

Features

- 2.4 - 2.485GHz Frequency Range
- Integrated PA, LNA, Bypass, T/R Switch
- Low TX Current Optimized for battery operation
- 38.5mA at +15dBm Output Power
- 2.0dB LNA Noise Figure
- 0.4uA Ultra-Low Bypass Current
- 1.9dB Bi-Directional Bypass with Low Insertion Loss
- 10dBm EDR Spectral Mask
- 2mm x 2mm x 0.45mm QFN-16 Package
- -40°C to 125°C Temperature Range

Applications

- IoT Connectivity
- Wireless Microphone
- Smart Watch, Sports and Medical Wearables
- Consumer Electronics, Toys
- Smart Home Appliances
- Remote Controllers
- Wireless Sensor Nodes
- Beacons
- Proximity Sensors
- Range Extenders

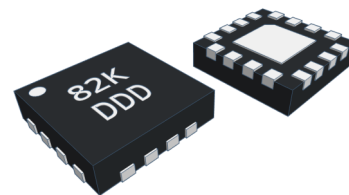
Description

The 8TR8213 is a compact, highly integrated front-end RFIC (Radio Frequency Integrated Circuit) intended for range extension of proprietary ISM wireless systems in the 2.4GHz band.

The 8TR8213 is optimized for battery operation with enhanced efficiency operating over a wide voltage supply range from 2.2V to 4.0V, suited for a wide array of applications including battery powered wireless systems.

The 8TR8213 combines a power amplifier (PA), Low Noise Amplifier (LNA), bypass, and a transmit / receive (T/R) switch in a 2mm x 2mm x 0.45mm 16-pin QFN package. The device also comes integrated with filter networks and input / output matching circuitry.

The 8TR8213 is RoHS compliant, halogen-free, and REACH Compliant. It is rated for Moisture Sensitivity Level 1 (MSL1), reflow at 260°C per JEDEC J-STD-020. Refer to IPC/JEDEC J-STD-020 for detailed solder reflow temperature and profile.



16-Lead 2mm x 2mm x 0.45mm, QFN Package

Figure 2. 8TR8213 Package Type

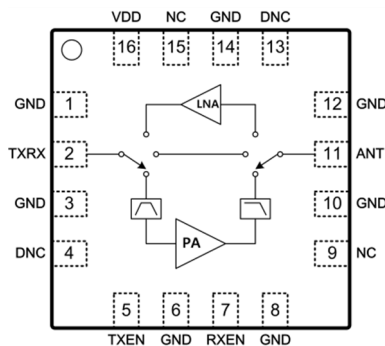


Figure 1. 8TR8213 Functional Block Diagram

Ordering Information

Part Number	Description
8TR8213	2.4GHz Front-End RFIC 2500pieces per Tape and Reel
8TR8213-EVB	Fully Tested and Characterized Evaluation Board
8TR8213-DWF	2.4GHz Front-End RFIC Die in Wafer Form

Pin Descriptions

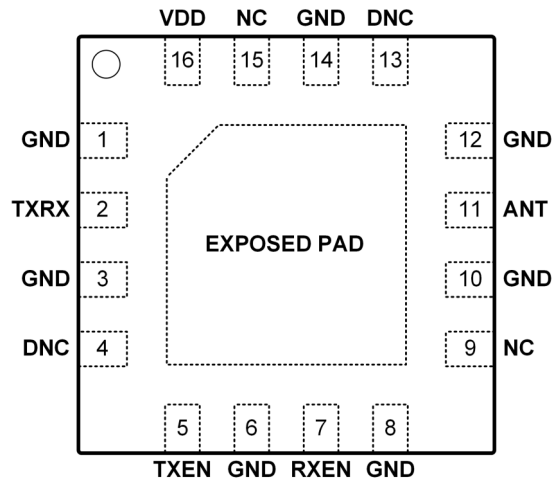


Figure 3. 8TR8213 Pinout (Top View)

Table 1. 8TR8213 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	9	NC	Not connected internally
2	TXRX	Transmit/Receive Port (DC shorted to GND)	10	GND	Ground
3	GND	Ground	11	ANT	Antenna Port (DC shorted to GND)
4	DNC	Do Not Connect	12	GND	Ground
5	TXEN	Control Logic Pin	13	DNC	Do Not Connect
6	GND	Ground	14	GND	Ground
7	RXEN	Control Logic Pin	15	NC	Not connected internally
8	GND	Ground	16	VDD	DC Voltage Supply
EXPOSED PAD		Exposed pad should be connected to GND.			

Electrical and Mechanical Specifications

The absolute maximum ratings of the 8TR8213 are provided in Table 2. The recommended operating conditions are specified in Table 3. The electrical specifications are provided in Tables 4 through 7, as measured on 8TR8213 evaluation board(Figure 4). The state of the 8TR8213 is determined by the logic provided in Table 8.

Table 2. 8TR8213 Absolute Maximum Ratings

Parameter		Units	Minimum	Maximum	Remark
Supply Voltage (VDD)		V	0	4.5	
Control Logic Pin (TXEN, RXEN)		V	0	VDD	
Transmit Output Power at ANT Port		dBm		17	
Receive Input power at ANT Port		dBm		10	
Transmit Input Power at TXRX Port		dBm		10	
Bypass Mode Power at TXRX or ANT Port		dBm		20	
Storage Temperature		°C	-40	150	
ESD - HBM ¹	All pins	V		±4000	
ESD - CDM ²	All pins	V		±1000	
MSL ³		Level		MSL1	

Note: Sustained operation at or above the Absolute Maximum Ratings for any single or combinations of the above parameters may result in permanent damage to the device and is not recommended. All Maximum RF Input Power Ratings assume 50Ω terminal impedance.

1. Electrostatic discharge Human Body Model(HBM) Reference Document: ANSI/ESDA/JEDEC JS-001-2017

2. Electrostatic discharge Charged Device Model(CDM) Reference Document: ANSI/ESDA/JEDEC JS-002-2018

3. Moisture Sensitivity Level(MSL) Reference Document: JEDEC Standard J-STD-020

Table 3. 8TR8213 Recommended Operating Conditions

Parameter	Units	Minimum	Typical	Maximum
Operating Frequency Range	GHz	2.4		2.485
Supply Voltage (VDD, recommended) ¹	V	2.2	3.0	4.0
Control Pin - Logic High State (TXEN, RXEN)	V	1.2		VDD ²
Control Pin - Logic Low State (TXEN, RXEN)	V	0		0.4
Operating Temperature	°C	-40	25	125

1. Functional working with degraded performance for the supply voltage range 2.2V to 2.7V.

2. For Control Voltages > 3.0V, a 10kΩ series resistor should be used at the Control Logic Pins.

Table 4. 8TR8213 Electrical Specifications: Transmit Mode

(VDD = 3.0V, TXEN = High, RXEN = High or Low, T_{Ambient} = 25°C, Excluding PCB and Connector Loss, Unless Otherwise Noted)

Parameter	Units	Min	Typ	Max	Test Conditions
Saturated Output Power	dBm		17.5		
EDR Spectral Mask	dBm		10		Spectral Mask compliant, 3Mbps EDR signal
Large-Signal Gain	dB		16.5		+14dBm Pout
Current Consumption	mA		38.5		+15dBm Pout
	mA		20		No RF Applied
Second Harmonic	dBm/MHz		-20		+16dBm Pout Without external harmonic filter
Third Harmonic	dBm/MHz		-30		
Input Return Loss	dB		8		
Output Return Loss	dB		8		
Load VSWR for Stability			6:1		All Non-harmonic Spurs Less than -50dBm/MHz up to 14dBm
Load VSWR for Ruggedness			10:1		No Damage

Table 5. 8TR8213 Electrical Specifications: Receive Mode

(VDD = 3.0V, TXEN = Low, RXEN = High, T_{Ambient} = 25°C, Excluding PCB and Connector Loss, Unless Otherwise Noted)

Parameter	Units	Min	Typ	Max	Test Conditions
Small-Signal Gain	dB		15.9		
Current Consumption	mA		6		
Noise Figure	dB		2		
Input P1dB	dBm		-10		
Input IP3	dBm		-2		Pin = -35dBm/Tone, 1MHz spacing
Input Return Loss	dB		7		
Output Return Loss	dB		11		

Table 6. 8TR8213 Electrical Specifications: Bypass Mode

(VDD = 3.0V, TXEN = Low, RXEN = Low, T_{Ambient} = 25°C, Excluding PCB and Connector Loss, Unless Otherwise Noted)

Parameter	Units	Min	Typ	Max	Test Conditions
Bypass Insertion Loss	dB		1.9		Between TXRX and ANT Ports
Bypass Current	uA		0.4		

Table 7. 8TR8213 Electrical Specifications: Switching Time

(VDD = 3.0V, T_{Ambient} = 25°C, Unless Otherwise Noted)

Parameter	Units	Min	Typ	Max	Test Conditions
TX to RX	nsec		500		From 50% of RXEN to 90% of RX power
TX to Bypass	nsec		300		From 50% of TXEN to 10% of TX power
RX to TX	nsec		700		From 50% of TXEN to 90% of TX power
RX to Bypass	nsec		300		From 50% of RXEN to 10% of RX power
Bypass to TX	nsec		700		From 50% of TXEN to 90% of TX power
Bypass to RX	nsec		500		From 50% of RXEN to 90% of RX power

Table 8. 8TR8213 Electrical Specifications: Mode Control Logic

"1" = Logic High, "0" = Logic Low, All Control logic pins must have a state defined as either "0" or "1".

TXEN	RXEN	Operational Mode
0	0	Bypass Mode ¹
0	1	RX Mode
1	0 or 1	TX Mode

1. The Bypass Mode feature provides an ultra-low current consumption, as in a conventional Sleep Mode

Application Note

The 8TR8213 Application note provides detailed descriptions and test data over various operating conditions. Visit www.berex.com or contact BeRex at sales@berex.com to request additional documentation.

Evaluation Board Schematic and PCB Layout

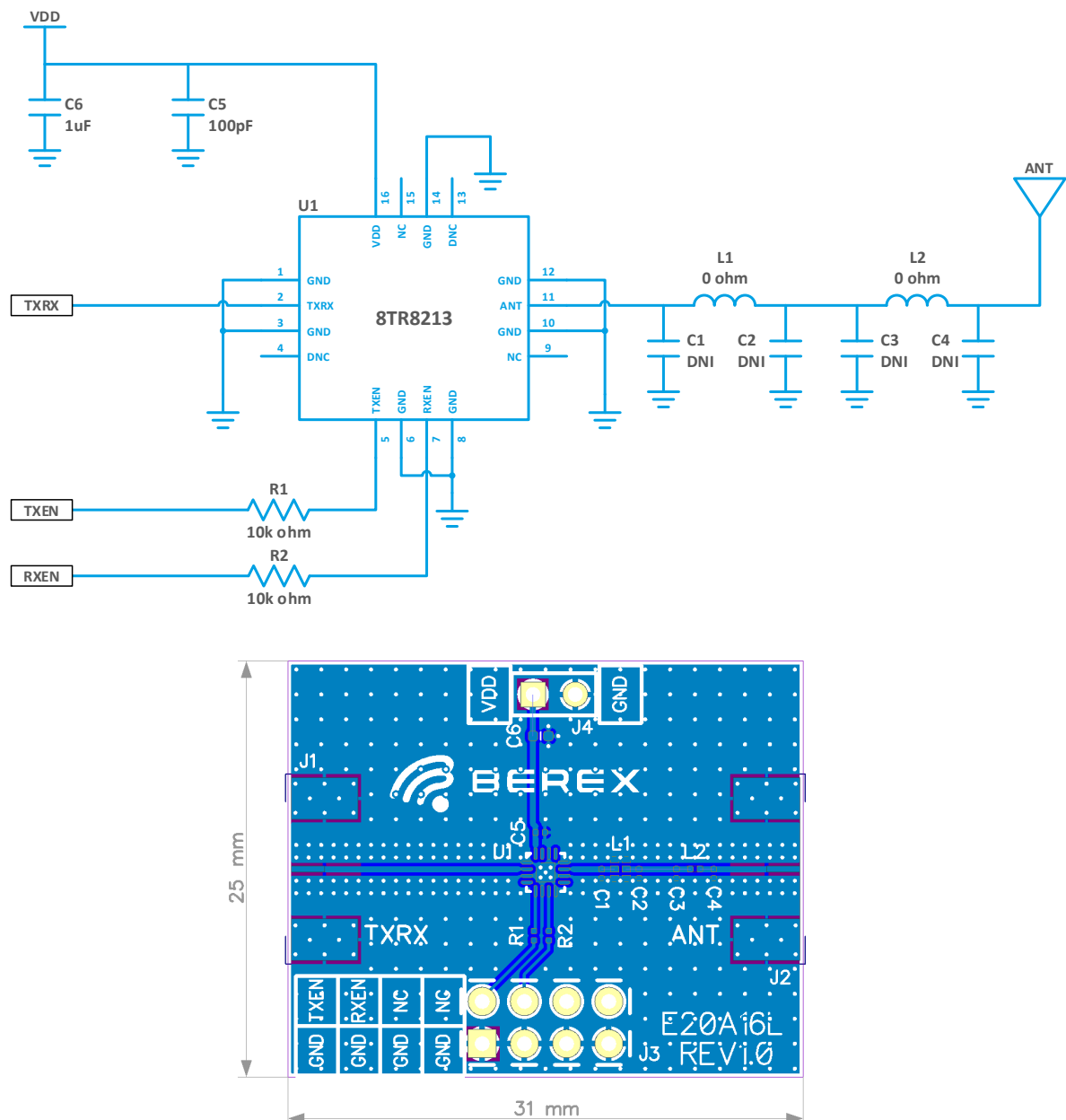
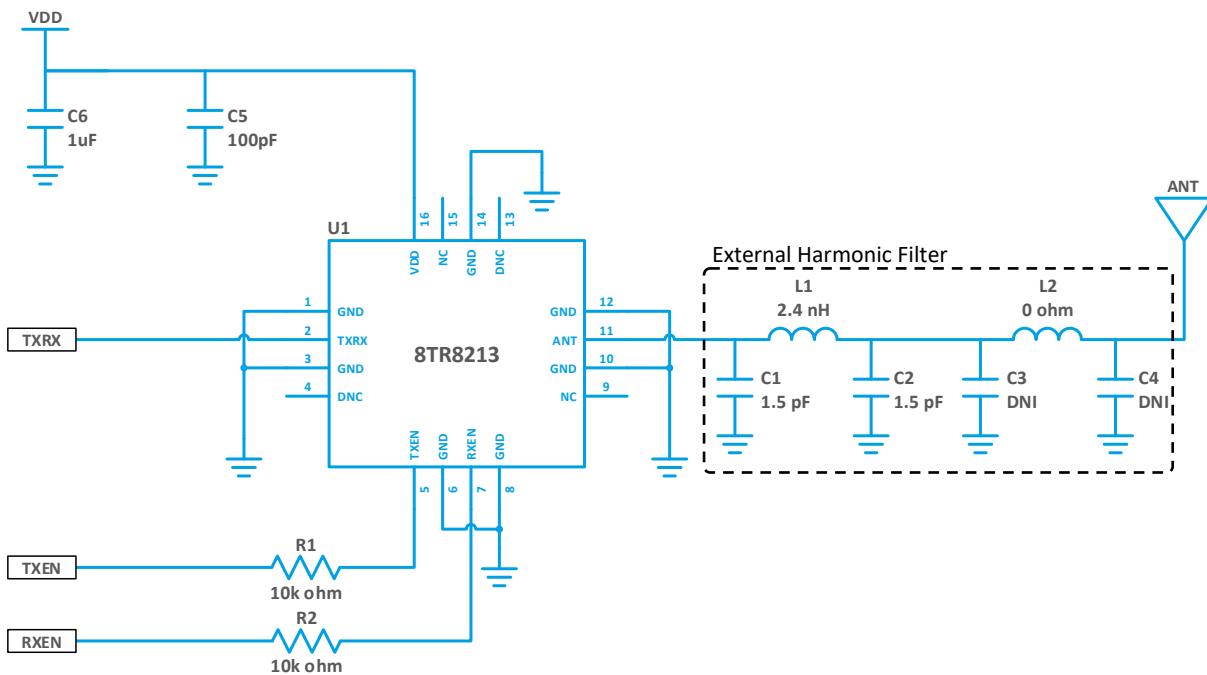


Figure 4. 8TR8213 Evaluation Board Schematic and PCB Layout

Table 9. 8TR8213 Evaluation Board Bill of Materials (BOM)

Component	Value	Manufacturer	Mfr Part Number	Size	Description
R1, R2	10k Ω	Panasonic	ERJ-1GNF1002C	0201	RES SMD 10k Ω 1% 1/20W 0201
C1, C2, C3, C4	DNI			0201	
C5	100pF	muRata	GRM0335C1H101JA01D	0201	CAP CER 100pF 50V COG/NP0 0201
C6	1 μ F	muRata	GRM155Z71A105KE01J	0402	CAP CER 1 μ F 10V X7R 0402
L1, L2	0 Ω	Panasonic	ERJ-1GN0R00C	0201	RES SMD 0 Ω JUMPER 1/20W 0201
J1, J2	SMA	Gigalane	PAF-S05-008	End launch	SMA 50 Ω End Launch Jack Receptacle
J3	2x4	Adam Tech	PH2RA-08-UA	2x4	HEADER DR RA TH 2x4
J4	1x2	Adam Tech	PH1RA-02-UA	1x2	HEADER DR RA TH 1x2
U1	8TR8213	BeRex	8TR8213	QFN 2x2	2.4GHz IoT Connectivity

Application Schematic



※ External Harmonic Filter

Performance is sensitive to PCB parasitics. Therefore, custom PCB layout should emulate the Evaluation Board PCB layout attached to this design as closely as possible.

All inductors and capacitors must be populated and located as close as possible to ANT pin. Use ceramic multi-layer inductors for effective filtering. Depending on layout, all inductor and capacitor values may require minor value tweaks for optimum impedance matching.

Figure 5. 8TR8213 Application Schematic

Table 10. 8TR8213 Application Bill of Materials (BOM)

Component	Value	Manufacturer	Mfr Part Number	Size	Description
R1, R2	10kΩ	Panasonic	ERJ-1GNF1002C	0201	RES SMD 10kΩ 1% 1/20W 0201
C1, C2	1.5 pF	muRata	GRM0335C1E1R5BA01D	0201	CAP CER 1.5PF 25V COG/NP0 0201
C3, C4	DNI			0201	
C5	100pF	muRata	GRM0335C1H101JA01D	0201	CAP CER 100pF 50V COG/NP0 0201
C6	1uF	muRata	GRM155Z71A105KE01J	0402	CAP CER 1uF 10V X7R 0402
L1	2.4 nH	muRata	LQP03TN2N4B02D	0201	Fixed IND 2.4 nH 500mA 200mΩ
L2	0Ω	Panasonic	ERJ-1GN0R00C	0201	RES SMD 0Ω JUMPER 1/20W 0201
J1, J2	SMA	Gigalane	PAF-S05-008	End launch	SMA 50Ω End Launch Jack Receptacle
J3	2x4	Adam Tech	PH2RA-08-UA	2x4	HEADER DR RA TH 2x4
J4	1x2	Adam Tech	PH1RA-02-UA	1x2	HEADER DR RA TH 1x2
U1	8TR8213	BeRex	8TR8213	QFN 2x2	2.4GHz IoT Connectivity

Package Dimensions

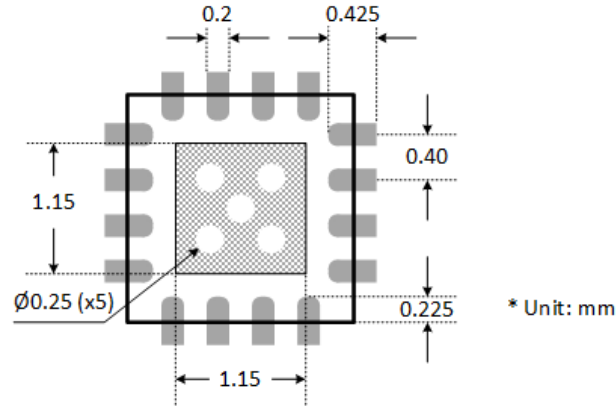
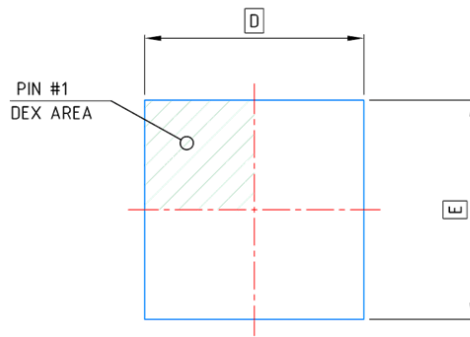
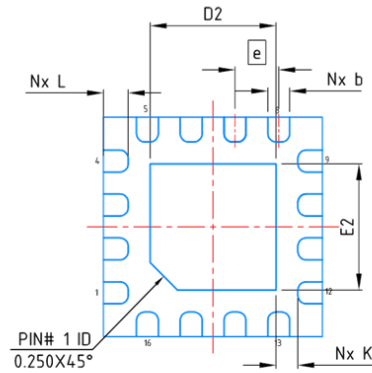


Figure 6. 8TR8213 PCB Layout Footprint

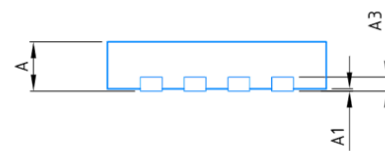


TOP VIEW



BOTTOM VIEW

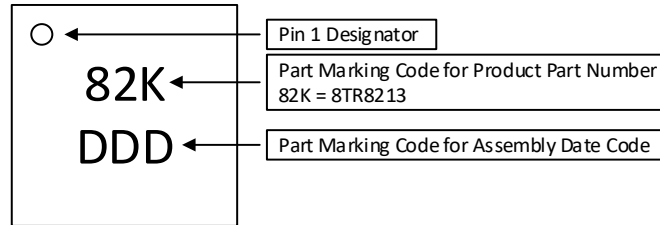
	MIN.	NOM.	MAX.
A	0.41	0.45	0.50
A1	0.00	0.02	0.05
A3	---	0.127 Ref	---
b	0.15	0.20	0.25
D	2.00 BSC		
E	2.00 BSC		
e	0.40 BSC		
D2	1.00	1.15	1.25
E2	1.00	1.15	1.25
K	0.20	---	---
L	0.125	0.225	0.325
N	16		



SIDE VIEW

Figure 7. 8TR8213 Package Dimension

Package Marking



Note: The part marking: 82K represents the Product Part Number: 8TR8213.

Due to the size limitations of this package, only three (3) characters can be marked on each of two (2) rows.
Therefore the Product Part Number is represented in the part marking by a 3-character code.

Figure 8. 8TR8213 Typical Part Marking

ESD Handling Information

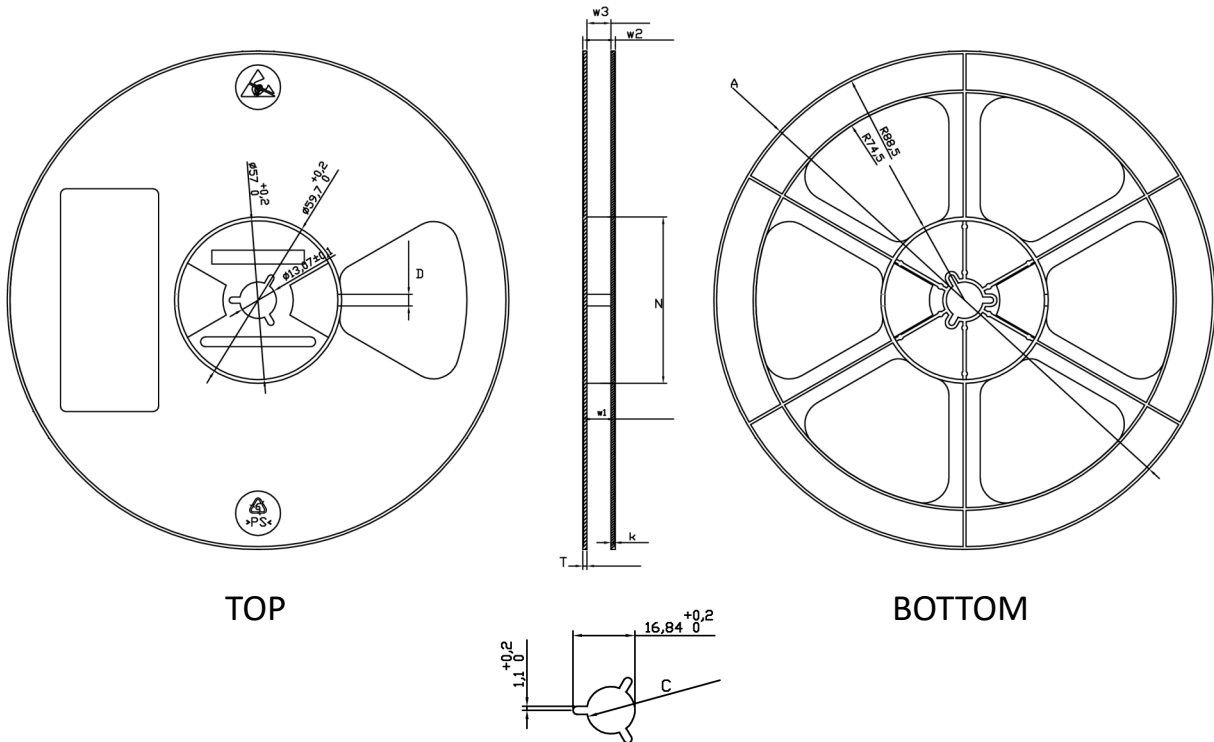
Electro Static Discharge (ESD) can cause immediate (or latent) failures in semiconductor Integrated Circuits (ICs). BeRex, Inc. RFIC products are designed with integral ESD protection structures, and all IC products are tested to meet industry standards for ESD event survival. Users must adhere to all precautions for handling ESD sensitive devices throughout the manufacturing, test, shipping, handling, or operational processes, and during field service operations in order to achieve optimum system performance and life expectancy. Production quantities of this product are shipped in a standard tape and reel format.

RoHS Compliance

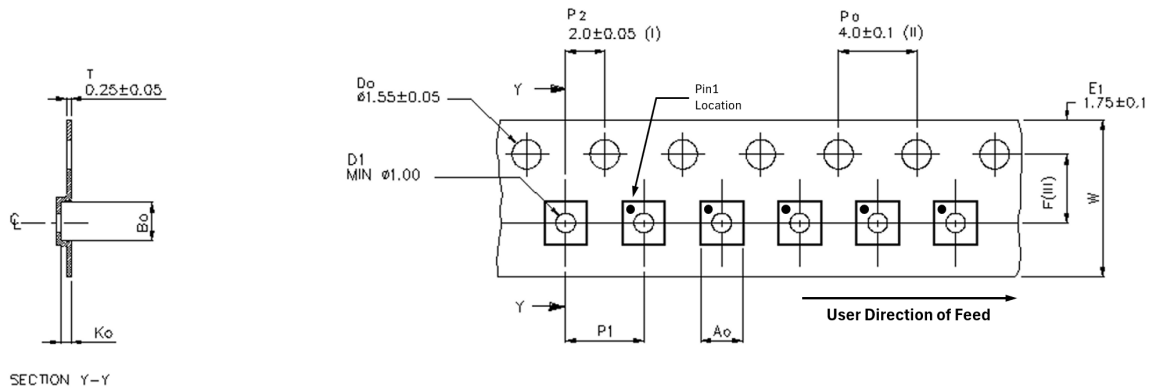
This part is compliant with Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive 2011/65/EU as amended by Directive 2015/863/EU.

This part is lead-free, halogen-free and 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 component of a product and/or its packaging placed on the European Community market by the BeRex and Suppliers.

Tape & Reel



TYPE	A	N	C	D	w1	w2	w3	T	K
8MM	+2 Φ180 - 2	+1 Φ60 - 1	+0,2 Φ13,1 - 0,2	4,2±0,5	+1 8,4 - 0	+1 11,6 - 1	+1 8,75 - 1	1,5±0,15	+0,1 1,25 - 0,05



Ao	2.20 + / - 0.05
Bo	2.20 + / - 0.05
Ko	0.55 + / - 0.05
F	3.50 + / - 0.05
P1	4.00 + / - 0.10
W	8.00 + 0.3 / - 0.1

- (I) Measured from centreline of sprocket hole to centreline to pocket.
 (II) Cumulative tolerance of 10 sprocket holes is ± 0.20.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED

Figure 9. 8TR8213 Tape and Reel Dimensions