

Product Description

The BSW6543 is a 50-ohm matched absorptive SP4T RF switch that provides ultra-high isolation with frequency coverage up to 10 GHz.

The BSW6543 is designed with high linearity and reliability, making it suitable for wireless communication applications such as 4G/5G/6G infrastructure.

The BSW6543 operates over a wide VDD range of 2.7V to 5.5V and is controlled via 3 logic pins.

The BSW6543 is designed with ESD protection circuits at all pins and packaged in an industry standard, fully RoHS2-compliant, 20-Lead, 3mm x 3mm x 0.55mm QFN thin package.

The BSW6543 does not require blocking capacitors. If DC is presented at the RF port, add a blocking capacitor.

Package Type



3mm x 3mm x 0.55mm, 20-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
 - : 0.61dB @ 2GHz
 - : 0.72dB @ 4GHz
 - : 0.81dB @ 6GHz
- High Isolation
 - RFC to RFx
 - : 68dB @ 2GHz
 - : 57dB @ 4GHz
 - : 49dB @ 6GHz
 - RFx to RFx
 - : 59dB @ 2GHz
 - : 54dB @ 4GHz
 - : 53dB @ 6GHz
- High Input 1dB Compression
 - : 36.5dBm @ 2.35GHz
 - : 36.8dBm @ 3.5GHz
 - : 36.6dBm @ 5.75GHz
- High IIP3
 - : 64dBm @ 2.35GHz
 - : 62dBm @ 3.5GHz
 - : 62dBm @ 5.75GHz
- Fast Switching Time : 180ns
- Operating temperature range : -40°C to +125°C
- ESD, HBM : 1.0kV
- 20-Lead QFN package : 3.0mm x 3.0mm x 0.55mm
- Lead-free/RoHS2-compliant QFN SMT package

Block Diagram

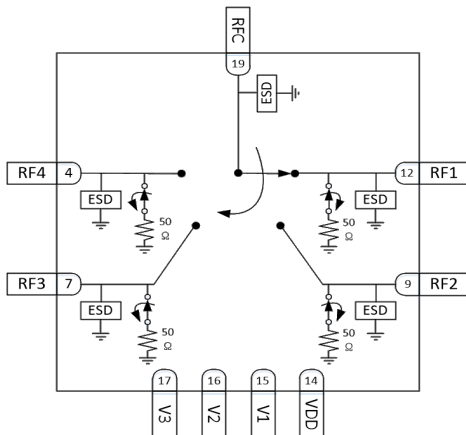


Figure 1. Functional Block Diagram

Applications

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

Electrical Specifications

Typical conditions are VDD = 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		0.55		dB
		2GHz		0.61		
		3GHz		0.65		
		4GHz		0.72		
		5GHz		0.83		
		6GHz		0.81		
		7GHz		0.79		
		8GHz		1.06		
		9GHz		1.43		
		10GHz		1.56		
	RFC - RF2	1GHz		0.52		dB
		2GHz		0.58		
		3GHz		0.63		
		4GHz		0.70		
		5GHz		0.79		
		6GHz		0.78		
		7GHz		0.80		
		8GHz		1.06		
		9GHz		1.49		
		10GHz		1.77		
	RFC - RF3	1GHz		0.53		dB
		2GHz		0.59		
		3GHz		0.64		
		4GHz		0.73		
		5GHz		0.82		
		6GHz		0.81		
		7GHz		0.83		
		8GHz		1.09		
		9GHz		1.53		
		10GHz		1.82		
	RFC - RF4	1GHz		0.53		dB
		2GHz		0.58		
		3GHz		0.63		
		4GHz		0.71		
		5GHz		0.81		
		6GHz		0.80		
		7GHz		0.80		
		8GHz		1.03		
		9GHz		1.43		
		10GHz		1.65		
Return Loss (Active port)	RFC, RFx	5MHz - 7GHz 7GHz - 10GHz		15 10		dB
Return Loss (Terminated port)	RFC, RFx	5MHz - 10GHz		20		dB

Table 1. Electrical Specifications (Cont.)

Parameter	Path	Conditions	Min	Typ	Max	Unit
Input P1dB	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		36.5 36.8 36.6		dBm
Input IP2 ¹	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		121 104 105		dBm
Input IP3 ¹	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		64 62 62		dBm
2 nd Harmonic ²	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		109 92 92		dBc
3 rd Harmonic ²	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		101 98 97		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 95		ns
Settling Time	RFC - RFx	50% CTRL to 0.05dB final value Rising Edge 50% CTRL to 0.05dB final value Falling Edge		225 100		ns
Maximum Spurious Level		1MHz - 10MHz > 10MHz ³		-127 < -140		dBm/10Hz

1. Tone Power is +18dBm and Tone spacing is 20kHz .
2. Tone Power is +18dBm.
3. No spurious signals were detected above 10MHz.

Isolation Matrix

Typical conditions are VDD = 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	-	77	68	74	dB
	2GHz	-	68	62	69	
	3GHz	-	62	59	68	
	4GHz	-	57	57	68	
	5GHz	-	53	56	62	
	6GHz	-	49	55	55	
	7GHz	-	45	53	50	
	8GHz	-	42	50	45	
	9GHz	-	39	47	41	
	10GHz	-	36	43	37	
RF2	1GHz	81	-	79	75	
	2GHz	74	-	70	71	
	3GHz	66	-	63	69	
	4GHz	60	-	59	67	
	5GHz	54	-	57	60	
	6GHz	50	-	52	54	
	7GHz	46	-	49	49	
	8GHz	42	-	46	45	
	9GHz	38	-	44	41	
	10GHz	35	-	42	38	
RF3	1GHz	79	78	-	79	
	2GHz	75	70	-	74	
	3GHz	73	62	-	67	
	4GHz	69	58	-	62	
	5GHz	60	57	-	55	
	6GHz	54	51	-	50	
	7GHz	49	48	-	46	
	8GHz	45	45	-	42	
	9GHz	41	43	-	38	
	10GHz	38	41	-	36	
RF4	1GHz	76	68	76	-	
	2GHz	72	62	68	-	
	3GHz	71	59	62	-	
	4GHz	74	57	57	-	
	5GHz	63	56	53	-	
	6GHz	56	55	49	-	
	7GHz	50	53	46	-	
	8GHz	45	49	43	-	
	9GHz	41	46	40	-	
	10GHz	37	42	37	-	

High Isolation Absorptive SP4T RF Switch
5MHz-10000MHz
Isolation Matrix

Typical conditions are VDD = 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	-	65	74	70	dB
	2GHz	-	59	68	65	
	3GHz	-	56	63	63	
	4GHz	-	54	60	63	
	5GHz	-	53	56	68	
	6GHz	-	53	52	70	
	7GHz	-	52	49	55	
	8GHz	-	49	45	48	
	9GHz	-	50	42	44	
	10GHz	-	46	38	39	
RF2	1GHz	64	-	59	69	
	2GHz	59	-	52	64	
	3GHz	56	-	48	62	
	4GHz	55	-	45	61	
	5GHz	55	-	42	64	
	6GHz	59	-	40	76	
	7GHz	60	-	38	57	
	8GHz	50	-	35	49	
	9GHz	46	-	33	45	
	10GHz	40	-	31	39	
RF3	1GHz	68	58	-	65	
	2GHz	63	52	-	60	
	3GHz	60	48	-	58	
	4GHz	59	45	-	57	
	5GHz	61	42	-	58	
	6GHz	66	40	-	67	
	7GHz	59	38	-	61	
	8GHz	49	35	-	50	
	9GHz	45	33	-	46	
	10GHz	40	31	-	39	
RF4	1GHz	69	75	65	-	
	2GHz	64	69	59	-	
	3GHz	62	64	56	-	
	4GHz	61	60	54	-	
	5GHz	63	57	53	-	
	6GHz	68	52	53	-	
	7GHz	57	49	52	-	
	8GHz	48	45	50	-	
	9GHz	44	41	51	-	
	10GHz	39	38	50	-	

Product Description

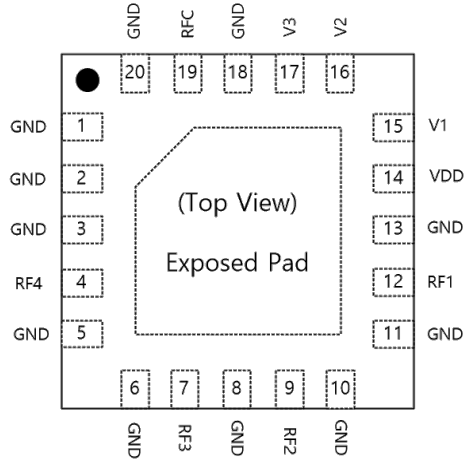


Figure 3. Pin Description

Table 4. Pin Descriptions

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

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

Table 6. 2-pin Control¹ 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

- 2-pin control is used only V1 and V2 pin. In this case, V3 pin (Pin 17) must be grounded.

Table 7. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	VDD	2.7	5	5.5	V
Supply Current	IDD	-	200		μA
Digital Input Voltage (V1/V2/V3)	VIH	1.17	-	3.6	V
	VIL	0	-	0.6	V
Digital Input Current (V1/V2/V3)	ICTRL	-	-	10	uA
Operating Temperature Range	T _A	-40	+25	+125	°C
RF Input Power, CW (Active Port, +25°C)	P _{Max,Active_+25°C}	-	-	31	dBm
RF Input Power, CW (Active Port, +125°C)	P _{Max,Active_+125°C}	-	-	31	dBm
RF Input Power, CW (Terminated Port, +25°C)	P _{Max,Term_+25°C}	-	-	27	dBm
RF Input Power, CW (Terminated Port, +125°C)	P _{Max,Term_+125°C}	-	-	24	dBm

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°C}	-	35	dBm
Maximum Input Power, CW (+125°C)			P _{max_abs_+125°C}	-	33	dBm
Storage Temperature range			-	-65	+150	°C
ESD	HBM ¹	All pins	-	-	1000	V
	CDM ²	All pins	-	-	1000	V

1. HBM Standard : JS-001-2017

2. CDM Standard : JS-002-2018

Typical Performances

Typical conditions are 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

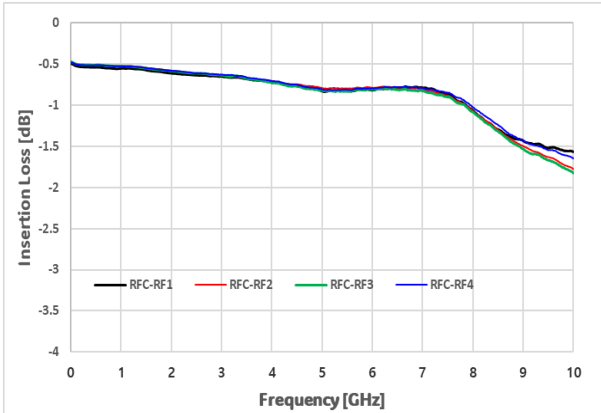


Figure 5. Insertion Loss vs VDD (RFC-RF1)

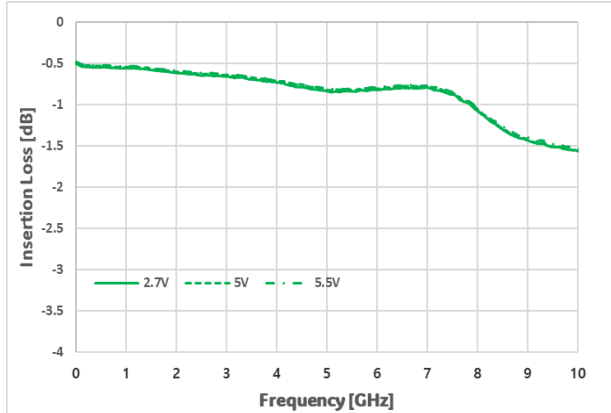


Figure 6. Insertion Loss vs Temp (RFC-RF1)

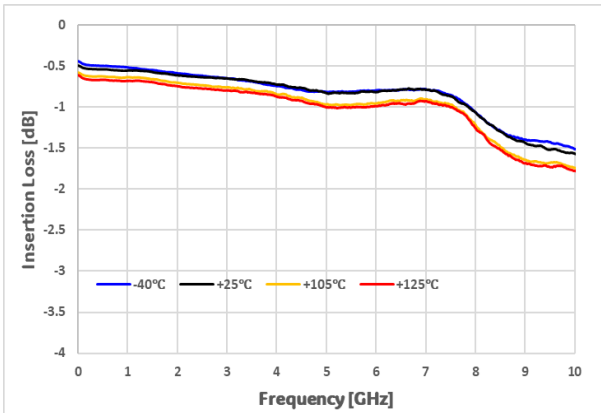


Figure 7. Return Loss vs Frequency (RFC Port)

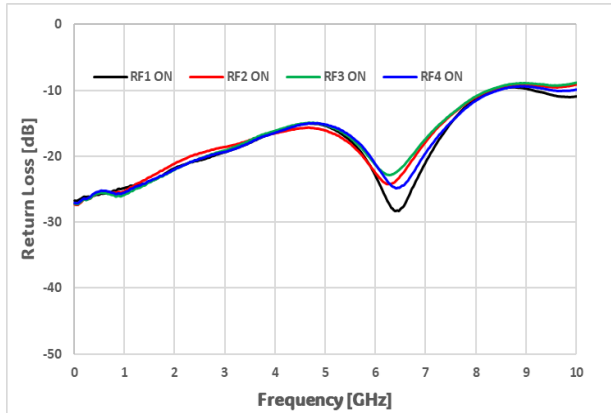


Figure 8. Return Loss vs VDD (RFC Port)

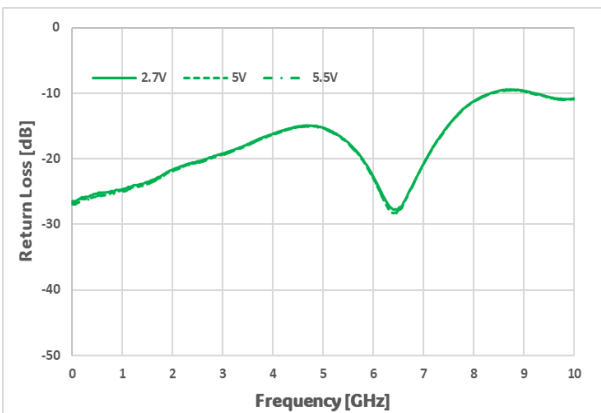
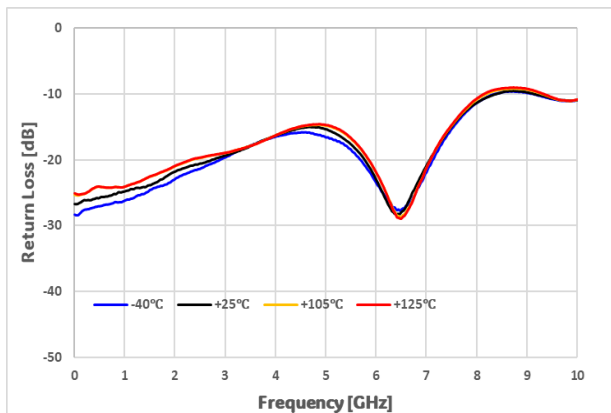


Figure 9. Return Loss vs Temp (RFC Port)



Typical Performances

Typical conditions are 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)

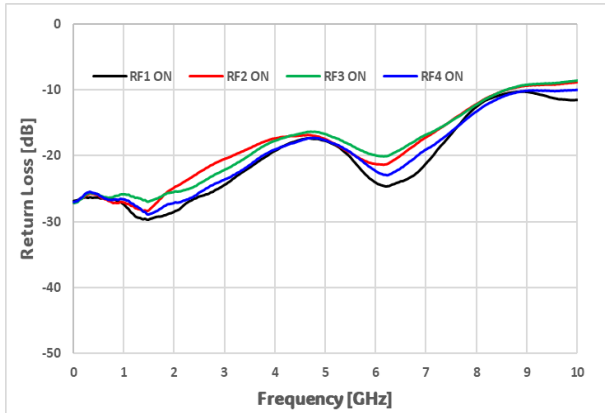


Figure 11. Return Loss vs VDD (Active Port)

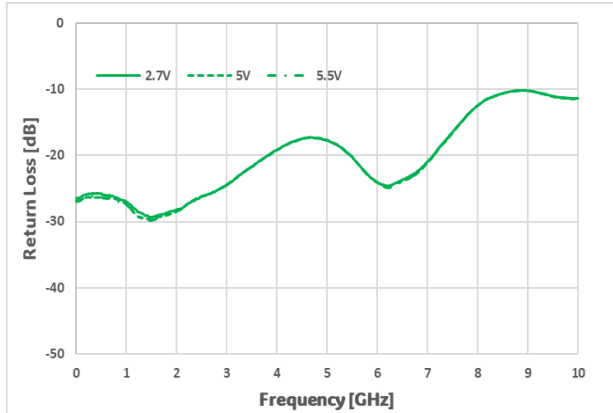


Figure 12. Return Loss vs Temp (Active Port)

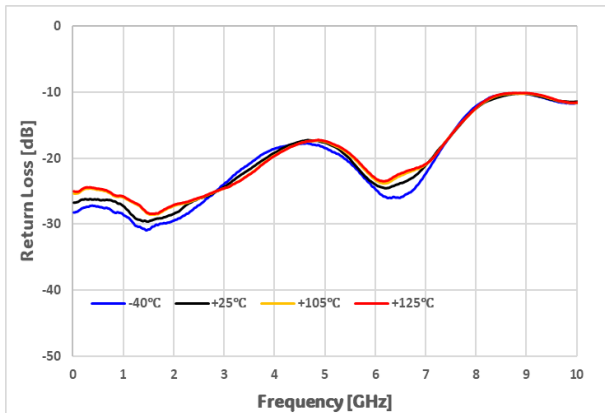


Figure 13. Return Loss vs Frequency (Terminated Port)

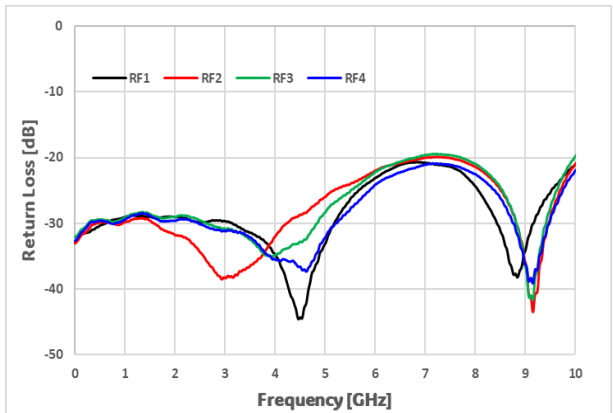


Figure 14. Return Loss vs VDD (Terminated Port)

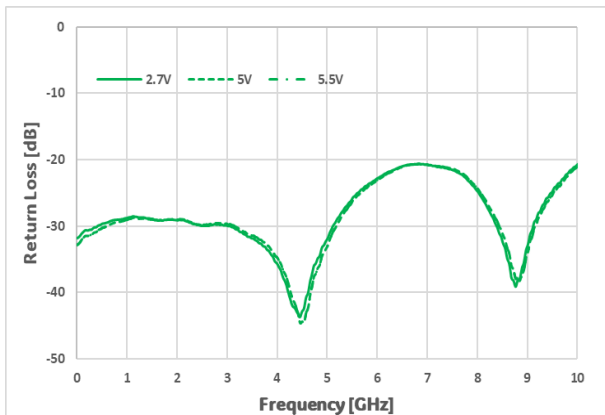
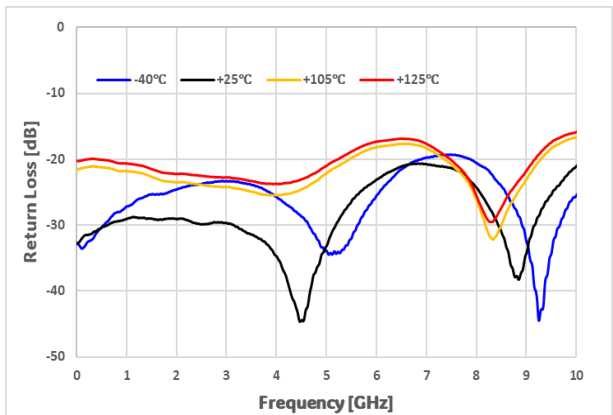


Figure 15. Return Loss vs Temp (Terminated Port)



Typical Performances

Typical conditions are 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)

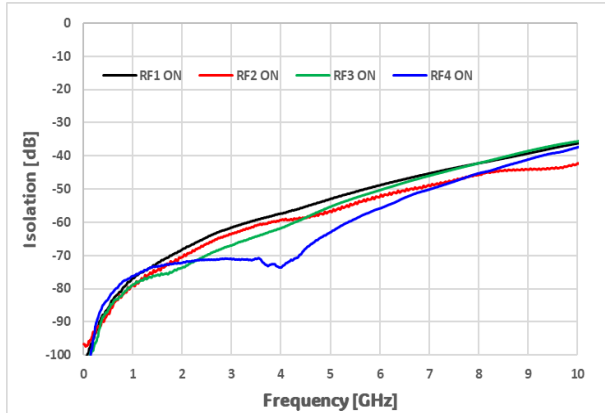


Figure 17. Isolation vs Frequency (RFC to RFx, RF1 ON)

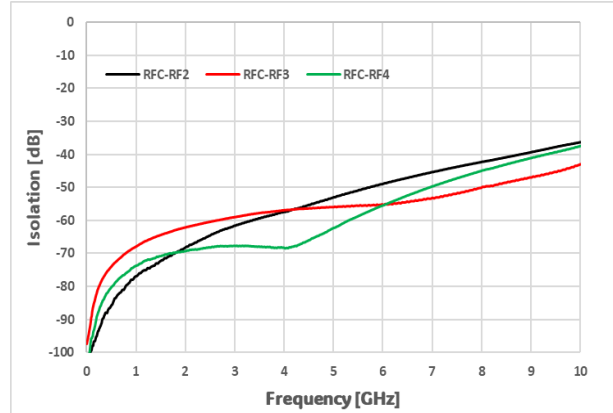


Figure 18. Isolation vs VDD (RFC to RF1, RF2 ON)

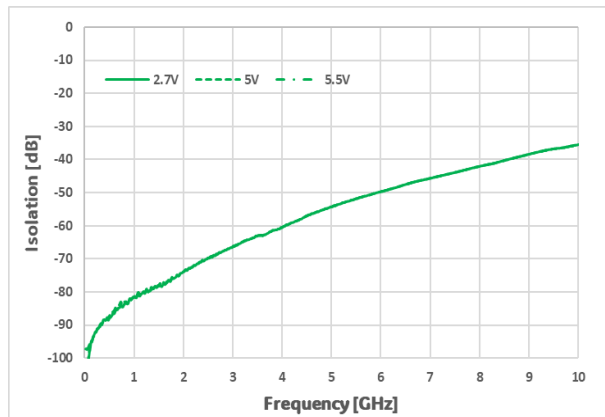


Figure 19. Isolation vs Temp (RFC to RF1, RF2 ON)

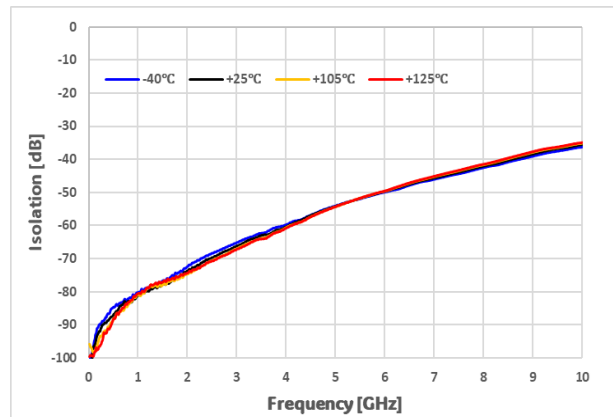


Figure 20. Isolation vs Frequency (RFx to RFx)

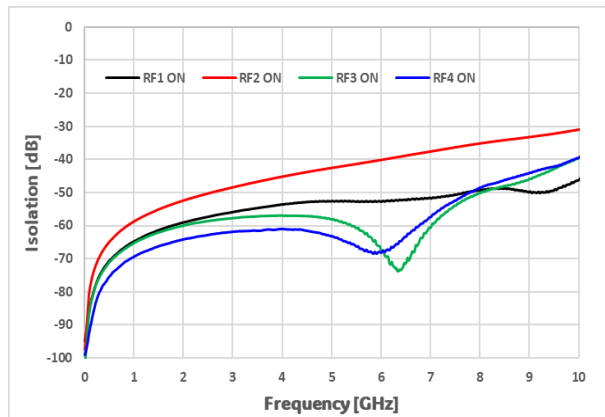
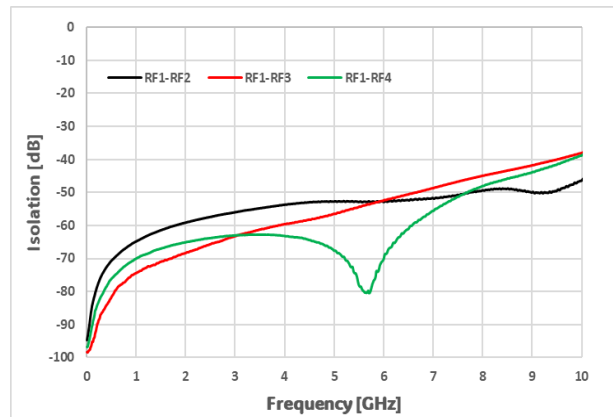


Figure 21. Isolation vs Frequency (RF1 to RFx, RF1 ON)



Typical Performances

Typical conditions are 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)

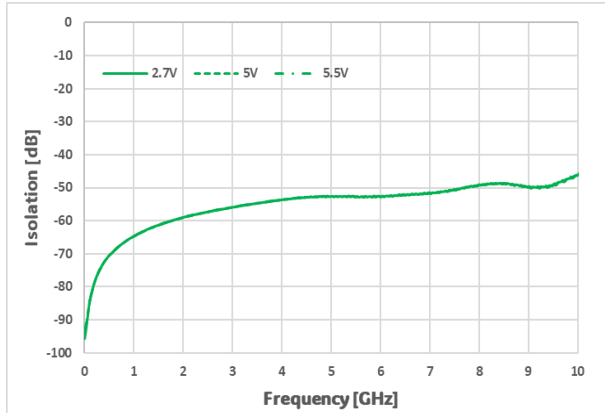


Figure 23. Isolation vs Temp (RF1 to RF2, RF1 ON)

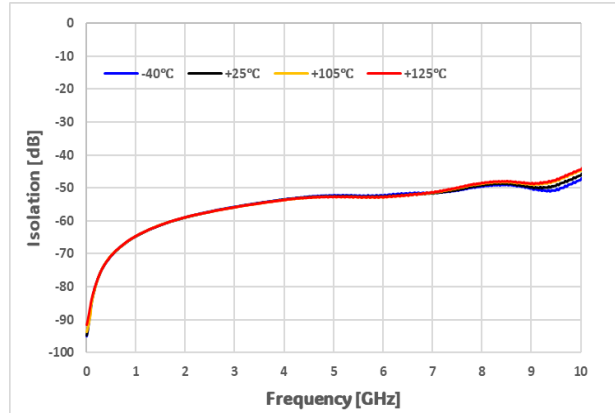


Figure 24. IIP3 vs RF Port

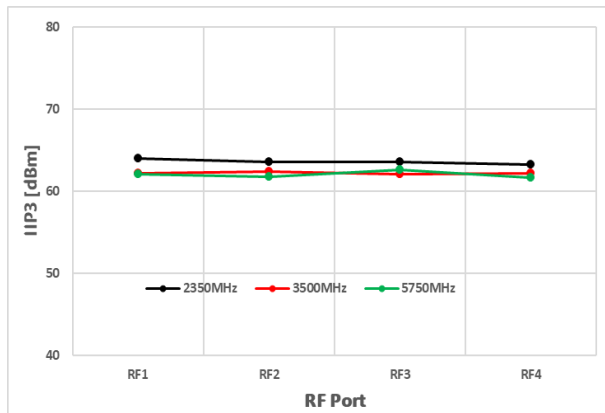
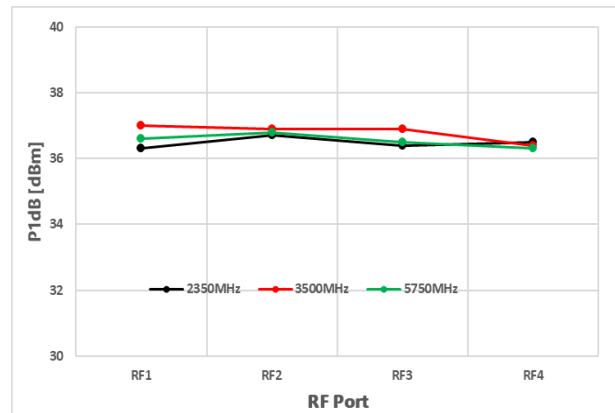


Figure 25. P1dB vs RF Port



Evaluation Board

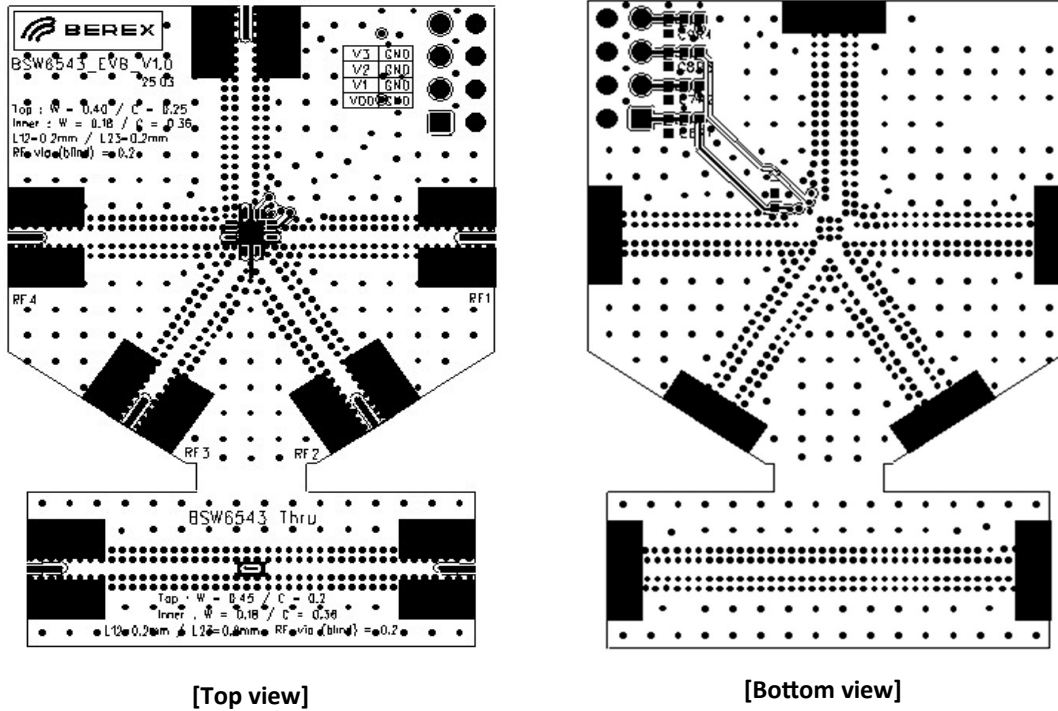


Figure 26. Evaluation Board Layout

RO4003C Er : 3.38	COPPER : 1oz (0.035mm), Top Layer	FINISH THICKNESS : 1.64T
	RO4003C / 0.2mm	
RO4450T Er : 3.35	COPPER : 1oz (0.035mm), Inner 1 Layer	
	RO4450T / 0.2mm	
FR-4 Er : 4.5~4.8	COPPER : 1oz (0.035mm), Inner 2 Layer	
	FR-4 / 1.1mm	
	COPPER : 1oz (0.035mm), Bottom Layer	

Figure 27. Evaluation Board PCB Layer Information

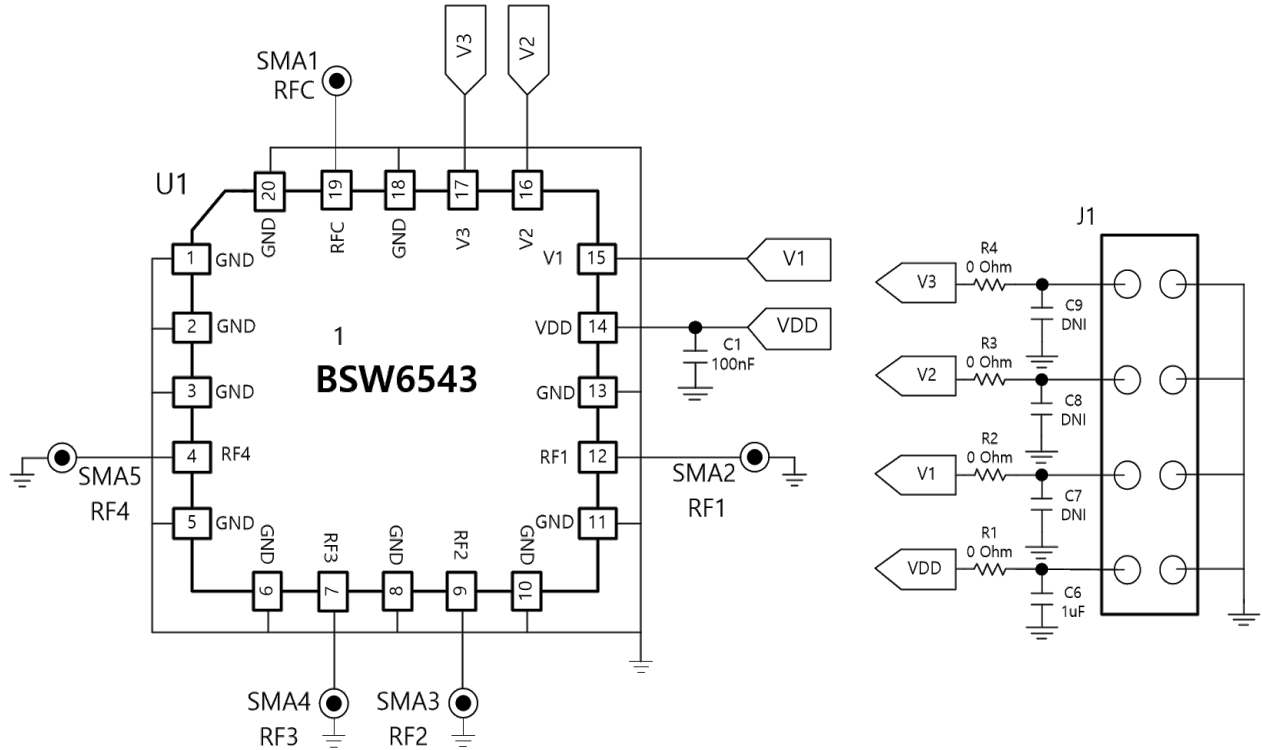
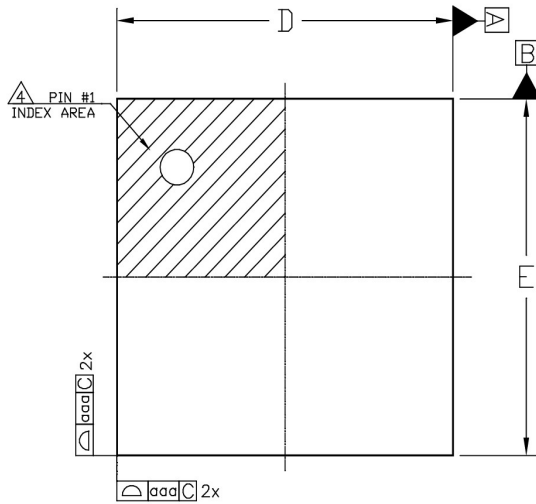


Figure 28. Evaluation Board Schematic

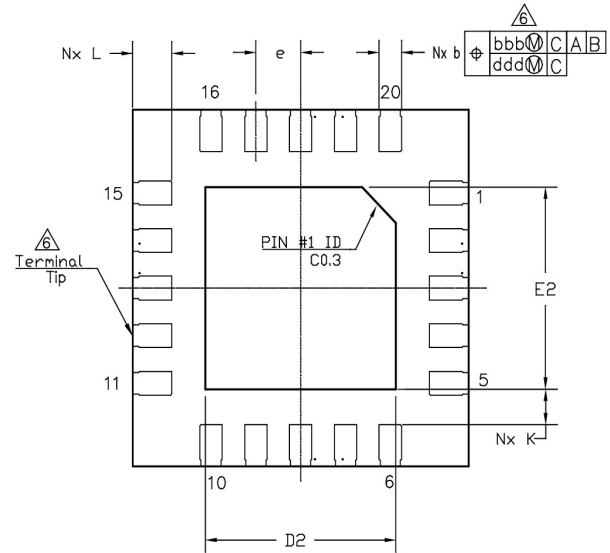
Table 9. Bill of Material - Evaluation Board

No.	Ref Des	Part Qty	Part Number	Remark
1	C1	1	CAP 1005 100nF J 50V	C1 should be placed near the BSW6543
2	C6	1	CAP 1005 1uF J 50V	
3	C7,C8,C9	3	CAP 1005 DNI	
4	R1,R2,R3,R4	4	RES 1005 0 ohm J 50V	
5	J1	1	2x4 Pin Header	2.54mm pitch
6	RFC,RF1,RF2,RF3,RF4	5	SMA_END_LAUNCH	
7	U1	1	BSW6543	

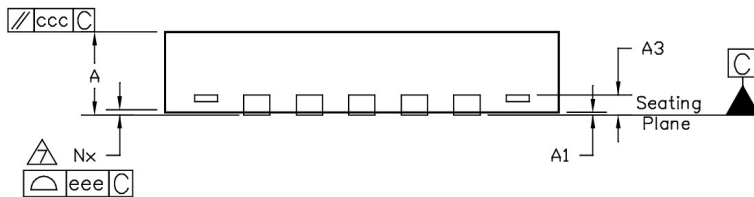
Package Outline Drawing



[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				
Thickness Symbol	Min	Nominal	Max	Note
A	0.51	0.55	0.60	
A1	0.00	0.02	0.05	
A3	---	0.152 Ref.	---	
b	0.15	0.20	0.25	6
D	3.00 BSC			
E	3.00 BSC			
e	0.40 BSC			
D2	1.60	1.70	1.80	
E2	1.60	1.70	1.80	
K	0.2	---	---	
L	0.25	0.35	0.45	
aaa	0.05			
bbb	0.10			
ccc	0.10			
ddd	0.05			
eee	0.08			
N	20			3
ND	5			5
NE	5			5

Figure 29. Package Outline Drawing

Recommended Land Pattern

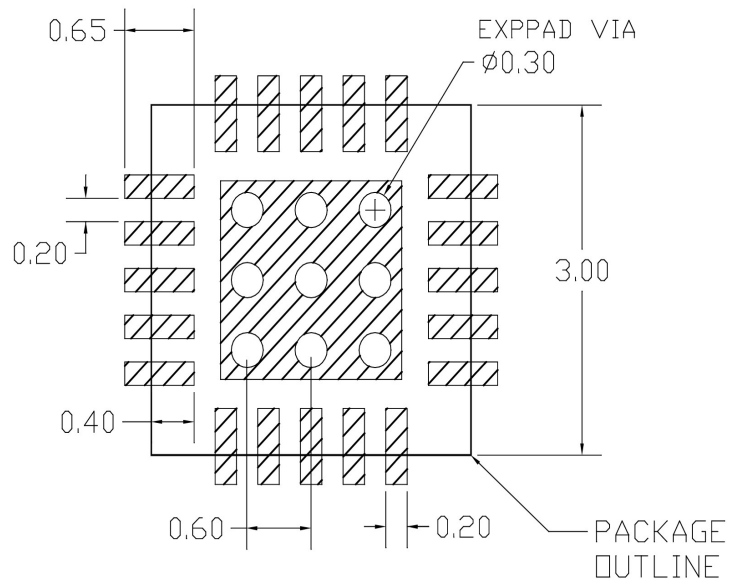
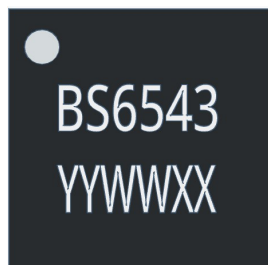


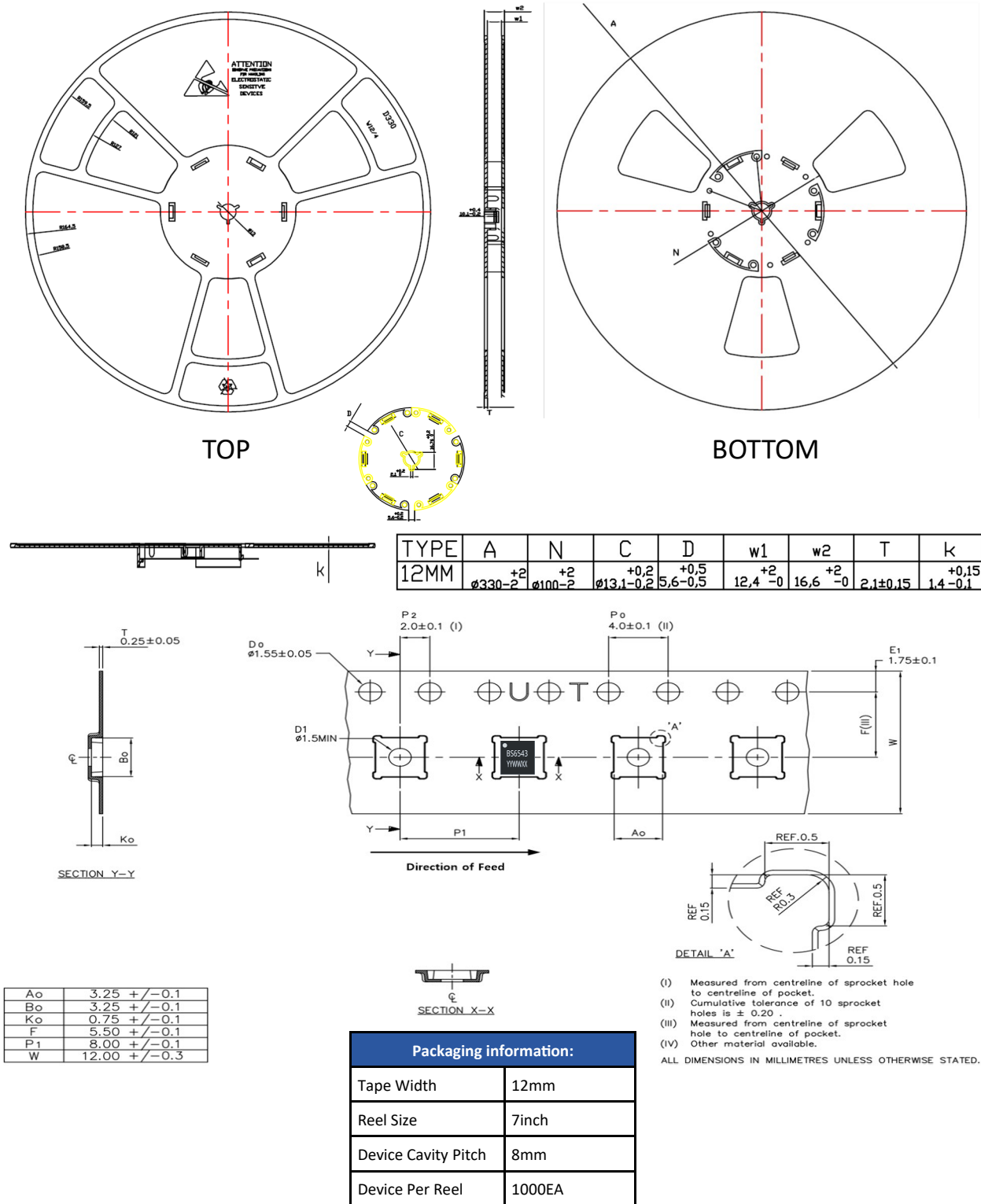
Figure 30. Recommended Land Pattern

Package Marking



Marking information:	
BS	BeRex RF Switch
6543	The name of switch
YY	Year
WW	Work Week
XX	Wafer Run Number

Figure 31. Package Marking

Tape & Reel

Figure 32. Tape & Reel

Lead plating finish

100% Tin Matte finish

(All BeRex products undergoes a 1 hour, 150 degree C, Anneal bake to eliminate thin whisker growth concerns.)

ESD / MSL Rating

ESD information1 :	
Rating	Class 1C (1000V)
Test	Human Body Model (HBM)
Standard	JS-001-2017

ESD information2 :	
Rating	Class C3 (1000V)
Test	Charged Device Model (CDM)
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
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