	2445	N/A*	8,16	6,37	4,24
ISM	20	2450	N/A*	8,11	6,32	4,20
ISM	25	2475	N/A*	7,61	5,87	3,84

Table 2. Total Isotropic Sensitivity JN5169

Band	Ch.	Freq. (MHz)	Cond. PWR (dBm)	TIS (dBm)	NHPRP $\pm 45^\circ$ (dBm)	NHPRP $\pm 30^\circ$ (dBm)
				FS	FS	FS
ISM	15	2425	N/A*	-87,06	-85,23	-83,30
ISM	19	2445	N/A*	-86,11	-84,31	-82,41
ISM	20	2450	N/A*	-85,50	-83,72	-81,82
ISM	25	2475	N/A*	-86,01	-84,27	-82,43

Table 1: Total Isotropic Sensitivity JN5169

Note: * No antenna connector available on JN5169 RF module

Legend:

FS = Free Space

NHPRP = Near Horizon Partial Radiated Power

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5. Packet Sniffer

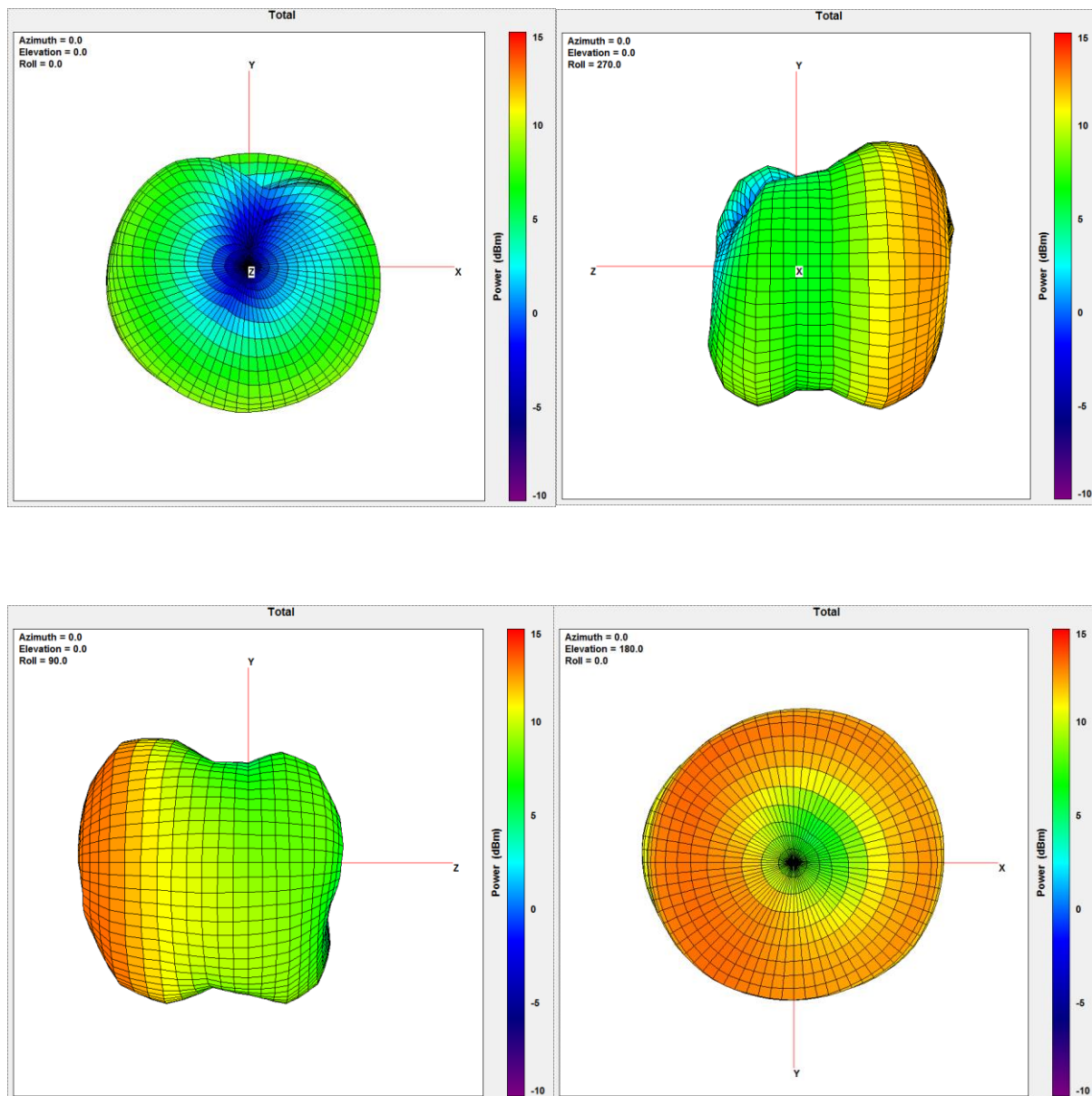
Packets generated for TISTRP do not contains a valid IEEE802.15.4 header or checksum. The packet sniffer application will allow TISTRP traffic to be sniffed. The application is compatible with Ubiqua and convention IEEE802.15.4 packets and is now released in binary form as the standard sniffer in the SDK.

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ANNEX A – JN5169 Total Radiated Power

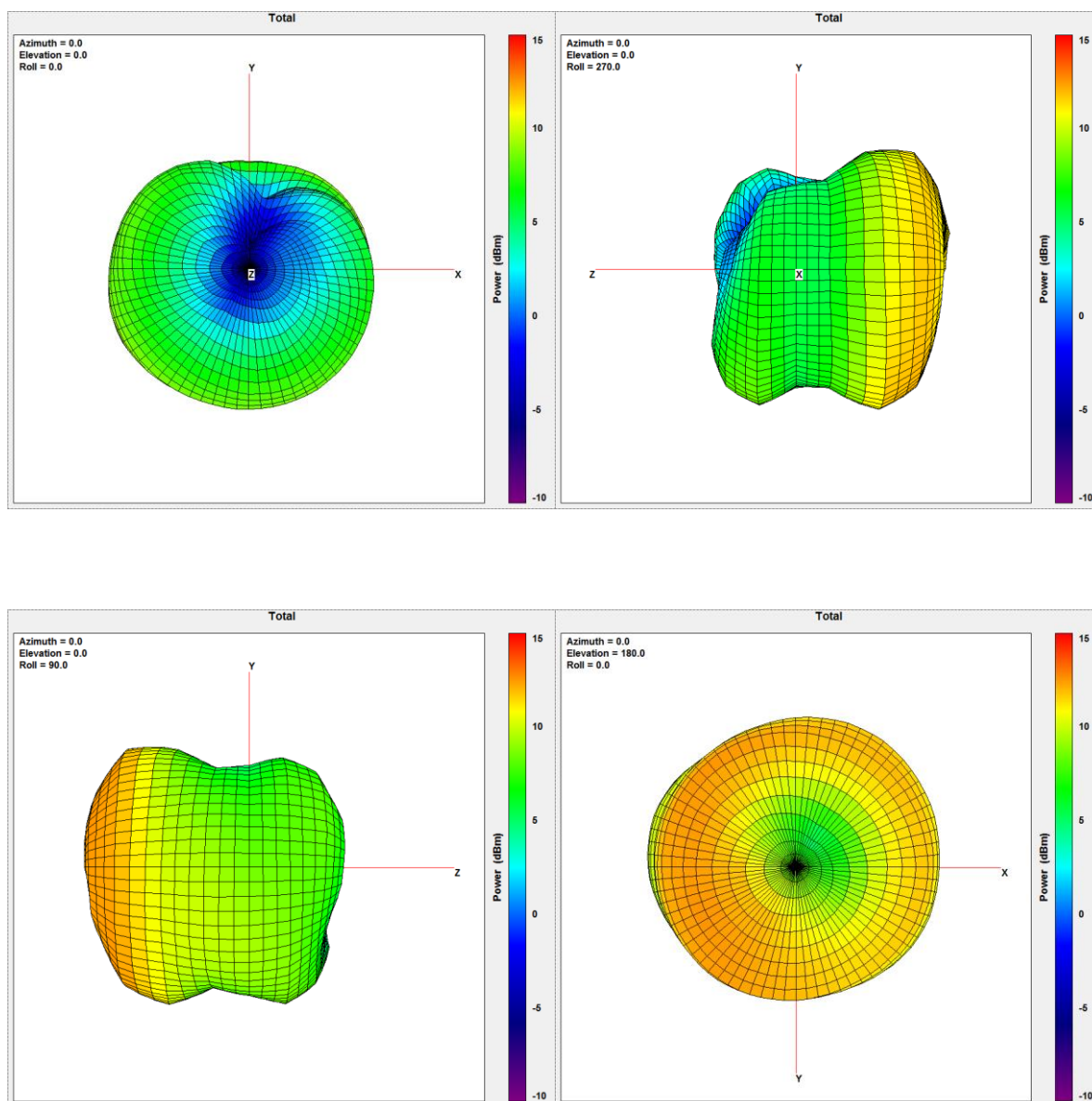
Channel 15, 2425MHz, JN5169 TRP



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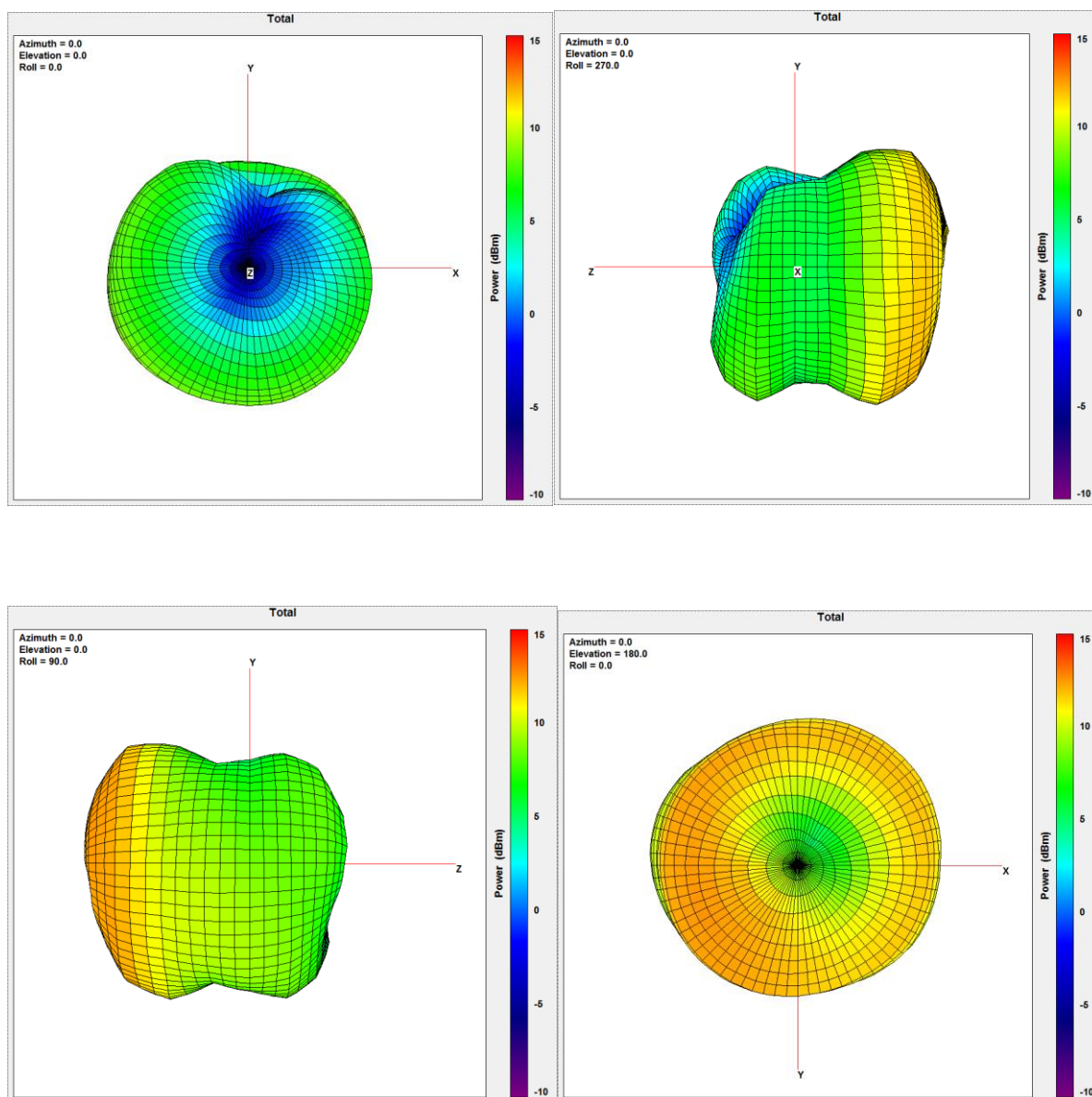
Channel 19, 2445MHz, JN5169 TRP



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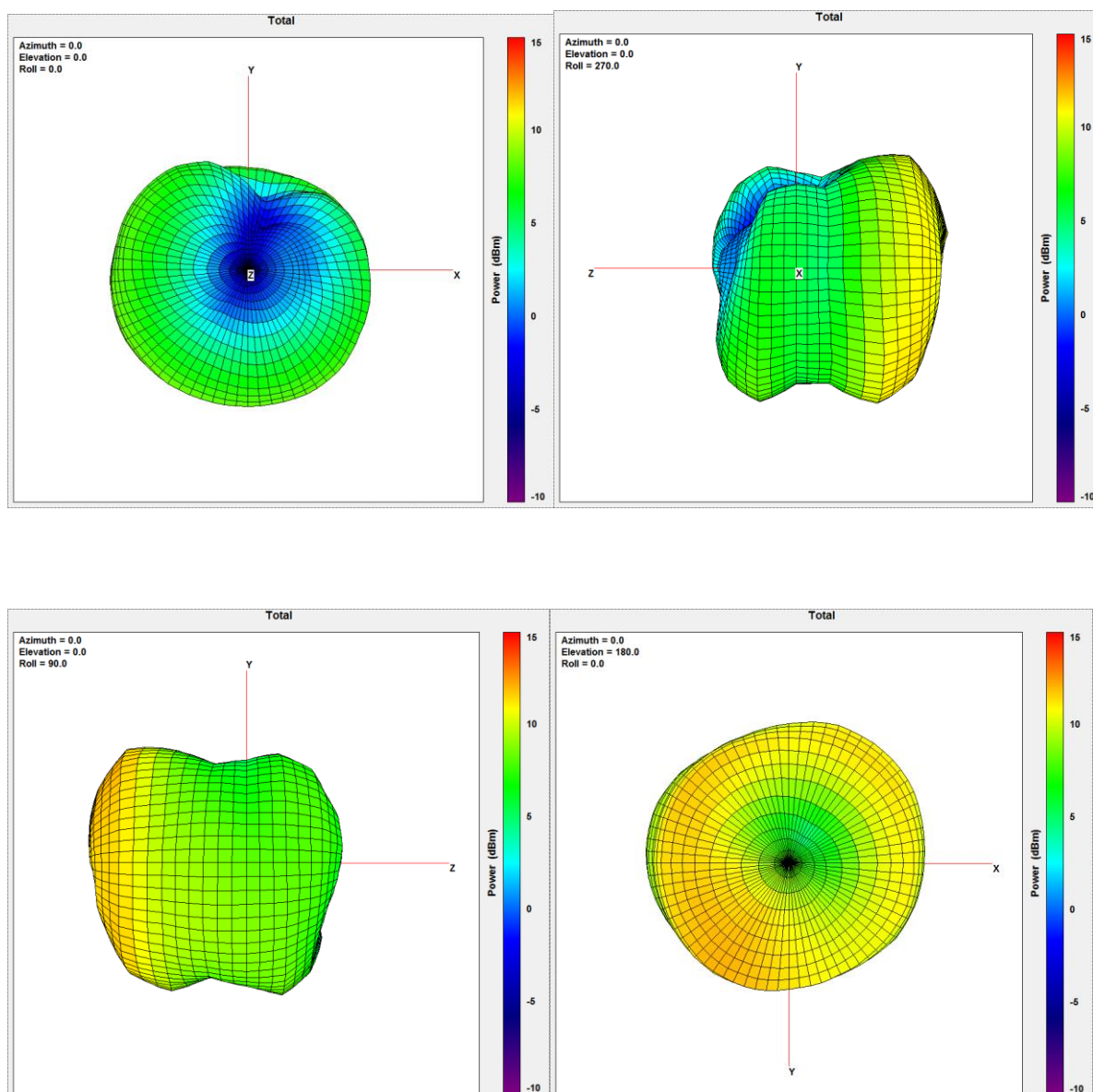
Channel 20, 2450MHz, JN5169 TRP



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Channel 25, 2475MHz, JN5169 TRP

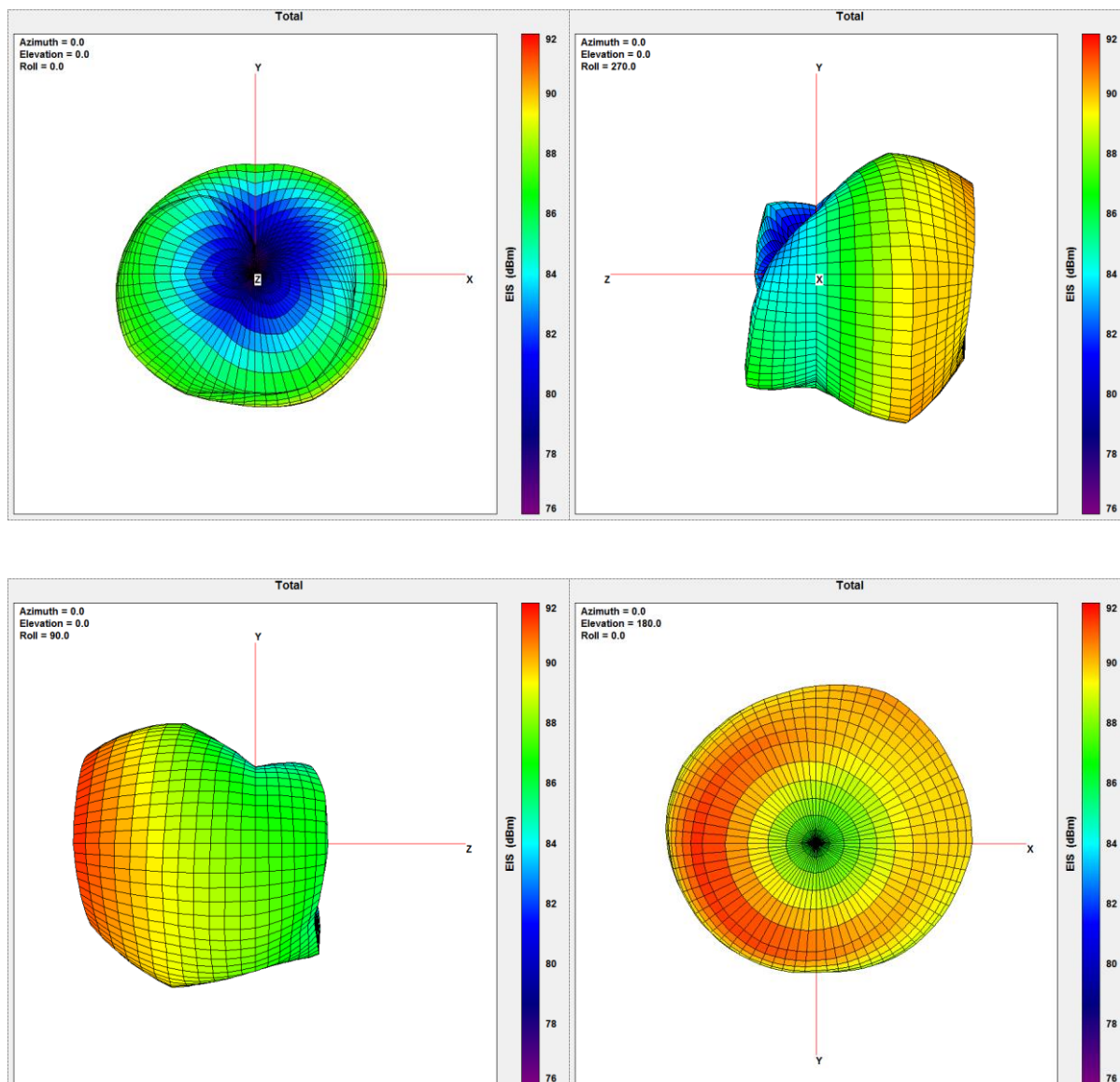


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ANNEX B – JN5169 Total Isotropic Sensitivity

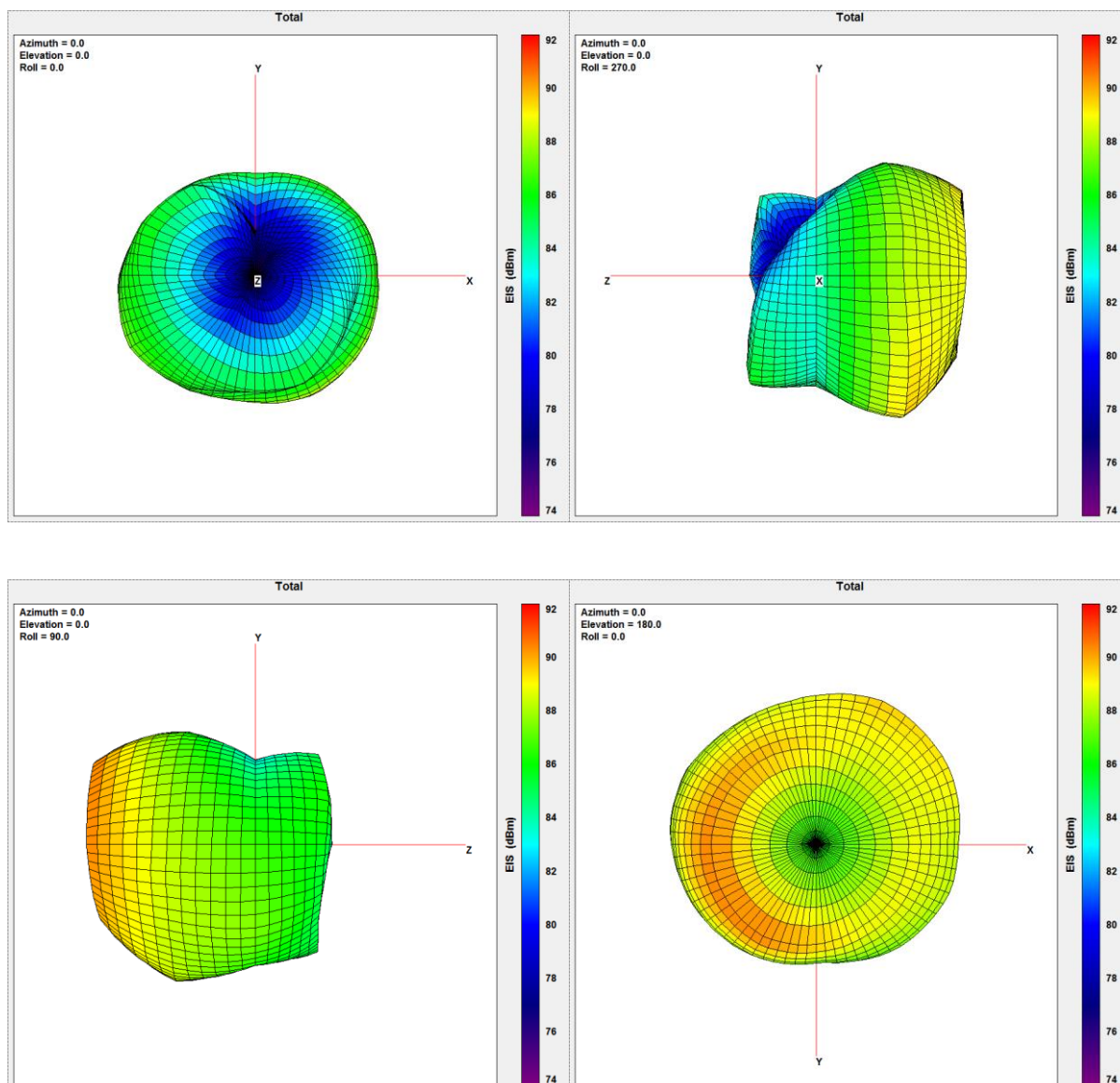
Channel 15, 2425MHz, JN5169 TIS



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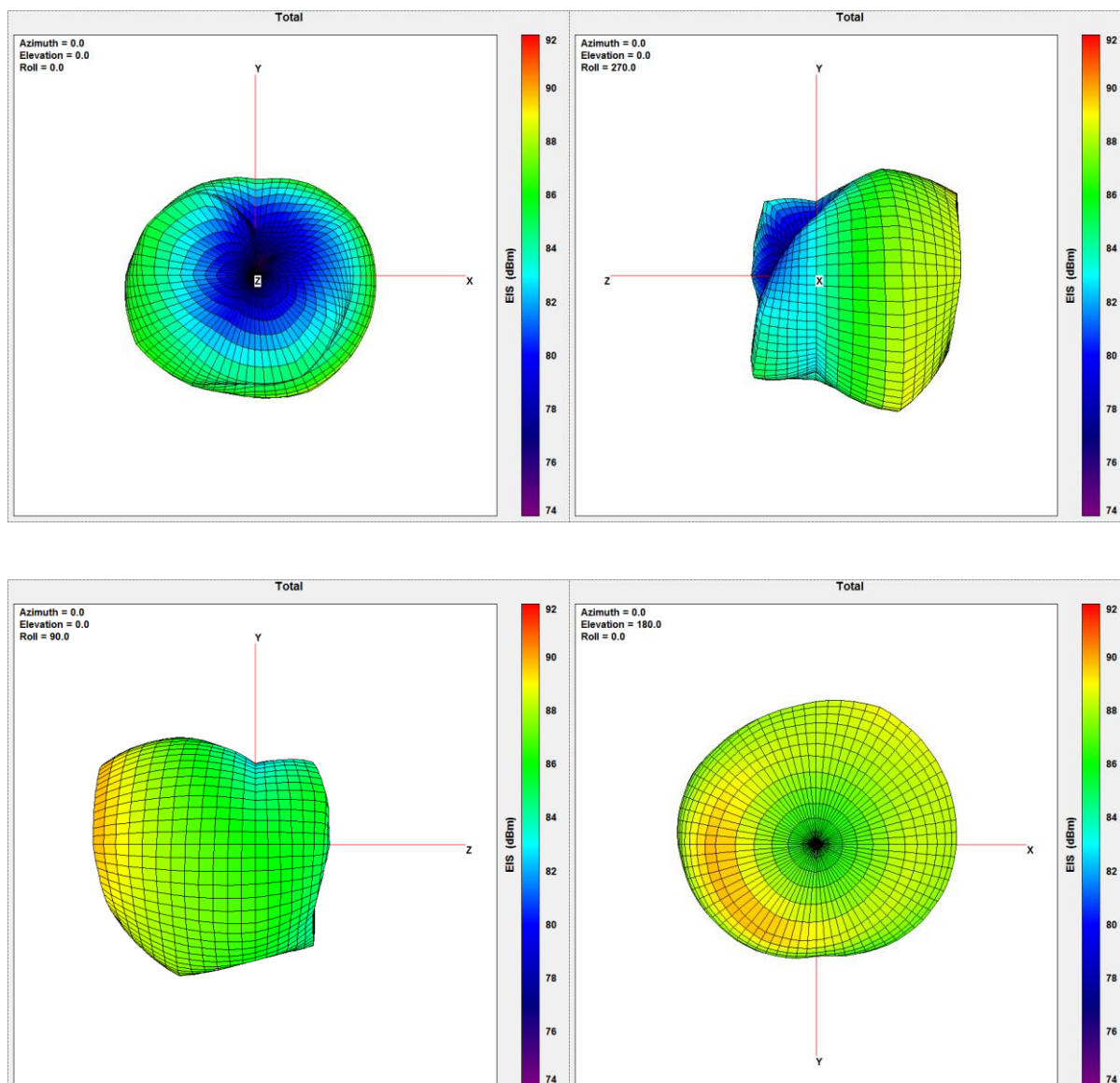
Channel 19,2445MHz, JN5169 TIS



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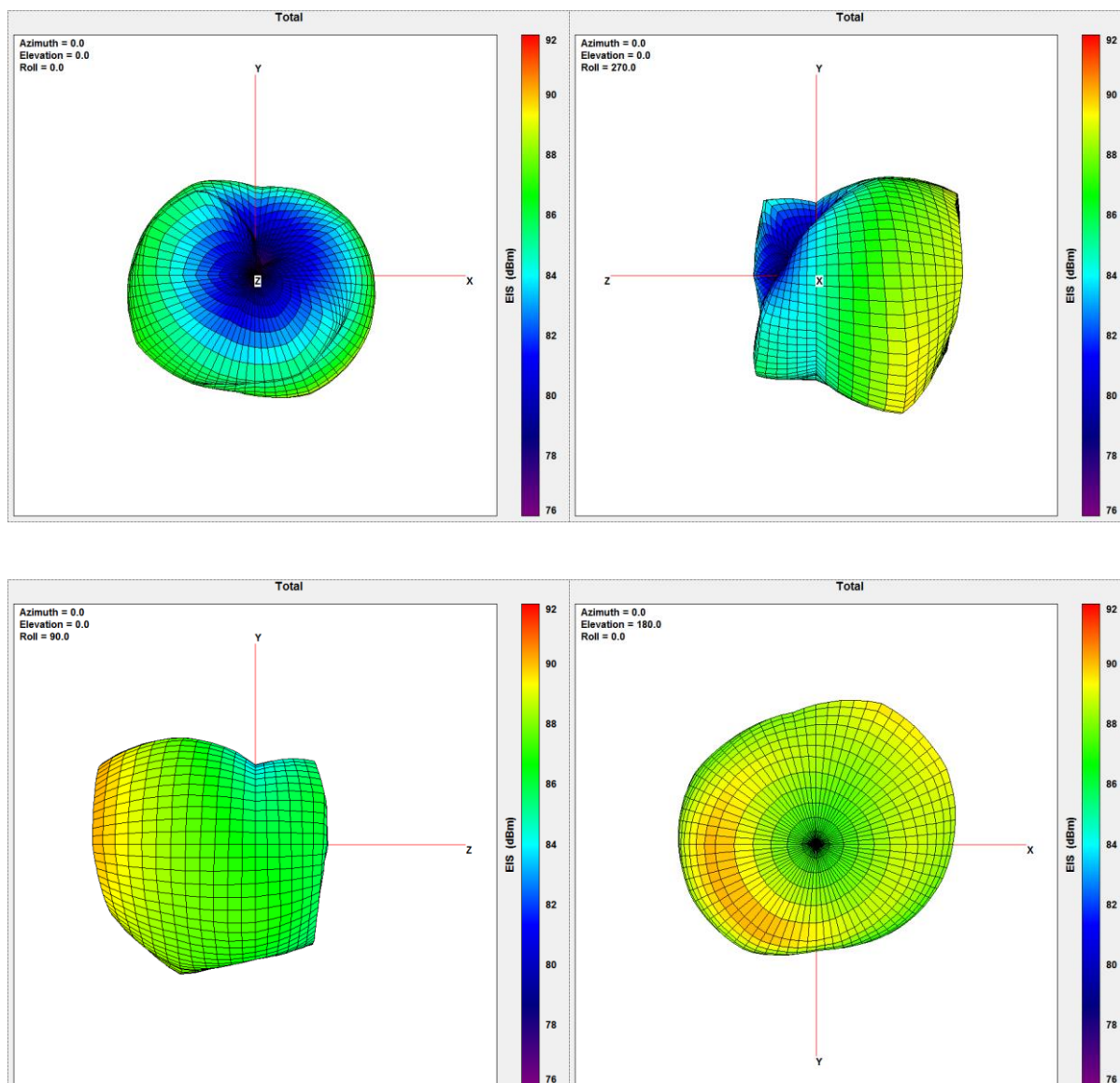
Channel 20, 2450MHz, JN5169 TIS



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Channel 25, 2475MHz, JN5169 TIS



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6. Abbreviations

Table 3. Abbreviations

Acronym	Description
EMC	Electro Magnetic Compatibility
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
PAN	Personal Area Network
PCB	Printed Circuit Board
RF	Radio Frequency
SPI-bus	Serial Peripheral Interface-bus
TQFN	Thin Quad Flat No-lead
WPAN	Wireless Personal Area Network

7. References

JN5189 Datasheet – IEEE 802.15.4 Wireless Microcontroller

K32W Datasheet – IEEE 802.15.4 and BLE 5.0 Wireless Microcontroller

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