

Radio Test Report

Manufacturer: Ellab A/S
Model: TrackSense Frigo UX SKY



In accordance with ARIB STD-T66 and MIC No.
88 Annex 43 (Article 2 Paragraph 1 Item 19)
Technology: (IEEE 802.15.4)

Prepared for: Ellab A/S
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COMMERCIAL-IN-CONFIDENCE

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SIGNATURE

NAME	JOB TITLE	RESPONSIBLE FOR	ISSUE DATE
Steve Marshall	Senior Engineer	Authorised Signatory	19 November 2025

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with ARIB STD-T66 3.7 (2014-10) and MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19) for the tests detailed in section 1.3.



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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
01	First version	02-Oct-2025
02	Technical description updated	06-Oct-2025
03	Table 13 (Antenna Information) updated Section 5 – Antenna Datasheet updated Hardware Version updated.	19-Nov-2025

Table 1

1.2 Introduction

Applicant	Ellab A/S
Manufacturer	Ellab A/S
Model Number(s)	TrackSense Frigo UX SKY
Manufacturer Declared Variant(s)	TrackSense Frigo UX SKY Combi TrackSense Frigo UX SKY Rigid TrackSense Frigo UX SKY Flexi
Serial Number(s)	806110 and 806083
Hardware Version(s)	66333009
Software Version(s)	125.1
Number of Samples Tested	2
Test Specification/Issue/Date	ARIB STD-T66: 3.7 (2014-10) MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)
Order Number	Project PU20230201/JJA
Date	11-June-2024
Date of Receipt of EUT	02-July-2025
Start of Test	04-July-2025
Finish of Test	25-September-2025
Name of Engineer(s)	Thomas Biddlecombe and George Williams
Related Document(s)	Radio Equipment Regulations, Article 24 Radio Equipment Regulations, Article 14 Radio Equipment Regulations, Article 5 Table 1 Radio Equipment Regulations, Article 7, Table 3 Radio Equipment Regulations, Article 6, Table 2 Radio Equipment Regulations, Article 49-20



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with ARIB STD-T66 and MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19) is shown below.

Section	Specification Clause	Test Description	Result	Comments/Base Standard
Configuration and Mode: TrackSense Frigo UX SKY Rigid - 802.15.4				
2.1	Article 2, Item (19) Notice 88, Appendix 43	Voltage Variations	Pass	
2.2	3.2 (2)	Antenna Power	Pass	Radio Equipment Regulations, Article 14
2.3	3.2 (4)	Frequency Deviation	Pass	Radio Equipment Regulations, Article 5 Table 1
2.4	3.2 (6)	Permissible Value of Spurious or Unnecessary Radiation Intensity	Pass	Radio Equipment Regulations, Article 7, Table 3
2.5	3.2 (7)	Allowable Value for Occupied Bandwidth	Pass	Radio Equipment Regulations, Article 6, Table 2
2.6	3.3 (1)	Limit on Secondary Radiation	Pass	Radio Equipment Regulations, Article 24
2.7	3.6 (2)	Antenna Gain	Pass	Radio Equipment Regulations, Article 49- 20

Table 2



1.4 Customer Supplied Form

Equipment Description

Technical Description: (Please provide a brief description of the intended use of the equipment)	The TrackSense Frigo UX SKY Loggers are part of a 2.4 GHz wireless measuring system with an Access Point connected to a PC with special software. A Reader Station is used to start-up and read measured samples from the Loggers via inductive communication. The logger is battery driven and can be provided with different sensor elements.
Manufacturer:	Ellab A/S, Trollesmindealle 25, 3400 Hillerød, Denmark
Model:	TrackSense Frigo UX SKY
Part Number:	31191110, 31191210UX, 31191211UX, 31191212UX, 31191213UX, 31191214UX, 31191215UX
Hardware Version:	66333009
Software Version:	NA

Table 3

Transmitter Technical Characteristics – Frequency Characteristics

Transmitter channel switching frequency range:	2.405 to 2.480 GHz
Transmitter frequency alignment range:	2.405 to 2.480 GHz
Please confirm that the OFDM system shall have one or more carriers per 1MHz Bandwidth	☐ Yes ☒ No

Table 4

Transmitter Power Characteristics

Maximum effective rated power (rated as stated by the manufacturer):	2.5 mW
Average effected radiated power (rated as stated by the manufacturer):	2.5 mW
Is transmitter intended for continuous duty	☐ Yes ☒ No
Is transmitter intended for intermittent duty	☒ Yes ☐ No
If intermittent state DUTY CYCLE	
Transmitter ON 4 milli seconds	Transmitter OFF 5, 10 or 60 seconds
Is transmitter output power variable:	
Continuous duty	☐ Yes ☒ No
Maximum power	2.5 mW
Continuously variable ☐	Stepped ☐
dB per step	
Maximum RF output power	
Minimum RF output power	

Table 5

Transmitter - Modulation

Frequency ☐ Phase ☐ Other ☒
If other supply details: DSSS

Table 6



Receiver Technical Characteristics – Frequency Characteristics

Receiver channel switching frequency range:	2.405 to 2.480 GHz
Receiver frequency alignment range:	2.405 to 2.480 GHz

Table 7

Channel Separation

Channel Separation	5 MHz
State the maximum number of channels over which the equipment can operate:	16

Table 8

Automatic Equipment Switch Off

If the equipment is designed to automatically switch off at a predetermined voltage level which is higher or lower in value than the battery minimum and minimum calculated values this shall be clearly stated.	
Applies ☐	Does Not Apply ☒
	V Cut off Voltage

Table 9

AC Power Source

AC supply frequency:		Hz
Voltage		V
Max current:		A
Single Phase ☐ Three Phase ☐		

Table 10

DC Power Source

Nominal voltage:		V
Extreme upper voltage:		V
Extreme lower voltage:		V
Max current:		A

Table 11

Battery Power Source

Voltage:	7.2	V
End-point voltage:	5.2	V (Point at which the battery will terminate)
Alkaline ☐ Leclanche ☐ Lithium ☒ Nickel Cadmium ☐ Lead Acid* ☐ *(Vehicle regulated)		
Other ☐	Please detail:	

Table 12

Antenna Information

Frequency	2400 – 2500 MHz
Gain	-1.0 (average), 1.5 (peak)
Impedance	50 Ohm
VSWR	3:1
Weight	
Length	3.2 mm
Diameter	1.6 x 1.2 mm (chip antenna)
Finish	
Connector	None
Operating Temperature	-40 to 85°C
Flame Rating	
Polarisation	None
RoHS Compliant	Yes
Pattern (i.e Omni Directional)	See datasheet: 2450AT18D0100001E (Johanson Technology)

Table 13

I hereby declare that the information supplied is correct and complete.

Name: James Jacobsson
Position held: Director of Engineering Services
Date: 17 November 2025



1.5 Product Information

1.5.1 Technical Description

The TrackSense Frigo UX SKY Loggers are part of a 2.4 GHz wireless measuring system with an Access Point connected to a PC with special software. A Reader Station is used to start-up and read measured samples from the Loggers via inductive communication. The logger is battery driven and can be provided with different sensor elements.

There are several configurations of the Frigo UX SKY Logger, all with same electronics and same PCB's including the same RF part, and same body size – but with different sensor elements mounted.

Rigid and Semi Flexible have a RTD element in the top of the sensor with wires to the PCB and they come in different lengths. Operating temperature is -90 to +140 °C.

Combi has also a RTD element in the top of the thin sensor with wires to the PCB, but also a pressure element with wires to the PCB. Operating temperature is -20 to +140 °C.

The sample used for testing was a Rigid variant.

1.6 Deviations from the Standard

No deviations from the applicable test standard were made during testing.

1.7 EUT Modification Record

The table below details modifications made to the EUT during the test programme.

The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
Rigid Sensor - Conducted, Model: TrackSense Frigo UX SKY Rigid, Serial Number: 806083			
0	As supplied by the customer	Not Applicable	Not Applicable
Rigid Sensor - Conducted, Model: TrackSense Frigo UX SKY Rigid, Serial Number: 806110			
0	As supplied by the customer	Not Applicable	Not Applicable

Table 14



1.8 Test Location

TÜV SÜD conducted the following tests at our Octagon House Test Laboratory.

Test Name	Name of Engineer(s)	Accreditation
Configuration and Mode: TrackSense Frigo UX SKY Rigid - 802.15.4		
Voltage Variations	Thomas Biddlecombe	UKAS
Antenna Power	George Williams	UKAS
Frequency Deviation	George Williams	UKAS
Permissible Value of Spurious or Unnecessary Radiation Intensity	George Williams	UKAS
Allowable Value for Occupied Bandwidth	George Williams	UKAS
Limit on Secondary Radiation	George Williams	UKAS
Antenna Gain	George Williams	UKAS

Table 15

Laboratory Address: TÜV SÜD, Octagon House,
Concorde Way, Fareham, Hampshire,
PO15 5RL, United Kingdom



2 Test Details

2.1 Voltage Variations

2.1.1 Specification Reference

MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.1.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806110 - Modification State 0

2.1.3 Date of Test

04-July-2025

2.1.4 Test Method

The input voltage was set to $\pm 10\%$ of the nominal voltage specified by the manufacturer. Using a DVM the input voltage to the RF circuit was measured.

2.1.5 Environmental Conditions

Ambient Temperature 21.5 °C

Relative Humidity 48.4 %

2.1.6 Test Results

Input Supply Voltage	Measured Voltage at RF Circuitry
6.48 VDC	3.30 VDC
7.20 VDC	3.29 VDC
7.92 VDC	3.29 VDC

Table 16 - Voltage Variation Results

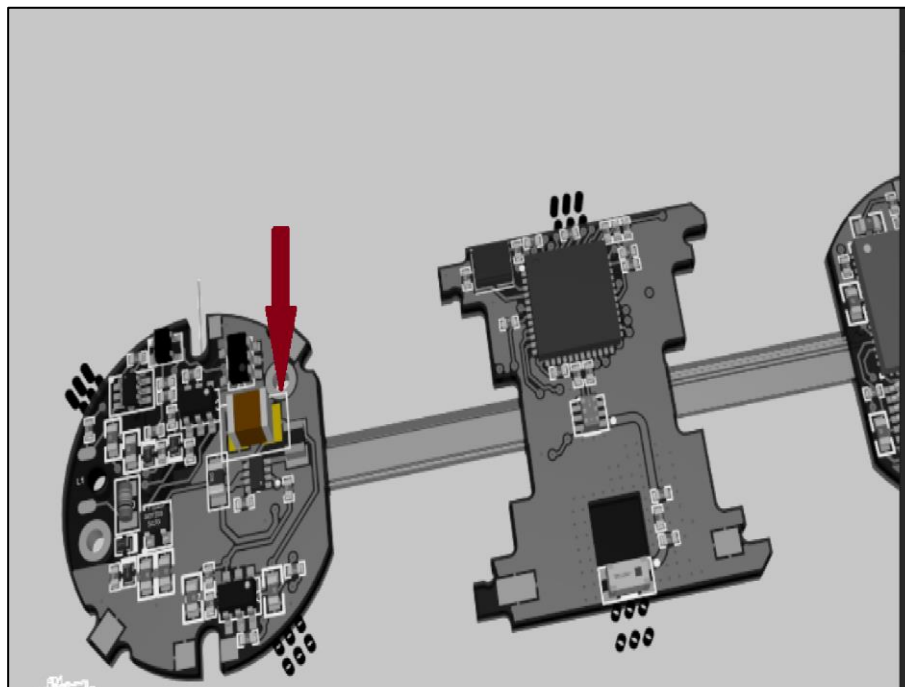


Figure 1 - Diagram showing the test point at which the voltage was measured to the RF Circuitry

The input voltage to the receiver RF circuit varied less than $\pm 1\%$ as the input voltage from the external power supply to the receiver was varied $\pm 10\%$ therefore tests are performed only at the manufacturers nominal voltage.

2.1.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
Digital Multi-meter	Iso-tech	IDM93N	4435	12	06-Mar-2026
Modular Power System Mainframe	Keysight Technologies	N6701C	5835	-	TU
DC Power Module 60V 20A 300W	Keysight Technologies	N6754A	5836	-	O/P Mon

Table 17

TU - Traceability Unscheduled

O/P Mon – Output Monitored using calibrated equipment



2.2 Antenna Power

2.2.1 Specification Reference

ARIB STD-T66: Clause 3.2 (2)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.2.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.2.3 Date of Test

16-September-2025

2.2.4 Test Method

The Power Spectral Density was measured using a spectrum analyser which was tuned to the test frequency with the relevant RBW to match the limit. The max hold function on the analyser was used to obtain output power. A percentage deviation from the measured power to the declared power was calculated and assessed against the tolerance limits.
The EUT was powered by its internal batteries, which were fully charged prior to the commencement of the test.

2.2.5 Environmental Conditions

Ambient Temperature	20.3 °C
Relative Humidity	31.9 %



2.2.6 Test Results

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz (WW)
Limit Clause(s):	3.2 (2) 3.2 (3)	Test Method(s):	Refer to Test Method
Note(s):	3.6		

DUT Configuration			
Mode:	Other 2.00 MHz	Duty Cycle (%):	100.0
Antenna Configuration:	SISO	DCCF (dB):	0.00
Active Port(s):	A (Conducted Port)	Peak Antenna Gain (dBi):	1.50

Test Frequency (MHz)	Conducted Output Power (mW)					Limit (mW)
	A	B	C	D	Σ	
2405	1.55	-	-	-	-	10.00
2440	1.42	-	-	-	-	10.00
2475	1.51	-	-	-	-	10.00

Table 18 - Output Power Results

Test Frequency (MHz)	Conducted Output Power (mW)					Declared (mW)	Tolerance (%)	Limit (%)
	A	B	C	D	Σ			
2405	1.55	-	-	-	-	2.51	-38.24	$80 \leq n \leq +20$
2440	1.42	-	-	-	-	2.51	-43.66	$80 \leq n \leq +20$
2475	1.51	-	-	-	-	2.51	-39.95	$-80 \leq n \leq +20$

Table 19 - Output Power Tolerance Results

ARIB STD T-66, Limit Clause 3.2 (2)

Clause	Requirement
3.2(2)(d)	10 mW

Table 20 - Antenna Power Limit

ARIB STD T-66, Limit Clause 3.2 (3)

Total Power:

The upper and lower allowable deviations in antenna power are 20% and 80%, respectively. However, these limits are for maximum rate antenna power. If the antenna power is reduced for communication reasons, there are no regulated upper or lower allowable deviations.

* Only the upper antenna tolerance of +20% applies to the Radio Equipment Regulations Article 14(8)(3) for radio stations of low-power data communications systems using radio waves with frequencies exceeding 2400 MHz and up to 2483.5 MHz.

The maximum antenna gain for this unit to pass the requirements has been found to be 7.83 dBi for antennas with a maximum half power beamwidth of 360 degrees. This is due to the max measurement of 2.70 mW/MHz and is in relation to the max permitted EIRP of 12.14 dBm/MHz according to clause 3.6(2). Higher gain antennas may be used so long as the half power beamwidth passes the requirements in ARIB STD-T66 3.6(2).

2.2.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	18-Sep-2025
EXA Signal Analyser	Keysight Technologies	N9010B	4969	24	07-Feb-2026
USB Power Sensor	Boonton	RTP5008	5833	12	29-Aug-2026
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Sep-2026
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6638	12	29-Aug-2026

Table 21



2.3 Frequency Deviation

2.3.1 Specification Reference

ARIB STD-T66: Clause 3.2 (4)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.3.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.3.3 Date of Test

16-September-2025

2.3.4 Test Method

The frequency of the spectrum was measured using a spectrum analyser by finding the centre point of the 10 dB bandwidth. The deviation of the measured value from the assigned frequency was calculated in ppm.

The EUT was powered by its internal batteries, which were fully charged prior to the commencement of the test.

2.3.5 Environmental Conditions

Ambient Temperature	20.3 °C
Relative Humidity	31.9 %

2.3.6 Test Results

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz (WW)
Limit Clause(s):	3.2(4)	Test Method(s):	Refer to Test Method
Additional Reference(s):	-		

DUT Configuration			
Mode:	Other 2.00 MHz	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (Conducted Port)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	Frequency Error (ppm)				Limit (ppm)
	A	B	C	D	
2405	10.644	-	-	-	±50.0
2440	10.820	-	-	-	±50.0
2475	4.848	-	-	-	±50.0

Table 22 - Frequency Tolerance Results

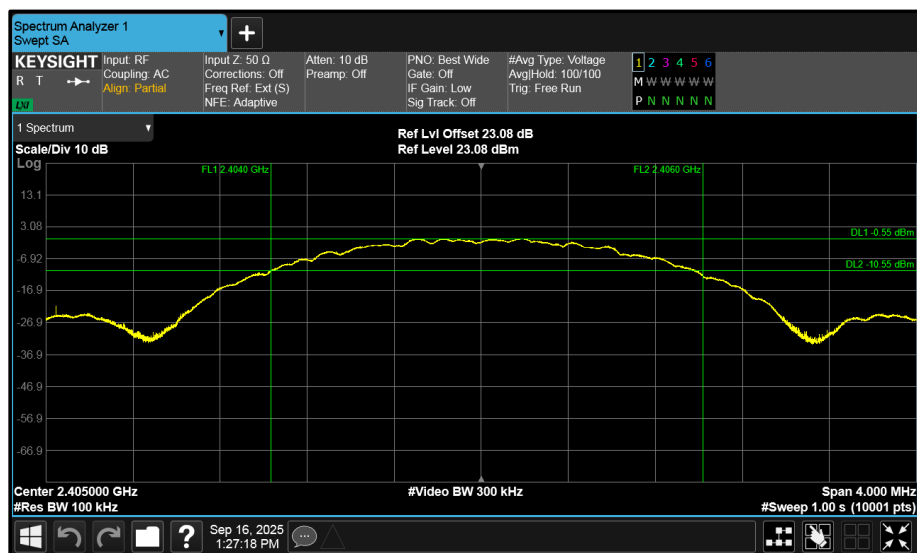


Figure 2 - Conducted Port (A) 2405 MHz (CH11) Pre-scan



Figure 3 - Conducted Port (A) 2440 MHz (CH18) Pre-scan

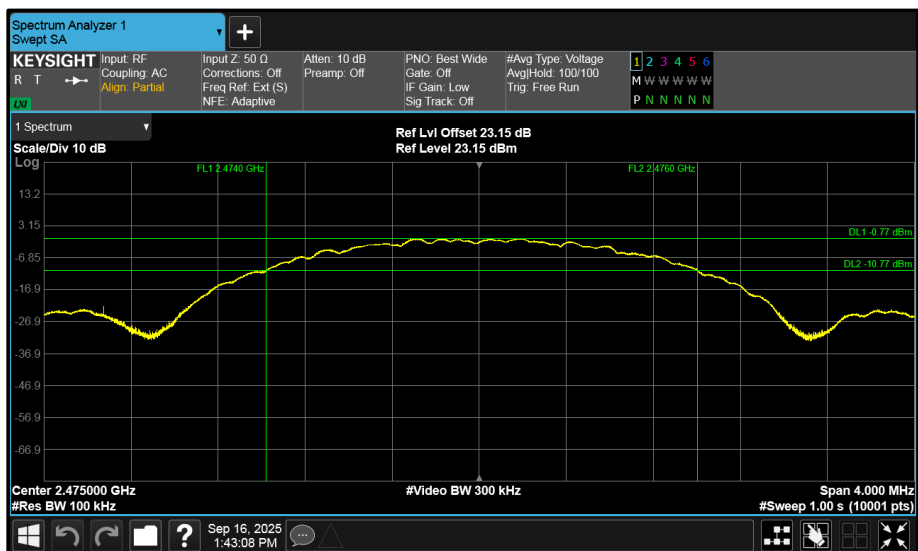


Figure 4 - Conducted Port (A) 2475 MHz (CH25) Pre-scan

ARIB STD T-66, Limit Clause 3.2 (4)

$\pm 50 \times 10^{-6}$.



2.3.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	18-Sep-2025
EXA Signal Analyser	Keysight Technologies	N9010B	4969	24	07-Feb-2026
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Sep-2026
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6638	12	29-Aug-2026

Table 23



2.4 Permissible Value of Spurious or Unnecessary Radiation Intensity

2.4.1 Specification Reference

ARIB STD-T66: Clause 3.2 (6)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19),

2.4.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.4.3 Date of Test

25-September-2025

2.4.4 Test Method

This test has been performed in accordance with ARIB STD-T66 v3.7 standard using a spectrum analyser with a Peak detector and a Max Hold trace.

In the range 30 MHz to 1 GHz an RBW of 100 kHz and VBW of 300 kHz were used, for the range 30 MHz to 13 GHz an RBW of 1 MHz and VBW of 3 MHz was used.

The EUT was powered by its internal batteries, which were fully charged prior to the commencement of testing and set to transmit a modulated carrier at 100% duty cycle.

2.4.5 Environmental Conditions

Ambient Temperature	18.8 °C
Relative Humidity	41.0 %

2.4.6 Test Results

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 24 - CH11_Tx, 2405 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

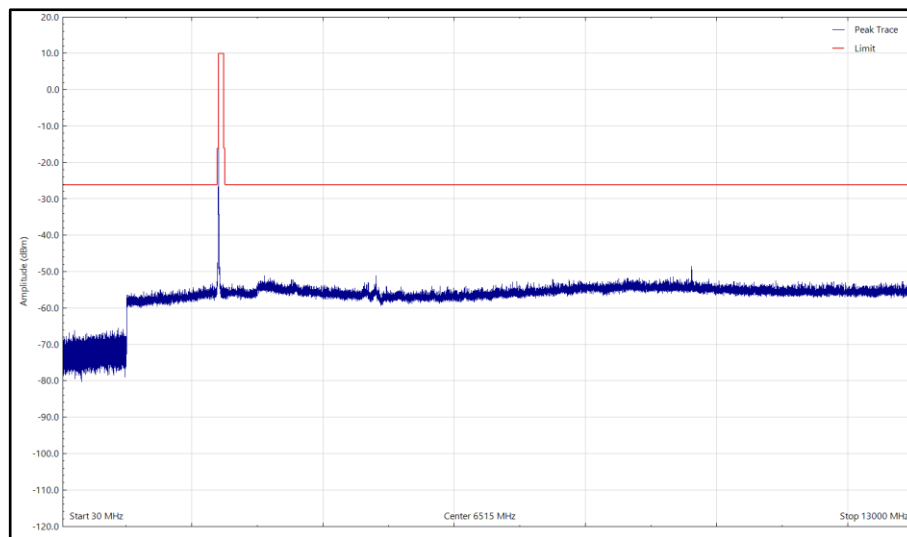


Figure 5 - CH11_Tx, 2405 MHz, 30 MHz to 13 GHz, Vertical (Peak)

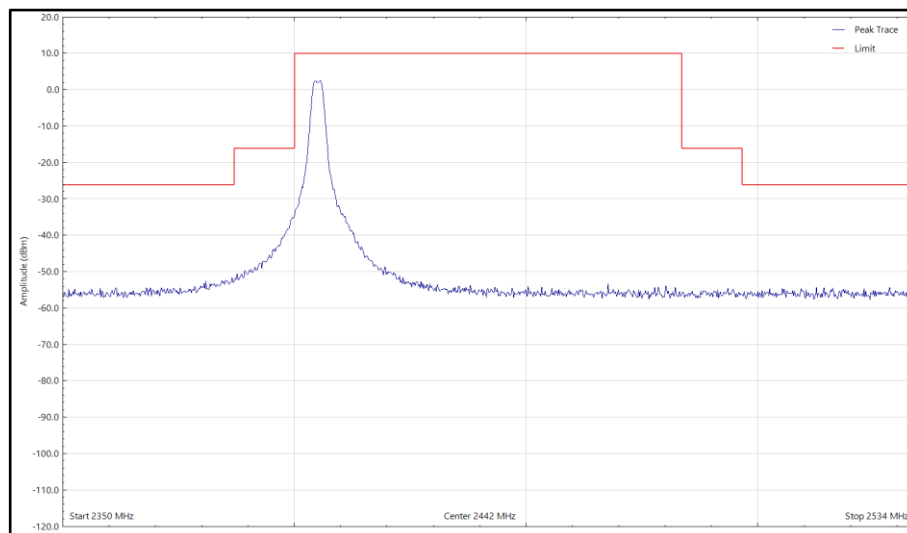


Figure 6 - CH11_Tx, 2405 MHz, 2350 MHz to 2534 MHz (Peak)

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 25 - CH18_Tx, 2440 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

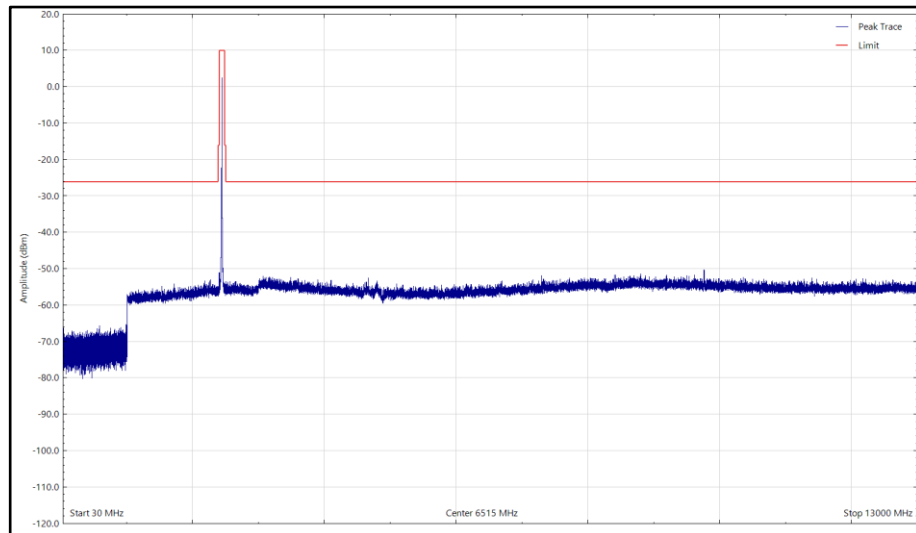


Figure 7 - CH18_Tx, 2440 MHz, 30 MHz to 13 GHz, Vertical (Peak)

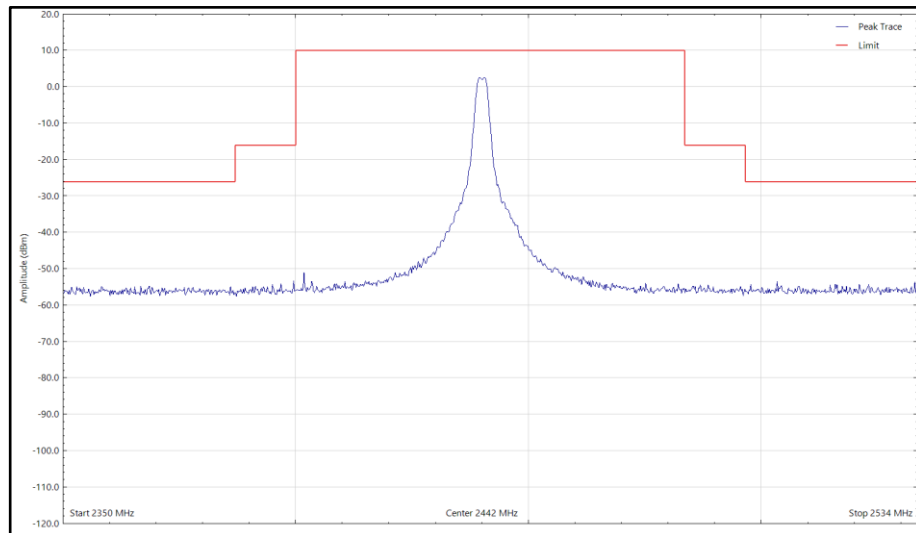


Figure 8 - CH18_Tx, 2440 MHz, 2350 MHz to 2534 MHz (Peak)

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 26 - CH25_Tx, 2475 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

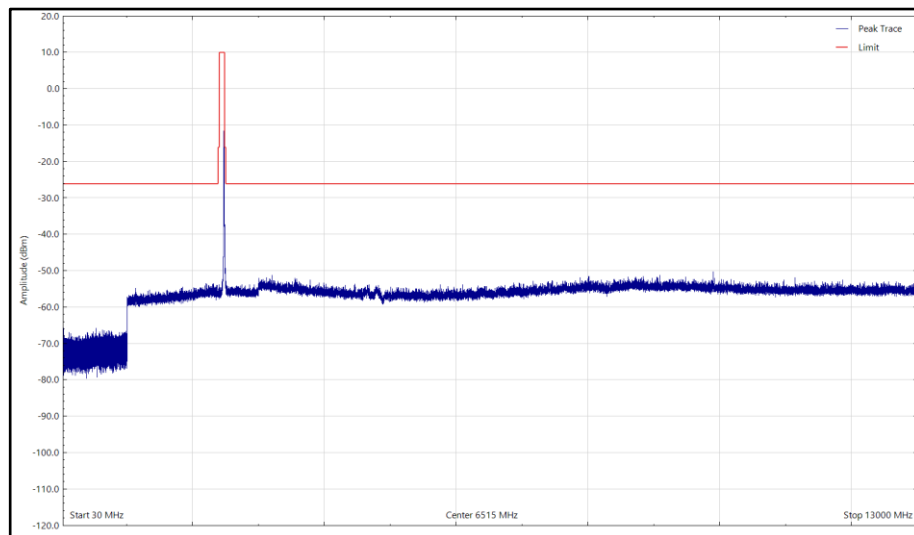


Figure 9 - CH25_Tx, 2475 MHz, 30 MHz to 13 GHz, Vertical (Peak)

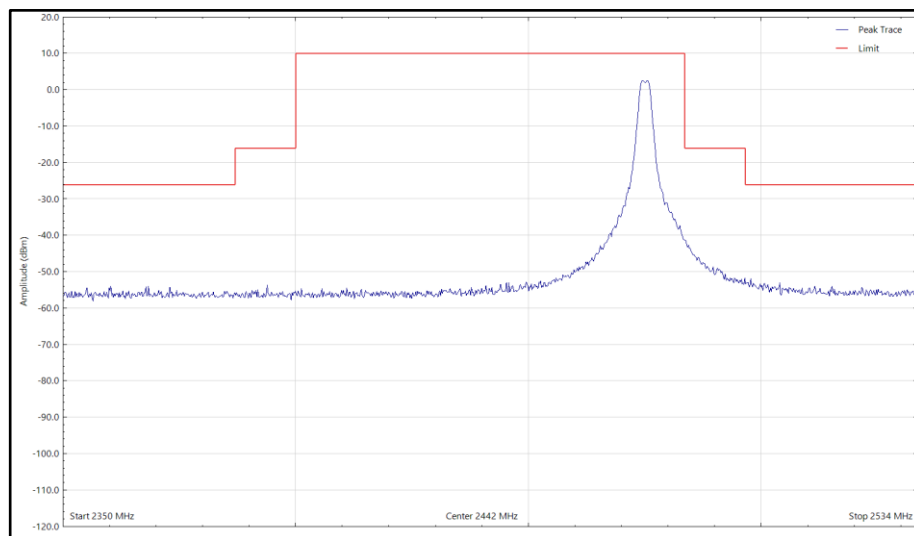


Figure 10 - CH25_Tx, 2475 MHz, 2350 MHz to 2534 MHz (Peak)

ARIB STD-T66, Limit Clause 3.2 (6)

Frequency Range	Limit
2387 MHz to 2400 MHz and 2483.5 MHz to 2496.5 MHz	25 µW or -16 dBm
9 kHz to <2387 MHz and >2496.5 MHz to 25 GHz	2.5 µW or -26 dBm

Table 27 – Spurious Emission Limits

2.4.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	18-Feb-2026
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-May-2026
Emissions Software	TUV SUD	EmX V3.5.4	5125	-	Software
3 GHz High pass Filter	Wainwright	WHKX12-2580-3000-18000-80SS	5548	12	31-Aug-2026
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	26-Nov-2025
Coaxial Fixed Attenuator DC-18GHz 5W 10dB	RF-Lambda	RFS5G18B10SMP	6172	12	21-Jul-2026
Attenuator 5W 20dB DC-18GHz	Aaren	AT40A-4041-D18-20	6558	12	29-Nov-2025
1m SMA Cable	Junkosha	MWX221-01000AMSAMS/B	6918	12	08-Dec-2025

Table 28



2.5 Allowable Value for Occupied Bandwidth

2.5.1 Specification Reference

ARIB STD-T66: Clause 3.2 (7)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.5.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.5.3 Date of Test

16-September-2025

2.5.4 Test Method

The spectrum analyser was tuned to the test frequency with a span to incorporate the entire bandwidth of the modulated signal. Allowing for the trace to stabilize, the bandwidth whereby 99% power of the power resides was recorded.

The EUT was powered by its internal batteries which were fully charged prior to the commencement of the test.

2.5.5 Environmental Conditions

Ambient Temperature	20.3 °C
Relative Humidity	31.9 %



2.5.6 Test Results

Test Configuration			
Frequency Range:	2400-2483.5 MHz	Band:	2.4 GHz (WW)
Limit Clause(s):	3.2(7)	Test Method(s):	Refer to Test Method
Additional Reference(s):	-		

DUT Configuration			
Mode:	Other 2.00 MHz	Duty Cycle (%):	-
Antenna Configuration:	SISO	DCCF (dB):	-
Active Port(s):	A (Conducted Port)	Peak Antenna Gain (dBi):	-

Test Frequency (MHz)	99% Bandwidth (MHz)					Limit (MHz)
	A	B	C	D	Maximum	
2405	2.400	-	-	-	2.400	≤26.0
2440	2.436	-	-	-	2.436	≤26.0
2475	2.492	-	-	-	2.492	≤26.0

Table 29 - 99% Bandwidth Results

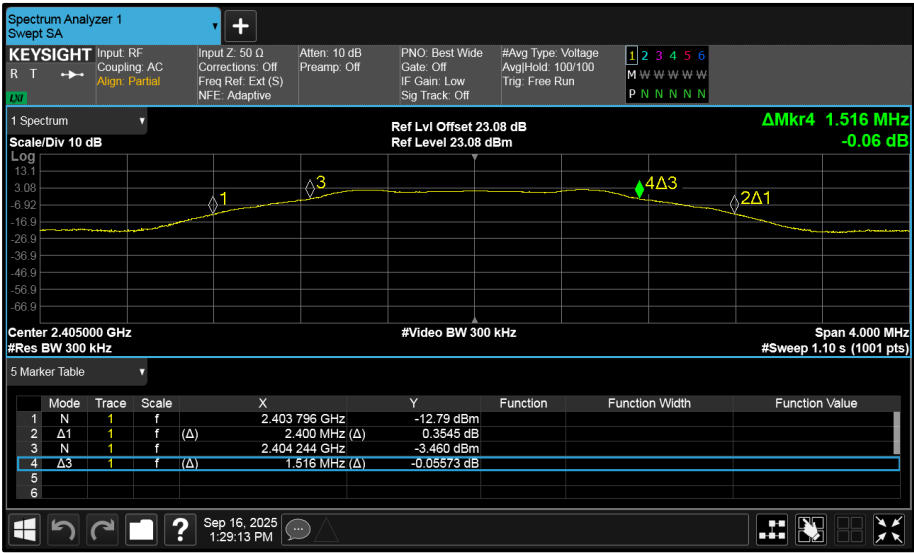


Figure 11 - Conducted Port (A) 2405 MHz (CH11)

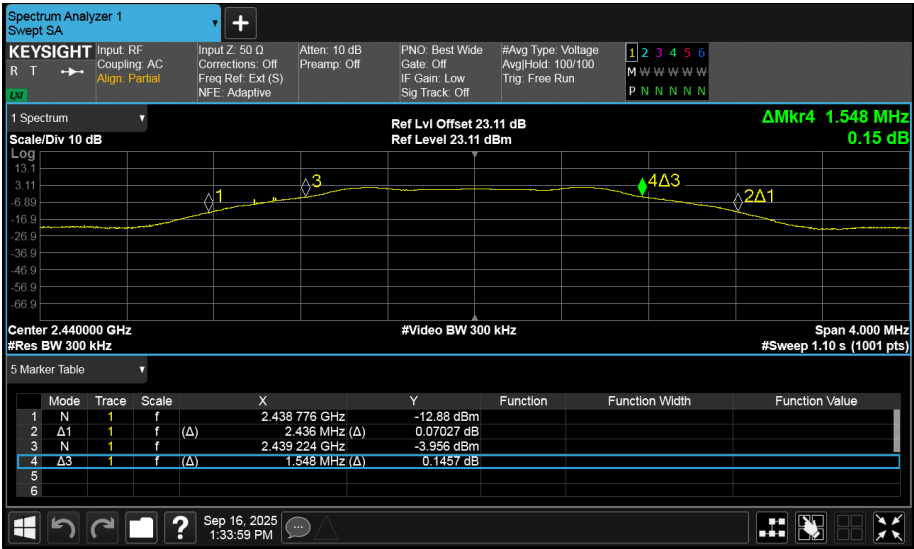


Figure 12 - Conducted Port (A) 2440 MHz (CH18)

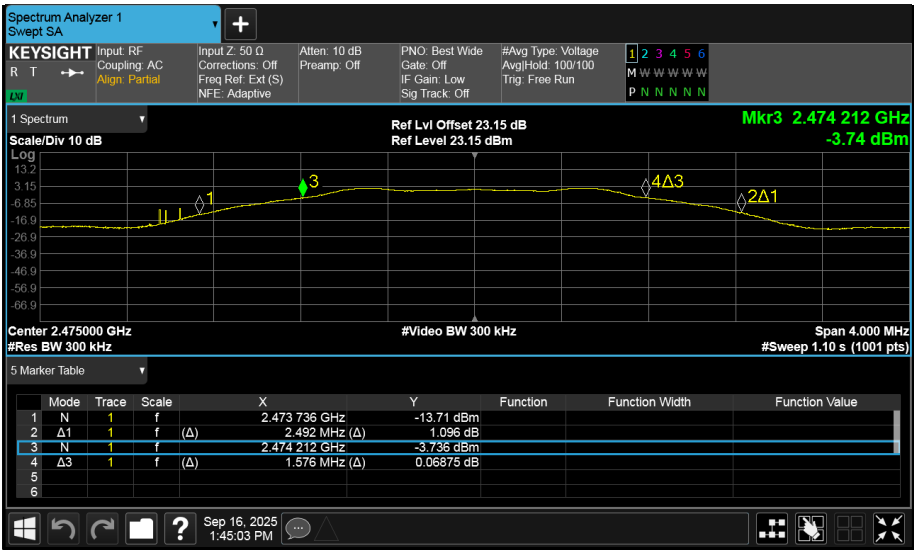


Figure 13 - Conducted Port (A) 2475 MHz (CH25)

ARIB STD T-66, Limit Clause 3.2 (7)

Permissible value of occupied frequency bandwidth for transmission devices using a FH system, a DS-FH hybrid system, or a FH-OFDM hybrid system is at most 83.5MHz; for transmission devices using an OFDM system is at most 38MHz; and for transmission devices using any other system the necessary frequency bandwidth is at most 26MHz.



2.5.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	18-Sep-2025
EXA Signal Analyser	Keysight Technologies	N9010B	4969	24	07-Feb-2026
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6350	12	02-Sep-2026
SCU Cable Assembly	TUV SUD	SPECTRUM_SCU_CA	6638	12	29-Aug-2026

Table 30



2.6 Limit on Secondary Radiation

2.6.1 Specification Reference

ARIB STD-T66: Clause 3.3 (1)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.6.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.6.3 Date of Test

25-September-2025

2.6.4 Test Method

The test was carried out according to ARIB STD-T66, clause 3.3 (1) Radiated Emissions method in receive mode.

The EUT was connected to a spectrum analyser via a cable and attenuator.

The spectrum analyser was configured with a 1 MHz RBW above 1 GHz and 100 kHz RBW below 1 GHz, peak detector and max hold trace and any observed emissions were confirmed as less than the appropriate limit.

Tests were carried out with the EUT set to receive on each of the Bottom, Middle and Top Channels.

2.6.5 Environmental Conditions

Ambient Temperature	18.8 °C
Relative Humidity	41.0 %

2.6.6 Test Results

Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 31 - CH11_Rx, 2405 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

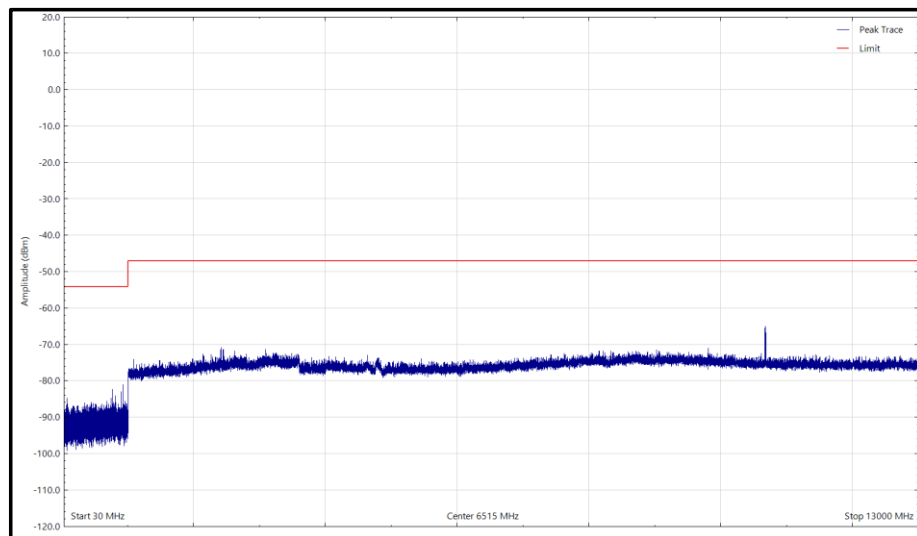


Figure 14 - CH11_Rx, 2405 MHz, 30 MHz to 13 GHz (Peak)



Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 32 - CH18_Rx, 2440 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

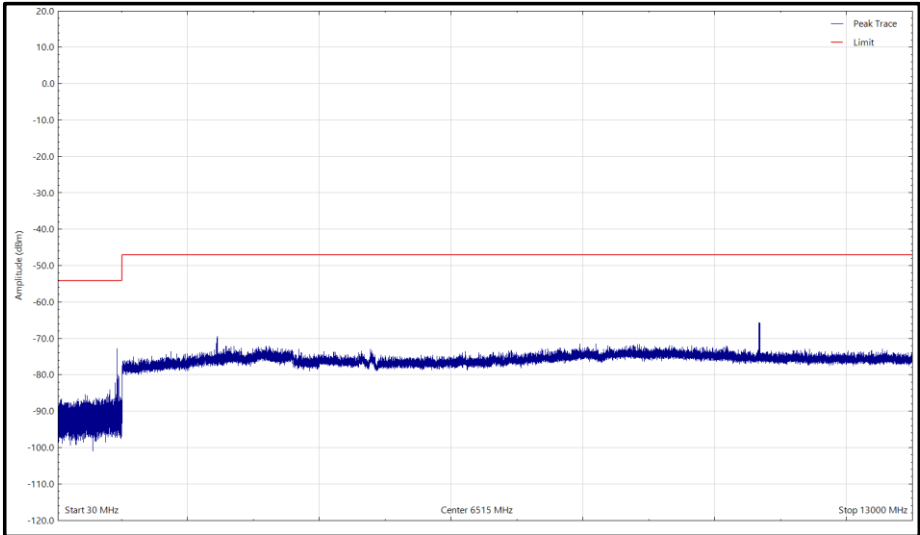


Figure 15 - CH18_Rx, 2440 MHz, 30 MHz to 13 GHz (Peak)



Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)	Detector
*				

Table 33 - CH25_Rx, 2475 MHz, 30 MHz to 13 GHz

*No emissions found within 6 dB of the limit.

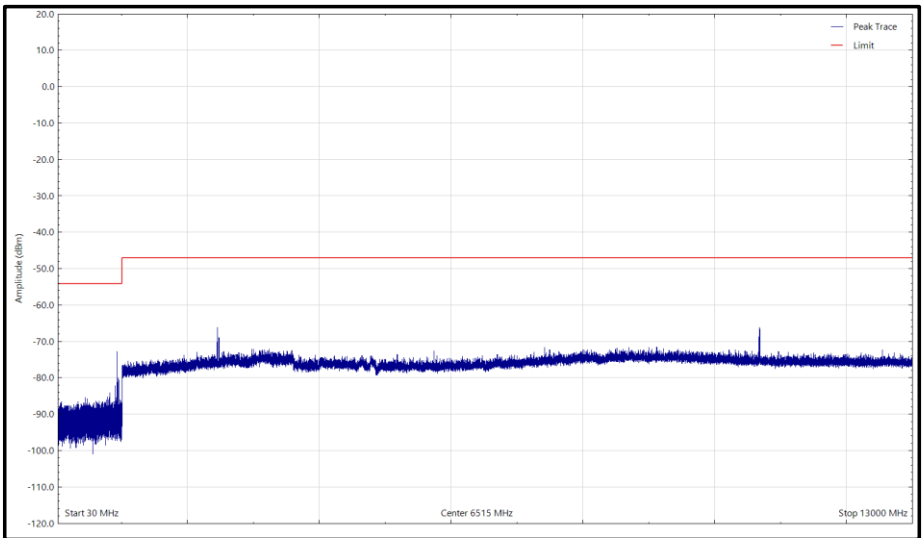


Figure 16 - CH25_Rx, 2475 MHz, 30 MHz to 13 GHz (Peak)

ARIB STD-T66, Limit Clause 3.3 (1)

The limit on secondary emissions radiated from the receiving equipment within which the function of other radio equipment will not be impaired shall be, in terms of the power of a dummy antenna circuit that has the same electrical constant as the receiving antenna, 4 nW or less at a frequency below 1 GHz and 20 nW or less at a frequency of 1 GHz or higher as measured using the circuit.



2.6.7 Test Location and Test Equipment Used

This test was carried out in RF Laboratory 1.

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Expires
Hygrometer	Rotronic	I-1000	2891	12	02-Dec-2025
GPSDR Frequency Standard	Spectracom	SecureSync 1200-0408-0601	4393	6	18-Feb-2026
PXA Signal Analyser	Keysight Technologies	N9030A	4653	12	06-May-2026
Emissions Software	TUV SUD	EmX V3.5.4	5125	-	Software
Thermo-Hygro-Barometer	PCE Instruments	PCE-THB 40	5604	12	26-Nov-2025
Coaxial Fixed Attenuator DC-18GHz 5W 10dB	RF-Lambda	RFS5G18B10SMP	6172	12	21-Jul-2026
1m SMA Cable	Junkosha	MWX221-01000AMSAMS/B	6918	12	08-Dec-2025

Table 34

2.7 Antenna Gain

2.7.1 Specification Reference

ARIB STD-T66: Clause 3.6 (2)
MIC No. 88 Annex 43 (Article 2 Paragraph 1 Item 19)

2.7.2 Equipment Under Test and Modification State

TrackSense Frigo UX SKY Rigid, S/N: 806083 - Modification State 0

2.7.3 Date of Test

16-September-2025

2.7.4 Test Method

The following information was provided by the manufacturer. (See Annex A for Details).

The maximum half power beamwidth was calculated by determining the EIRP relative to an antenna with a transmitting power of 12.14 dBm/MHz (16.37 mW/MHz).

$$A = \text{EIRP (mW/MHz)} / 16.37$$

$$\text{Maximum Half-Power Beamwidth} = 360 \text{ degrees} / A.$$

2.7.5 Environmental Conditions

Ambient Temperature 20.3 °C
Relative Humidity 31.9 %

2.7.6 Test Results

Parameter	Results
Frequency Range (MHz)	2405-2475 MHz
Antenna Gain (dBi)	1.5
Half-Power Beamwidth	360 degrees max
EIRP (mW/MHz)	1.58
A	1
Calculated Maximum Half-Power Beamwidth	360 degrees max

Table 35

ARIB STD-T66, Limit Clause 3.6 (2)

The absolute gain of transmitting antennas must be at most 12.14 dB.

3 Photographs

3.1 Equipment Under Test (EUT)



Figure 17 - EUT General View – Rigid

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Test Name	Measurement Uncertainty
Voltage Variations	-
Antenna Power	± 0.64 dB
Frequency Deviation	± 48.996 kHz
Permissible Value of Spurious or Unnecessary Radiation Intensity	± 3.454 dB
Allowable Value for Occupied Bandwidth	± 82.321 kHz
Limit on Secondary Radiation	± 3.45 dB
Antenna Gain	-

Table 36

Measurement Uncertainty Decision Rule

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2021, Clause 4.4.3 (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.



5 **Antenna Datasheet**

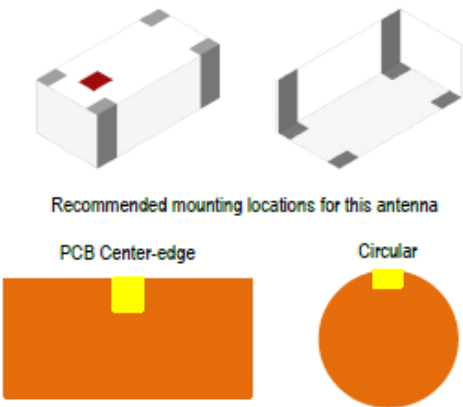


P/N: 2450AT18D0100001E
Legacy P/N: 2450AT18D0100

2.45 GHz RF Chip Antenna

- 2.4 – 2.5 GHz pass band
- Bluetooth, WLAN, detuning resilient
- SMD, EIA 1206
- Center-edge mount, circular PCB, or thin edge
- RoHS compliant and AEC-Q200 Qualified available

Johanson Technology, Inc. (JTI) miniature RF ceramic chip antennas are made using Low Temperature Co-fired Ceramic (LTCC) technology which has the ability to embed low and high dielectric constants inside our antenna. This enables our components to have high detuning resilience and stability over extreme temperatures (~2ppm).



General Specifications^{1 2}

Passband Frequency (MHz)	2400 - 2500
Impedance (Ω)	50
Return Loss (dB)	6 Min.
Peak Gain (dBi)	1.5 Typ.
Average Gain (dBi)	-1.0 Typ.
Average Radiated Efficiency (%)	72

Maximum Ratings

Power Capacity (W)	3 Max. (CW)
Operating Temperature (°C)	-40 to +85
Recommended Storage Conditions post-installation (°C)	-40 to +85
Recommended Storage Conditions and Period for Unused T&R Product	45% - 75% RH +5 to +35 °C 18 Months Max.

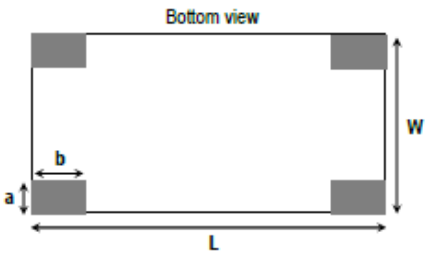
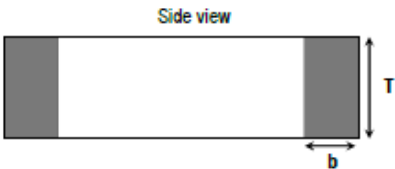
¹ Typical value represents average measurement at 25°C. Min./Max. values represent measurements over specified operating temperature.
² General specifications measured on Johanson's evaluation board P/N 2450AT18D0100001CE1.



P/N: 2450AT18D0100001E
Legacy P/N: 2450AT18D0100

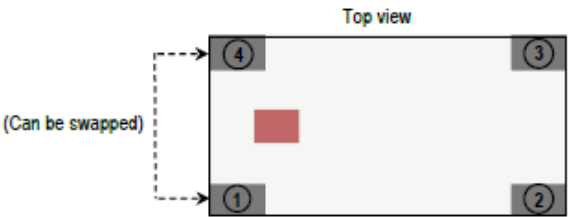
Mechanical Dimensions

	Inches			Millimeters		
L	0.126	±	0.008	3.20	±	0.20
W	0.063	±	0.008	1.60	±	0.20
T	0.047	±	0.008	1.20	±	0.20
a	0.012	+0.004/-0.008		0.30	+0.10/-0.20	
b	0.020	±	0.008	0.50	±	0.20



Terminal Configuration³

Pin Number	Function	
1	Feed	GND
2	GND	GND
3	GND	GND
4	GND	Feed



³ The termination type is Nickel Tin. Go to: <https://www.johansontechnology.com/ipcsoldering-profile> for Typical Soldering Profile.

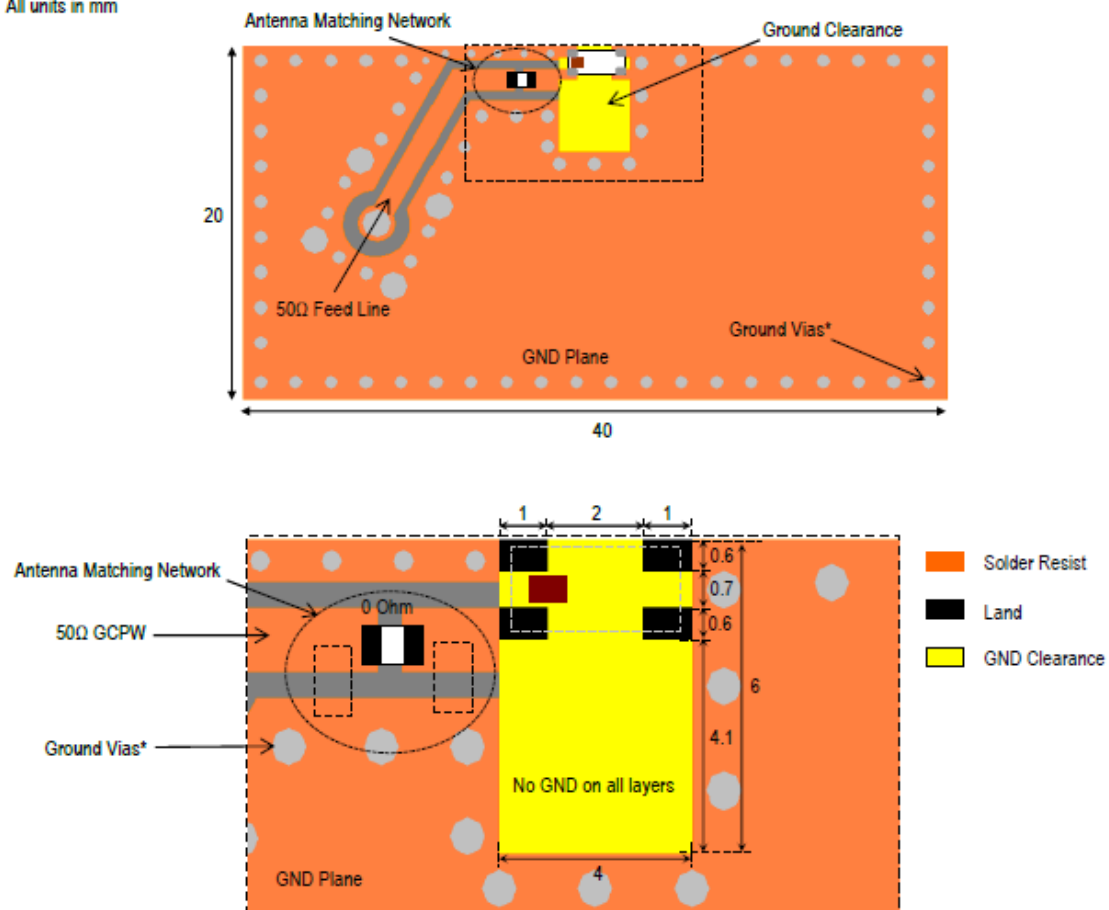


P/N: 2450AT18D0100001E

Legacy P/N: 2450AT18D0100

Evaluation Board and Recommended Mounting Configuration (P/N 2450AT18D0100001CE1)

All units in mm



JTI P/N's for Matching Network⁴
N/A

*Note: Ground Vias are highly recommended to have better antenna efficiency.

If you'd like the CAD PCB layout or have any questions,
contact our application engineers at <https://www.johansontechnology.com/ask-a-question>

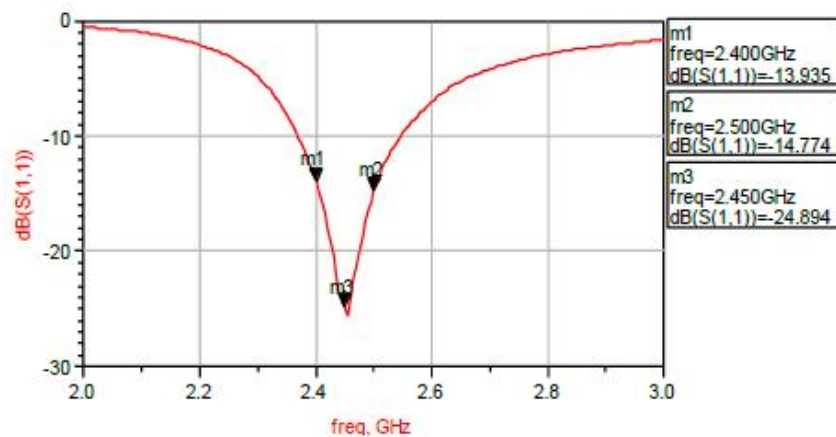
⁴ It is recommended that the designer leave available slots for a "pi" (or shunt-series-shunt) network. The antenna matching network values above are used when antenna is mounted on Johanson's evaluation board. The matching values on client's PCB will be different, depending on the layout, thickness, material, etc. Go to: <https://www.johansontechnology.com/tuning> and see how to obtain the new values.



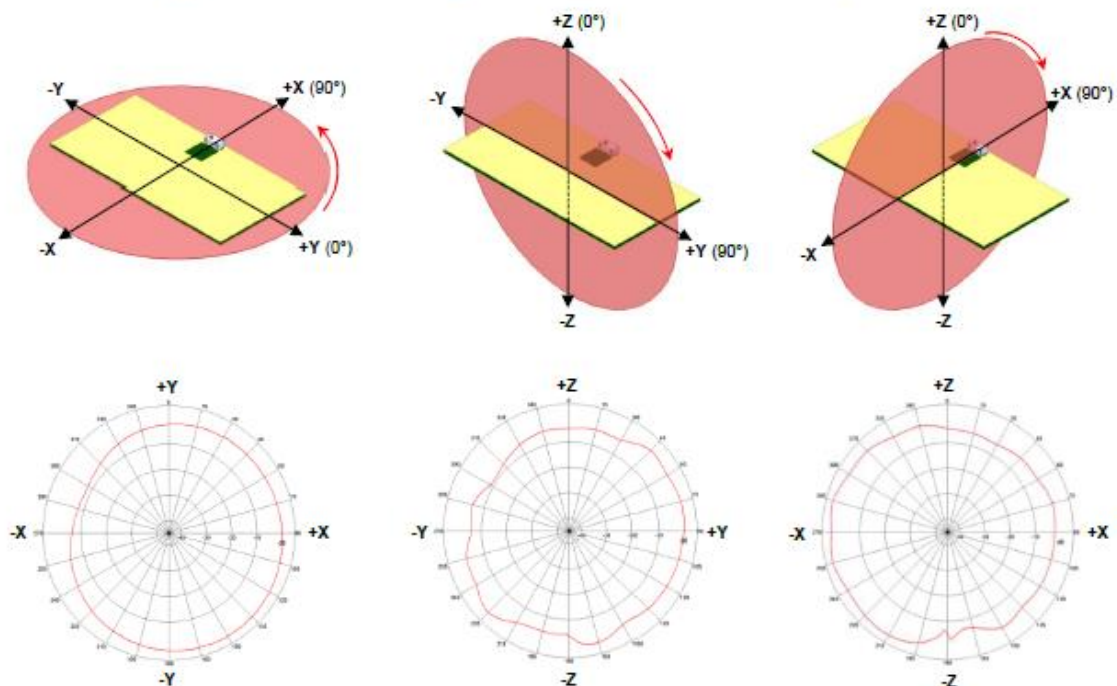
P/N: 2450AT18D0100001E

Legacy P/N: 2450AT18D0100

Evaluation Board Typical Return Loss Measurement (P/N 2450AT18D0100001CE1)



Evaluation Board Typical 2D Radiation Patterns @2.45GHz (P/N 2450AT18D0100001CE1)



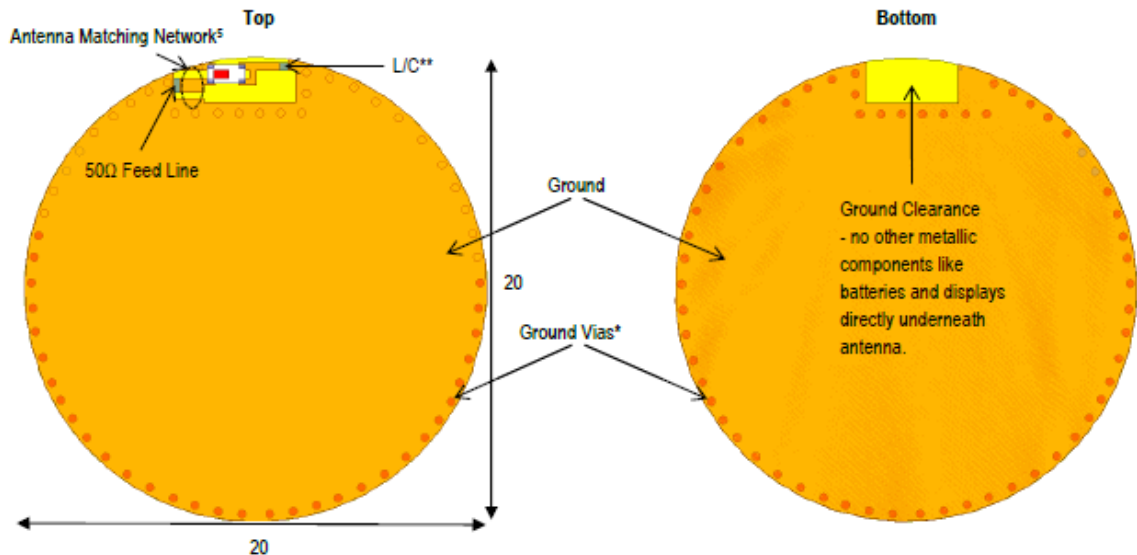


P/N: 2450AT18D0100001E

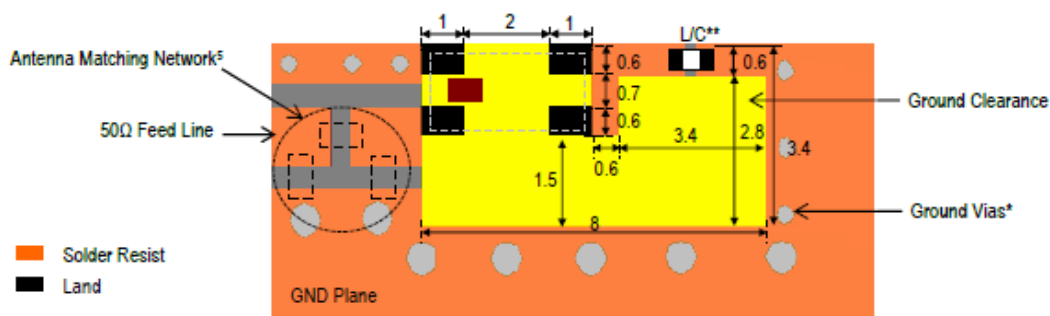
Legacy P/N: 2450AT18D0100

Other Mounting Configurations – for reference purpose only (no evaluation boards available)

Circular PCB



Small Clearance or "Thin edge" Applications



*Note1: Ground Vias are highly recommended to have better antenna efficiency.

**Note2: L/C component is added to adjust the initial frequency for antenna tuning.

If you have any questions regarding the implementation of this antenna in your PCB's layout, please contact our application engineers at <https://www.johansontechnology.com/ask-a-question>

⁵ It is recommended that the designer leave available slots for a "pi" (or shunt-series-shunt) network. The matching values on client's PCB will be different, depending on the layout, thickness, material, etc. Go to: <https://www.johansontechnology.com/tuning> and see how to obtain the new values.

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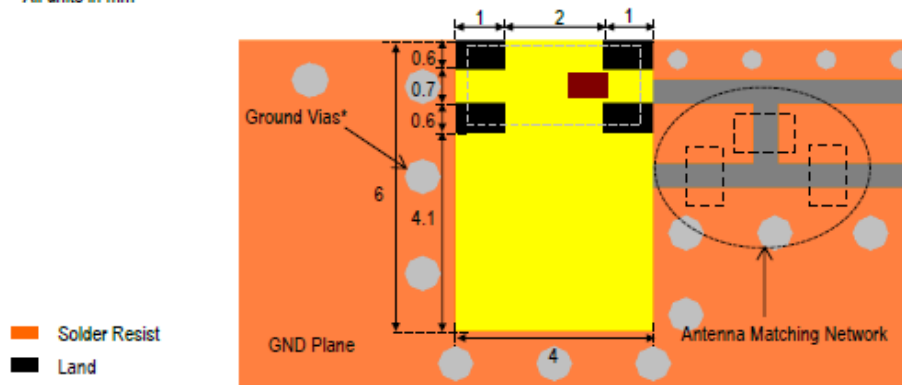


P/N: 2450AT18D0100001E

Legacy P/N: 2450AT18D0100

Fed from Right Side (Feeding the antenna from the right will have no impact on antenna performance)

All units in mm



JTI P/N's for Matching Network⁶

N/A

Note: Ground Vias are highly recommended to have better antenna efficiency.

If you'd like the CAD PCB layout or have any questions,
contact our application engineers at <https://www.johansontechnology.com/ask-a-question>

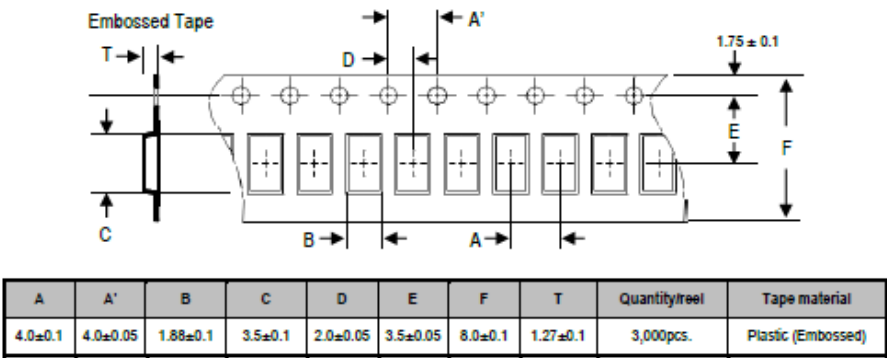
⁶ It is recommended that the designer leave available slots for a "pi" (or shunt-series-shunt) network. The matching values on client's PCB will be different, depending on the layout, thickness, material, etc. Go to: <https://www.johansontechnology.com/tuning> and see how to obtain the new values.



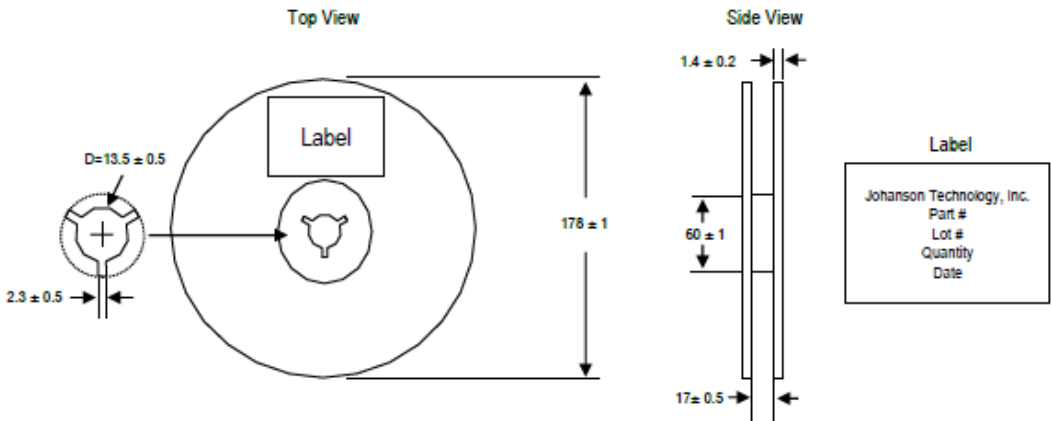
P/N: 2450AT18D0100001E
Legacy P/N: 2450AT18D0100

Tape and Reel Specification (Units in mm)

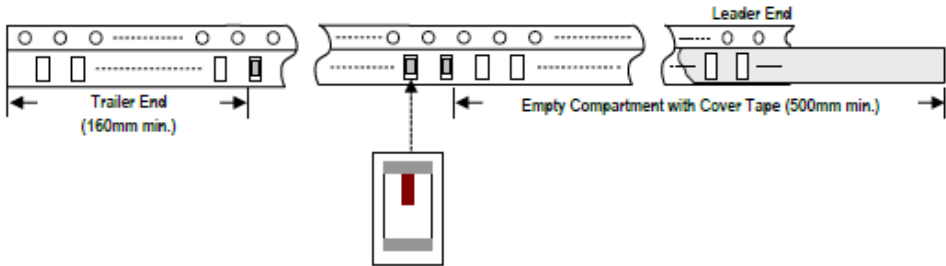
Tape Dimensions



Reel Dimensions



Leader and Trailer Dimensions





P/N: 2450AT18D0100001E
Legacy P/N: 2450AT18D0100

Orderable Part Number

Packaging Style	Part Number	Termination
Bulk (loose pcs.)	2450AT18D0100001B	Nickel Tin
T & R (7" Reel Embossed Tape)	2450AT18D0100001E (Qty: 3,000 pcs./reel)	
Evaluation Board with 1 SMA Connector	2450AT18D0100001CE1	

Important Links

- [2450AT18D0100001E Product Page](#)
 - [More RF Chip Antennas](#)
 - [Antenna Tuning, Optimization, and Validation Services](#)
 - [Soldering Information](#)
 - [MSL Information](#)
 - [Packaging Information](#)
 - [Recommended Storage Condition and Max Shelf Life](#)
 - [RoHS Compliance](#)
- Contact our application engineers for a PCB layout review.*

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All sales are subject to Johanson Technology, Inc. terms and conditions.

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Datasheet: 2450AT18D0100001E

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