muRata
INNOVATOR IN ELECTRONICS

Type2AE
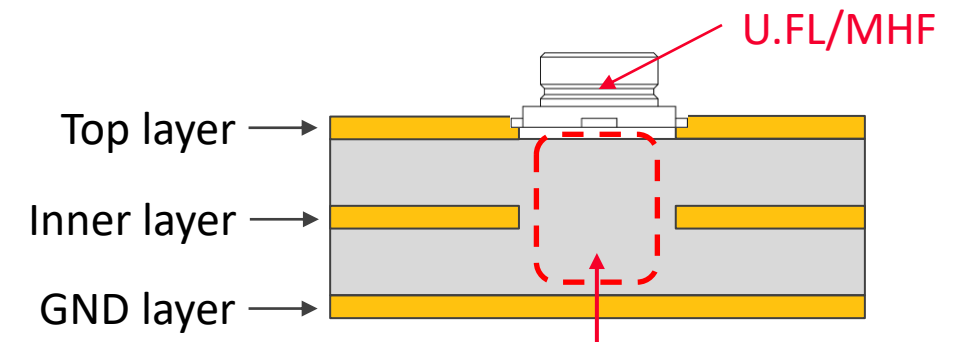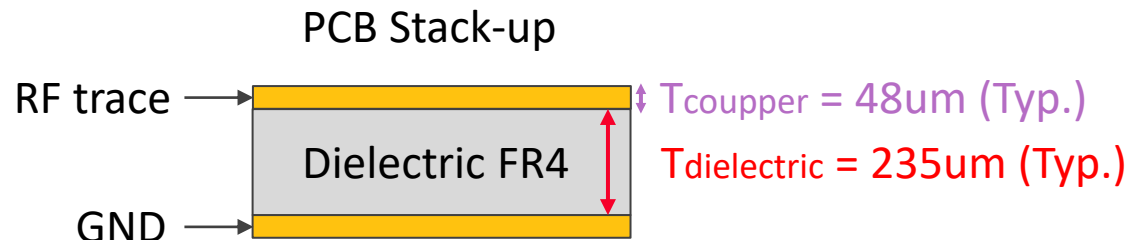# RF trace and trace antenna design guidelines for FCC

Rev.1.0

22 December 2021

Layout guide of RF trace for the u.FL antenna connector
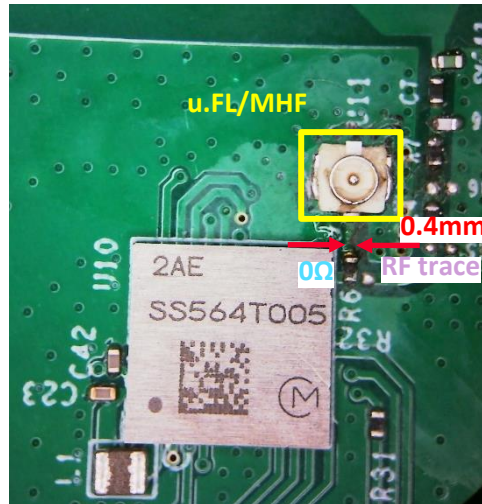
muRata
INNOVATOR IN ELECTRONICS

u.FL/MHF
0.4mm
RF trace
0Ω
2AE
SS564T005

- 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

RF trace

Dielectric FR4

GND

$T_{coupper}$ = 48um (Typ.)

$T_{dielectric}$ = 235um (Typ.)

U.FL/MHF

Top layer

Inner layer

GND layer

Do not place any conductors such as GND, signal traces, power lines more than 400um from bottom of the connector.
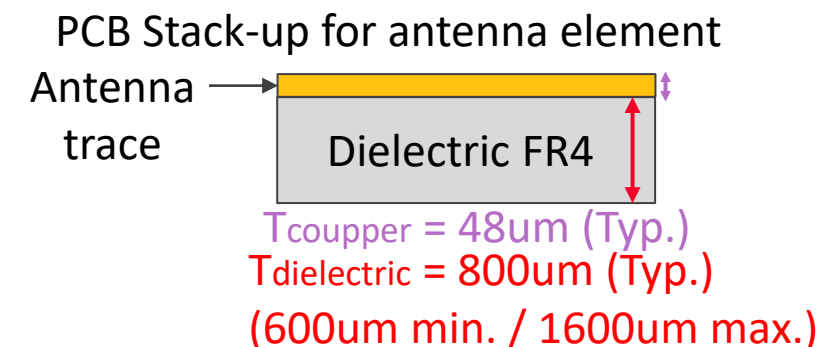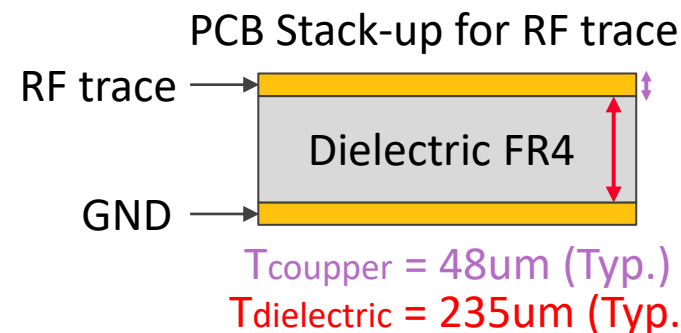
Layout guide of RF trace for the trace antenna

muRata
INNOVATOR IN ELECTRONICS

<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
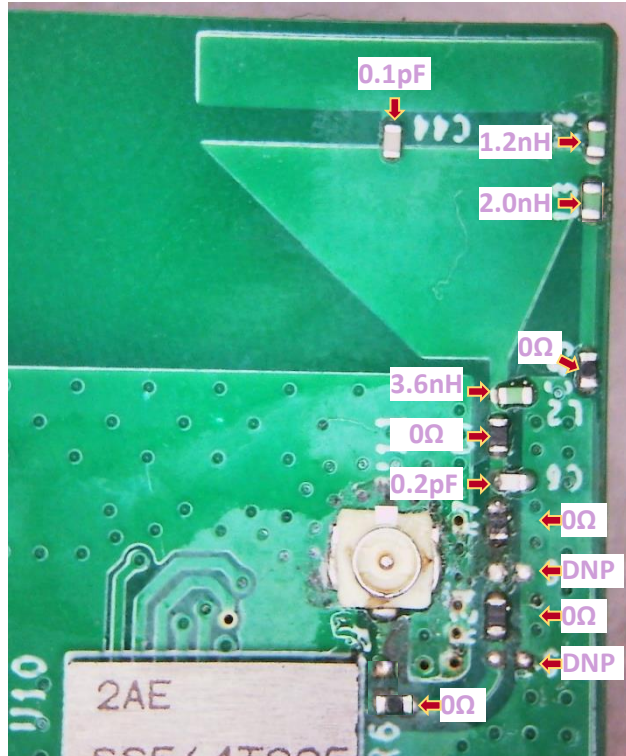
- Must copy the antenna design of the DXF file on the board completely

- 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

RF trace →
Dielectric FR4
GND →

$T_{coupper}$ = 48um (Typ.)
$T_{dielectric}$ = 235um (Typ.)

PCB Stack-up for antenna element

Antenna trace →
Dielectric FR4

$T_{coupper}$ = 48um (Typ.)
$T_{dielectric}$ = 800um (Typ.)
(600um min. / 1600um max.)

22 December 2021   3

Planning certified external antenna

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

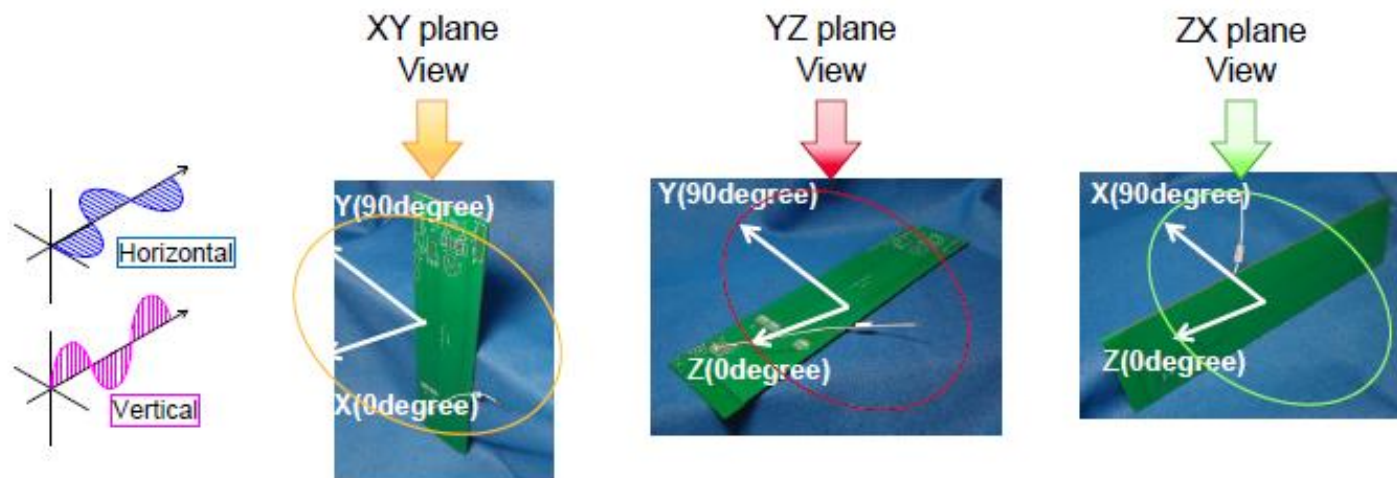| Maker	P/N	Form factor	Type	2.4Ghz Gain (dBi)	5Ghz Gain (dBi)
Molex	146187	u.FL/flexible	dipole	3.4	4.75

- 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)
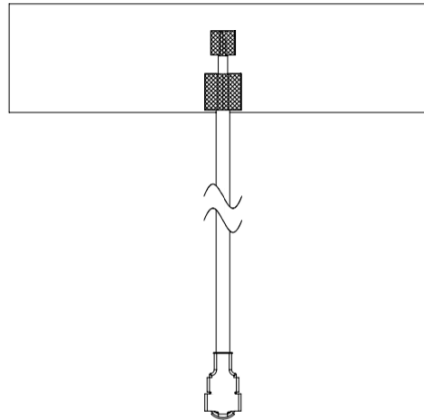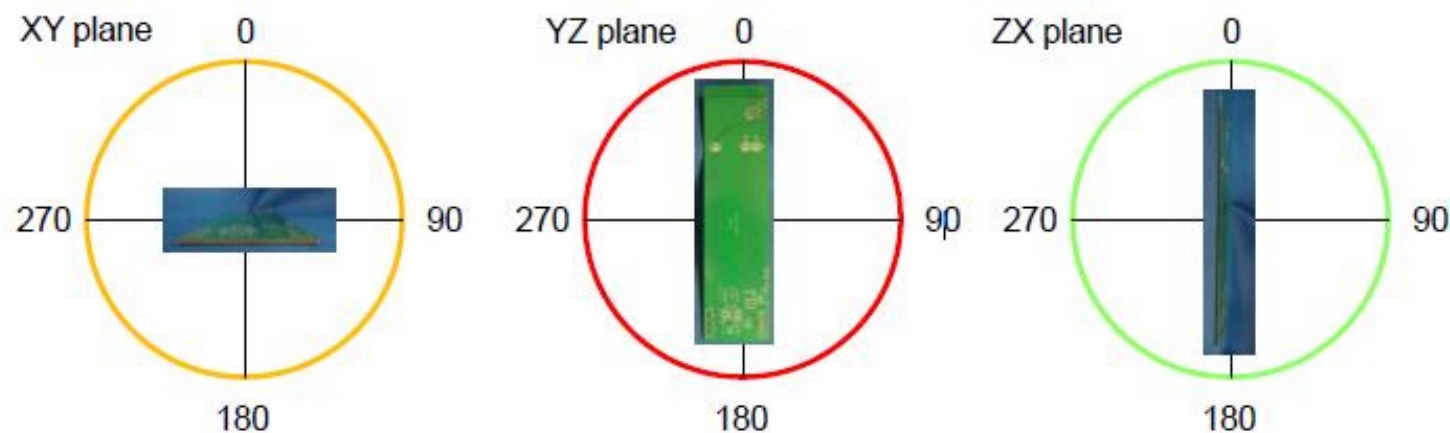

  - Antenna type : Dipole antenna

  - Antenna gain :

    - 2.4GHz   0dBi ≤ 2.4GHz Gain ≤ 3.4dBi (Planning)

    - 5GHz   0dBi ≤ 5GHz Gain ≤ 4.75dBi (Planning)

Certified trace antenna - measurement conditions
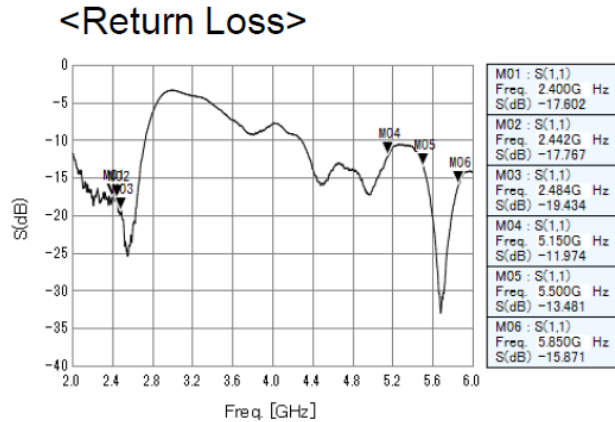

Board appearance
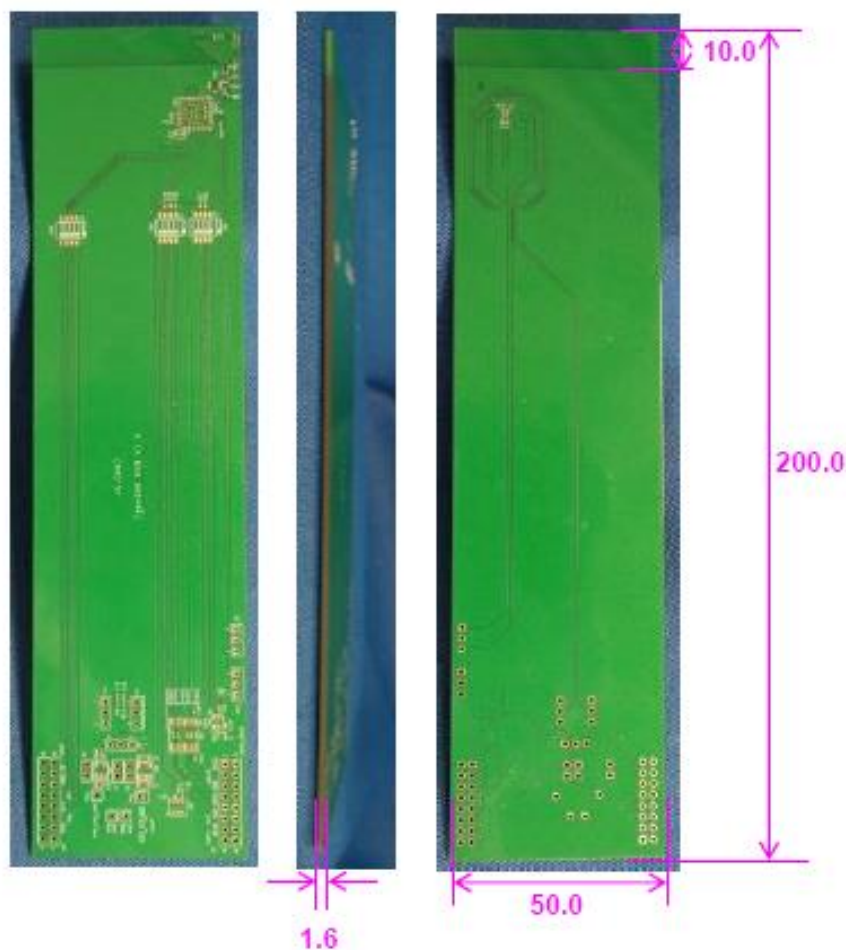
2D Directional indication

Certified trace antenna - performance

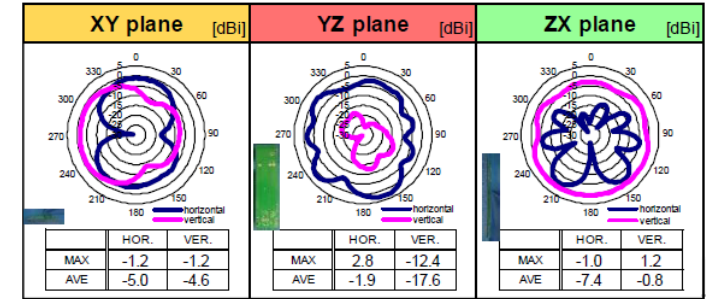**muRata**
INNOVATOR IN ELECTRONICS

<Return Loss>

M01 : S(1,1) Freq. 2.400G Hz S(dB) −17.602
M02 : S(1,1) Freq. 2.442G Hz S(dB) −17.767
M03 : S(1,1) Freq. 2.484G Hz S(dB) −19.434
M04 : S(1,1) Freq. 5.150G Hz S(dB) −11.974
M05 : S(1,1) Freq. 5.500G Hz S(dB) −13.481
M06 : S(1,1) Freq. 5.850G Hz S(dB) −15.871

<Efficiency>

*Red color shows peak gain

LINEAR POLAMIZATION		XY-plane [dBi] hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency [dB]
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

LINEAR POLAMIZATION		XY-plane [dBi] hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency [dB]
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
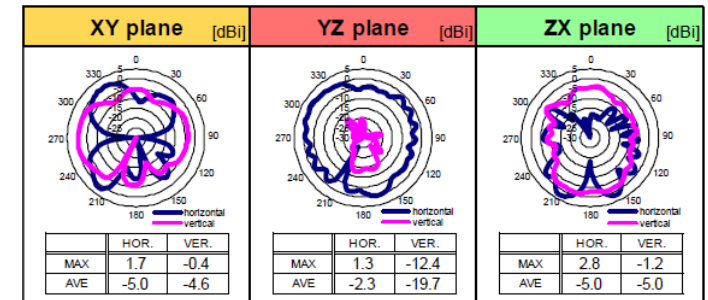
<Directivity>

@2442MHz

	XY plane HOR.	XY plane VER.
MAX	-1.2	-1.2
AVE	-5.0	-4.6

	YZ plane HOR.	YZ plane VER.
MAX	2.8	-12.4
AVE	-1.9	-17.6

	ZX plane HOR.	ZX plane VER.
MAX	-1.0	1.2
AVE	-7.4	-0.8

@5500MHz

	XY plane HOR.	XY plane VER.
MAX	1.7	-0.4
AVE	-5.0	-4.6

	YZ plane HOR.	YZ plane VER.
MAX	1.3	-12.4
AVE	-2.3	-19.7

	ZX plane HOR.	ZX plane VER.
MAX	2.8	-1.2
AVE	-5.0	-5.0

<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

CONFIDENTIAL