Type2AE
RF trace and trace antenna design guidelines for FCC

Rev.1.0

Certified antennas

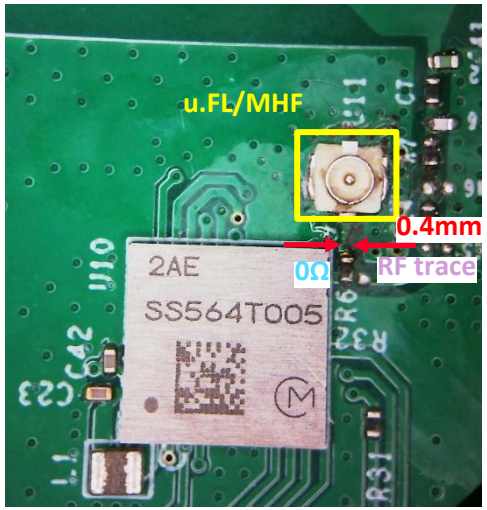
Two types of antenna are certified associating with the module.

- PCB antenna
- Dipole antenna

Their peak gains in dual bands are summarized as below.

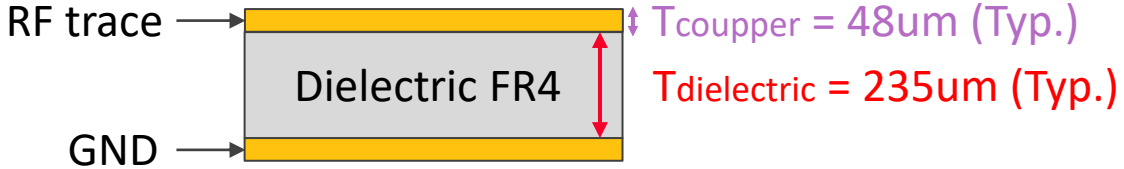
Antenna Type	Peak gain at 2.4GHz	Peak gain at 5GHz
PCB antenna	3.0dBi	3.3dBi
Dipole antenna	3.4dBi	4.75dBi

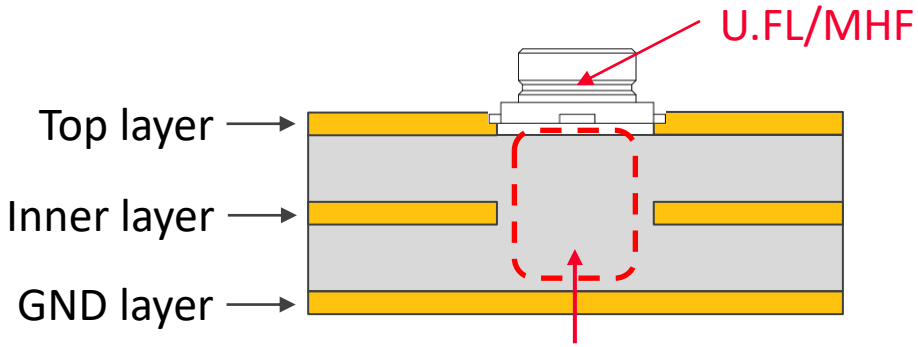
Layout guide of RF trace for the u.FL antenna connector



- Must copy the RF traces of the DXF file on the board completely.
  Allowance to inaccuracy of trace width is Typ. +/-0.025mm (1mil).
  Typical width should be read from the DXF file.
- Stack height between the standard GND layer and the RF trace layer must be 235um (Typ.)
  Allowance to inaccuracy of stack height is +/-0.025mm (1mil).
- Passive components must be placed on the same location as the DXF file shows and also same values must be used as the left figure.
- Keep out more than 400um under the U.FL/MHF connectors.
  Ask to connector vendor in detail.

PCB Stack-up



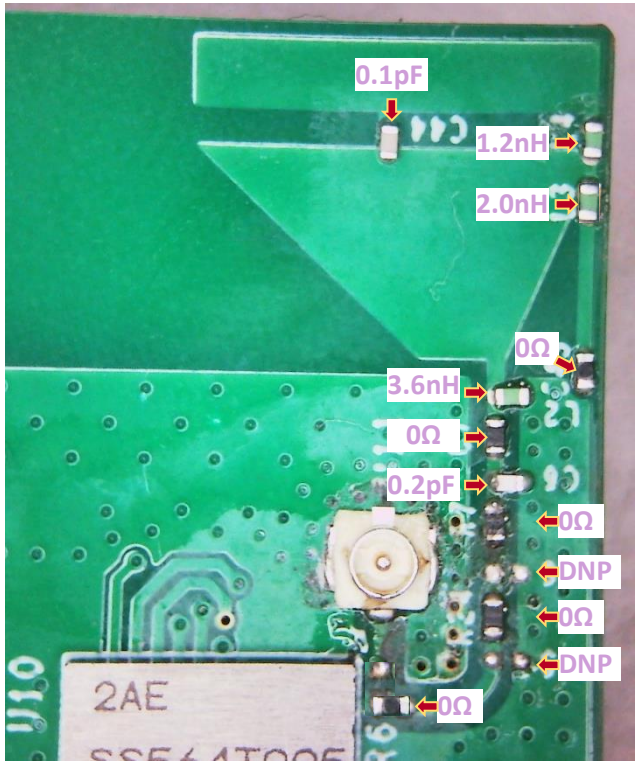


Do not place any conductors such as GND, signal traces, power lines more than 400um from bottom of the connector.

Layout guide of RF trace for the trace antenna

<Measurement condition>

Condition	Memo	Tuning 1	Tuning 2	Tuning 3	Tuning 4	Matching circuit						
						Shunt 1	Series 1	Shunt 2	Series 2	Shunt 3	Series 3	Shunt 4
Condition 1	Optimized matching	1.2nH	0.1pF	2.0nH	0ohm	3.6nH	0ohm	0.2pF	0ohm	None	0ohm	None
						Size:1005 GRM15 / LQG15HS / Register				Size:1005 GJM15		



- Must copy the antenna design of the DXF file on the board completely
- Must copy the RF traces of the DXF file on the board completely.
  Allowance to inaccuracy of trace width is Typ. +/-0.025mm (1mil).
  Typical width should be read from the DXF file.
- Recommended total thickness of PCB (Dielectric) is 0.8mm.
  (Must be 0.6mm ≤ PCB Thickness ≤ 1.6mm)
- Stack height between the standard GND layer and the RF trace layer must be 235um (Typ.)
  Allowance to inaccuracy of stack height is +/-0.025mm (1mil).
- Passive components must be placed on the same location as the DXF file shows and also same values must be used as the left figure.

PCB Stack-up for RF trace

Tcoupper = 48um (Typ.)
Tdielectric = 235um (Typ.)

PCB Stack-up for antenna element

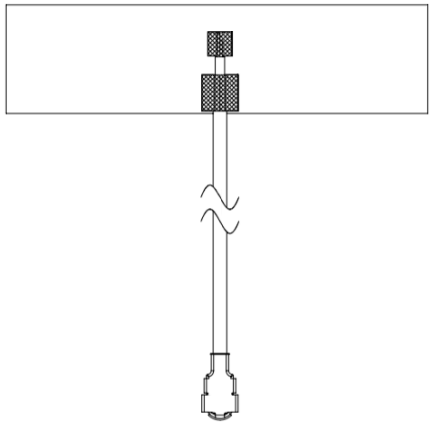
Tcoupper = 48um (Typ.)
Tdielectric = 800um (Typ.)
(600um min. / 1600um max.)

Planning certified external antenna

- Type2AE module is going to be certified with below antennas.

Maker	P/N	Form factor	Type	2.4Ghz Gain (dBi)	5Ghz Gain (dBi)
Molex	146187	u.FL/flexible	dipole	3.4	4.75

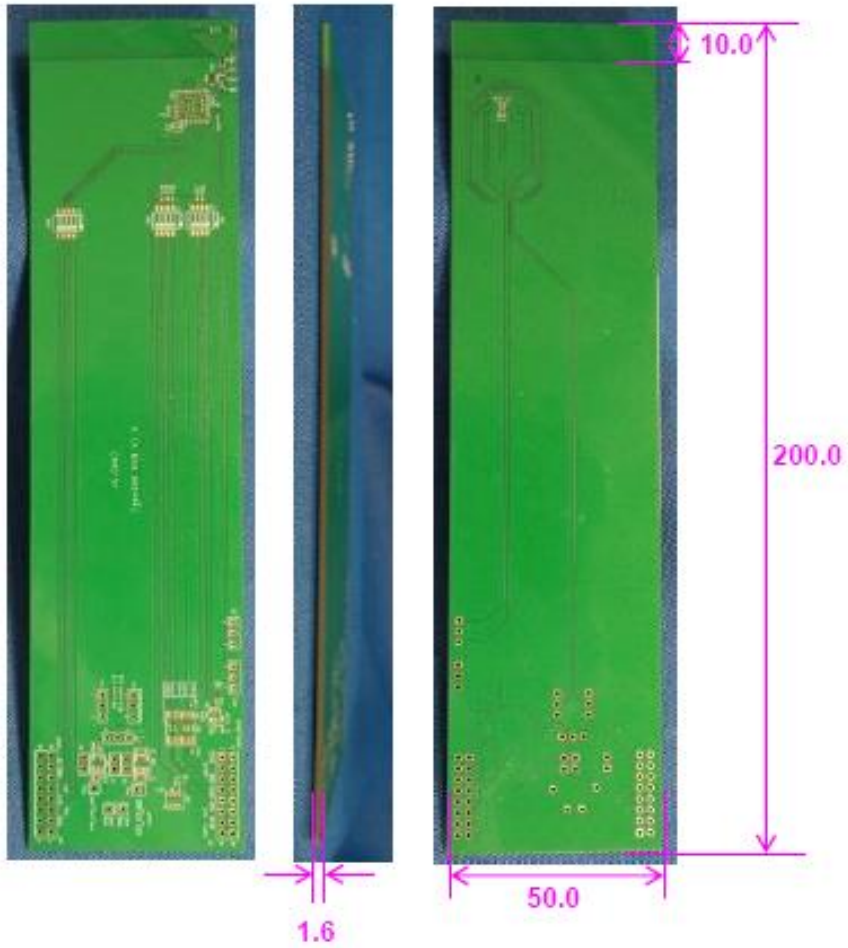
- The user can use any other antennas that is attached to the U.FL/MHF connectors with following conditions.
  - Form factor : PCB/Film type antenna (Similar “T-Shape” appearance is acceptable)

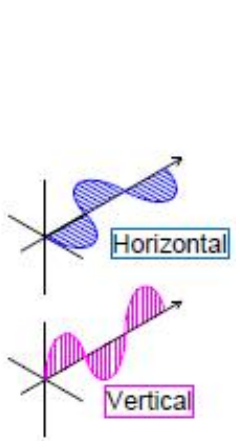


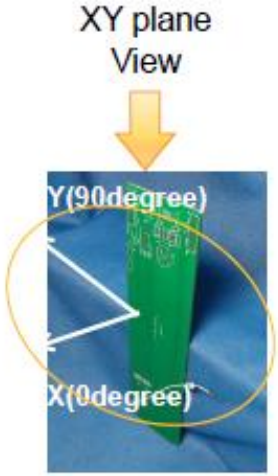
  - Antenna type : Dipole antenna
  - Antenna gain :
    - 2.4GHz 0dBi ≤ 2.4GHz Gain ≤ 3.4dBi (Planning)
    - 5GHz 0dBi ≤ 5GHz Gain ≤ 4.75dBi (Planning)

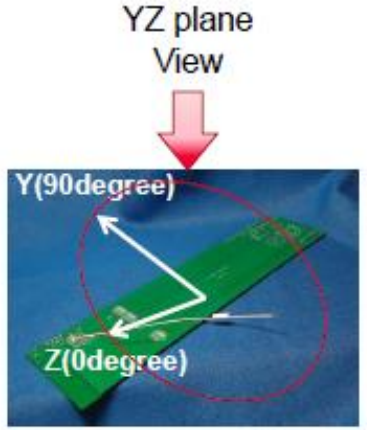
Certified trace antenna - measurement conditions

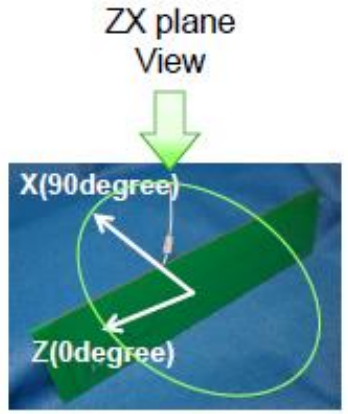
Board appearance



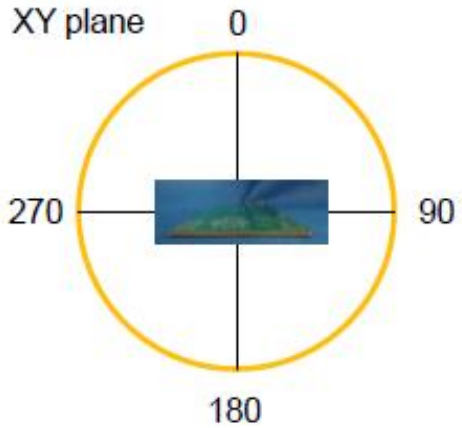


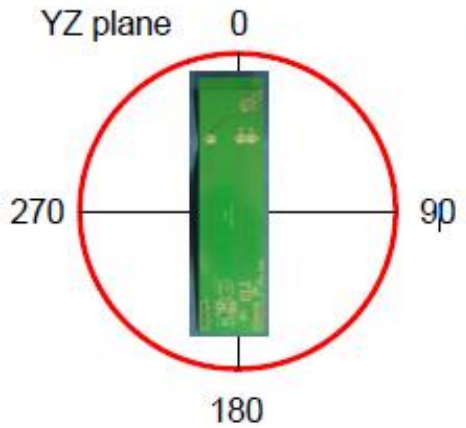


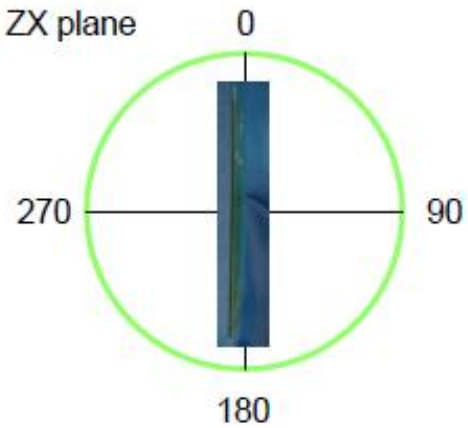




2D Directional indication

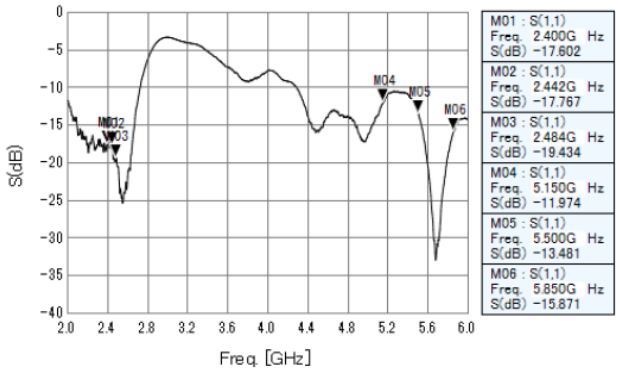






Certified trace antenna - performance

<Return Loss>



<Efficiency>

*Red color shows peak gain

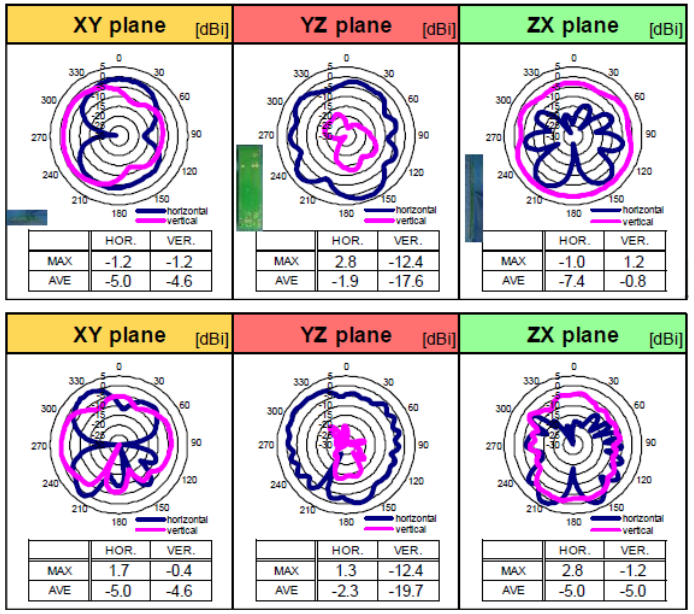
[dBi] [dB]

LINEAR POLAMIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
2400 MHz	MAX.	-1.1	-1.0	3.0	-13.4	-1.1	0.9	
	AVE.	-4.8	-4.5	-2.0	-18.7	-7.5	-1.0	-0.9
2442 MHz	**MAX.**	**-1.2**	**-1.2**	**2.8**	**-12.4**	**-1.0**	**1.2**	
	AVE.	**-5.0**	**-4.6**	**-1.9**	**-17.6**	**-7.4**	**-0.8**	**-0.9**
2484 MHz	MAX.	-1.5	-0.5	3.0	-11.8	-0.5	1.7	
	AVE.	-5.2	-4.1	-1.7	-16.8	-7.3	-0.6	-0.8

[dBi] [dB]

LINEAR POLAMIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
5150 MHz	MAX.	1.8	-0.8	1.9	-12.2	2.7	-0.7	
	AVE.	-4.4	-4.7	-2.1	-19.6	-4.6	-4.4	-1.4
5500 MHz	**MAX.**	**1.7**	**-0.4**	**1.3**	**-12.4**	**2.8**	**-1.2**	
	AVE.	**-5.0**	**-4.6**	**-2.3**	**-19.7**	**-5.0**	**-5.0**	**-1.6**
5850 MHz	MAX.	2.1	-1.4	0.9	-12.7	3.3	-3.0	
	AVE.	-4.7	-5.6	-2.5	-19.8	-4.4	-6.0	-1.6

<Directivity>



@2442MHz

@5500MHz

<Measurement result>

Total efficiency [dB] [%]

Condition	Frequency [MHz] 2400	2442	2484	5150	5500	5850	Average 2GHz band	Average 5GHz band	Average 2GHz band	Average 5GHz band
Condition 1	-0.9	-0.9	-0.8	-1.4	-1.6	-1.6	-0.9	-1.5	82.1	70.3

Peak gain [dBi]

Condition	Frequency [MHz] 2400	2442	2484	5150	5500	5850	Max. 2GHz band	Max. 5GHz band
Condition 1	3.0	2.8	3.0	2.7	2.8	3.3	3.0	3.3

Dipole antenna

- The dipole antenna is a model from Molex with a U.FL connector

Maker	P/N	Form factor	Type	2.4GHz Gain (dBi)	5GHz Gain (dBi)
Molex	146187	U.FL/flexible	dipole	3.4	4.75