BSW6553

High Isolation Absorptive SP5T RF Switch

5MHz-9000MHz

Product Description

The BSW6553 is a 50-ohm matched absorptive SP5T RF switch that provides ultra-high isolation with frequency coverage up to 9 GHz.

The BSW6553 is designed with high linearity and reliability, making it suitable for wireless communication applications such as 4G/5G/6G infrastructure .

The BSW6553 operates over a wide VDD range of 2.7V to 5.5V and is controlled via 3 logic pins.

The BSW6553 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 BSW6553 does not require blocking capacitors. If DC is presented at the RF port, add a blocking capacitor.

Block Diagram

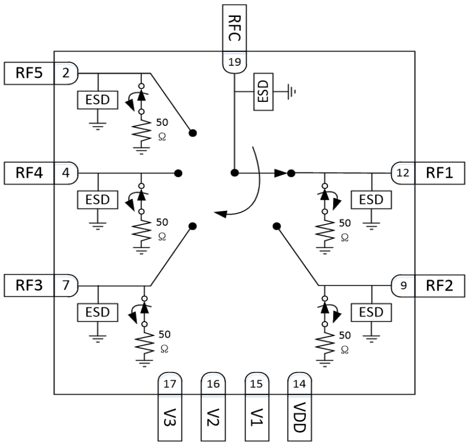


Figure 1. Functional Block Diagram

Applications

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

Package Type

3mm x 3mm x 0.55mm, 20-Lead QFN Package

Figure 2. Package Type

Device Features

- Output frequency range : 5 MHz to 9.0 GHz
- Supply Voltage : 2.7V to 5.5V
- Low Insertion Loss
  - : 0.70dB @ 2GHz
  - : 1.06dB @ 4GHz
  - : 0.95dB @ 6GHz
- High Isolation
  - - RFC to RFx
    - : 69dB @ 2GHz
    - : 58dB @ 4GHz
    - : 49dB @ 6GHz
  - - RFx to RFx
    - : 64dB @ 2GHz
    - : 59dB @ 4GHz
    - : 56dB @ 6GHz
- High Input 1dB Compression
  - : 35.4dBm @ 2.35GHz
  - : 35.6dBm @ 3.5GHz
  - : 35.7dBm @ 5.75GHz
- High IIP3
  - : 63dBm @ 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

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		9000	MHz
Insertion Loss	RFC - RF1	1GHz		0.66		dB
		2GHz		0.70		
		3GHz		0.86		
		4GHz		1.06		
		5GHz		0.95		
		6GHz		0.95		
		7GHz		1.43		
		8GHz		2.36		
		9GHz		2.10		
	RFC - RF2	1GHz		0.62		dB
		2GHz		0.72		
		3GHz		0.90		
		4GHz		1.13		
		5GHz		1.05		
		6GHz		1.08		
		7GHz		1.54		
		8GHz		2.48		
		9GHz		2.35		
	RFC - RF3	1GHz		0.60		dB
		2GHz		0.68		
		3GHz		0.86		
		4GHz		1.13		
		5GHz		1.04		
		6GHz		1.05		
		7GHz		1.52		
		8GHz		2.46		
		9GHz		2.28		
	RFC - RF4	1GHz		0.56		dB
		2GHz		0.63		
		3GHz		0.80		
		4GHz		1.06		
		5GHz		0.95		
		6GHz		0.93		
		7GHz		1.41		
		8GHz		2.41		
		9GHz		2.06		
	RFC - RF5	1GHz		0.56		dB
		2GHz		0.63		
		3GHz		0.78		
		4GHz		0.98		
		5GHz		0.90		
		6GHz		0.92		
		7GHz		1.20		
		8GHz		2.01		
		9GHz		1.83		

Table 1. Electrical Specifications (Cont.)

Parameter	Path	Conditions	Min	Typ	Max	Unit
Return Loss (Active port)	RFC, RFx	5MHz - 6GHz 6GHz - 9GHz		15 8		dB
Return Loss (Terminated port)	RFC, RFx	5MHz - 8GHz 8GHz - 9GHz		20 15		dB
Input P1dB	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		35.4 35.6 35.7		dBm
Input IP2[1]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		111 113 111		dBm
Input IP3[1]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		63 62 62		dBm
2nd Harmonic[2]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		98 100 97		dBc
3rd Harmonic[2]	RFC - RFx	2.35GHz 3.5GHz 5.75GHz		101 98 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		190 105		ns
Maximum Spurious Level		1MHz - 10MHz >10MHz[3]		-127 < -140		dBm/10Hz

1. The each-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	RF5	
RF1	1GHz	-	80	74	84	84	dB
	2GHz	-	69	69	74	73	
	3GHz	-	63	66	67	66	
	4GHz	-	58	64	61	59	
	5GHz	-	53	62	55	53	
	6GHz	-	49	57	51	49	
	7GHz	-	46	53	47	45	
	8GHz	-	43	49	43	42	
	9GHz	-	40	46	40	39	
RF2	1GHz	79	-	77	85	81	
	2GHz	72	-	69	74	71	
	3GHz	65	-	64	66	64	
	4GHz	59	-	60	60	58	
	5GHz	54	-	55	55	53	
	6GHz	49	-	50	50	48	
	7GHz	46	-	48	46	44	
	8GHz	43	-	46	43	41	
	9GHz	40	-	45	41	39	
RF3	1GHz	83	75	-	82	79	
	2GHz	75	67	-	71	69	
	3GHz	68	62	-	63	63	
	4GHz	61	59	-	58	57	
	5GHz	56	55	-	52	52	
	6GHz	51	50	-	48	48	
	7GHz	48	47	-	45	44	
	8GHz	45	46	-	42	41	
	9GHz	42	44	-	39	38	
RF4	1GHz	90	75	82	-	62	
	2GHz	80	69	70	-	56	
	3GHz	71	65	63	-	52	
	4GHz	63	63	58	-	49	
	5GHz	57	61	53	-	44	
	6GHz	52	56	49	-	42	
	7GHz	48	52	46	-	39	
	8GHz	45	49	44	-	38	
	9GHz	42	46	41	-	35	
RF5	1GHz	95	76	84	75	-	
	2GHz	83	70	73	67	-	
	3GHz	72	66	66	62	-	
	4GHz	64	63	61	58	-	
	5GHz	57	61	56	53	-	
	6GHz	52	55	51	48	-	
	7GHz	48	51	48	45	-	
	8GHz	45	47	45	43	-	
	9GHz	42	44	42	41	-	

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	RF5	
RF1	1GHz	-	70	88	76	71	dB
	2GHz	-	64	75	71	66	
	3GHz	-	61	67	68	64	
	4GHz	-	59	61	65	65	
	5GHz	-	58	56	63	69	
	6GHz	-	56	52	55	64	
	7GHz	-	55	48	50	54	
	8GHz	-	53	44	46	48	
	9GHz	-	53	41	42	44	
RF2	1GHz	69	-	61	74	70	
	2GHz	64	-	54	69	65	
	3GHz	62	-	50	66	63	
	4GHz	62	-	47	64	63	
	5GHz	65	-	44	63	66	
	6GHz	65	-	41	56	67	
	7GHz	57	-	38	51	56	
	8GHz	52	-	36	47	49	
	9GHz	46	-	34	43	44	
RF3	1GHz	73	61	-	69	69	
	2GHz	69	54	-	64	64	
	3GHz	67	50	-	62	62	
	4GHz	68	46	-	60	62	
	5GHz	73	44	-	61	64	
	6GHz	61	41	-	57	69	
	7GHz	54	38	-	53	57	
	8GHz	49	36	-	49	51	
	9GHz	45	34	-	45	47	
RF4	1GHz	75	85	70	-	56	
	2GHz	71	74	64	-	50	
	3GHz	70	66	61	-	47	
	4GHz	71	61	59	-	45	
	5GHz	72	56	59	-	43	
	6GHz	59	51	57	-	42	
	7GHz	53	48	56	-	40	
	8GHz	48	44	53	-	38	
	9GHz	44	41	52	-	37	
RF5	1GHz	76	85	75	59	-	
	2GHz	72	74	69	53	-	
	3GHz	71	67	65	49	-	
	4GHz	73	62	62	46	-	
	5GHz	69	57	60	44	-	
	6GHz	58	52	56	40	-	
	7GHz	52	48	53	37	-	
	8GHz	47	45	49	35	-	
	9GHz	43	41	46	33	-	

Product Description

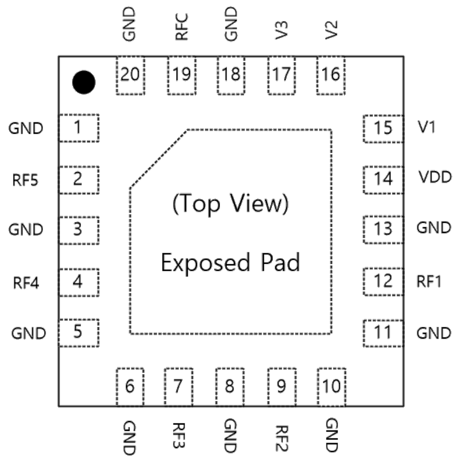


Figure 3. Pin Description

Table 4. Pin Descriptions

No.	Pin Name	Descriptions
14	VDD	Supply Voltage
17	V3	Switch control input 3
16	V2	Switch control input 2
15	V1	Switch control input 1
2	RF5	RF5 Port
4	RF4	RF4 Port
7	RF3	RF3 Port
9	RF2	RF2 Port
12	RF1	RF1 Port
19	RFC	RFC Port
1,3,5,6, 8,10,11, 13,18,20	GND	Ground
Pad	Exposed Pad	Ground

Table 5. Control Truth Table

V3	V2	V1	RFC-RF1	RFC-RF2	RFC-RF3	RFC-RF4	RFC-RF5
0	0	0	OFF[1]	OFF[1]	OFF[1]	OFF[1]	OFF[1]
0	0	1	ON	OFF	OFF	OFF	OFF
0	1	0	OFF	ON	OFF	OFF	OFF
0	1	1	OFF	OFF	ON	OFF	OFF
1	0	0	OFF	OFF	OFF	ON	OFF
1	0	1	OFF	OFF	OFF	OFF	ON
1	1	0	OFF[1]	OFF[1]	OFF[1]	OFF[1]	OFF[1]
1	1	1	OFF[1]	OFF[1]	OFF[1]	OFF[1]	OFF[1]

1. Logic state 000, 110 and 111 are all path OFF mode.

Table 6. 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)	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

Table 7. 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			-	-65	+150	°C
ESD	HBM[1]	All pins	V_{ESDHBM}	-	1000	V
	CDM[2]	All pins	V_{ESDCDM}	-	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

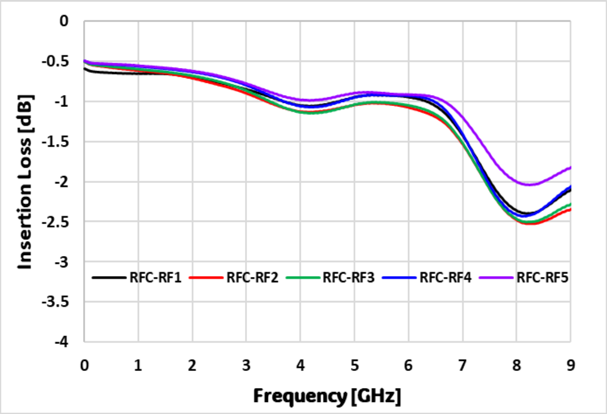


Figure 5. Insertion Loss vs VDD (RFC-RF1)

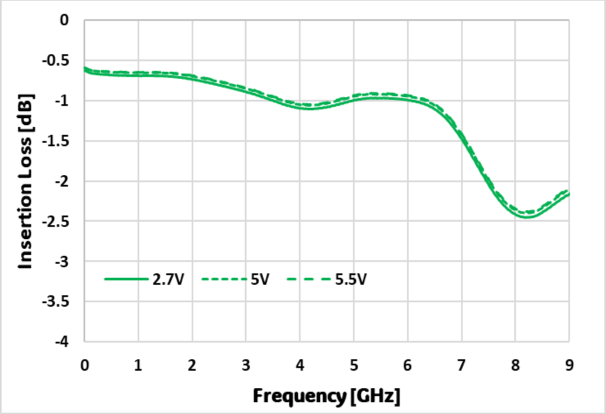


Figure 6. Insertion Loss vs Temp (RFC-RF1)

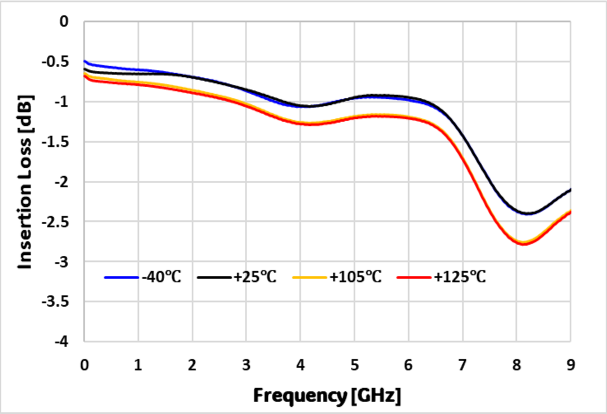


Figure 7. Return Loss vs Frequency (RFC Port)

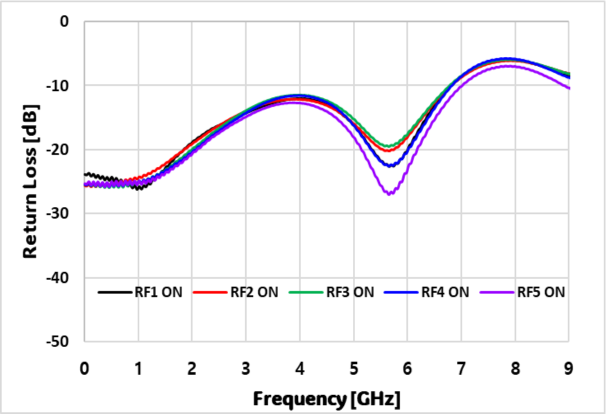


Figure 8. Return Loss vs VDD (RFC Port)

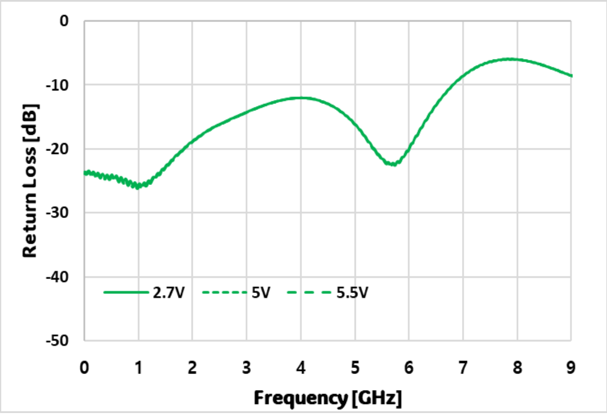
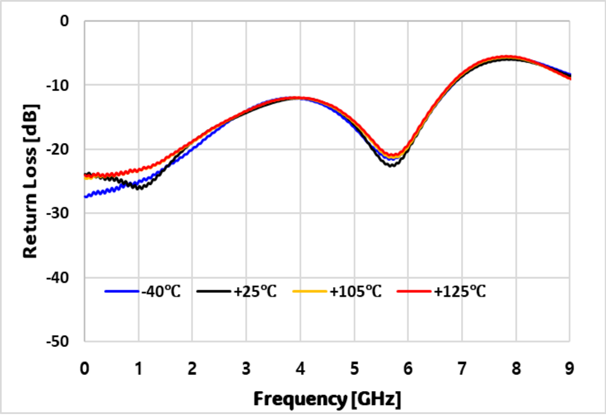


Figure 9. Return Loss vs Temp (RFC Port)



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)

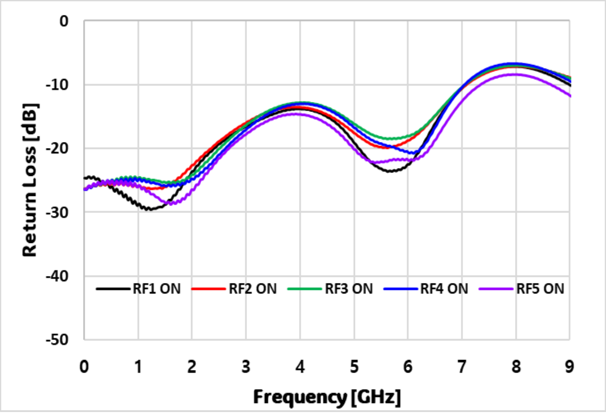


Figure 11. Return Loss vs VDD (Active Port)

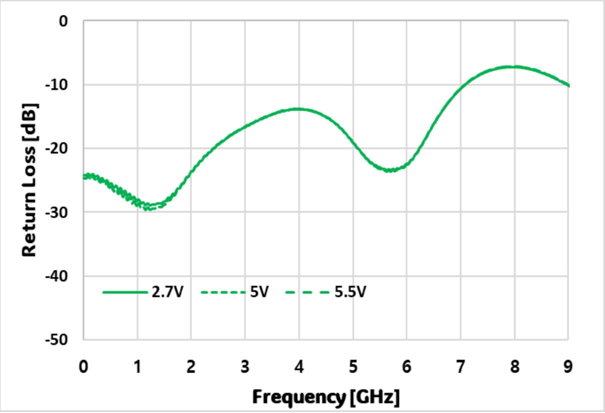


Figure 12. Return Loss vs Temp (Active Port)

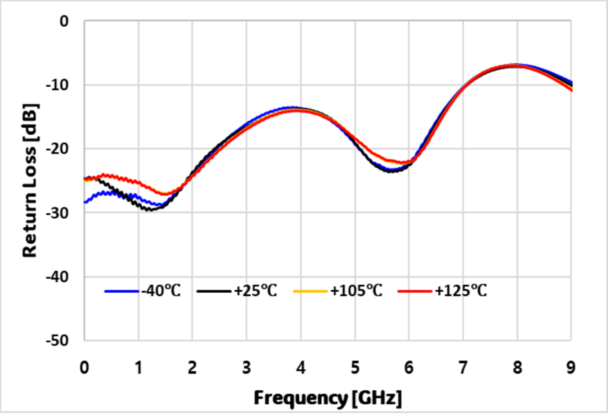


Figure 13. Return Loss vs Frequency (Terminated Port)

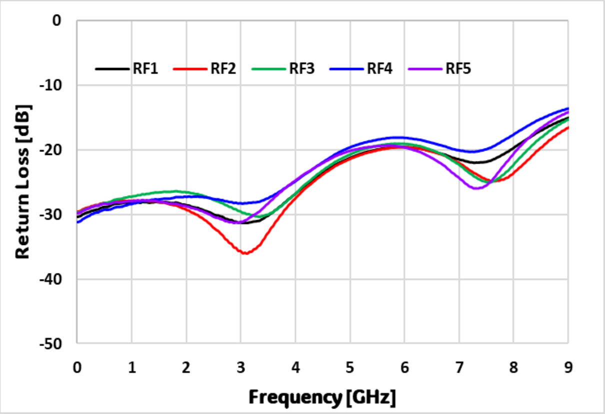


Figure 14. Return Loss vs VDD (Terminated Port)

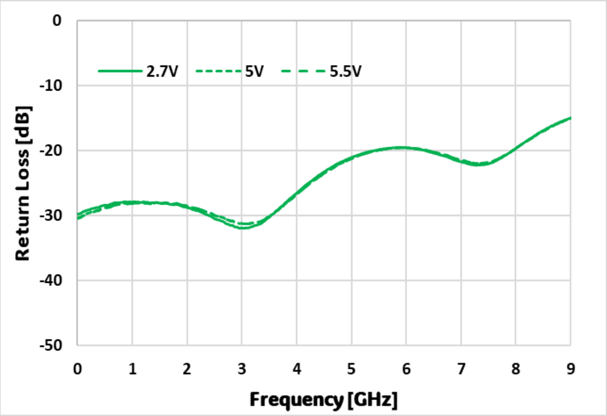
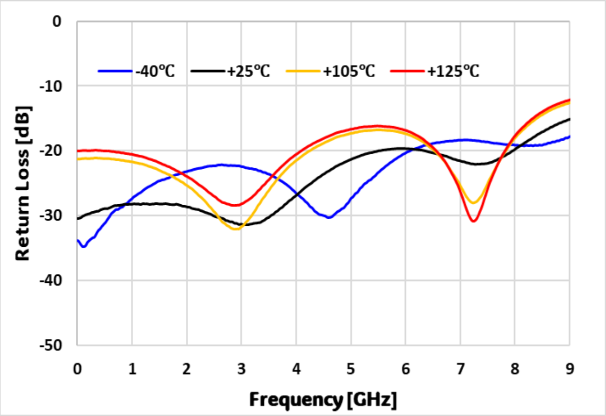


Figure 15. Return Loss vs Temp (Terminated Port)



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)

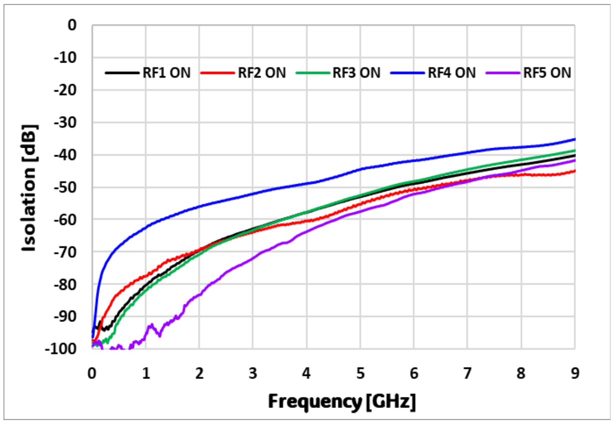


Figure 17. Isolation vs Frequency (RFC to RFx, RF1 ON)

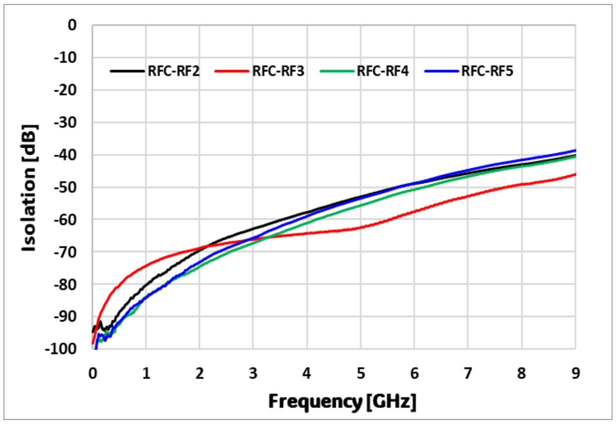


Figure 18. Isolation vs VDD (RFC to RF1, RF2 ON)

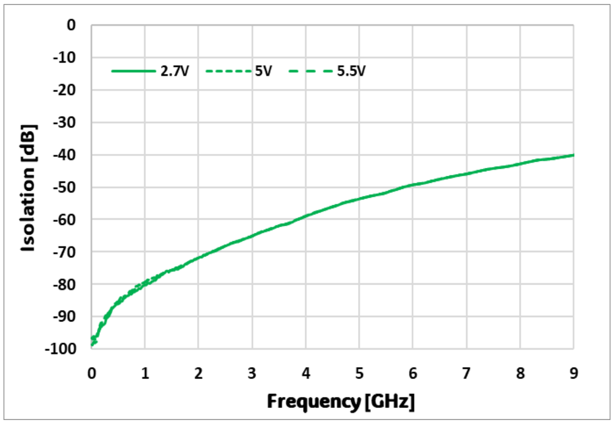


Figure 19. Isolation vs Temp (RFC to RF1, RF2 ON)

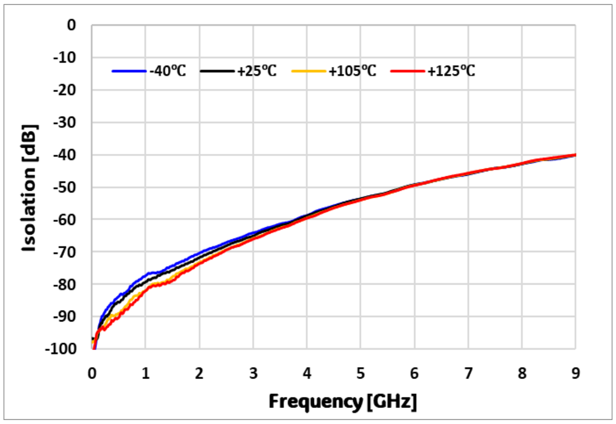


Figure 20. Isolation vs Frequency (RFx to RFx)

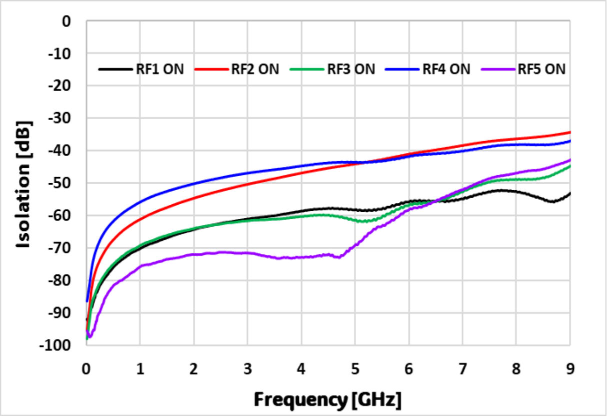
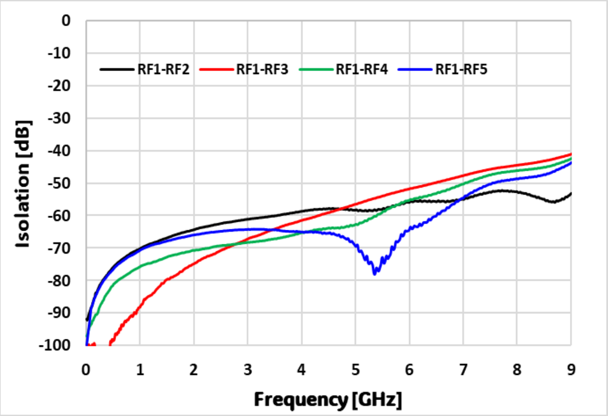


Figure 21. Isolation vs Frequency (RF1 to RFx, RF1 ON)



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)

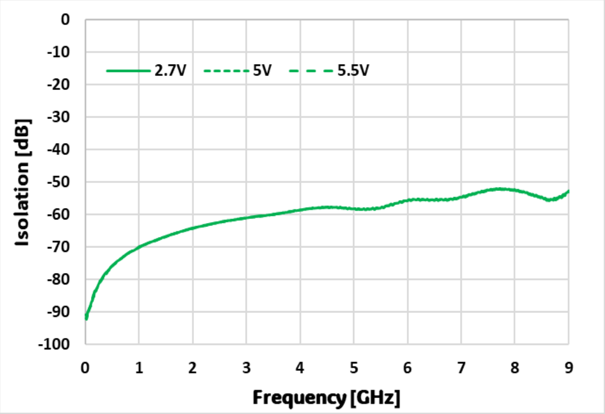


Figure 23. Isolation vs Temp (RF1 to RF2, RF1 ON)

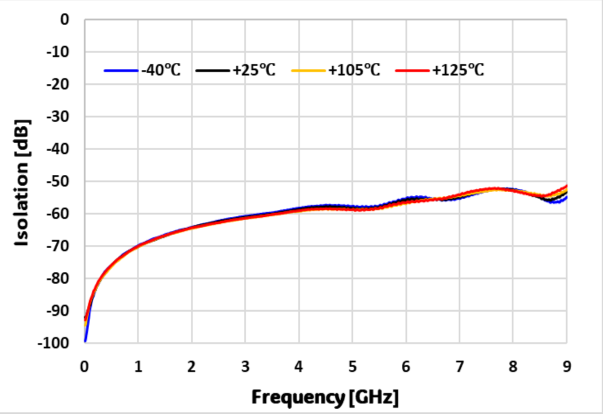


Figure 24. IIP3 vs RF Port

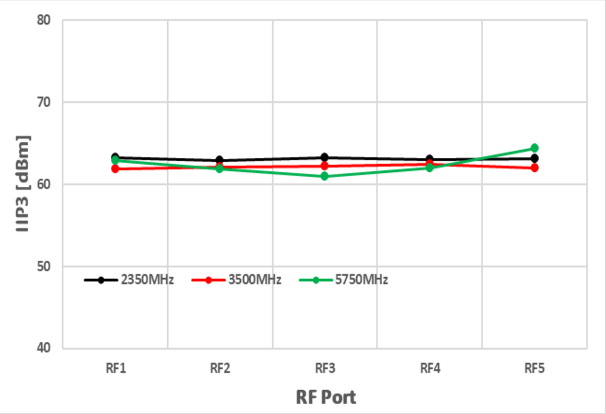
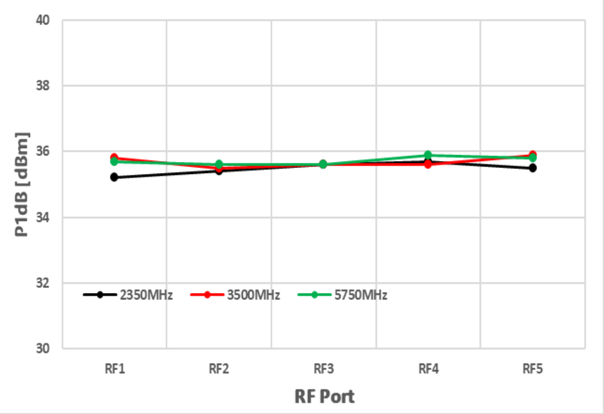
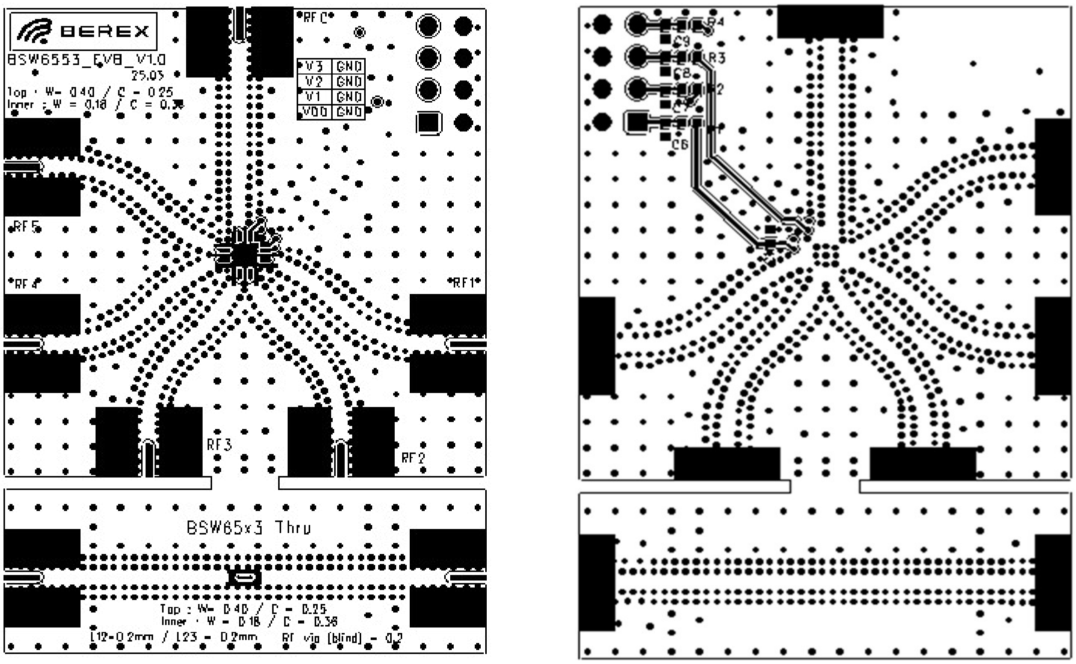


Figure 25. P1dB vs RF Port



Evaluation Board



[Top view]

[Bottom view]

Figure 26. Evaluation Board Layout

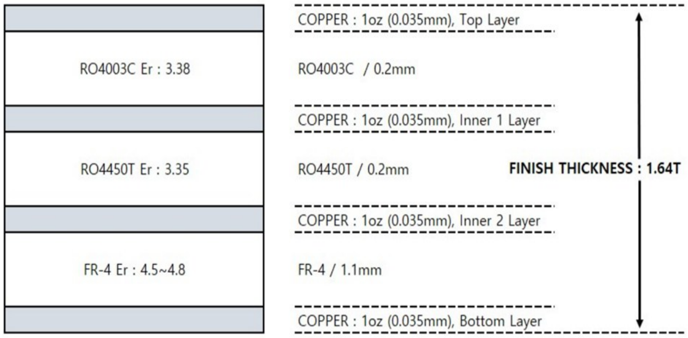


Figure 27. Evaluation Board PCB Layer Information

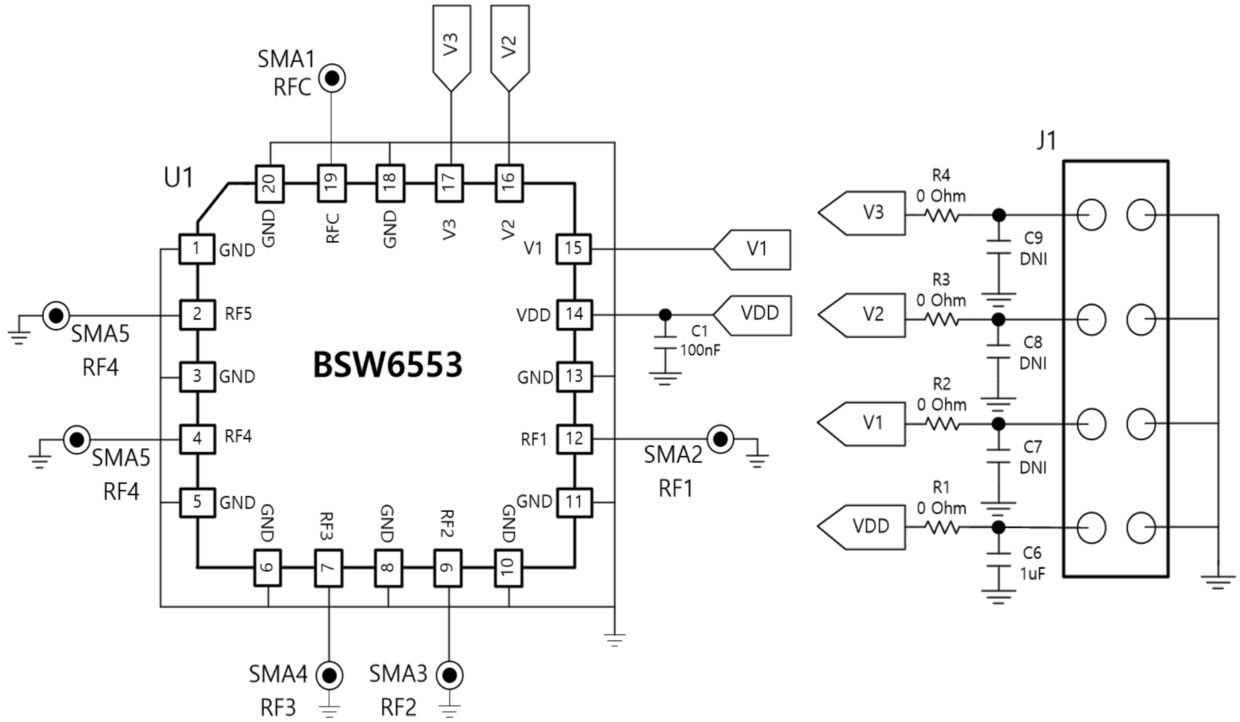
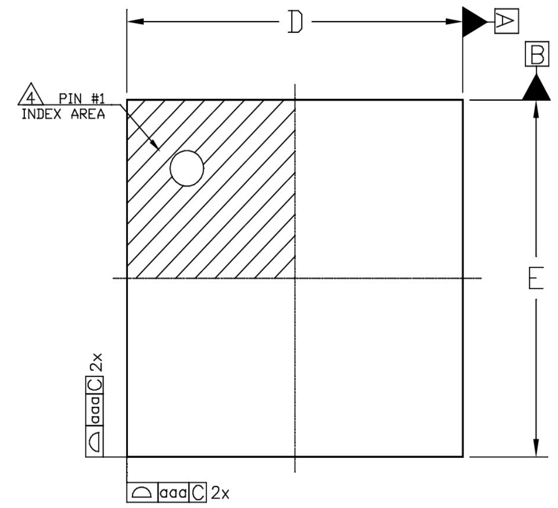


Figure 28. Evaluation Board Schematic

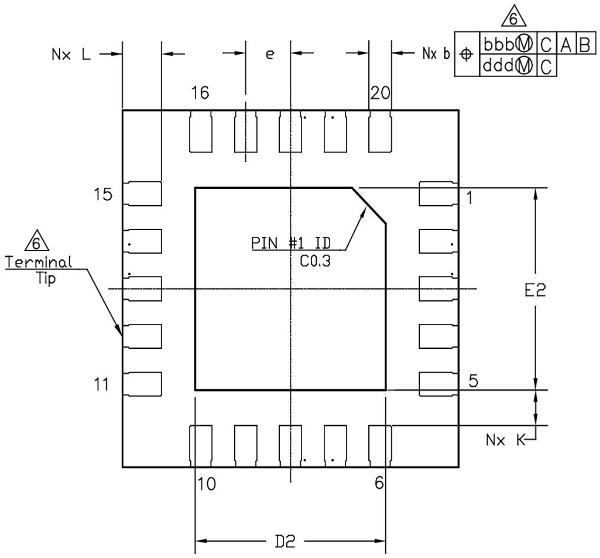
Table 8. Bill of Material - Evaluation Board

No.	Ref Des	Part Qty	Value	Description	Remark
1	C1	1	100nF	CAP 1005 J 50V	
2	C6	1	1uF	CAP 1005 J 50V	
3	C7,C8,C9	3	DNI	CAP 1005	
4	R1,R2,R3,R4	4	0 ohm	RES 1005 J 50V	
5	J1	1	2.54mm	2x4 pin Header	
6	RFC,RF1,RF2,RF3,RF4,RF5	6	CON	SMA_END_LAUNCH	
7	U1	1	Chip	BSW6553	

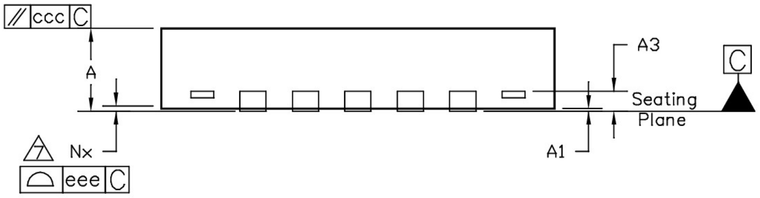
Package Outline Drawing



[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

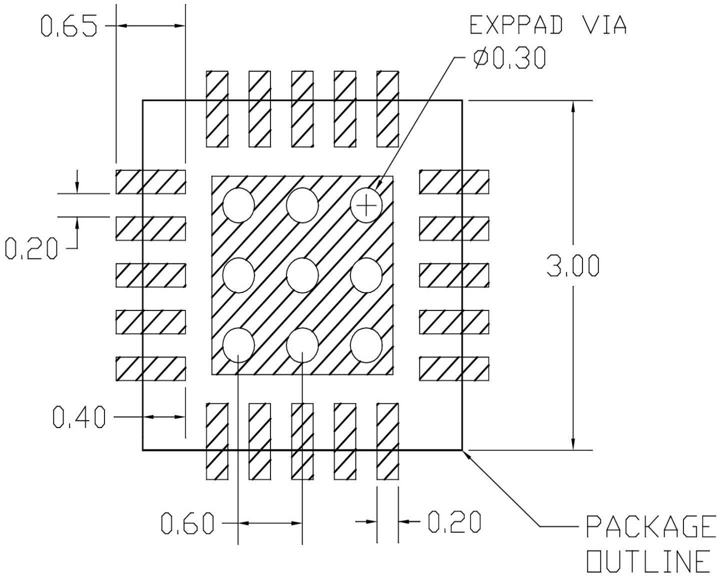


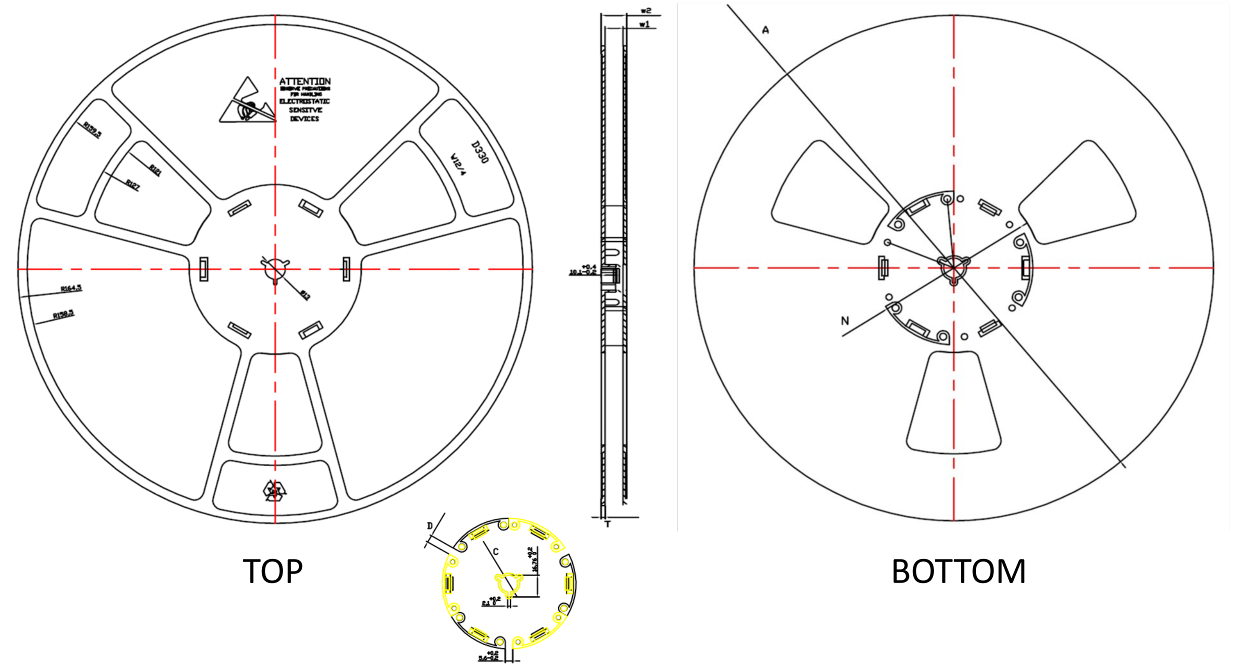
Figure 30. Recommended Land Pattern

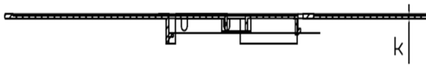
Package Marking

Marking information:	
BS	BeRex RF Switch
6553	The name of switch
YY	Year
WW	Work Week
XX	Wafer Run Number

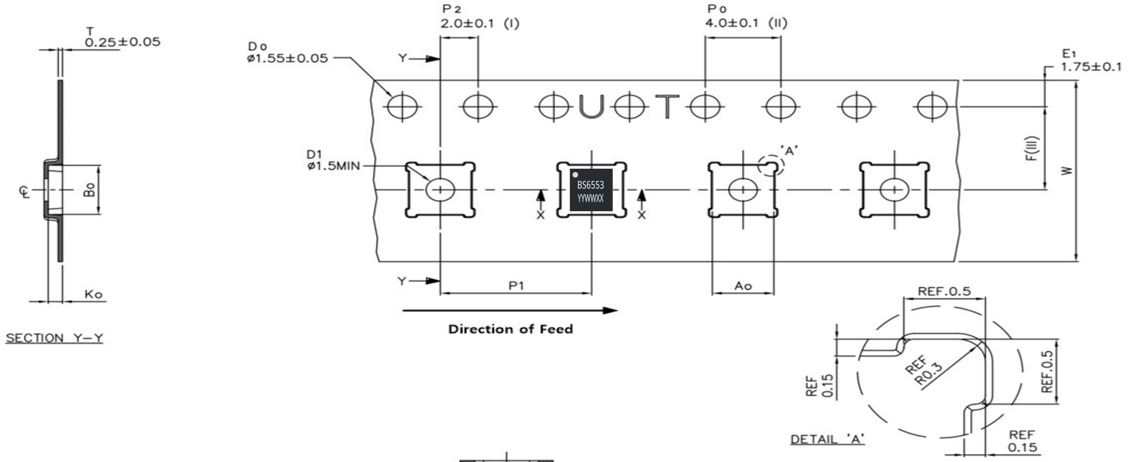
Figure 31. Package Marking

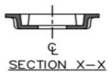
Tape & Reel





TYPE	A	N	C	D	w1	w2	T	k
12MM	$\varnothing 330^{+2}_{-2}$	$\varnothing 100^{+2}_{-2}$	$\varnothing 13{,}1^{+0{,}2}_{-0{,}2}$	$5{,}6^{+0{,}5}_{-0{,}5}$	$12{,}4^{+2}_{-0}$	$16{,}6^{+2}_{-0}$	2,1±0,15	$1{,}4^{+0{,}15}_{-0{,}1}$





Ao	3.25 +/−0.1
Bo	3.25 +/−0.1
Ko	0.75 +/−0.1
F	5.50 +/−0.1
P1	8.00 +/−0.1
W	12.00 +/−0.3

(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

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** (1000V)
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

Caution : ESD Sensitive

Appropriate precautions in handling, packaging and testing devices must be observed.

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