External Antenna Gain Information
Model: INFO3.5 CSM MY20

GIS-770 Dual Band Antenna Requirements Specification

This specification defines the requirements for a standalone passive Wi-Fi dual band (2.4 and 5 GHz) antenna module. It is composed of the following parts:

- Module and Installation Requirements
- RF Characteristics

Document Owner Info

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Document References

This section defines reference documents that apply in whole or in part to this specification:

- GMW16640 – Coaxial cables
- USCAR17
- USCAR18
- GMW3172 – Component level validation
- GMW16261- High Frequency (≥ 450 MHz) Antenna Gain, Directionality, and Impedance Test

GIS-770-1000 Module Installation and Validation Requirements

This section defines the module level requirements and details the installation environment and its implications.

GIS-770-1100 Module Structure

The dual band antenna module should comply with the following:

GIS-770-1110 Dimensions

The module dimensions shall not exceed 30X30X48.5 mm (Length X Width X Height) not including mounting provisions.

Antenna module design shall follow Figure 1 (final design shall be approved by GM).

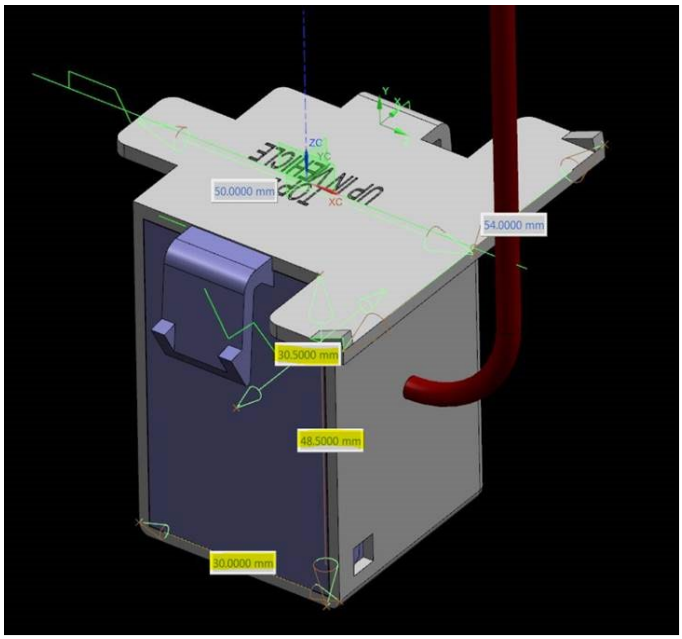

Figure 1: Antenna module.

GIS-770-1120 Coaxial Cable and Connector

The module shall have a coaxial cable in accordance with GMW16640 with a USCAR approved Fakra male connector Beige code I at the end.

GIS-770-1130 Module Validation Requirements

The module shall comply with GMW3172 in accordance to the validation requirements.

GIS-770-1200 Installation Requirements

GIS-770-1210 Installation Location

The dual band antenna module shall be designed to be installed within the dashboard area close to the surface in broad range of vehicles, and in a manner that mitigates the difference in the vehicles structure and exact installation location. GM requires the antenna to maintain performance and dimensions/size in various integration locations which are program dependent. The supplier will work with GM to optimize the antenna to address this requirement

GIS-770-1220 Diagnostics Capability

To ensure compatibility of the associated transceiver's built-in antenna connection diagnostics, the antenna port shall present a DC resistance of no less than 6 kΩ and no more than 10 kΩ and typical 9.1kΩ at the output of the antenna coaxial lead-in. The input resistance is a KPC and shall be noted as such on the part drawing.

GIS-770-2000 RF Characteristics

The dual band antenna Module shall support the following RF requirements.

GIS-770-2100 Frequency Range

The dual band antenna module shall support the 2.4 GHz Wi-Fi and Bluetooth frequency range, and 5GHz Wi-Fi frequency range, as detailed in the table below.

RF Band Identification	Start Frequency	Stop Frequency	Center Frequency
IEEE 802.11 (2.4 GHz)	2.400 GHz	2.497 GHZ	2.44 GHz
IEEE 802.11 (5 GHz)	5.15 GHz	5.85 GHz	5.5 GHz

Table 1 Antenna Frequency Range

GIS-770-2200 Impedance

The measurements in this section shall be taken in free space.

The dual band antenna module nominal impedance shall be 50 Ohms.

Impedance measurements shall be made using a 50 ohm reference load using properly calibrated test equipment and measured at the connector per corresponding GMW document.

GIS-770-2300 VSWR

The measurements in this section shall be taken in free space.

The following VSWR requirements shall be met at the 2.4GHz and 5GHz bands. **Minimum Roll Off** offset is defined as 100MHz for 2.4GHz band and 500MHz for 5GHz band from the band edges, and described in the image below.

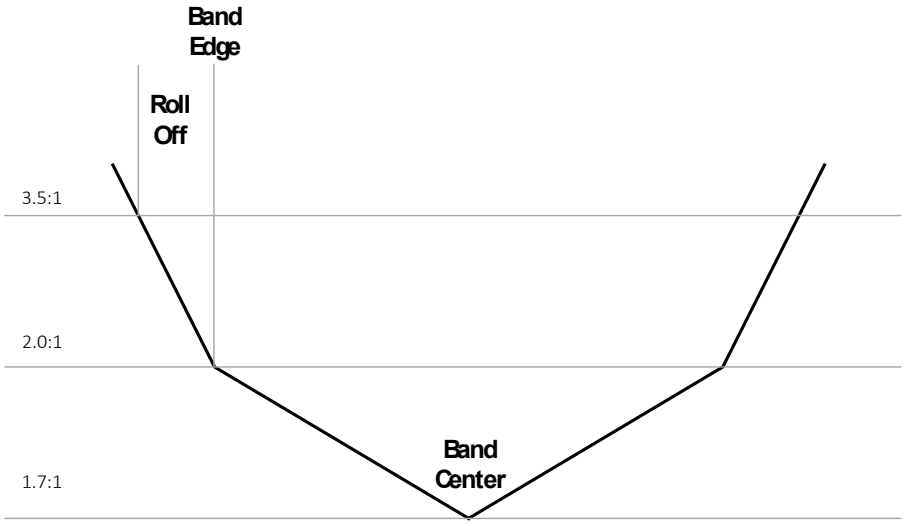

Figure 2 Definitions of band center, band edge and roll-off

	VSWR (50 Ohm)
Center Frequency (Center Frequency given in section GIS-770 2100)	≤ 1.7:1
Band Edges (Start &Stop Frequencies given in section GIS-770 2100)	≤ 2:1
Minimum Roll Off (defined above)*	≥ 3.5:1

Table 2 Antenna VSVW Requirements

Note*: Roll-off requirements are guidelines

VSWR measurements shall be made using a 50 ohm reference load using properly calibrated test equipment per corresponding GMW document.

GIS-770-2500 Detuning Study

The antenna supplier shall perform an antenna impedance detuning study against metal (conductive) and plastic (non-conductive) material from all sides of the antenna that mainly targets gain and its directionality variations. The antenna housing shall be included as part of the study from where the clearance distance starts. This study will help determine the in-vehicle clearance distance required to keep the return loss (S11) equal to or greater than -10dB. This requirement applies to the dual Wi-Fi antenna bandwidth for both low (2.4GHz) and high (5GHz) bands. The antenna supplier shall deliver the final antenna clearance figures to GM either along with simulation or measurement results. This study shall take into account material properties such as conductivity and permeability of the metal around the housing and permittivity of the plastic housing

GIS-770-2600 Free Space Antenna Gain

Measurement set-up:

Refer to the following set-up for free space antenna gain measurements. The measurements in this section shall be taken in free space. The antenna in the housing shall be installed on a pedestal on a non-conducting surface as can be seen in the following picture where the pigtail aligns with azimuth angle 180 ˚. The antenna pig-tail losses shall be accounted for and the measurements shall reflect the performance at the feed point of the antenna.

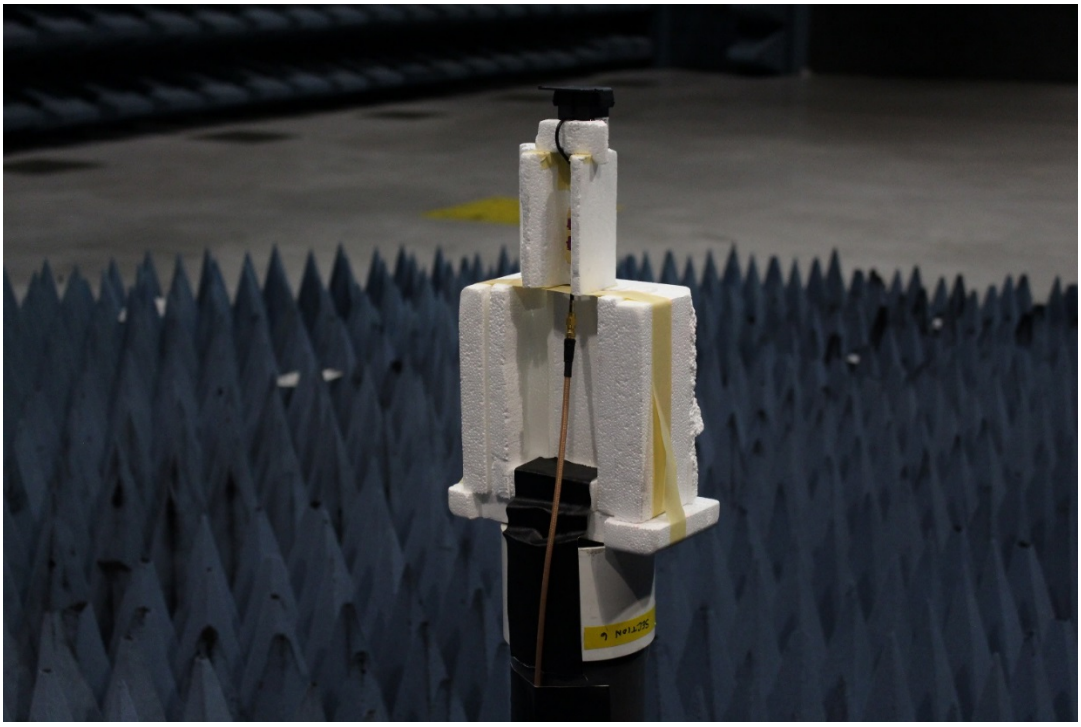

Figure 3 Free space gain measurement setup

The dual band antenna module shall have omnidirectional type pattern in free space, with linear average gain value of at least +1.0 dBi (in 2.4GHz frequency band) +0dBi (in 5GHz frequency band) when measured with complete antenna housing at the elevation angles of 55˚-90˚ (antenna level/horizon) level and in granularity of 1˚ from 0˚ in azimuth angles (module front) to 359˚ per GMW16261.

Measurements shall be conducted in the following frequencies for free space gain at the end of antenna pigtail:

- For 2.4GHz – 2.412 GHz, 2.427 GHz, 2.437 GHz, 2.462 GHz, 2.472 GHz
- For 5GHz – 5.155 GHz, 5.325 GHz, 5.5 GHz, 5.675 GHz, 5.85 GHz

Any deviation requested by the supplier shall need to be approved by GM.

GIS-770-2700 In-Vehicle Subsystem Antenna Requirements

The dual band Wi-Fi antenna is installed in the Instrument Panel area. Although keep out zones are shared with vehicle teams, the allocated locations could be in violation of these guide lines. In addition, each vehicle platform has different IP with metallic structures around the dual band antenna causing reflections impacting its radiation pattern. Consequently, unlike the roof top antennas, it becomes impossible to come up with standalone in-vehicle antenna performance in terms of antenna gain for varying elevation angles. In order to overcome this restriction, a subsystem level specification shall be employed.

The test set-up shall be such that the dual band Wi-Fi antenna is installed in its production intent location in the vehicle which is customer deliverable condition. The production intent Wi-Fi modem shall be used. The feature level requirements defined in GIS 331 and Provide Internet access FTS.

The system level requirements are as follows:

a) Wi-Fi module shall have a TCP/IP throughput of greater than 30 Mbps at 100 m in the 20 MHz BW in the 2.4 GHz band through use of external Wi-Fi antenna.

b) Wi-Fi module should have a TCP/IP throughput of greater than 10 Mbps at 100 m in the 40 MHz BW in the 5 GHz U-NII 1 band.

These requirements shall be met at four azimuth angles at 0, 90, 180, 270 for the elevation angle range 55-90 degrees using channel 6 in 2.4 GHz and channels 44 and 48 for 5GHz.

Starting MY22, another use case brings modification to the above requirement while a) and b) still remains active.

c) Wi-Fi module shall have a TCP/IP throughput of greater than 30 Mbps at 10 m in the 20 MHz BW in the 2.4 GHz band through use of external Wi-Fi antenna.
d) Wi-Fi module should have a TCP/IP throughput of greater than 10 Mbps at 10 m in the 40 MHz BW in the 5 GHz U-NII 1 band.

These requirements shall be met at four azimuth angles at 0, 90, 180 and 270 degrees for the elevation angle range 0-20 using channel 6 in 2.4 GHz and for channels 44 and 48 for 5GHz.

Refer to GMW document that reflects the system level tests in order to assess the requirements given above.

Vehicle level antenna gain measurements for the above requirements shall be measured as data collection exercise and for correlation purposes.

GIS-770-2800 Antenna Efficiency

All antenna element efficiency measurements shall be made with the complete antenna housing for free space measurements as was outlined before.

The antenna efficiency ε_R shall be calculated using the general model given below with $P_{radiated}$ calculated for the total hemisphere of the antenna only. P_{input} is the input power to the antenna.

$$\varepsilon_R = \frac{P_{radiated}}{P_{input}}$$

The dual band antenna module shall have minimum radiation efficiency of 65% across 2.4GHz frequency band and a minimum efficiency of 60% across the 5GHz frequency band.

Revision Log

Revision	ROIN	Change	Author	Date
1.0		Initial release	Nadav Lavi	3/30/2016
1.3		Change Package dimensions and LAG values	Eray Yasan	8/29/2016
1.5	All	Revised free space gains, subsystem level performance	Eray Yasan	5/22/2017
1.6	All	Detune study in vehicle, 5 GHz band frequency changes	Eray Yasan	5/29/2017
1.7	All	VSWR/return loss line up, PV replaced by DV, removed return loss	Eray Yasan	10/13/2017
1.8	All	VSWR center value change, roll-off as guideline, removal of DV sample, more info on detuning	Eray Yasan	12/15/2017
1.9	All	Details on azimuth, elevation angles, test channels, new use case requirements	Eray Yasan	9/19/2018