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Datasheet

Multi-Band GNSS Front End Module covering L1+B1+G1/L2/L5/L6+L-band

Part No:
TFM.120A

Description

Surface mount GNSS front-end module covering L1+B1+G1/L2/L5/L6+L-band

Features:

Two-stage LNA providing >25 dB Gain across all bands

Low Noise Figure: <3.25 dB in low bands and <3.0 dB in high bands

Vin = +1.8 to +5.5 VDC

Easy to integrate surface-mount

Dimensions: 25mm x 25mm x 4.75mm

RoHS & Reach Compliant

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Taiwan ISO 9001:2015 Certified

IATF16949

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1. Introduction



The Taoglas TFM.120A is a surface-mount Multi-Band GNSS front-end which covers L1+B1+G1/L2/L5/L6+L-band for high-precision applications that require the full spectrum of GNSS constellations. The TFM.120A is a dual input single output and features a SAW/LNA/SAW/LNA topology in both the low and high band signal paths to prevent unwanted out-of-band interference from overdriving the GNSS LNAs or receiver. The SAW filters have been carefully selected and placed to provide excellent out-of-band rejection while also maintaining low noise figure.

Many currently available dual-band GNSS receivers require additional RF circuits between the antenna and the receiver to properly set the overall system noise figure. This requires additional development time for an otherwise simple module integration. Many organizations don't have the RF expertise to effectively design such a solution. The TFM.120A captures the required additional RF circuits in modular form, allowing the designer to simply place the TFM.120A between their GNSS antenna and GNSS receiver.

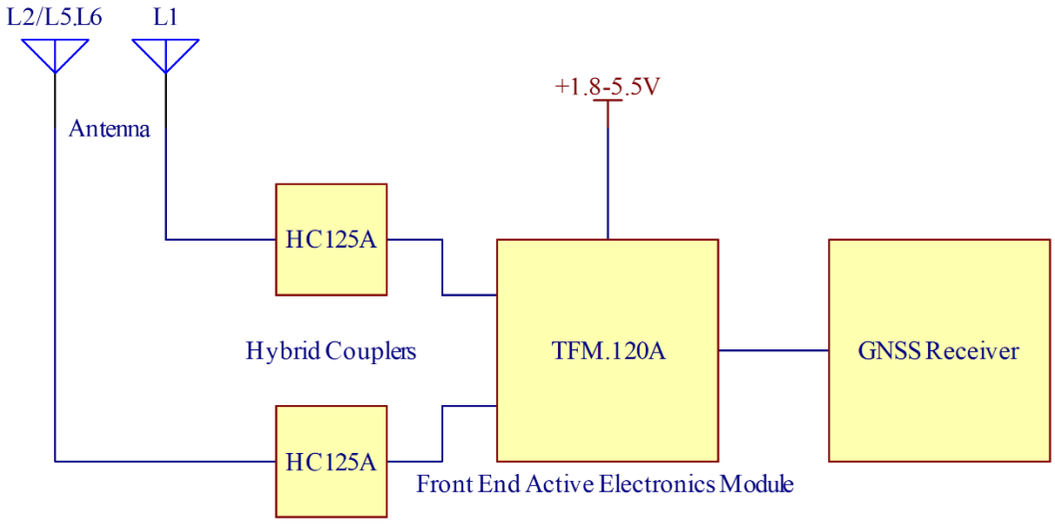
The TFM.120 offers > 25 dB gain across all applicable bands while maintaining a high Input P1dB of -25 dBm or better. Noise Figure is < 3.5 dB in the low bands and < 4.0 dB in the high bands. A wide input voltage of +1.8 to +5.5 VDC allows for easy integration in most GNSS systems.

TFM.120A Features and Benefits:

- Ease-of-integration – Single-package solution combines impedance matching, filter efficiency and low noise design for easy, drop-in use with any antenna or GNSS receiver
- Low-noise System Design – Integrated pre-filters deliver exceptional out-of-band rejection across multiple band configurations and neighboring interference to properly set noise figure
- Dual-gain Stage Architecture – Cascaded LNAs, pre-filters and optimized impedance matching deliver sufficient gain to the GNSS receiver without signal-to-noise overload
- Low-profile Form Factor – Small footprint and low-profile design saves valuable real estate without the need for external components and routing
- Accelerated Development Cycles – 2+ years of development by antenna and RF design experts, delivering the highest levels of integration, manufacturability and robustness in a single package

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For further information, please contact your regional Taoglas customer support team.



Block diagram of the integration for the TFM.120A.

We used the GPDF6010.A to demonstrate the integration of this module but please note that we have other compatible antennas that can also be used alongside the TFM.120A please see table below.

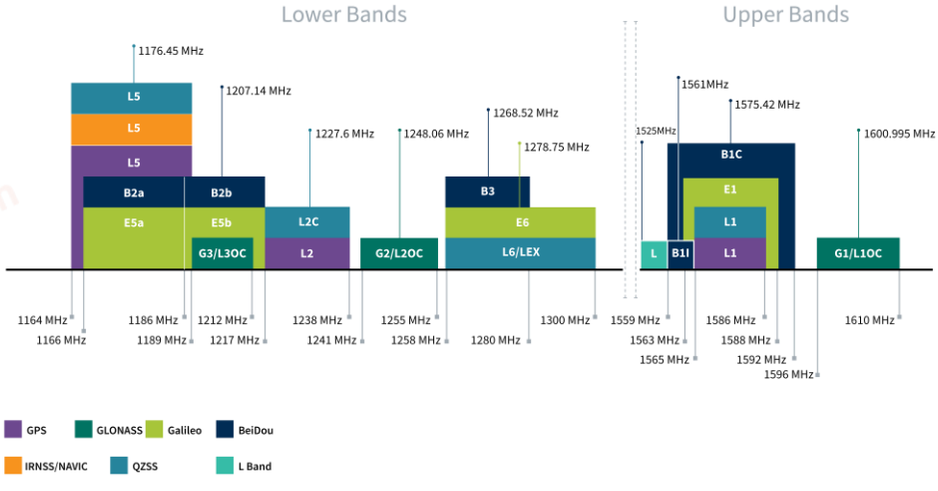
Compatible Antennas
GPDF6010.A
GPDF5012.A
HP24510A
HP54510A

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2. Specification

GNSS Frequency Bands					
GPS	L1 1575.42 MHz	L2 1227.6 MHz	L5 1176.45 MHz		
	■	■	■		
GLONASS	G1 1602 MHz	G2 1248 MHz	G3 1207 MHz		
	■	■	■		
Galileo	E1 1575.24 MHz	E5a 1176.45 MHz	E5b 1201.5 MHz	E6 1278.75 MHz	
	■	■	■	■	
BeiDou	B1C 1575.42 MHz	B1I 1561 MHz	B2a 1176.45 MHz	B2b 1207.14 MHz	B3 1268.52 MHz
	■	■	■	■	■
L-Band	L-Band 1542 MHz				
	■				
QZSS (Regional)	L1 1575.42 MHz	L2C 1227.6 MHz	L5 1176.45 MHz	L6 1278.75e6	
	■	■	■	■	
IRNSS (Regional)	L5 1176.45 MHz				
	■				
SBAS	L1/E1/B1 1575.42 MHz	L5/B2a/E5a 1176.45 MHz	G1 1602 MHz	G2 1248 MHz	G3 1207 MHz
	■	■	■	■	■



GNSS Bands and Constellations

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Electrical								
Frequency (MHz)	**1176**	**1207**	**1227**	**1248**	**1278**	**1559**	**1575.42**	**1603**
Noise Figure (dB)*	2.71	2.15	1.93	2.03	2.17	2.31	2.21	2.21
Gain (dB)	28.09	28.34	28.81	28.72	28.38	26.84	26.83	25.78
Group Delay (ns)	10.95	8.61	8.54	7.96	8.03	8.62	8.98	9.78
Input P1dB (dBm)	-30.7	-29.2	-27.7	-27.2	-26.5	-24.3	-24.1	-23.1
Input Return Loss (dB)	-16.33	-8.74	-14.02	-18.29	-18.23	-19.60	-21.56	-11.11
Output Return Loss	-7.79	-8.70	-10.15	-10.13	-11.84	-28.36	-25.57	-27.61
Vin	+1.8 to +5.5 VDC							
Typical Current (@1.8V)	7.5 – 9.0mA							

***Note: Tested on an evaluation board. Board losses removed.**

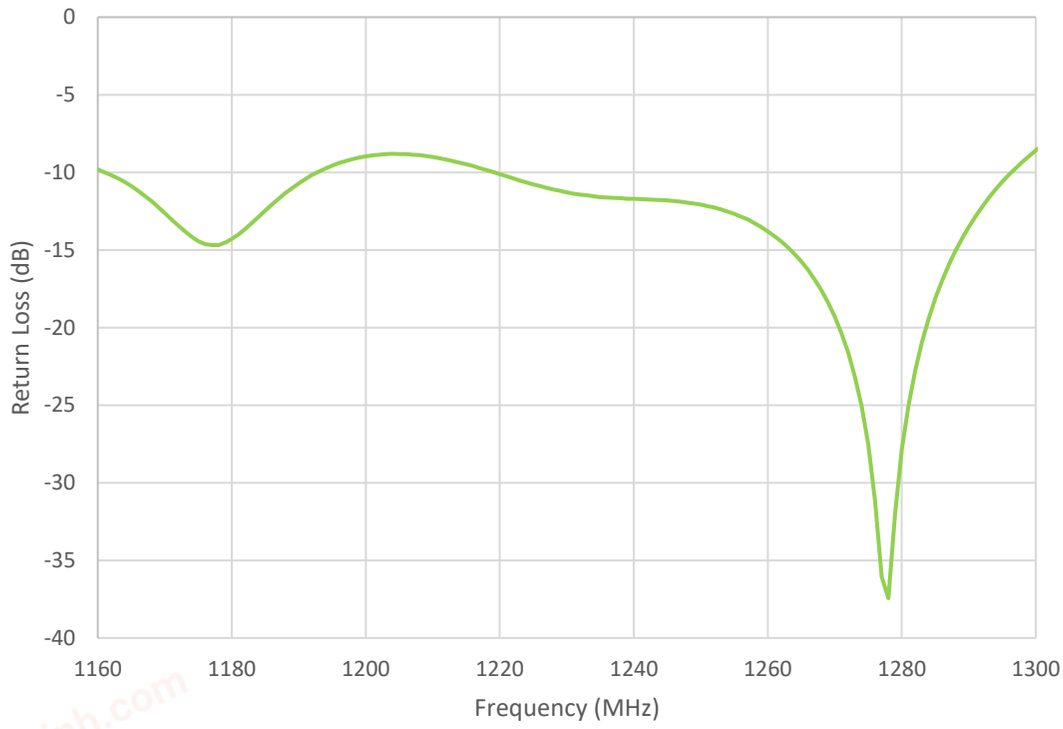
Mechanical	
Height	2.75 mm max.
Planar Dimension	25 mm x 25 mm
Weight	2g

Environmental	
Temperature Range	-40°C to 85°C
RoHS Compliant	Yes
REACH Compliant	Yes
Moisture Sensitivity Level (MSL)	3

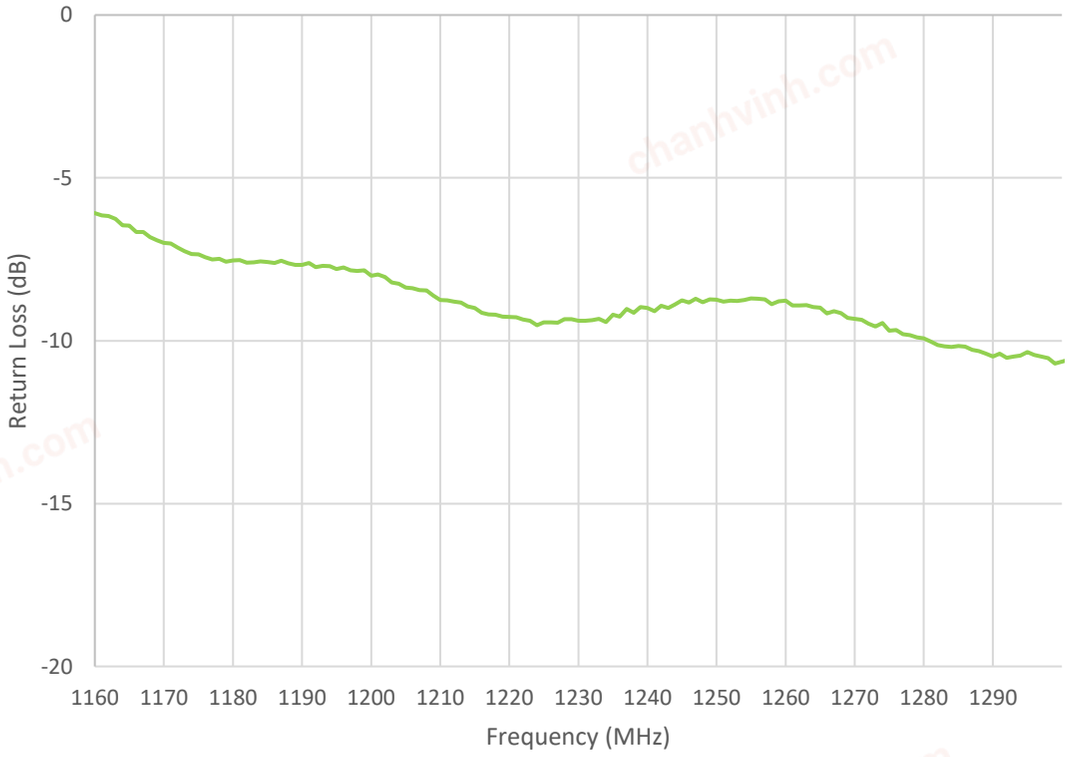
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3. FEM Low Band Characteristics

3.1 Low Band Input Return Loss

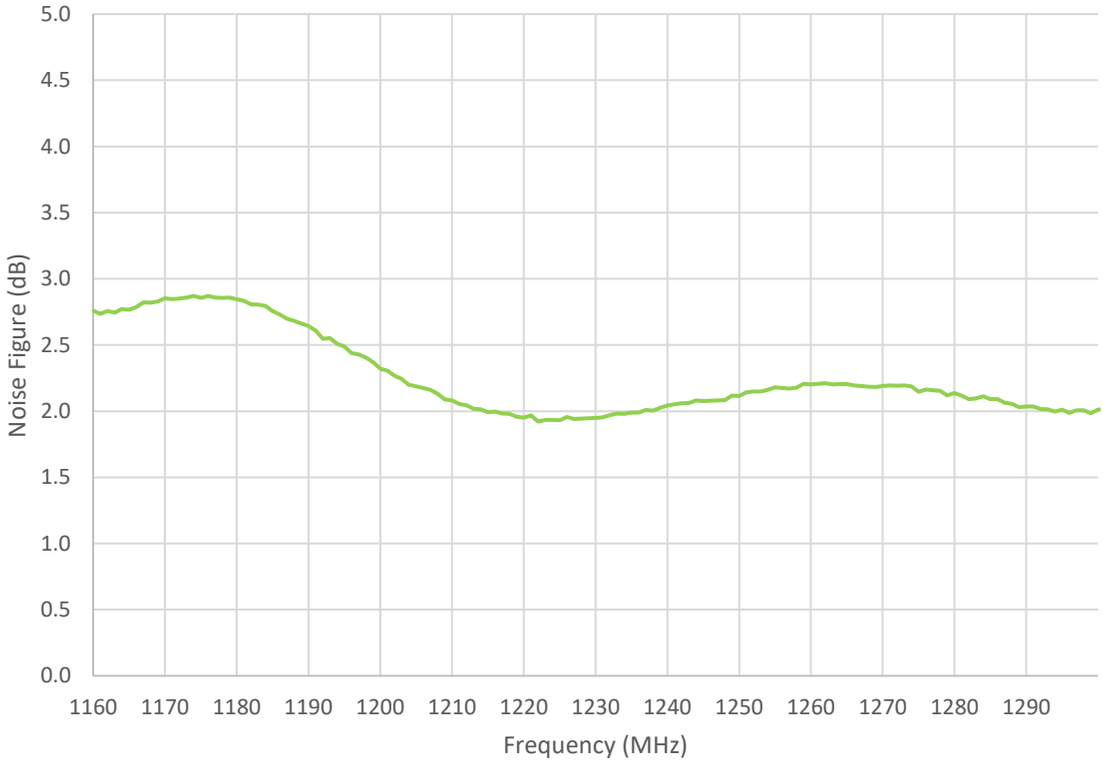


3.2 Low Band Output Return Loss

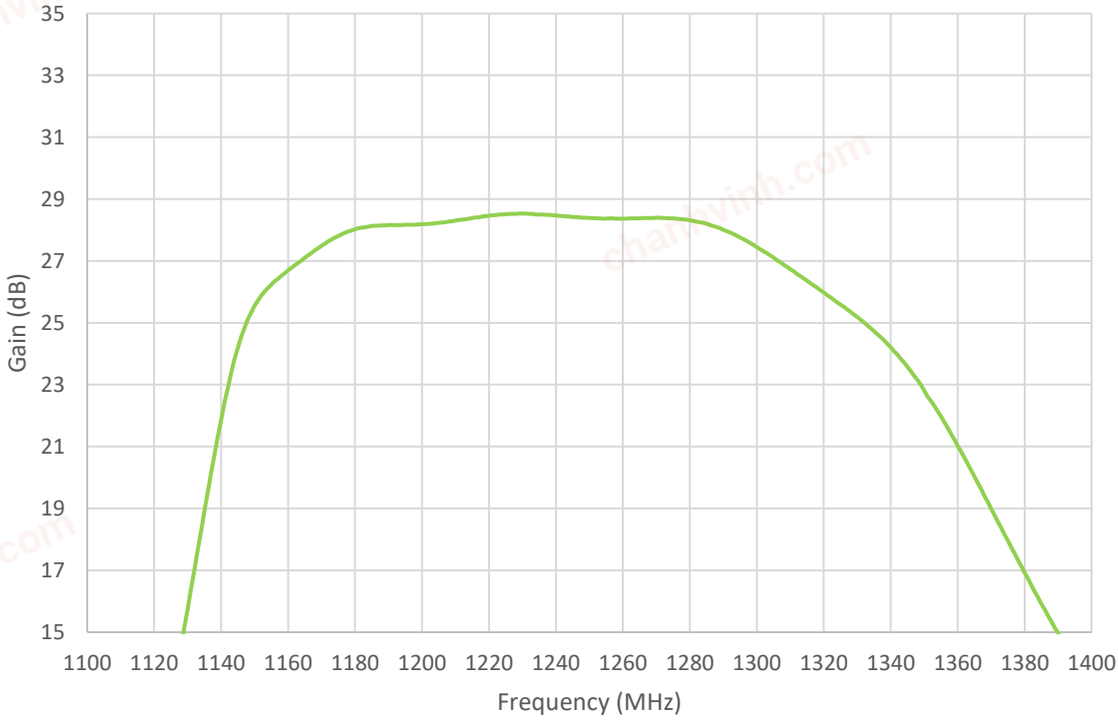


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3.3 Low Band Noise Figure

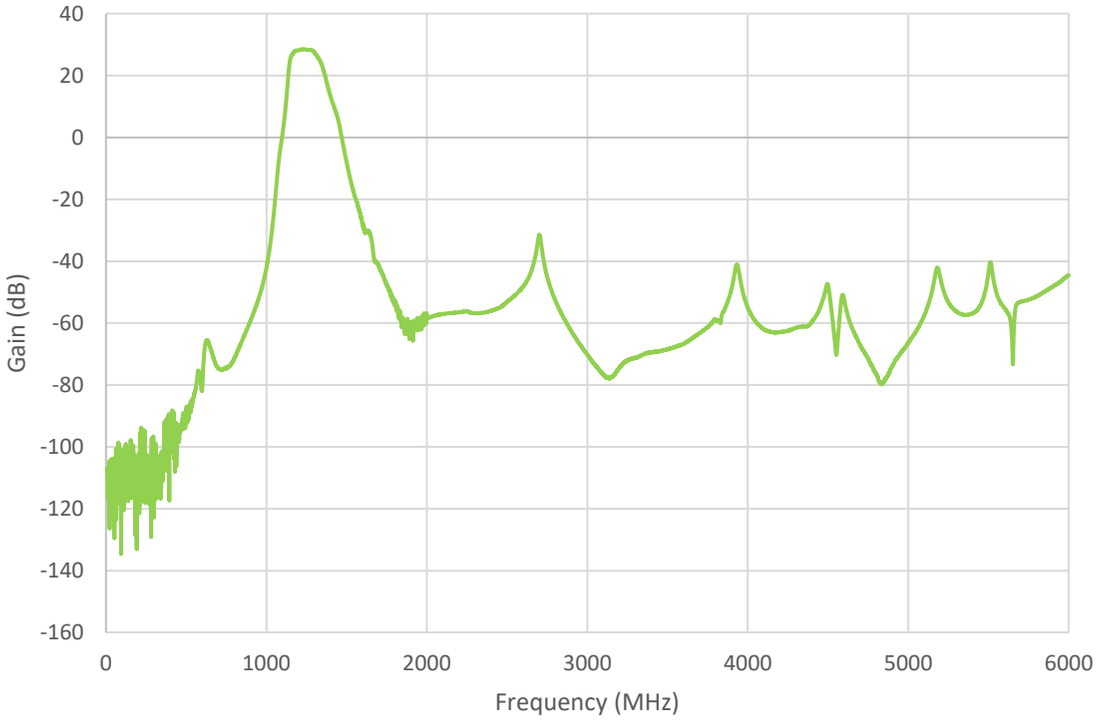


3.4 Low Band Gain

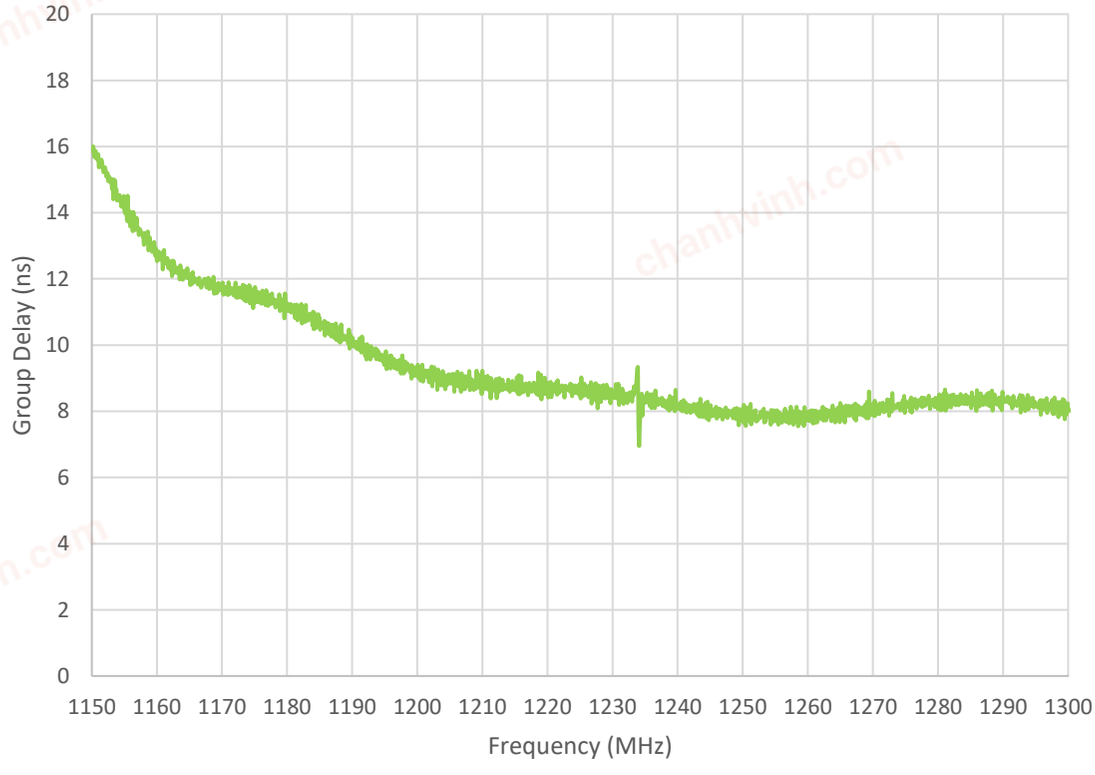


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3.5 Low Band Gain and Attenuation



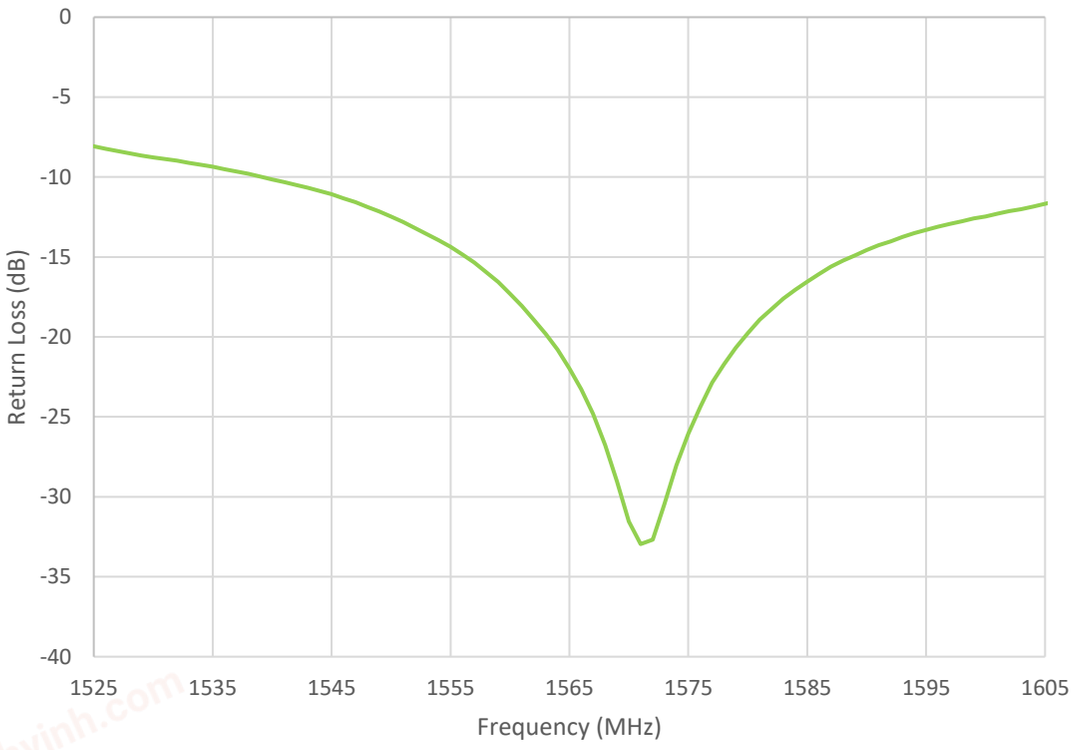
3.6 Low Band Group Delay



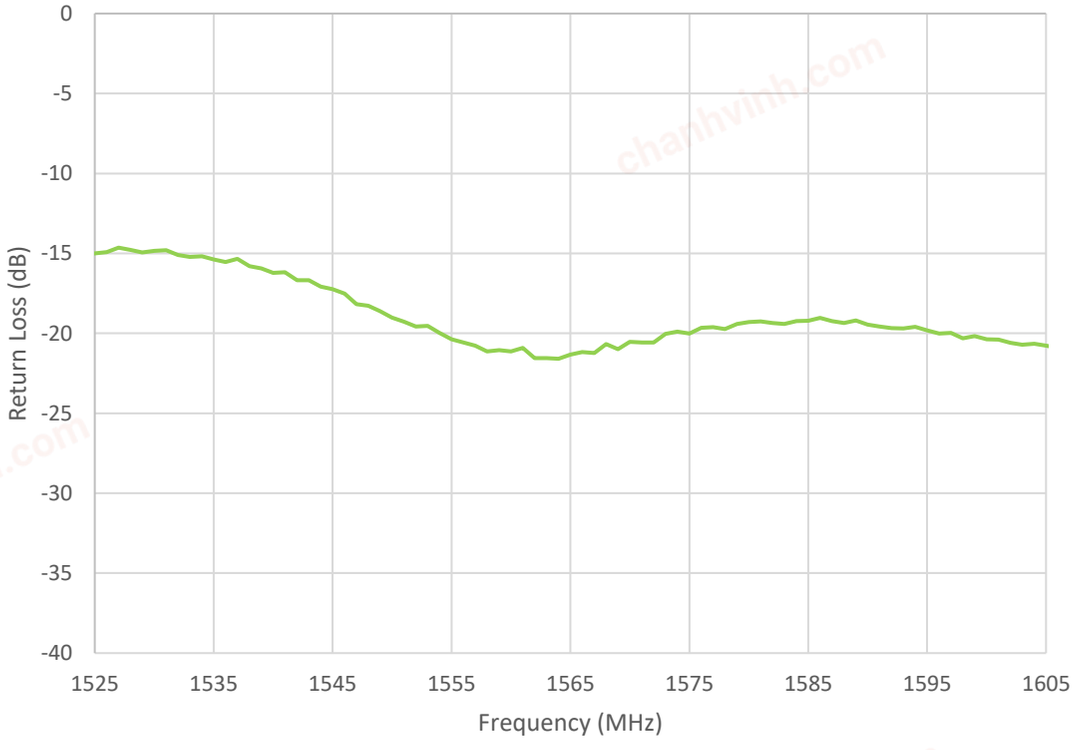
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4. FEM High Band Characteristics

4.1 High Band Input Return Loss

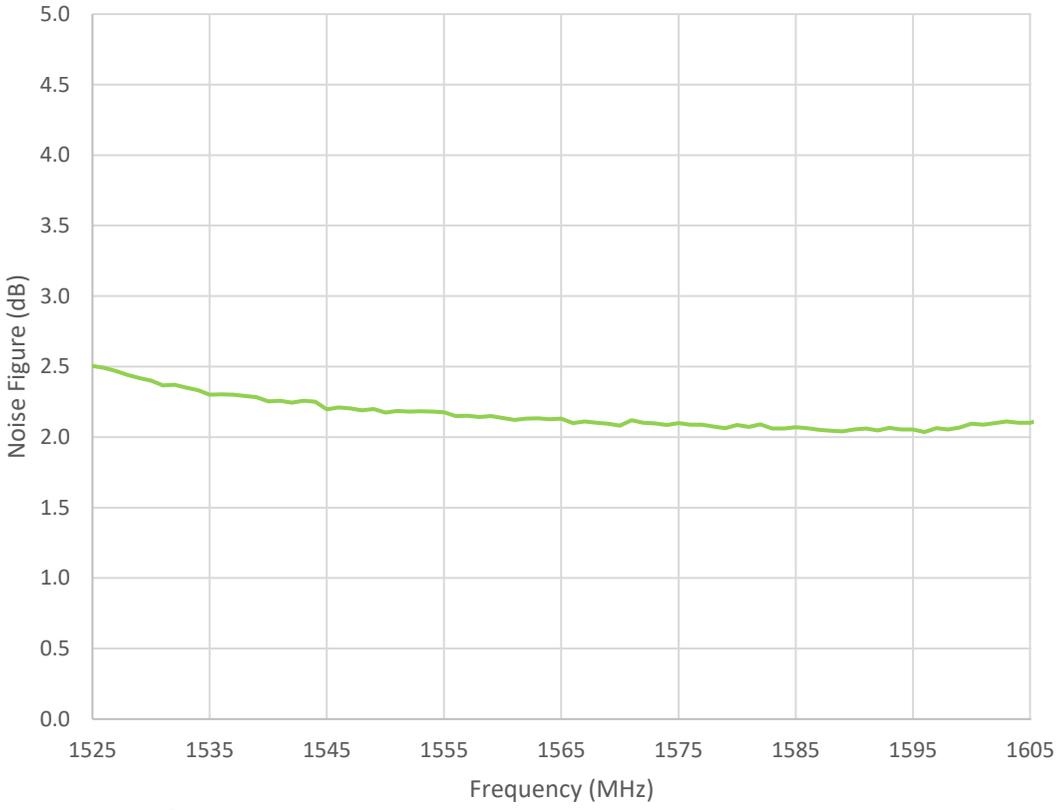


4.2 High Band Output Return Loss

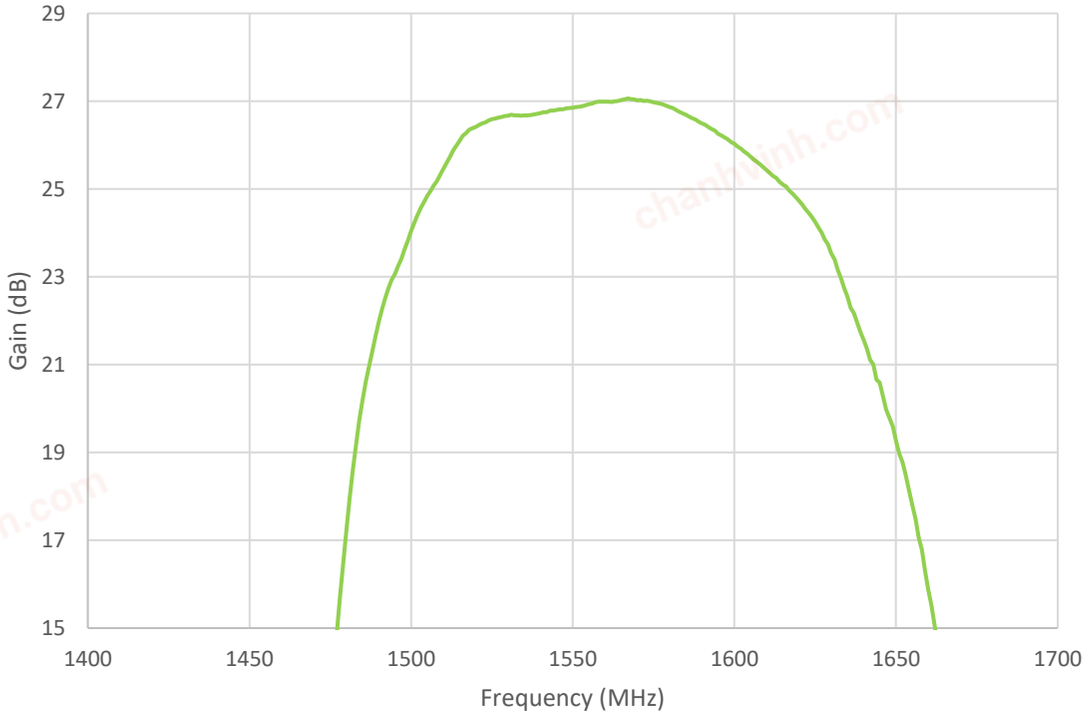


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4.3 High Band Noise Figure

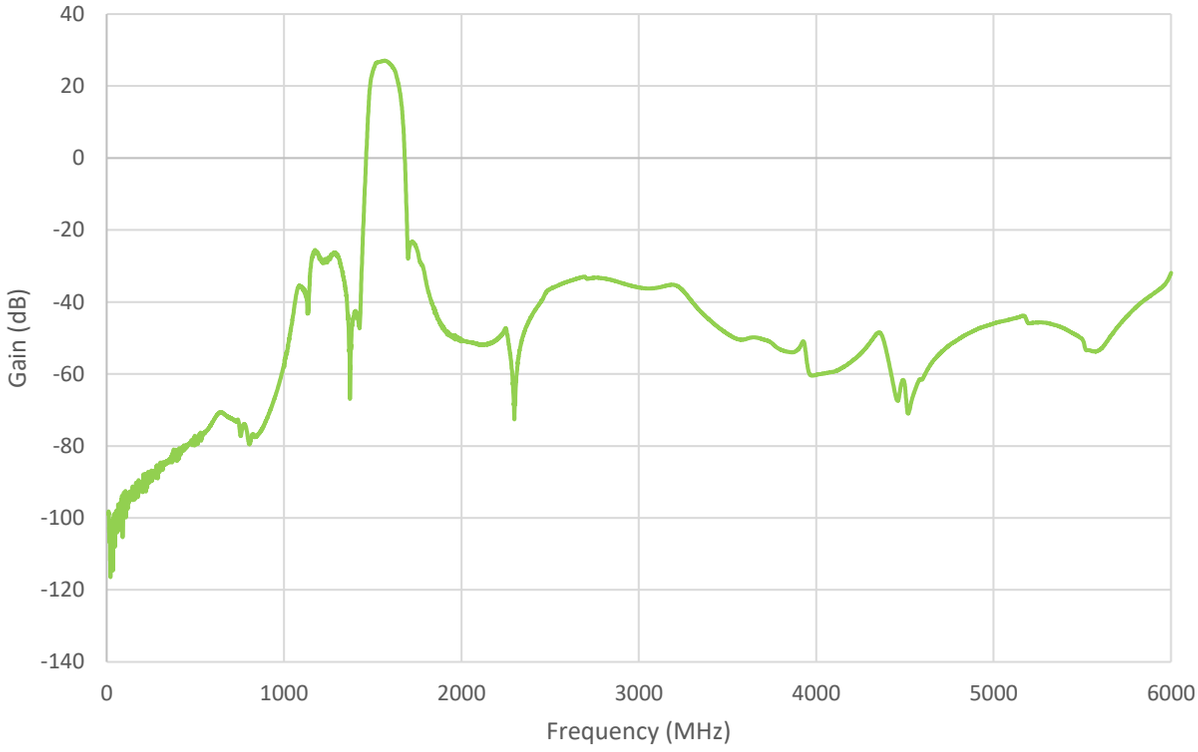


4.4 High Band Gain

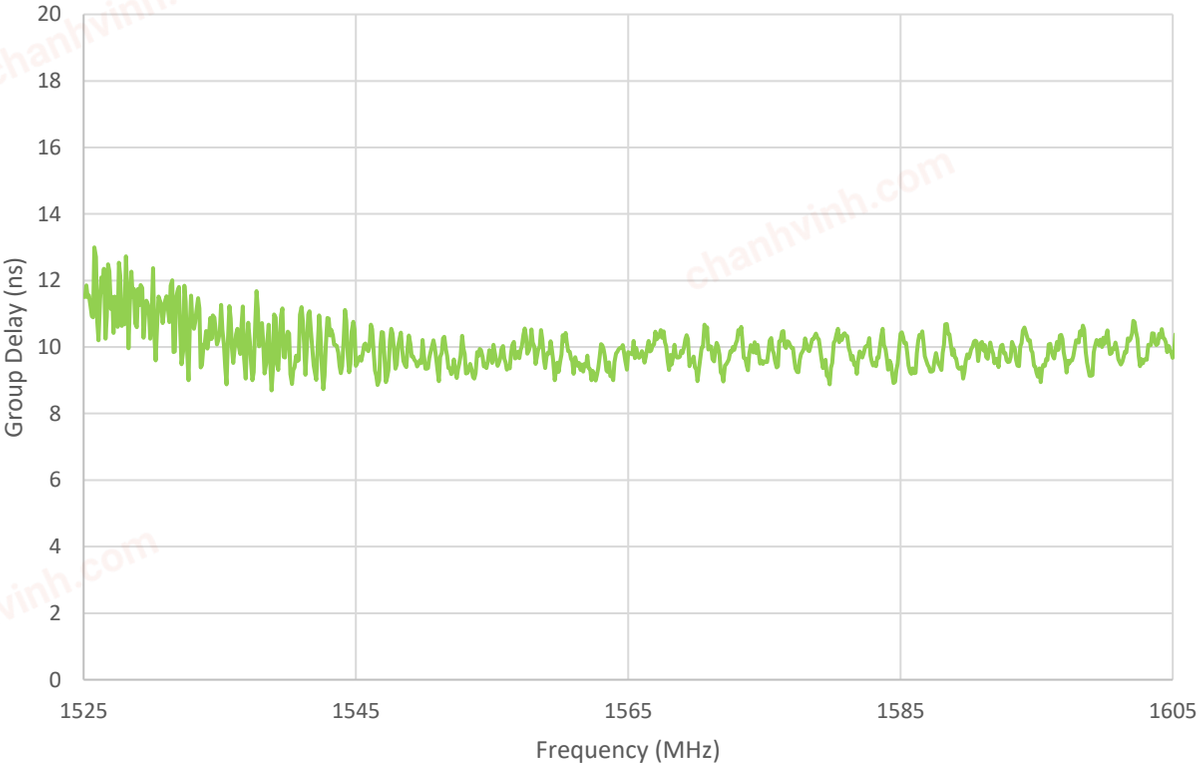


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4.5 High Band Gain and Attenuation

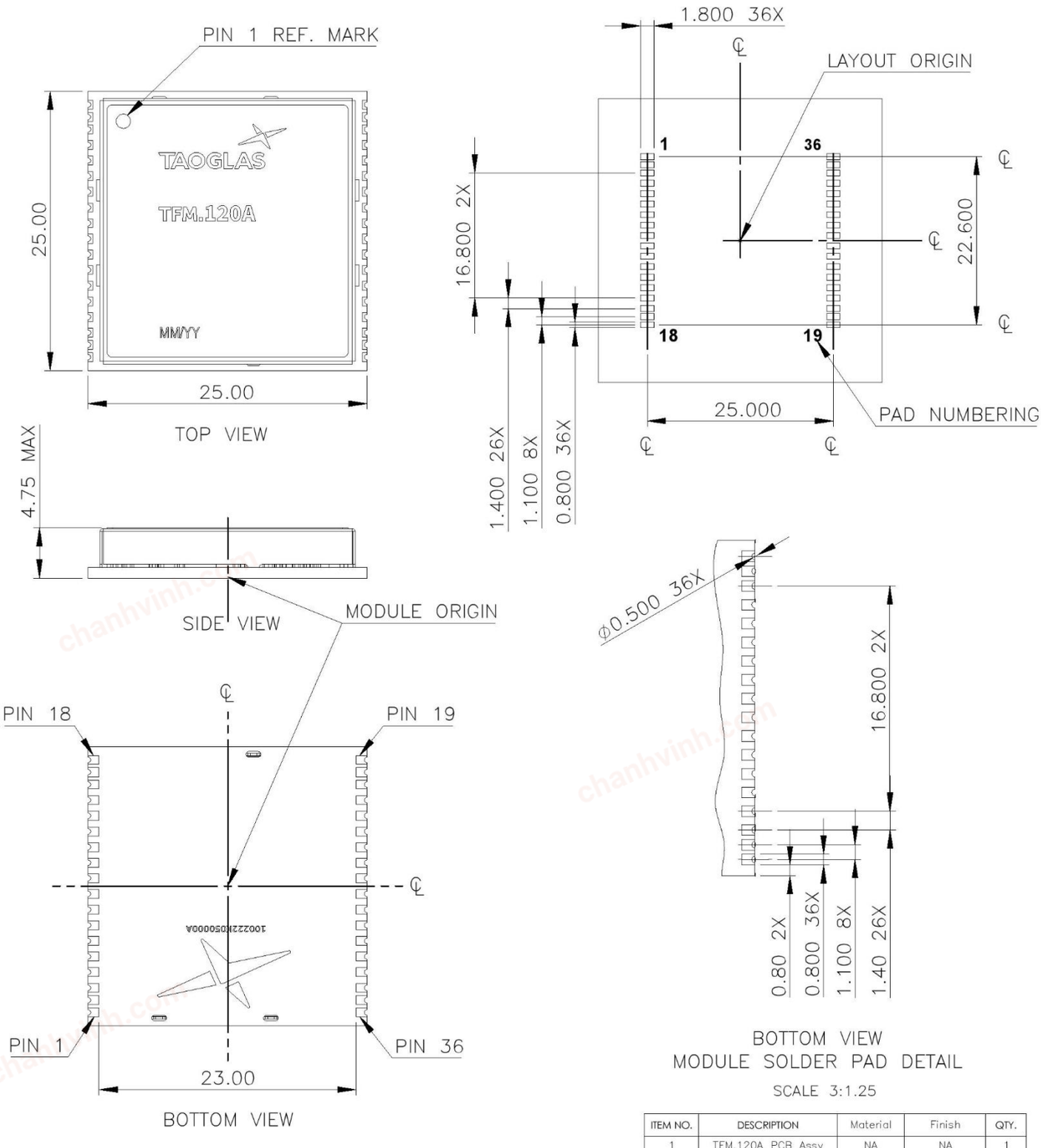


4.6 High Band Group Delay



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5. Mechanical Drawing

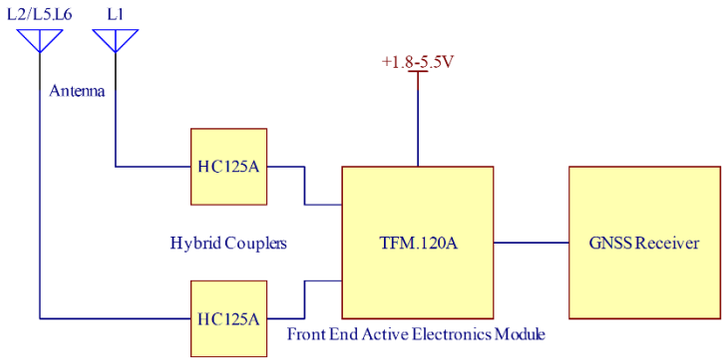


ITEM NO.	DESCRIPTION	Material	Finish	QTY.
1	TFM.120A PCB Assy	NA	NA	1
2	TFM.120A Cover	Steel	Tin plated	1
3	TFM.120A Label	Polyimide	Glossy White	1

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6. Module Integration

The following is an example on how to integrate the TFM.120A into a design. In this example, the GPDF6010.A is used as the antenna. This antenna has four pins, two pins are used for L1 band and two pins are used for L2/L5/L6 bands. Hybrid couplers (HC125A) are used to combine the feeds for each of the bands, to create a Right hand circular polarized (RHCP) signal, before being presented to the corresponding inputs on the TFM.120A. The TFM.120A is powered from a separate power DC supply (1.8V-5.5V). The output of the TFM.120A can then be fed to a relevant GNSS receiver module. Taoglas recommends using a minimum of 100mm diameter or 100x100mm ground plane (PCB) to ensure optimal performance.



Block Diagram of integration of the TFM.120A

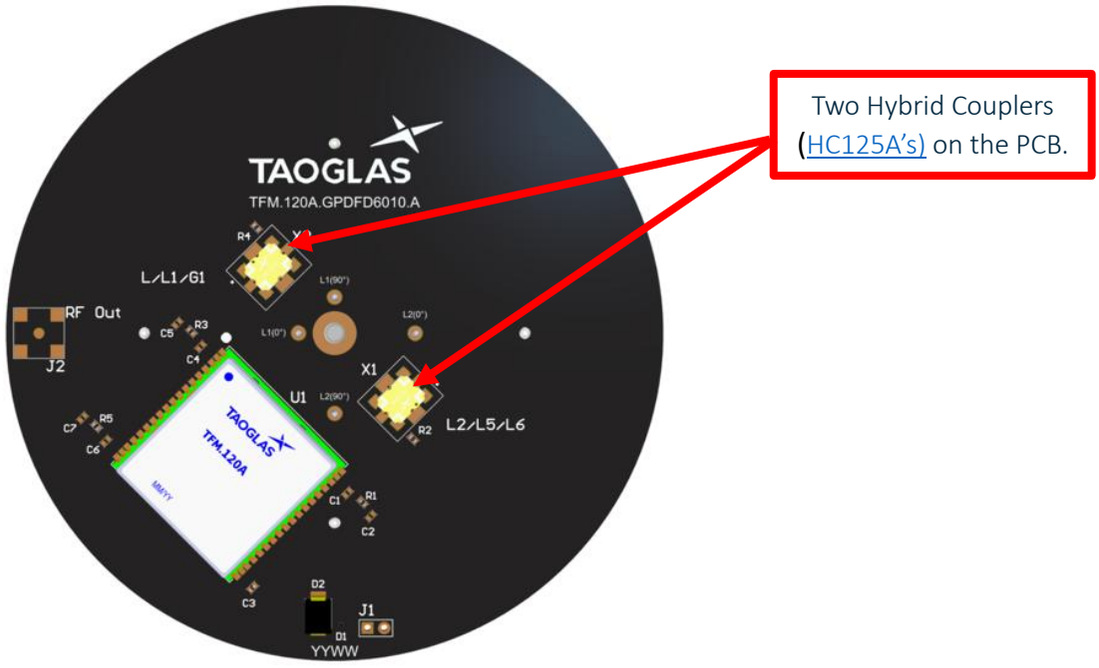


Top and bottom view of PCB.

Please find the Integration files in Altium, 2D formats and the 3D model for the TFM.120A here:
https://www.taoglas.com/product/gpdf6010-a-all-band-high-precision-gnss-stacked-patch-antenna/

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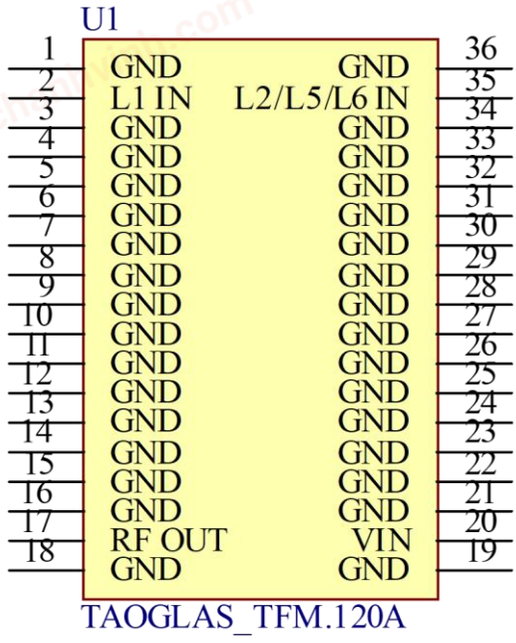
6.1 Schematic Symbol and Pin Definitions



Above is a 3D model of the TFM.120A and two HC125A's on the PCB.

The circuit symbol for the TFM.120A is shown below. The front-end module has 36 pins as indicated below.

Pin	Description
1, 3-15, 17-18, 20-32, 34	Ground
2	L1 Input
17	Signal Output
20	Voltage Input
35	L2/L5/L6 Input



Above is a schematic symbol of TFM.120A and a table of the pin definitions.

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6.2 Schematic Layout

The GPDF6010.A uses two orthogonal feeds that need to be combined in a hybrid coupler to ensure optimal axial ratio. Taoglas recommends our HC125A, a high-performance hybrid coupler specifically engineered for use with our multi feed patches.

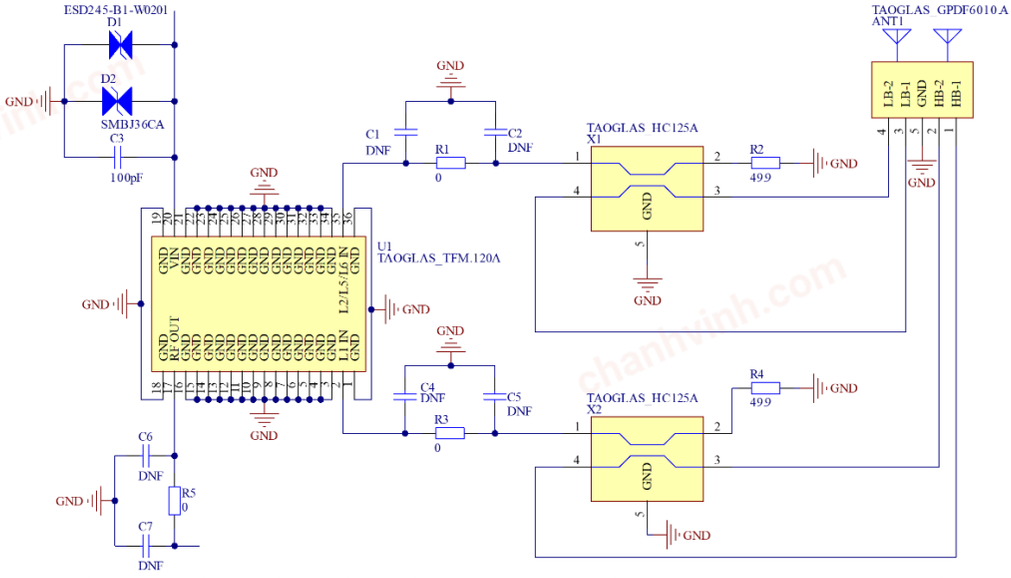
Two HC125A's are required for this antenna, one for the high GNSS band of operation (1559- 1610MHz) and another for the low GNSS band (1180MHz – 1280MHz). These hybrid couplers should be placed close to the antenna pins and terminated correctly using a 49.9 Ohm resistors.

The output of each of the hybrid couplers can be fed into the relevant inputs of the TFM.120A module.

Matching components with the TFM.120A are required for the module to have optimal performance in the spaces specified in the schematic below. Additional matching components may be necessary for your device, Taoglas recommends incorporating extra component footprints, forming a "pi" network, between the TFM.120A and the HC125A's. Matching components should also be placed between the RF output pin and the GNSS receiver module input pin.

Taoglas recommends placing an ESD diode and decoupling capacitor (100pF) on the input pin of the supply rail.

Note: The RF In & RF out of the TFM module are all DC-blocked internally. External DC block capacitors are not required.



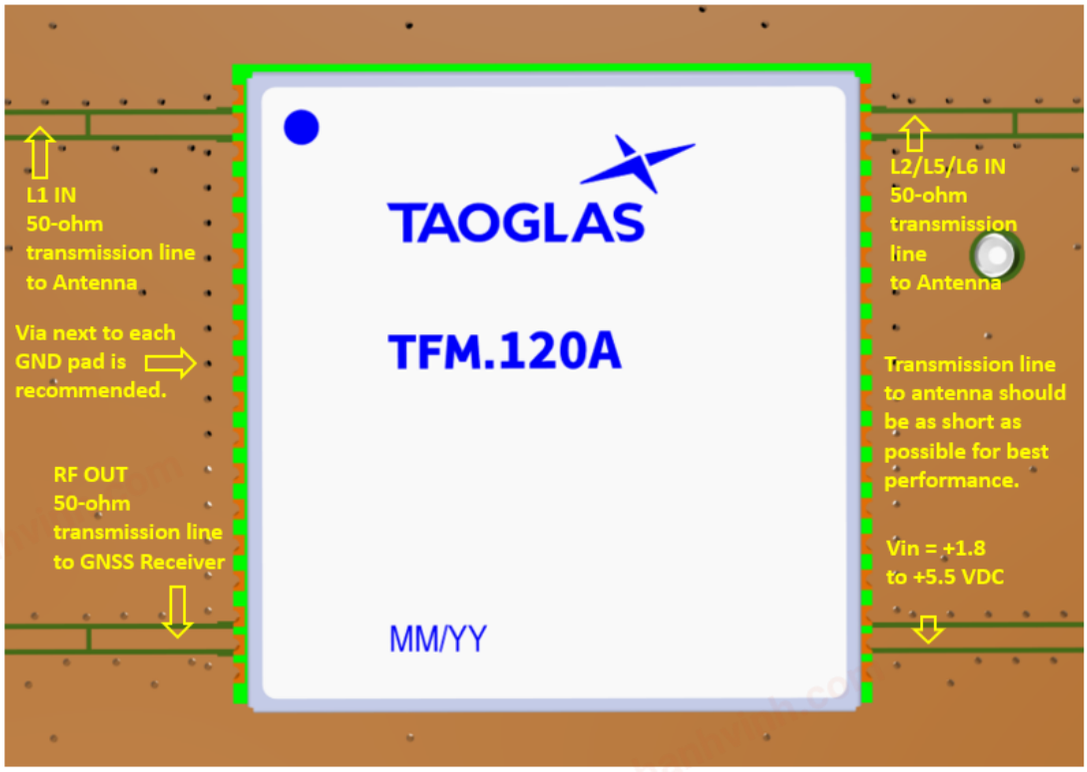
Schematic above shows how the TFM.120A and GPDF6010.A are integrated.

Designator	Type	Value	Manufacturer	Manufacturer Part Number
C1, C2, C4, C5, C6, C7	Capacitor	Not Fitted	-	-
C3	Capacitor	100pF	Murata	GRM1555C1H101JA01D
D1	Diode	-	Infineon	ESD245B1W0201E6327XTSA1
D2	Diode	-	Littelfuse	SMBJ36CA
R2, R4	Resistor	49.9 Ohms	Panasonic	ERJ-2RKF49R9X
R1, R3, R5	Resistor	0 Ohms	YAGEO	RC0402JR-070RL

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6.3 Module Integration

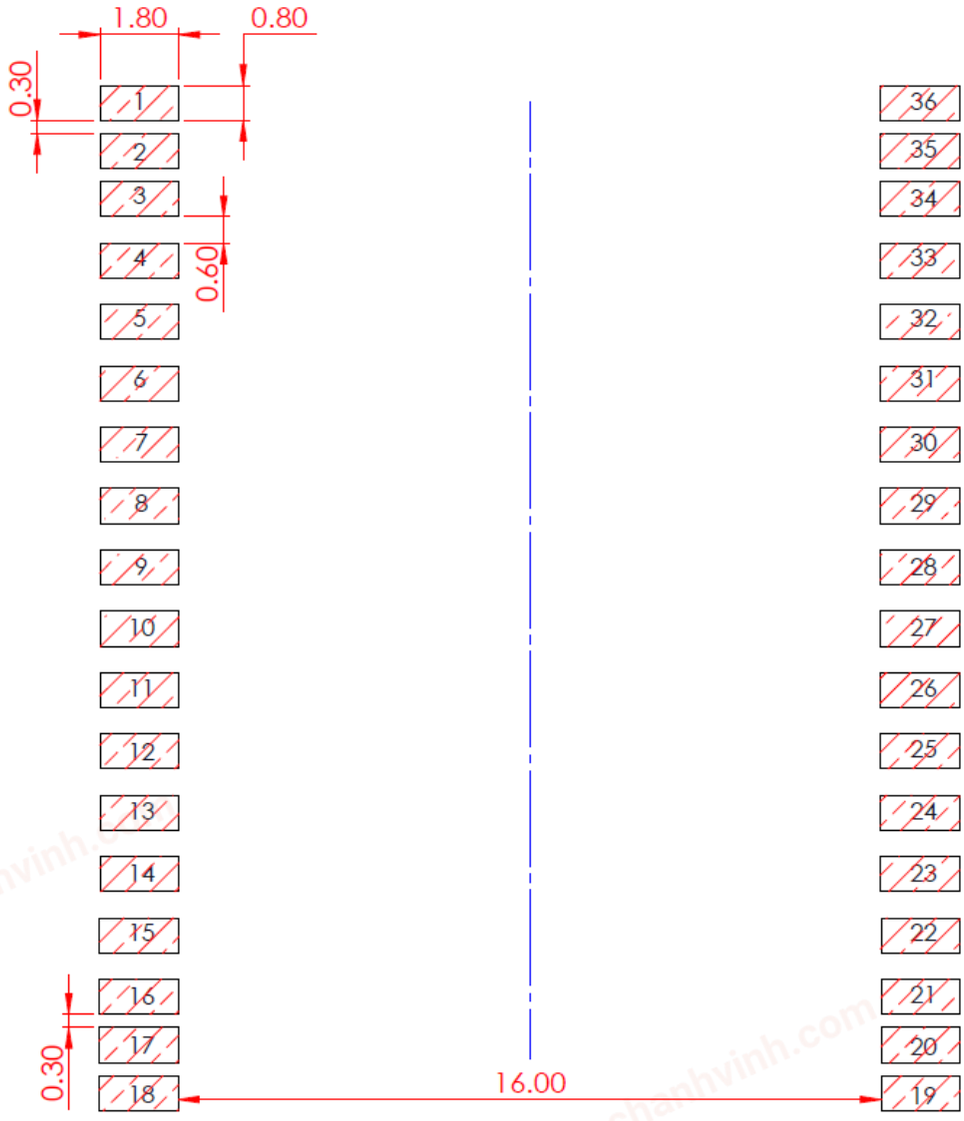
The TFM.120A should be placed as close to the signal input and output as possible to shorten the length of the transmission lines. The RF IN/OUT traces must maintain a 50 Ohm transmission line. A Pi Matching Network is recommended for the RF IN transmission lines, the values and components for the matching circuit will depend on the tuning needed. Ground vias should be placed beside each ground pad and the DC Voltage input should be between +1.8 and +5.5 VDC. It's recommended that the DC Voltage input should be coupled with a 100pF Capacitor and an ESD Diode.



TFM.120A module mounted on a PCB, showing transmission lines and integration notes.

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6.4 Module Footprint

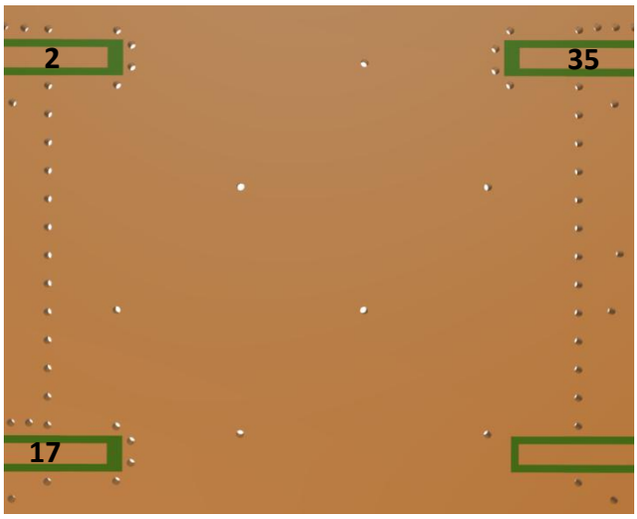


PIN	DESCRIPTION	PIN	DESCRIPTION
1	GND	19	GND
2	L1 IN	20	VIN
3	GND	21	GND
4	GND	22	GND
5	GND	23	GND
6	GND	24	GND
7	GND	25	GND
8	GND	26	GND
9	GND	27	GND
10	GND	28	GND
11	GND	29	GND
12	GND	30	GND
13	GND	31	GND
14	GND	32	GND
15	GND	33	GND
16	GND	34	GND
17	RF OUT	35	L2/L5/L6 IN
18	GND	36	GND

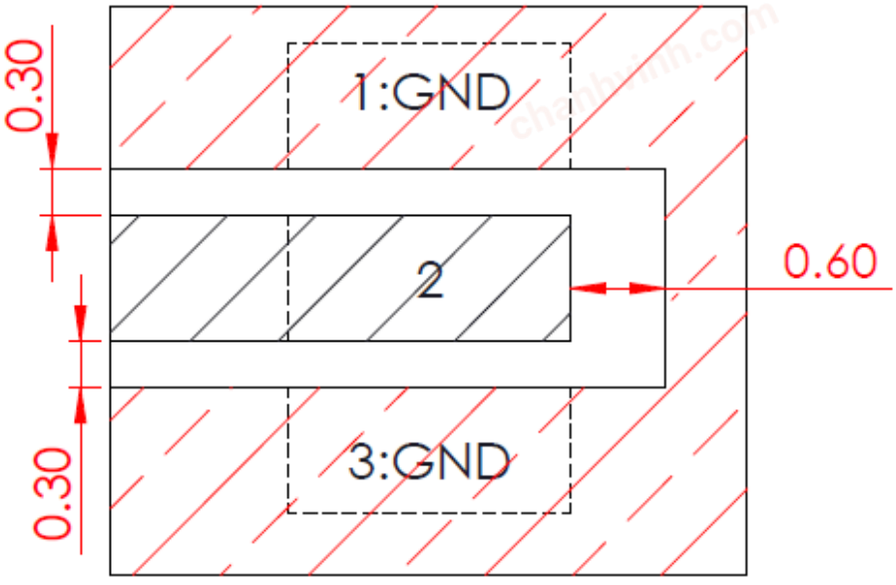
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6.5 Copper Clearance for TFM.120A

The footprint and clearance on the PCB must comply with the front-end module's specification. The PCB layout shown in the diagram below demonstrates the TFM.120A clearance area for Pin 2 (L1 IN Pad), Pin 17 (RF OUT Pad) and Pin 35 (L2/L5/L6 IN Pad). The copper keep out area only applies to the same layer that the TFM120.A has been placed on.
There should be 0.3mm copper clearance between the feed pad and ground pads with at least a 0.6mm copper clearance from the ground plane .

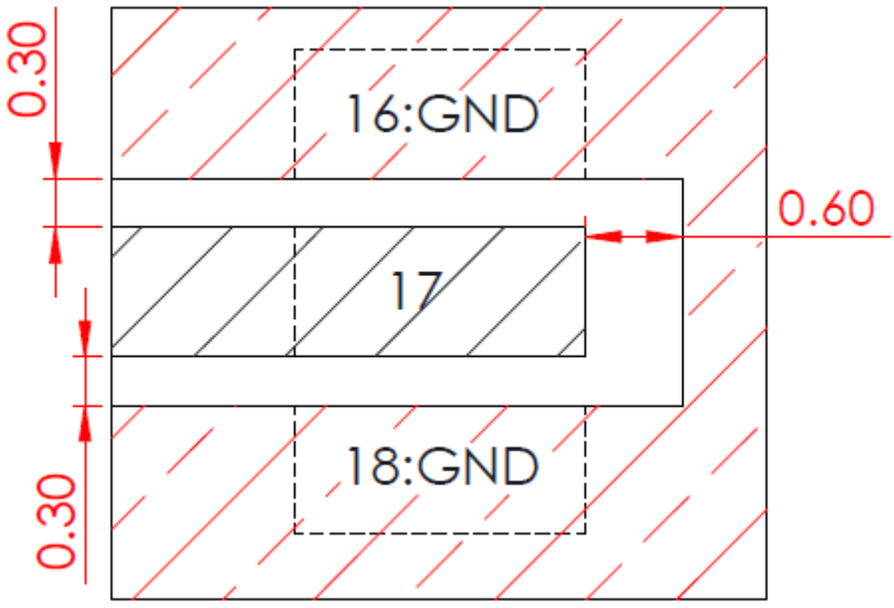


3D Image of Copper Clearance TFM.120A.

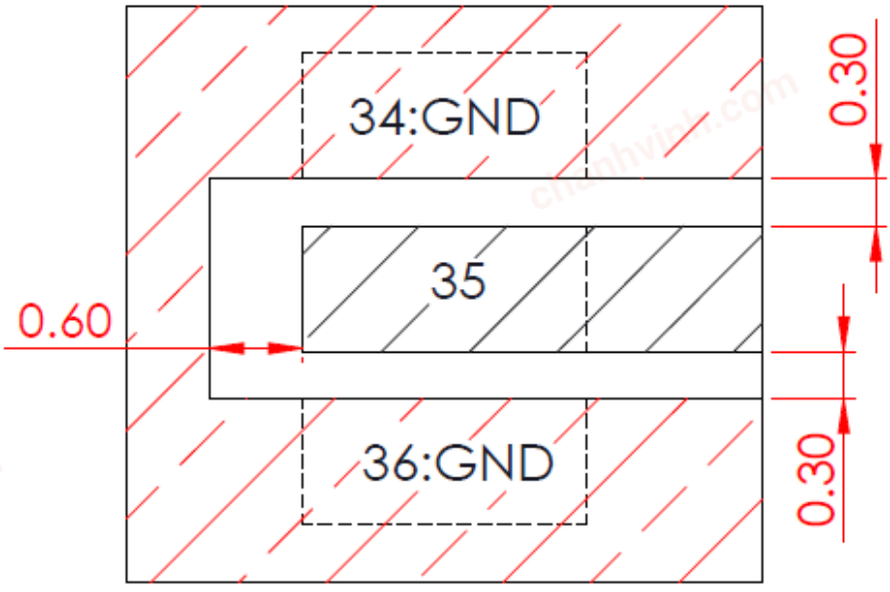


Copper Clearance for Pin 2 (L1 IN Pad) of the TFM.120A.

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Copper Clearance for Pin 17 (RF OUT Pad) of the TFM.120A.



Copper Clearance Pin 33 (L2/L5/L6 IN Pads) of the TFM.120A

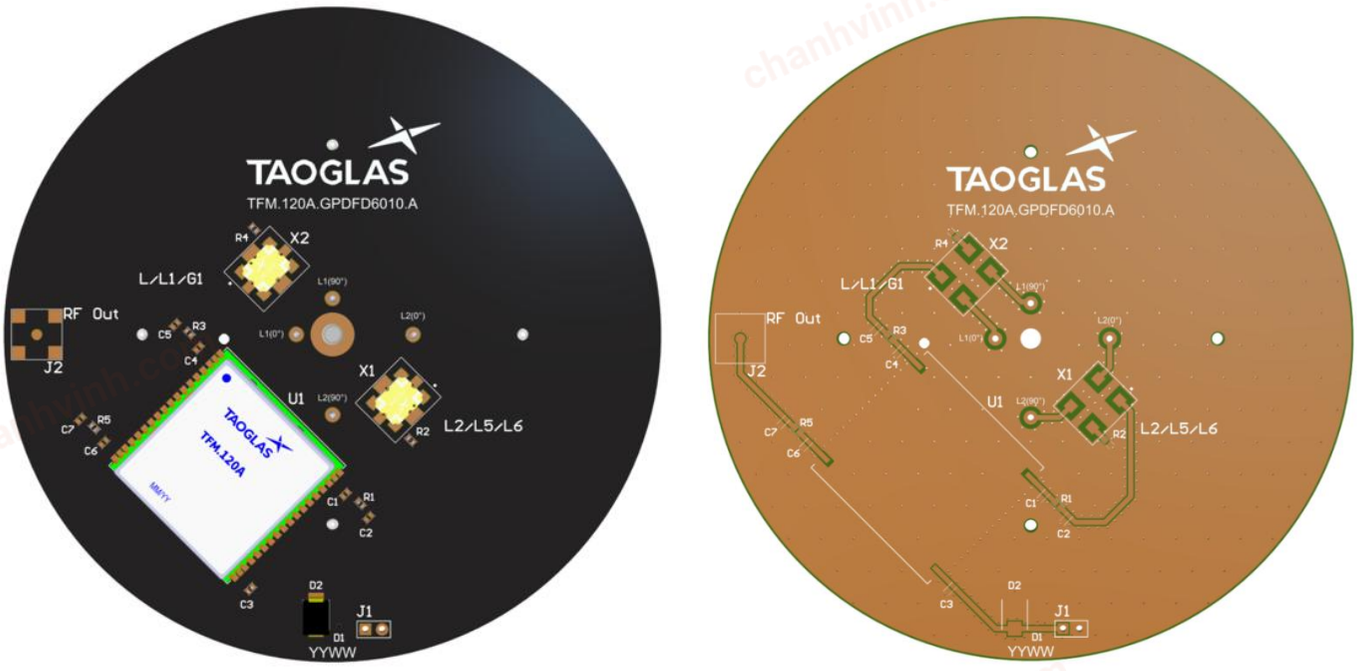
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6.6 Final Integration

The top side image shown below highlights the antenna connection to the hybrid couplers (HC125A's). It highlights the outputs of the hybrid couplers connected to the relevant inputs of the TFM.120A module. It shows the 49.9 Ohm terminating resistor necessary for the hybrid coupler (HC125A). It also demonstrates the output of the TFM.120A module that needs to be connected to a GNSS receiver input. It displays the DC connection required with ESD diode and decoupling capacitor.



Top Side (GPDF6010.A Placement on Ø100mm PCB)

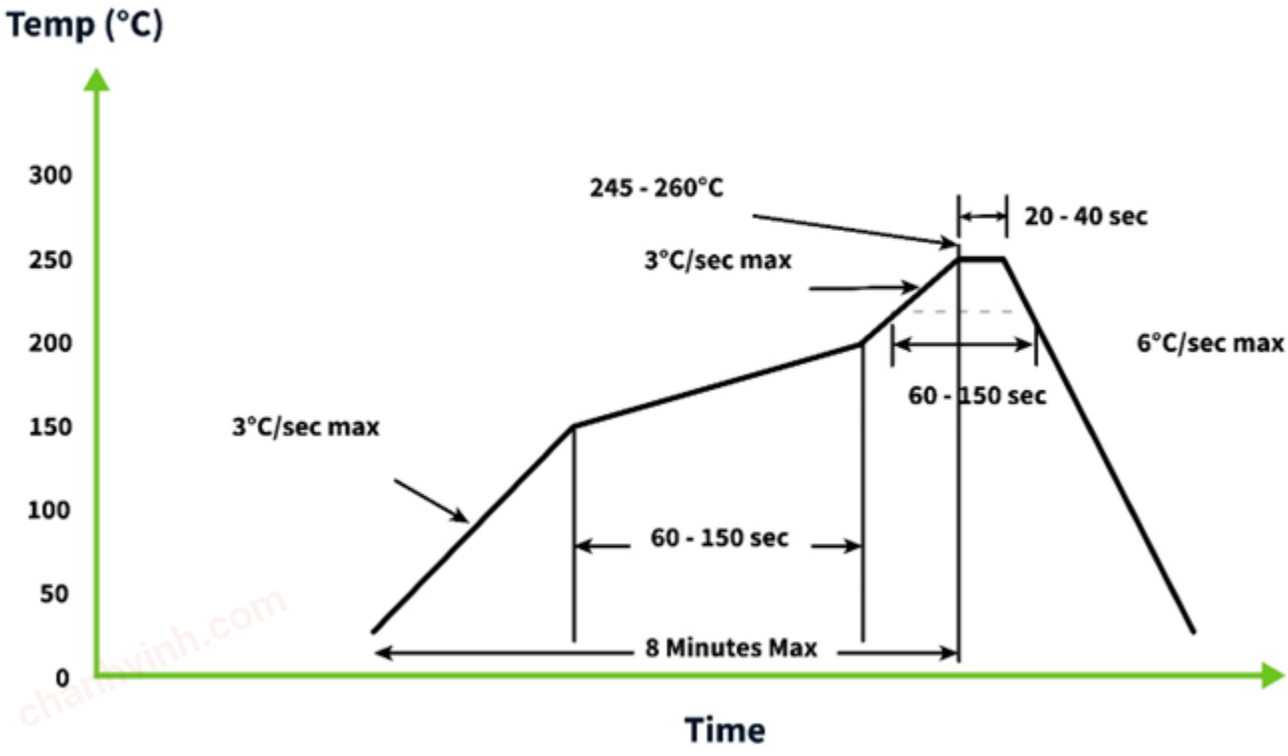


Bottom side (TFM.120A placement including HC125.A's)

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7. Solder Recommendations

The TFM.120A can be assembled by following the recommended soldering temperatures as follows:



Smaller components are typically mounted on the first pass, however, we do advise mounting the TFM.120A when placing larger components on the board during subsequent reflows.

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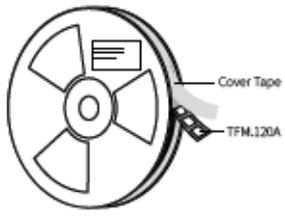
8. Packaging

350 PCS / Reel
SPQ Label



350 PCS / Vacuum bag
2 PCS / 3g Desiccant
1 PCS / Humidity test paper
SPQ Label

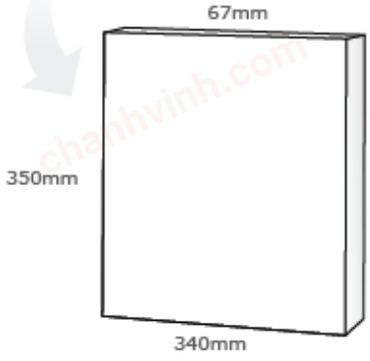




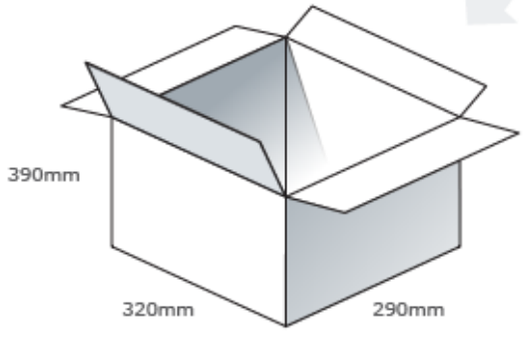
Caution Label
Product Label
SPQ Label



1 PCS / Box
Box(mm): 350x340x67
Weight (Kg): 2
SPQ Label



1050 PCS / Carton
Carton(mm): 390x320x290
Weight (Kg): 7
Carton Label



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Changelog for the datasheet

SPE-23-8-172 – TFM.120A

Revision: F (Current Version)	
Date:	2025-04-03
Notes:	Added bands E5b and E6.
Author:	Gary West

Previous Revisions

Revision: E	
Date:	2024-05-29
Notes:	Added moisture sensitivity level information to datasheet
Author:	Conor McGrath

Revision: D	
Date:	2023-12-11
Notes:	Updated Schematic Layout Image
Author:	Gavin Mackey

Revision: C	
Date:	2023-11-23
Notes:	Updated module integration guide & ME Drawings
Author:	Gary West

Revision: B	
Date:	2023-09-04
Notes:	Updated solder reflow recommendations and electrical specification table
Author:	Cesar Sousa

Revision: A (Original First Release)	
Date:	2023-05-08
Notes:	Initial Release
Author:	Gary West

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