BSW6540

High Isolation Absorptive SP4T RF Switch

5MHz-10000MHz

Product Description

The BSW6540 is a 50-ohm matched absorptive SP4T RF switch that provides ultra-high isolation with frequency coverage up to 10 GHz.

The BSW6540 is designed with high linearity and reliability, making it suitable for wireless communication applications such as 4G/5G/6G infrastructure .

The BSW6540 operates over a wide VDD range of 2.7V to 5.5V and is controlled via 3 logic pins. Additionally, the BSW6540 has a bypass mode function that can disable the internal negative voltage, and an external negative Vss can be supplied through pin 20.

The BSW6540 is designed with ESD protection circuits at all pins and packaged in an industry standard, fully RoHS2-compliant, 24-Lead, 4mm x 4mm x 0.75mm QFN thin package.

The BSW6540 does not require blocking capacitors. If DC is presented at the RF port, add a blocking capacitor.

Block Diagram

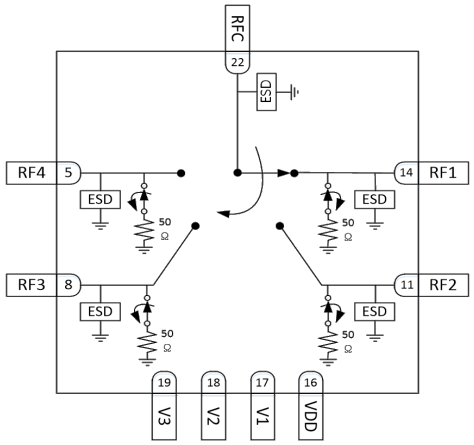


Figure 1. Functional Block Diagram

Applications

- Wireless Communication such as 4G/5G/6G
- Massive MIMO active Antenna Systems
- Repeaters
- Digital Pre-Distortion
- Military Systems
- UWB
- Test & Measurement

Package Type

4mm x 4mm x 0.75mm, 24-Lead QFN Package

Figure 2. Package Type

Device Features

- Output frequency range : 5 MHz to 10.0 GHz
- Supply Voltage : 2.7V to 5.5V
- Low Insertion Loss
  : 0.60dB @ 2GHz
  : 0.73dB @ 4GHz
  : 0.84dB @ 6GHz
- High Isolation
  - RFC to RFx
    : 71dB @ 2GHz
    : 59dB @ 4GHz
    : 51dB @ 6GHz
  - RFx to RFx
    : 62dB @ 2GHz
    : 57dB @ 4GHz
    : 55dB @ 6GHz
- High Input 1dB Compression
  : 35.7dBm @ 2.35GHz
  : 35.3dBm @ 3.5GHz
  : 35.1dBm @ 5.75GHz
- High IIP3
  : 66dBm @ 2.35GHz
  : 63dBm @ 3.5GHz
  : 63dBm @ 5.75GHz
- Fast Switching Time : 180ns
- Operating temperature range : -40°C to +125°C
- ESD, HBM : 1.5kV
- Optional External Negative Supply (Bypass Mode)
- 24-Lead QFN package : 4.0mm x 4.0mm x 0.75mm
- Lead-free/RoHS2-compliant QFN SMT package

Electrical Specifications

Typical conditions are Normal Mode[1](VDD = 5V, VSSEXT= 0V) or Bypass Mode[2](VDD = 5V, VSSEXT = -3.5V), T_A = 25°C,
Control Logic V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, PCB and RF Connector loss are de-embedded, unless otherwise noted.

Table 1. Electrical Specifications

Parameter	Path	Conditions	Min	Typ	Max	Unit
Operating Frequency			5		10000	MHz
Insertion Loss	RFC - RF1	1GHz 2GHz 3GHz 4GHz 5GHz 6GHz 7GHz 8GHz 9GHz 10GHz		0.55 0.60 0.69 0.73 0.76 0.84 0.86 0.98 1.59 1.91		dB
	RFC - RF2	1GHz 2GHz 3GHz 4GHz 5GHz 6GHz 7GHz 8GHz 9GHz 10GHz		0.58 0.65 0.73 0.76 0.79 0.87 0.91 1.05 1.74 2.15		dB
	RFC - RF3	1GHz 2GHz 3GHz 4GHz 5GHz 6GHz 7GHz 8GHz 9GHz 10GHz		0.57 0.64 0.73 0.76 0.80 0.89 0.93 1.09 1.75 2.12		dB
	RFC - RF4	1GHz 2GHz 3GHz 4GHz 5GHz 6GHz 7GHz 8GHz 9GHz 10GHz		0.56 0.62 0.71 0.75 0.78 0.89 0.90 1.03 1.68 2.09		dB
Return Loss (Active port)	RFC, RFx	5MHz - 8GHz 8GHz - 10GHz		15 10		dB
Return Loss (Terminated port)	RFC, RFx	5MHz - 6GHz 6GHz - 10GHz		20 15		dB

1. Normal Mode : Single external positive supply voltage(VDD) inputted.
2. Bypass Mode : Both external positive supply voltage(VDD) and external negative voltage(VSSEXT) inputted.

Table 1. Electrical Specifications (Cont.)

Parameter	Path	Conditions	Min	Typ	Max	Unit
Input P1dB	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		35.7 35.3 35.1		dBm
Input IP2[3]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		112 108 106		dBm
Input IP3[3]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		66 63 63		dBm
2nd Harmonic[4]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		100 96 94		dBc
3rd Harmonic[4]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		103 100 95		dBc
Rising Time Falling Time	RFC - RFx	10% RF to 90% RF 90% RF to 10% RF		40 40		ns
Switching Time	RFC - RFx	50% CTRL to 90% RF 50% CTRL to 10% RF		180 100		ns
Settling Time	RFC - RFx	50% CTRL to 0.05dB final value Rising Edge 50% CTRL to 0.05dB final value Falling Edge		220 105		ns
Maximum Spurious Level		1MHz - 10MHz > 10MHz[5]		-127 < -140		dBm/10Hz

3. The each-tone Power is +18dBm and Tone spacing is 20kHz .
4. Tone Power is +18dBm.
5. No spurious signals were detected above 10MHz.

Isolation Matrix

Typical conditions are Normal Mode[1](VDD = 5V, VSSEXT= 0V) or Bypass Mode[2](VDD = 5V, VSSEXT = -3.5V), T_A = 25°C, Control Logic V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, unless otherwise noted.

Table 2. RFC-to-RFx Isolation

"ON" Port	Frequency	RFC to RFx Isolation				Unit
		RF1	RF2	RF3	RF4	
RF1	1GHz	-	81	74	93	dB
	2GHz	-	71	68	85	
	3GHz	-	64	66	73	
	4GHz	-	59	64	64	
	5GHz	-	55	62	58	
	6GHz	-	51	58	52	
	7GHz	-	46	52	47	
	8GHz	-	43	47	42	
	9GHz	-	39	43	39	
	10GHz	-	35	38	35	
RF2	1GHz	88	-	69	95	
	2GHz	80	-	63	81	
	3GHz	70	-	61	70	
	4GHz	63	-	60	63	
	5GHz	56	-	62	57	
	6GHz	51	-	72	51	
	7GHz	46	-	60	47	
	8GHz	42	-	49	42	
	9GHz	38	-	44	39	
	10GHz	34	-	39	35	
RF3	1GHz	87	69	-	89	
	2GHz	78	63	-	85	
	3GHz	69	61	-	72	
	4GHz	63	60	-	64	
	5GHz	57	61	-	57	
	6GHz	52	71	-	51	
	7GHz	47	59	-	46	
	8GHz	43	49	-	41	
	9GHz	39	43	-	38	
	10GHz	35	38	-	34	
RF4	1GHz	93	74	84	-	
	2GHz	83	68	71	-	
	3GHz	72	66	65	-	
	4GHz	64	65	59	-	
	5GHz	58	63	55	-	
	6GHz	52	58	51	-	
	7GHz	48	53	47	-	
	8GHz	43	47	43	-	
	9GHz	39	42	39	-	
	10GHz	35	37	36	-	

Isolation Matrix

Typical conditions are Normal Mode[1](VDD = 5V, VSSEXT= 0V) or Bypass Mode[2](VDD = 5V, VSSEXT = -3.5V), T_A = 25°C, Control Logic V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, unless otherwise noted.

Table 3. RFx-to-RFx Isolation

"ON" Port	Frequency	RFx to RFx Isolation				Unit
		RF1	RF2	RF3	RF4	
RF1	1GHz	-	67	86	75	dB
	2GHz	-	62	74	71	
	3GHz	-	59	66	70	
	4GHz	-	57	60	76	
	5GHz	-	56	56	70	
	6GHz	-	55	52	59	
	7GHz	-	53	48	52	
	8GHz	-	47	43	45	
	9GHz	-	43	39	40	
	10GHz	-	38	35	36	
RF2	1GHz	71	-	77	73	
	2GHz	65	-	66	69	
	3GHz	63	-	59	68	
	4GHz	63	-	54	72	
	5GHz	67	-	50	73	
	6GHz	56	-	46	60	
	7GHz	50	-	42	52	
	8GHz	42	-	39	45	
	9GHz	32	-	35	41	
	10GHz	25	-	32	36	
RF3	1GHz	73	78	-	68	
	2GHz	69	66	-	63	
	3GHz	68	59	-	62	
	4GHz	71	54	-	64	
	5GHz	78	50	-	68	
	6GHz	60	46	-	57	
	7GHz	53	42	-	49	
	8GHz	45	39	-	42	
	9GHz	41	35	-	38	
	10GHz	36	31	-	34	
RF4	1GHz	75	87	68	-	
	2GHz	71	74	62	-	
	3GHz	70	66	59	-	
	4GHz	75	61	57	-	
	5GHz	72	56	56	-	
	6GHz	59	52	55	-	
	7GHz	52	47	53	-	
	8GHz	45	43	47	-	
	9GHz	41	39	43	-	
	10GHz	36	35	39	-	

Product Description

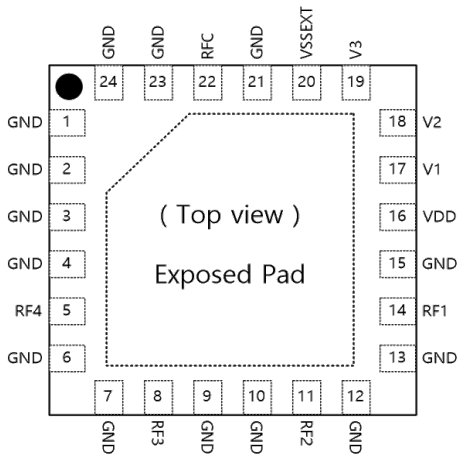


Figure 3. Pin Description

Table 4. Pin Descriptions

No.	Pin Name	Descriptions
16	VDD	Supply Voltage
20	VSSEXT	Ground or External negative Voltage
19	V3	Switch control input 3 or Ground (See table 6)
18	V2	Switch control input 2
17	V1	Switch control input 1
5	RF4	RF4 Port
8	RF3	RF3 Port
11	RF2	RF2 Port
14	RF1	RF1 Port
22	RFC	RFC Port
1,2,3,4,6, 7,9,10,12, 13,15,21,23,24	GND	Ground
Pad	Exposed Pad	Ground

Table 5. 3-pin Control Truth Table

V3	V2	V1	RFC-RF1	RFC-RF2	RFC-RF3	RFC-RF4
0	0	0	OFF	OFF	OFF	ON[1]
0	0	1	ON	OFF	OFF	OFF
0	1	0	OFF	ON	OFF	OFF
0	1	1	OFF	OFF	ON	OFF
1	0	0	OFF	OFF	OFF	ON[1]
1	0	1	OFF[2]	OFF[2]	OFF[2]	OFF[2]
1	1	0	OFF[2]	OFF[2]	OFF[2]	OFF[2]
1	1	1	OFF[2]	OFF[2]	OFF[2]	OFF[2]

1. Logic state 000 is redundant RF4 ON state of 100.
2. Logic state 101, 110 and 111 are all path OFF mode.

Table 6. 2-pin Control[1] Truth Table

V2	V1	RFC-RF1	RFC-RF2	RFC-RF3	RFC-RF4
0	0	OFF	OFF	OFF	ON
0	1	ON	OFF	OFF	OFF
1	0	OFF	ON	OFF	OFF
1	1	OFF	OFF	ON	OFF

1. 2-pin control is used only V1 and V2 pin. In this case, V3 pin (Pin 19) must be grounded.

Table 7. Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Unit
Normal Mode[1]	Supply Voltage	VDD	2.7	5	5.5	V
	Supply Current	IDD	-	200	-	μA
Bypass Mode[2]	Supply Voltage	VDD	2.7	5	5.5	V
	Supply Current	IDD	-	160	-	μA
	Negative Supply Voltage	VSSEXT	-	-3.5	-3.2	V
Digital Input Voltage (V1/V2/V3)		V_{IH}	1.17	-	3.6	V
		V_{IL}	0	-	0.6	V
Digital Input Current (V1/V2/V3)		I_{CTRL}	-	-	10	uA
Operating Temperature Range		T_{OP}	-40	+25	+125	°C
RF Input Power, CW (Active Port, +25°C)		$P_{Max,Act\_+25℃}$	-	-	31	dBm
RF Input Power, CW (Active Port, +125°C)		$P_{Max,Act\_+125℃}$	-	-	31	dBm
RF Input Power, CW (Terminated Port, +25°C)		$P_{Max,Term\_+25℃}$	-	-	27	dBm
RF Input Power, CW (Terminated Port, +125°C)		$P_{Max,Term\_+125℃}$	-	-	24	dBm

* Specifications are not guaranteed over all recommended operating conditions.
1. Normal Mode : Single external positive supply voltage(VDD) is inputted.
2. Bypass Mode : Both external positive supply voltage(VDD) and external negative voltage(VSSEXT) are inputted.

Table 8. Absolute Maximum Ratings

Parameter			Symbol	Min	Max	Unit
Supply Voltage			VDD	-0.3	5.5	V
Digital Input Voltage			V1/V2/V3	-0.3	3.6	V
Maximum Input Power, CW (+25°C)			$P_{Max\_Abs\_+25℃}$	-	35	dBm
Maximum Input Power, CW (+125°C)			$P_{Max\_Abs\_+125℃}$	-	33	dBm
Storage Temperature range			T_{ST}	-65	+150	°C
ESD	HBM[1]	All pins	V_{ESDHBM}	-	1500	V
	CDM[2]	All pins	V_{ESDCDM}	-	1000	V

1. HBM Standard : JEDEC Standard JS-001-2017
2. CDM Standard : JEDEC Standard JS-002-2018

Typical Performances

Typical conditions are Normal mode, VDD = 5V, T_A = 25°C, V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, PCB and RF Connector loss are de-embedded, unless otherwise noted.

Figure 4. Insertion Loss vs Frequency

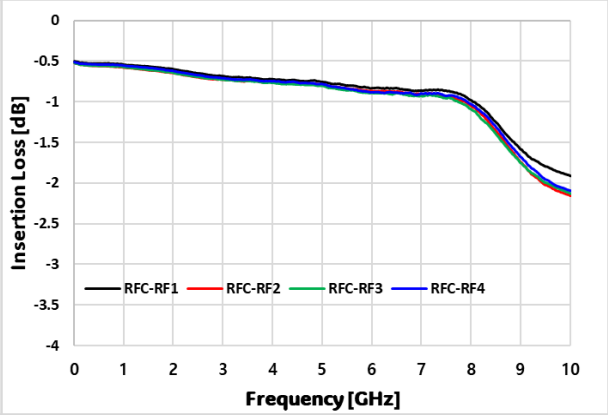


Figure 5. Insertion Loss vs VDD (RFC-RF1)

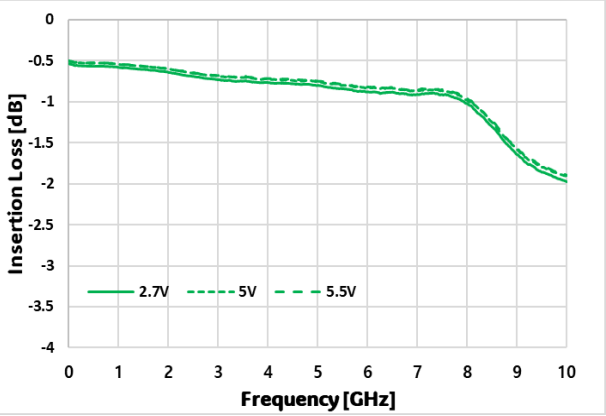


Figure 6. Insertion Loss vs Temp (RFC-RF1)

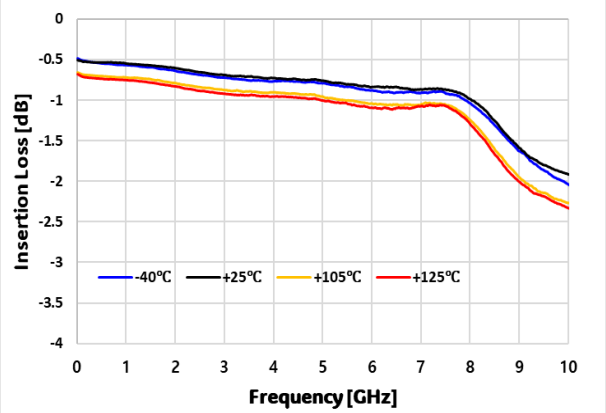


Figure 7. Return Loss vs Frequency (RFC Port)

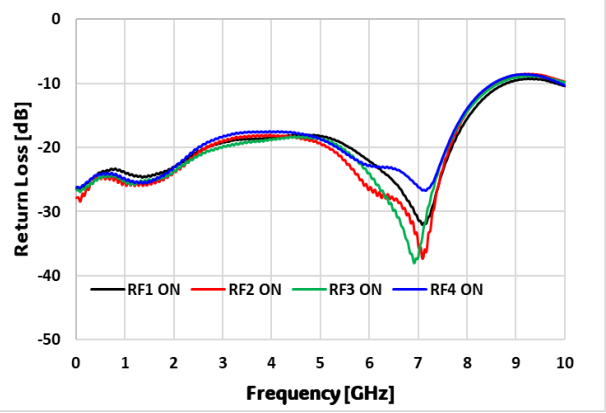


Figure 8. Return Loss vs VDD (RFC Port)

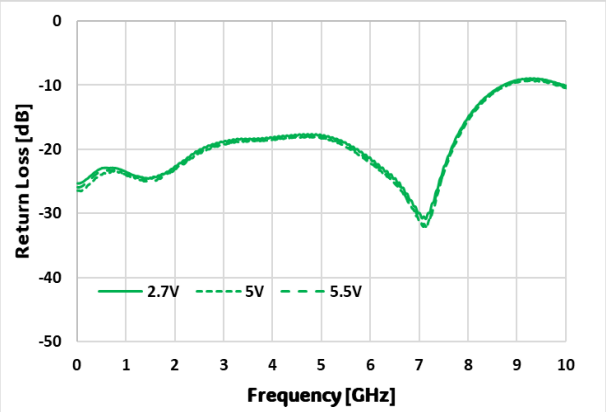
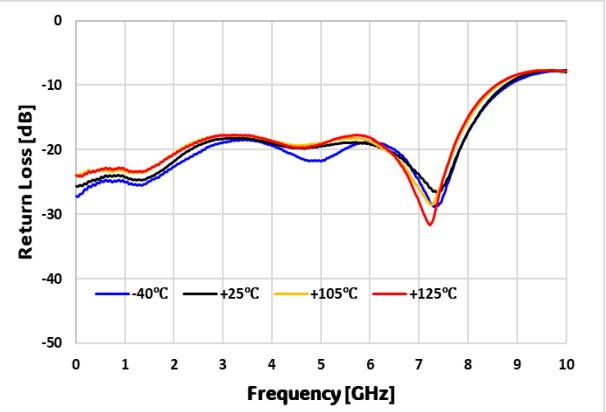


Figure 9. Return Loss vs Temp (RFC Port)



Typical Performances

Typical conditions are Normal mode, VDD = 5V, T_A = 25°C, V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, PCB and RF Connector loss are de-embedded, unless otherwise noted.

Figure 10. Return Loss vs Frequency (Active Port)

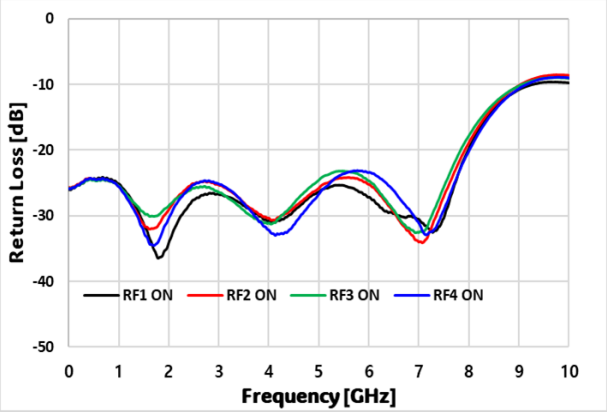


Figure 11. Return Loss vs VDD (Active Port)

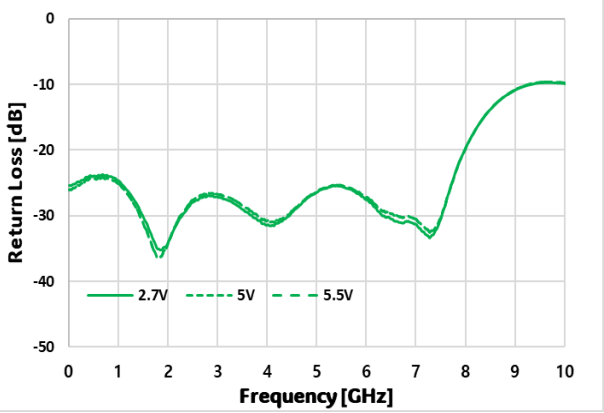


Figure 12. Return Loss vs Temp (Active Port)

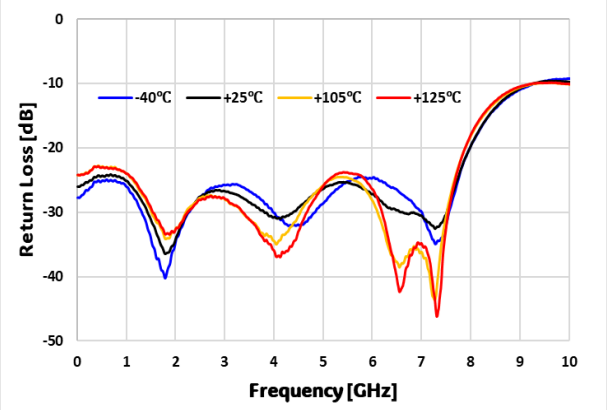


Figure 13. Return Loss vs Frequency (Terminated Port)

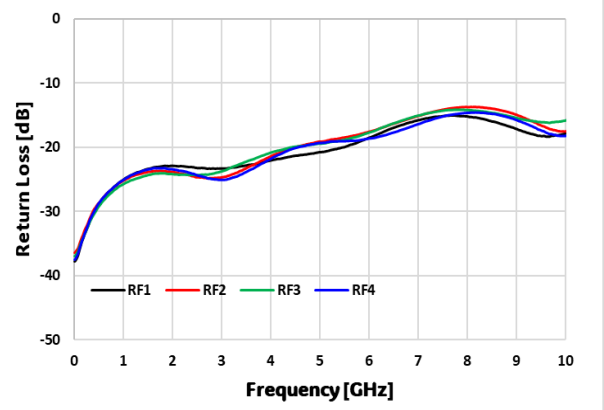


Figure 14. Return Loss vs VDD (Terminated Port)

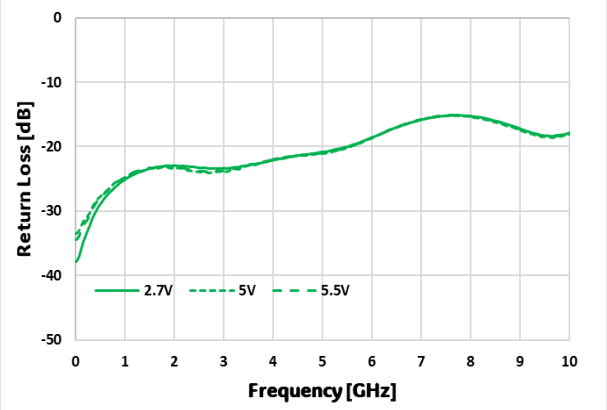
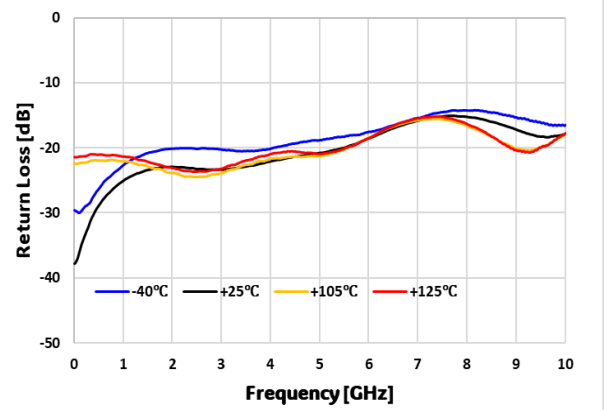


Figure 15. Return Loss vs Temp (Terminated Port)



Typical Performances

Typical conditions are Normal mode, VDD = 5V, T_A = 25°C, V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, PCB and RF Connector loss are de-embedded, unless otherwise noted.

Figure 16. Isolation vs Frequency (RFC to RFx)

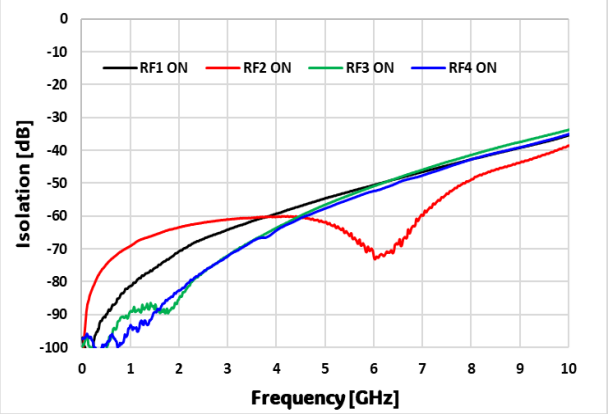


Figure 17. Isolation vs Frequency (RFC to RFx, RF1 ON)

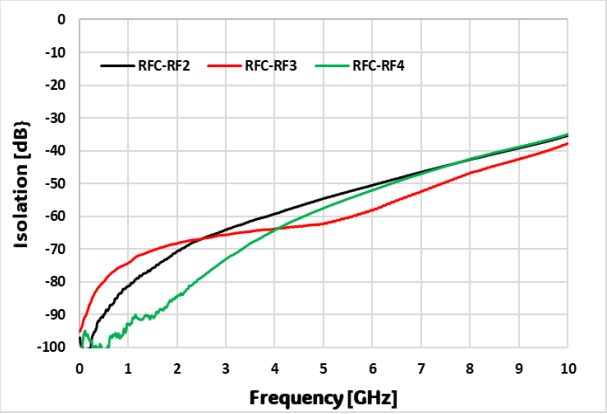


Figure 18. Isolation vs VDD (RFC to RF3, RF1 ON)

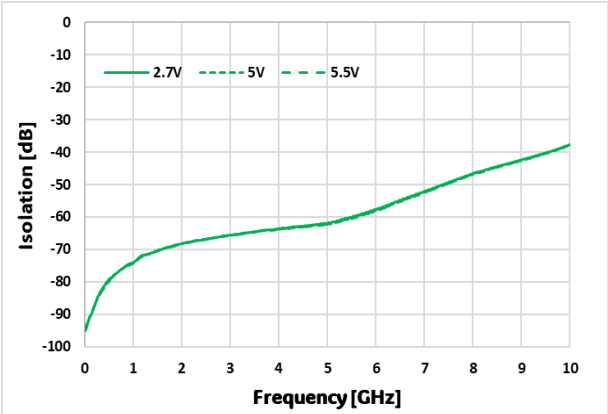


Figure 19. Isolation vs Temp (RFC to RF3, RF1 ON)

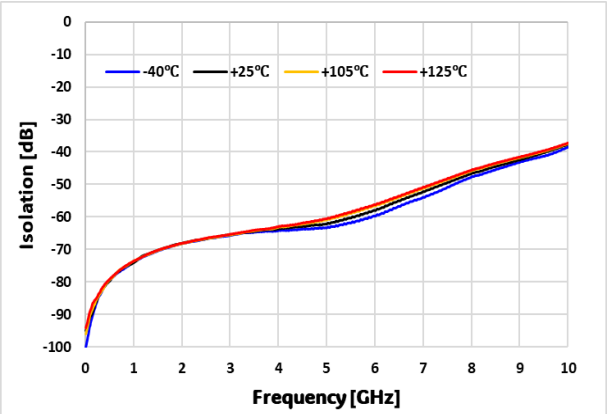


Figure 20. Isolation vs Frequency (RFx to RFx)

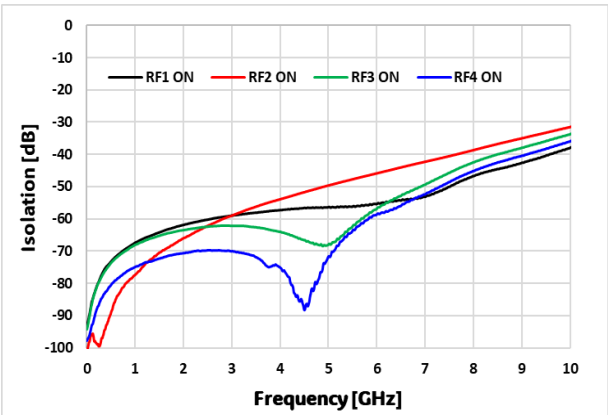
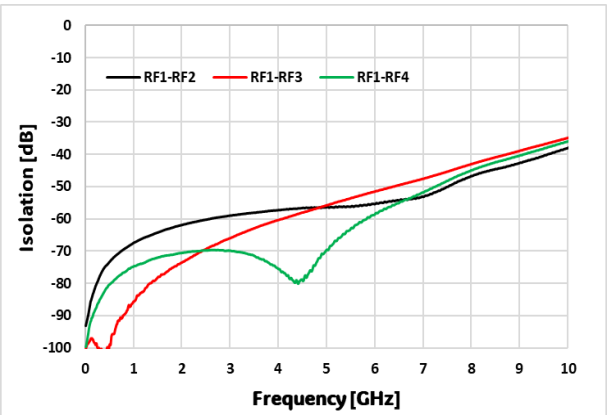


Figure 21. Isolation vs Frequency (RF1 to RFx, RF1 ON)



Typical Performances

Typical conditions are Normal mode, VDD = 5V, T_A = 25°C, V1/V2/V3 Low = 0V, V1/V2/V3 High = 3.3V, Z_L = 50Ω, PCB and RF Connector loss are de-embedded, unless otherwise noted.

Figure 22. Isolation vs VDD (RF1 to RF2, RF1 ON)

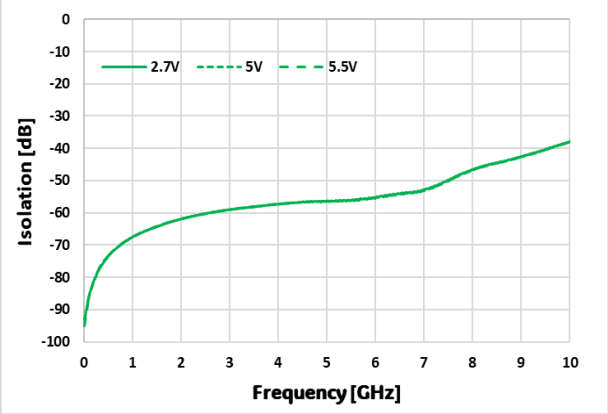


Figure 23. Isolation vs Temp (RF1 to RF2, RF1 ON)

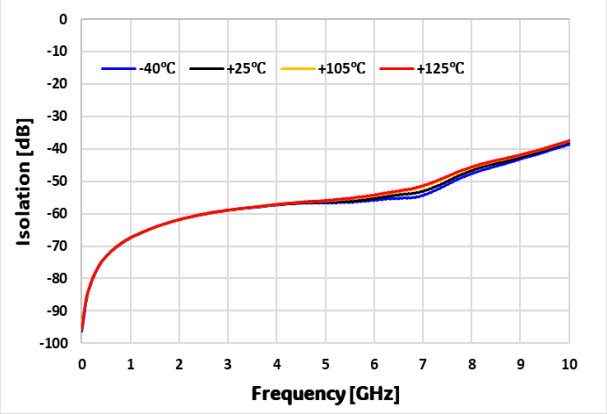


Figure 24. IIP3 vs RF Port

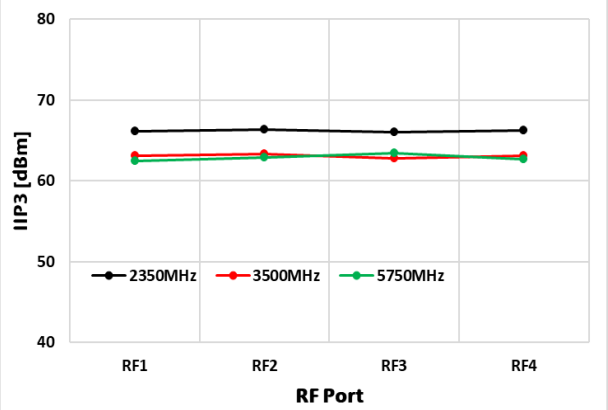
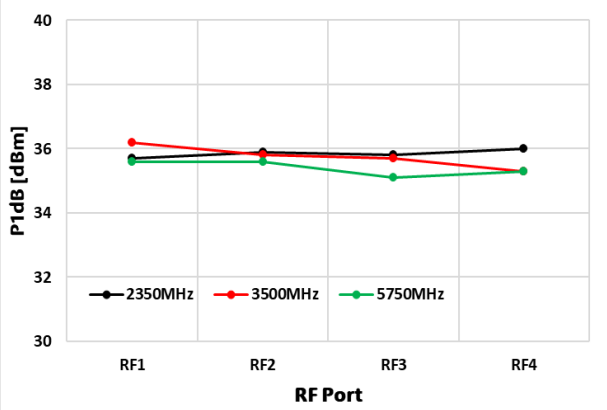
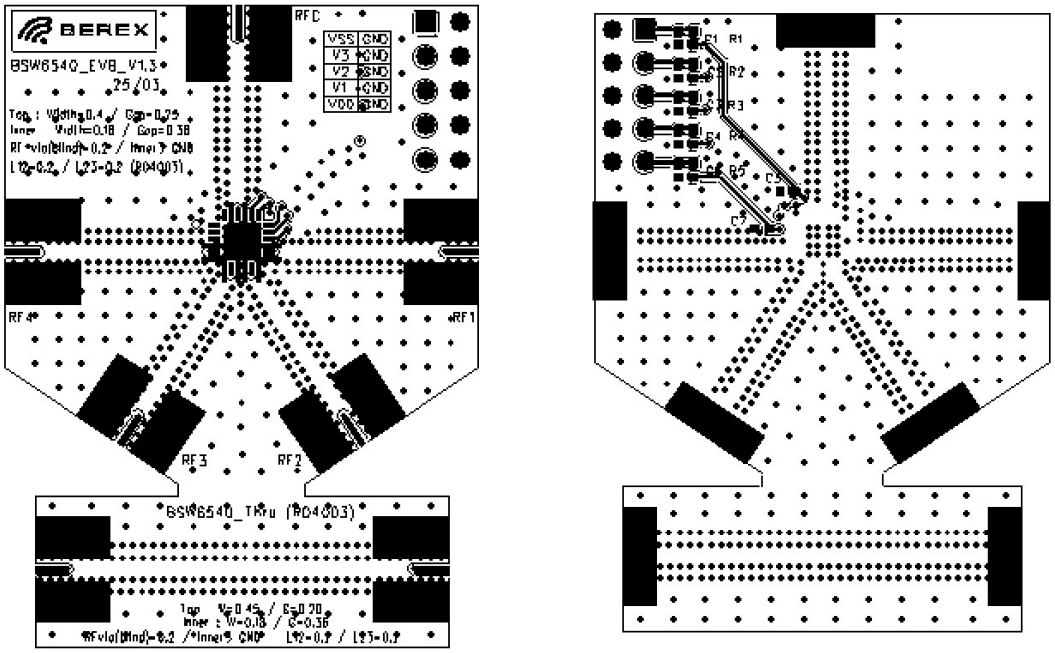


Figure 25. P1dB vs RF Port



Evaluation Board



[Top view] [Bottom view]

Figure 26. Evaluation Board Layout

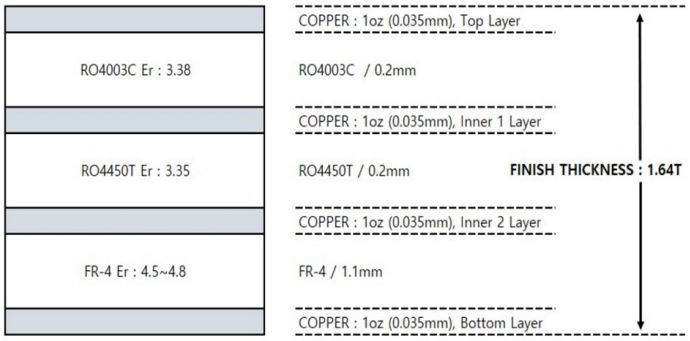


Figure 27. Evaluation Board PCB Layer Information

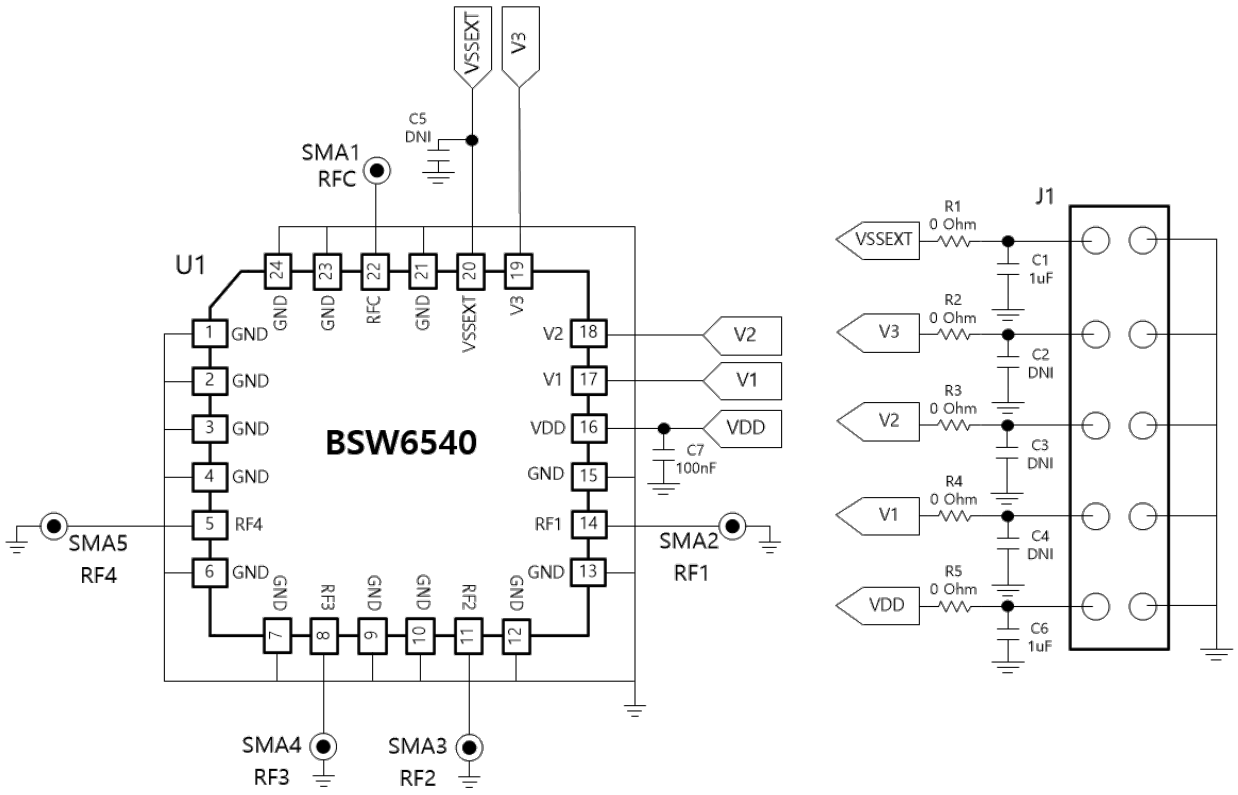
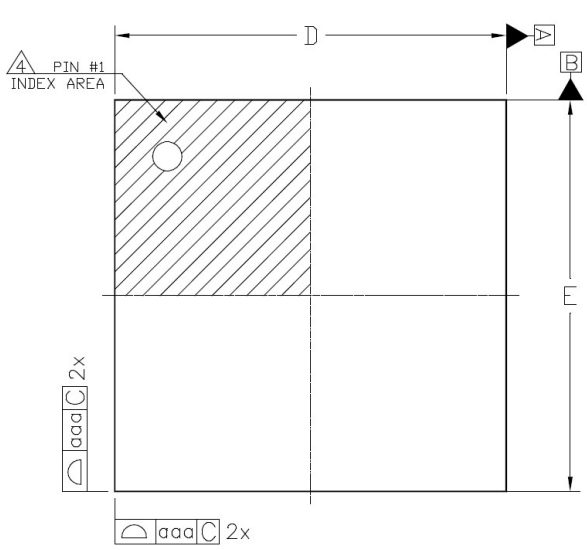


Figure 28. Evaluation Board Schematic

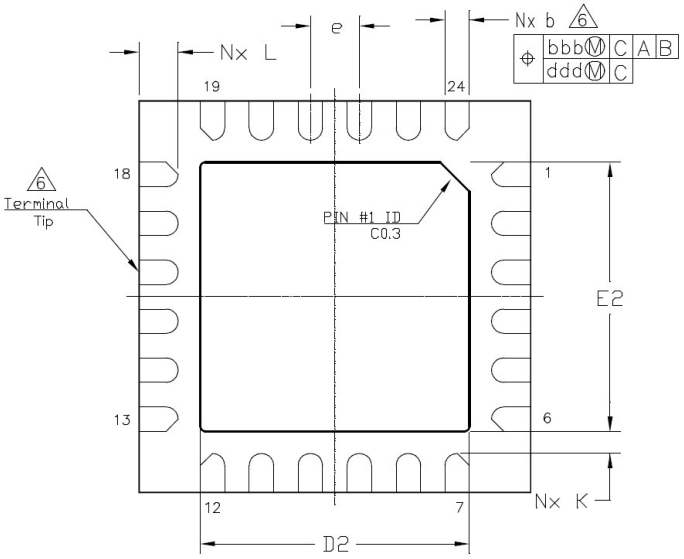
Table 9. Bill of Material - Evaluation Board

No.	Ref Des	Part Qty	Value	Description	Remark
1	C1,C6	2	1uF	CAP 1005 J 50V	
2	C7	1	100nF	CAP 1005 J 50V	
3	C2,C3,C4,C5	4	DNI	CAP 1005	
4	R1,R2,R3,R4,R5	5	0 ohm	RES 1005 J 50V	
5	J1	1	2.54mm	2x5 pin Header	
6	RFC,RF1,RF2,RF3,RF4	5	CON	SMA_END_LAUNCH	
7	U1	1	Chip	BSW6540	

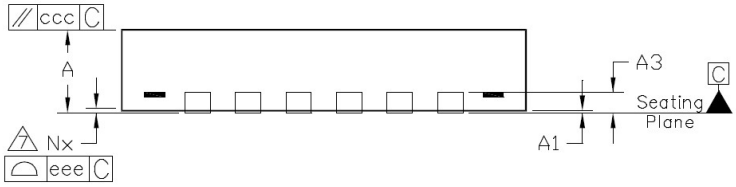
Package Outline Drawing



[Top View]



[Bottom View]



[Side View]

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5–2009.
2. All dimensions are in millimeters.
3. N is the total number of terminals.
4. The location of the marked terminal #1 identifier is within the hatched area.
5. ND and NE refer to the number of terminals each D and E side respectively.
6. Dimension b applies to the metallized terminal and is measured between 0.15mm and 0.3mm from the terminal tip. If the terminal has a radius on the other end of it, dimension b should not be measured in that radius area.
7. Coplanarity applies to the terminals and all other bottom surface metallization.

Dimension Table (Notes 1,2)				
Symbol Thickness	Min	Nominal	Max	Note
A	0.70	0.75	0.80	
A1	0.00	0.02	0.05	
A3	---	0.203 Ref.	---	6
b	0.20	0.25	0.30	
D		4.00 BSC		
E		4.00 BSC		
e		0.50 BSC		
D2	2.65	2.70	2.75	
E2	2.65	2.70	2.75	
K	0.2	---	---	
L	0.30	0.40	0.50	
aaa		0.05		
bbb		0.10		
ccc		0.10		
ddd		0.05		
eee		0.08		
N		24		3
ND		6		5
NE		6		5

Figure 29. Package Outline Drawing

Recommended Land Pattern

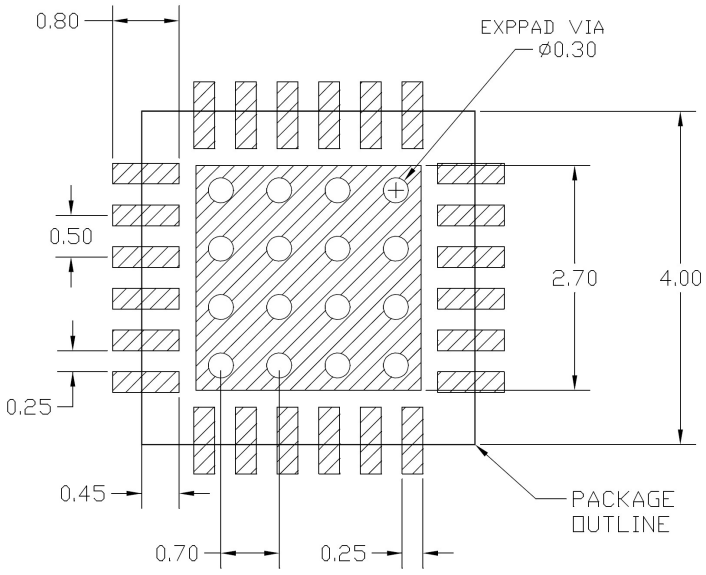


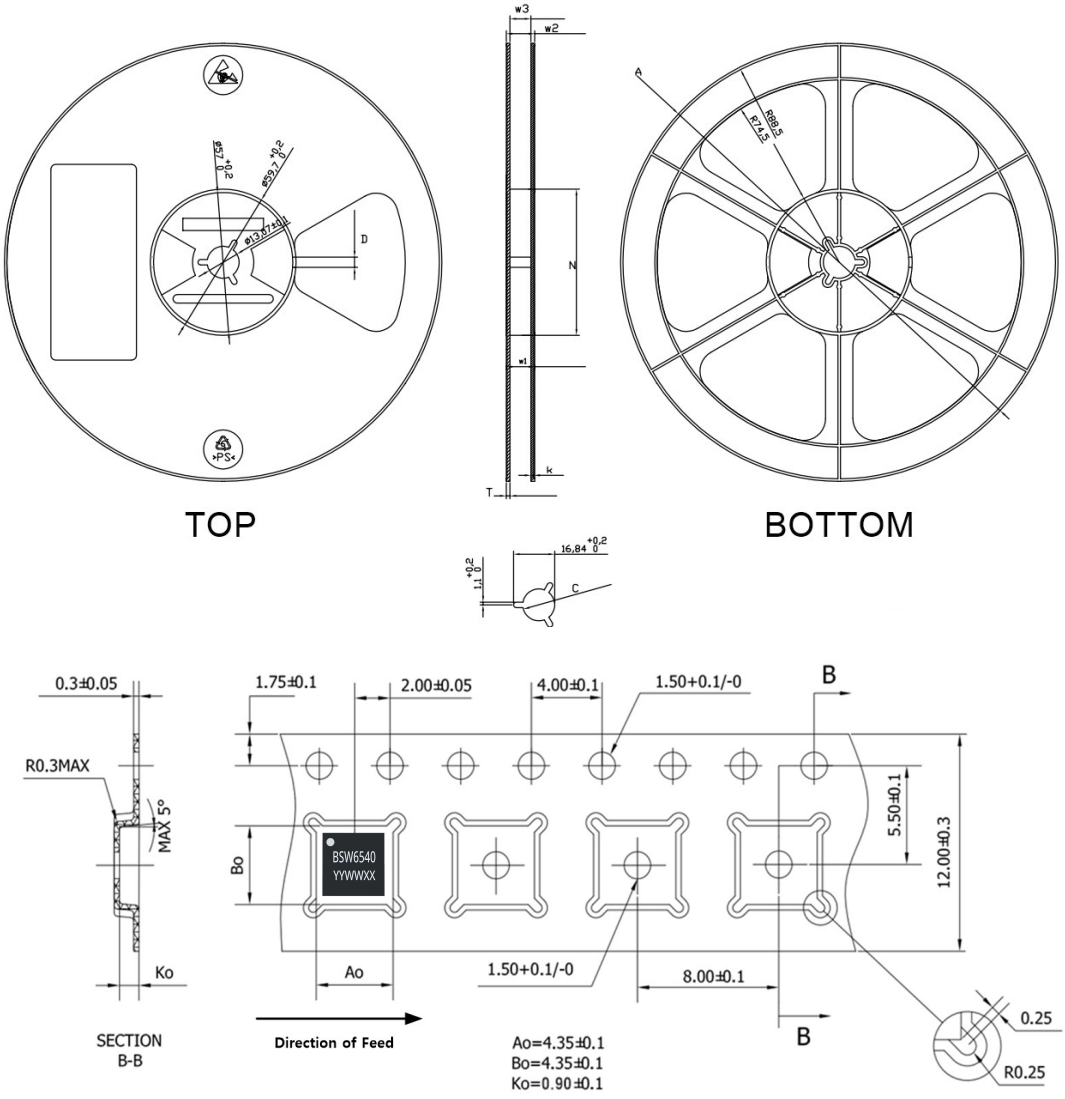
Figure 30. Recommended Land Pattern

Package Marking

Marking information:	
BSW	BeRex RF Switch
6540	The name of switch
YY	Year
WW	Work Week
XX	Wafer Run Number

Figure 31. Package Marking

Tape & Reel (TBD)



NOTES:
1 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2 CAMBER IN COMPLANCE WITH EIA 481
3 POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET,NOT POCKET HOLE

Packaging information:	
Tape Width	12mm
Reel Size	7inch
Device Cavity Pitch	8mm
Device Per Reel	1000EA

Figure 32. Tape & Reel

Lead plating finish

100% Tin Matte finish

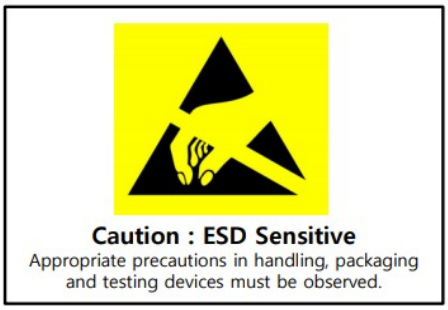
(All BeRex products undergo a 1 hour, 150℃, anneal bake to eliminate thin whisker growth concerns.)

ESD / MSL Rating

ESD information1 :	
Rating	Class 1C (1500V)
Test	Human Body Model (HBM)
Standard	JEDEC Standard JS-001-2017

ESD information2 :	
Rating	Class C3 (1000V)
Test	Charged Device Model (CDM)
Standard	JEDEC Standard JS-002-2018

MSL information:	
Rating	Level 1 at +260°C convection reflow
Standard	JEDEC Standard J-STD-020



Proper ESD procedures should be followed when handling the device.

RoHS Compliance

This part is compliant with Restrictions on the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU as amended by Directive 2015/863/EU.

This product also is compliant with a concentration of the Substances of Very High Concern (SVHC) candidate list which are contained in a quantity of less than 0.1%(w/w) in each components of a product and/or its packaging placed on the European Community market by the BeRex and Suppliers.

NATO CAGE code:

2	**N**	**9**	**6**	**F**