

Tunable 10Gb/s ROSA for NG-PON2

1. INTRODUCTION

With increasing demand for data and video from home, business and wireless, higher and higher bandwidth for the Optical Access Network is required.

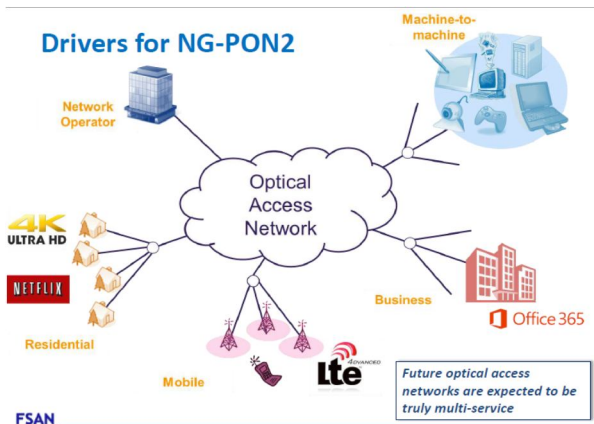


Figure 1, Drivers for NG-PON2

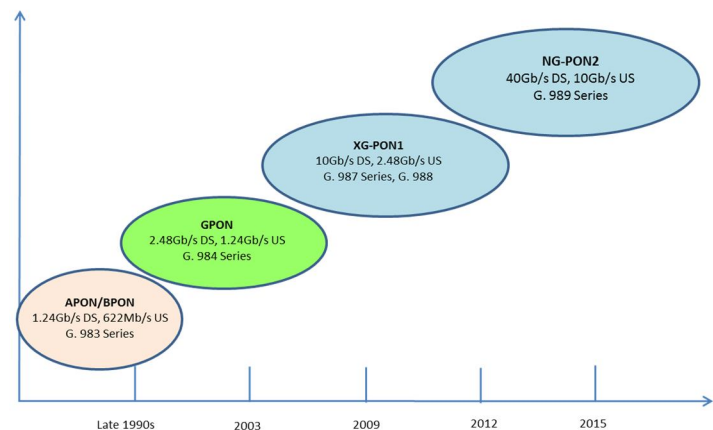


Figure 2, PON Roadmap

FSAN (Full Service Access Network) initiated a working group to work on NG-PON2 in 2010 in collaboration with ITU-T. TWDM (TDM/WDM: Time Division Multiplexing/Wavelength Division Multiplexing) was selected as the preferred technology for NG-PON2. The first recommendation of NG-PON2 general requirements was published by ITU-T (G.989.1) in late 2012, and the physical layer requirements (ITU G.989.2) was approved in December 2014.

The major requirements (physical layer) of NG-PON2 can be summarized as

- Downstream 40 Gb/s, upstream 10Gb/s , per OLT port
- 4 wavelengths per OLT port, both upstream and downstream (option for future upgradeable to 8 wavelengths)
- 100GHz channel spacing
- Wavelength plan, downstream: 1596 ~ 1603nm; upstream: 1532-1540nm
- Colorless ONU
- Support ≥ 64 ONUs per port (256 ONUs or more also of interest)
- Max loss ≥ 29 dB (Class N1)
- Compatible with legacy PON infrastructure (> 40 km reach)
- Smooth Migration
 - Legacy PON co-existence (G-PON and/or XG-PON1)
 - Smooth migration from a legacy PON on a per ONU basis
- Support for multiple applications on the same ODN (e.g. residential + business + backhaul)
- PtP WDM overlay channels were added for easier handling of mobile front-haul applications

Optoplex started to work closely with major GPON equipment suppliers (the leading companies in FSAN) to develop colorless ONU for NG-PON2 since the very beginning when FSAN initiated the working group. With proprietary technology, Optoplex developed a periodic tuning filter – cost effective and small form factor for easy integration with APD/TIA, suitable for NG-PON2 application, and then a 10Gbps Tunable ROSA (10G APD/TIA integrated with a tunable filter). This 10G tunable ROSA has been successfully verified by many major companies in past three years and then deployed in field by a couple of T-1 service providers recently. The tunable ROSA used in NG-PON2 is illustrated in Figure 3.

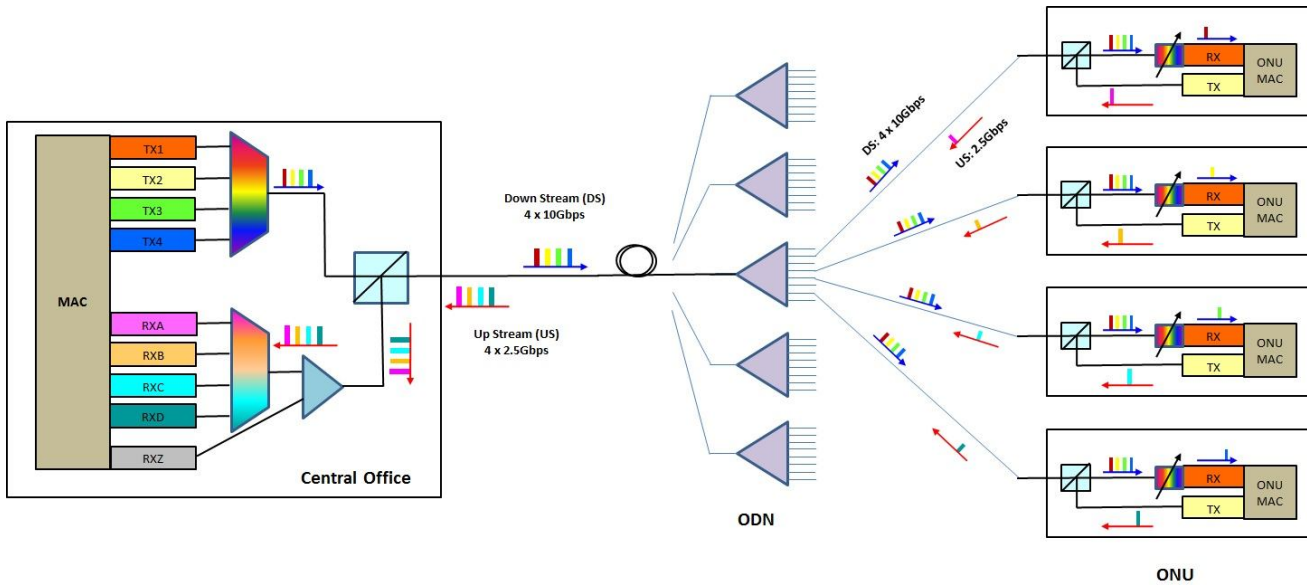


Figure 3, 10Gb/s Tunable ROSA for colorless ONU in NG-PON2

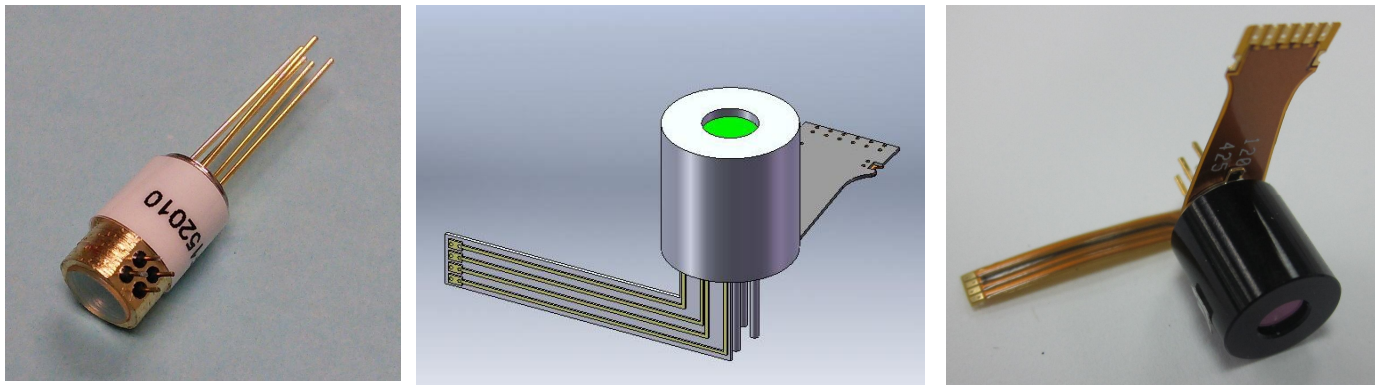


Figure 4, Optoplex's 10G Tunable ROSAs for NG-PON2

Features

- 100GHz tunable filter with tuning range of 4 channels
- InGaAs APD for 10Gbps
- High gain 12kΩ transimpedance pre-amplifier
- Differential data output
- High sensitivity: < -28dBm
- Low power consumption: < 0.4W

Applications

- Digital fiber optic receiver for access networks for telecor
- High speed optical data networks
- Fiber in the loop (FTTx)
- SFP+/XFP/300pin MSA optical transceiver

2. ABSOLUTE MAXIMUM RATINGS

Item	Parameter	Symbol	Condition	Min	Max	Unit
1	Storage Temperature Range	T_{stg}		-40	75	°C
2	Storage Humidity	RH_{stg}	Non Condensing	5	85	%
3	Maximal Optical Input Power	$P_{opt-max}$	Continuous wave on input port	-26	-5	dBm
4	TIA Supply Voltage	V_{CC}		-0.7	5	V
5	APD Supply Voltage	V_{PD}		0	V_{BR}	V
6	APD Reverse Current	I_R			2	mA
7	Tunable Filter Driving Voltage	V_{TF}	DC		4.0	V

3. OPERATING CONDITIONS

Item	Parameter	Unit	Condition	Min	Typ.	Max
1	Operating Case Temperature Range ¹⁾	°C		-5		75
2	Relative Humidity Range	%		5		85
3	Operating Frequency Range	THz	C-Band	191.15		196.1
4	Optical Input Power	dBm		-26		-5
5	TIA Supply Voltage	V		3.0	3.3	3.6
6	TIA Supply Current	mA	$P_{in}=0 \mu A$	40	55	70
7	Tunable Filter Driving Voltage	V	DC	0		3.8

NOTES

1. Short term refers to the operation of the device for a period of less than 100 hours per year.

4. Product Description

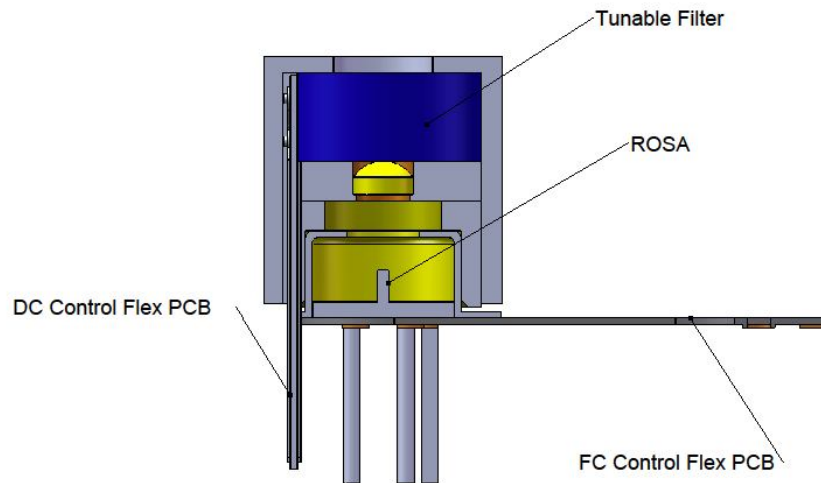
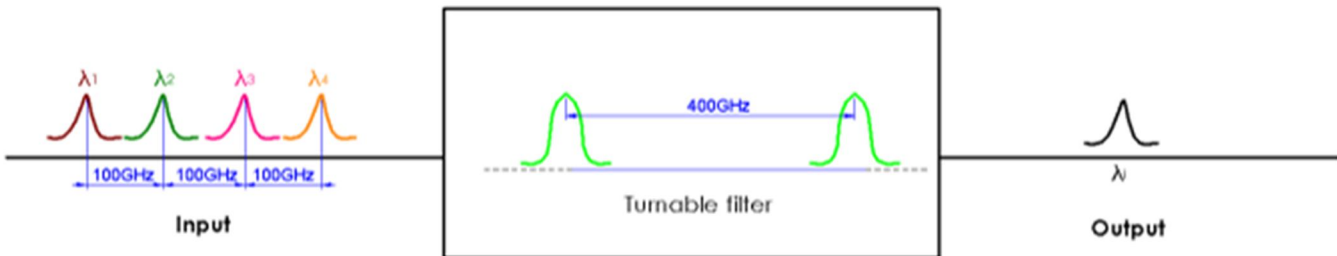


Figure 4.1 Functional block diagram of 10G Tunable ROSA

5. Tunable Filter Specifications

5.1, Functional Block Diagram of Tunable Filter



Description:

- λ_x ($x=1$ to 4): The output of the tunable filter can be any channel of the input selected by input voltage.

5.2, Specification of Tunable Filter

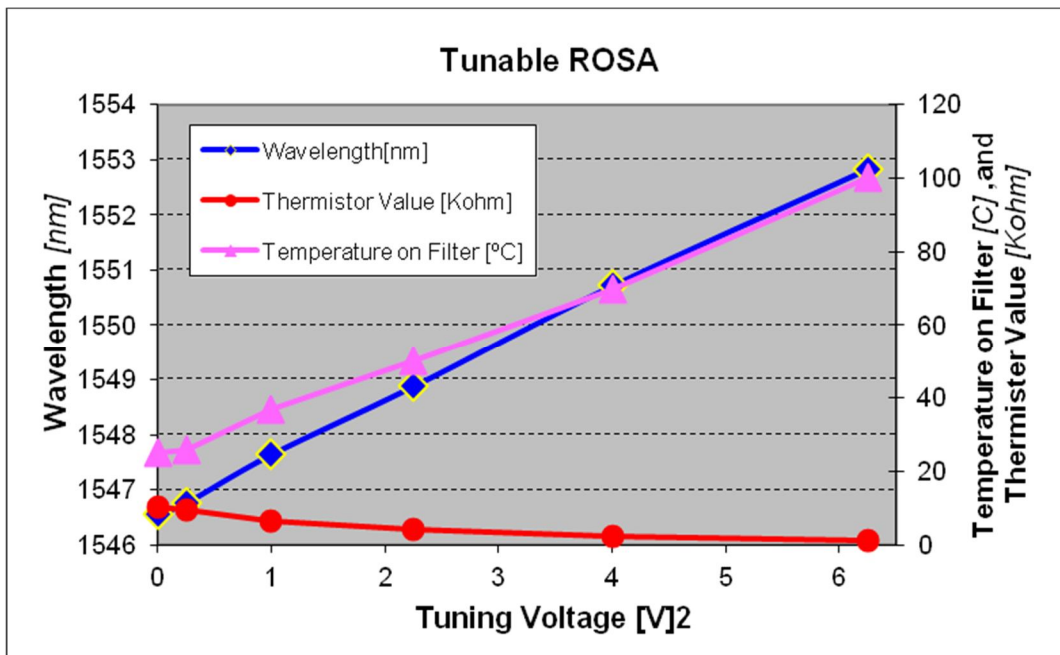
Table 5.1 Tunable Filter Specification

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range ¹⁾		1570		1610	nm
2	Tunable Filter Insertion Loss				2.5	dB
3	Wavelength Tuning Range ²⁾	-5°C to 75°C	450			GHz
4	Filter Pass Band Width	@1dB	20			GHz
		@20dB			150	
5	Optical Return Loss		27			dB
6	PDL				0.8	dB
7	Tuning Speed	From channel <i>i</i> to <i>i+1</i>			1	s
8	Thermistor Resistance			10		kΩ
9	TF Tuning Voltage				3.8	V
10	Voltage Dependent Loss			0.5	1	dB

Notes

- 1) 1570 ~ 1610nm is the required operating wavelength for the 4 TWDM channels of NGPON2. Optoplex tunable filter can work in a much wider wavelength range from 1500 ~ 1650nm
- 2) The maximum working temperature of wavelength tuner is 120°C.

5.3, Control of Tunable Filter



6. 10G ROSA Specifications

6.1, Optical Characteristics

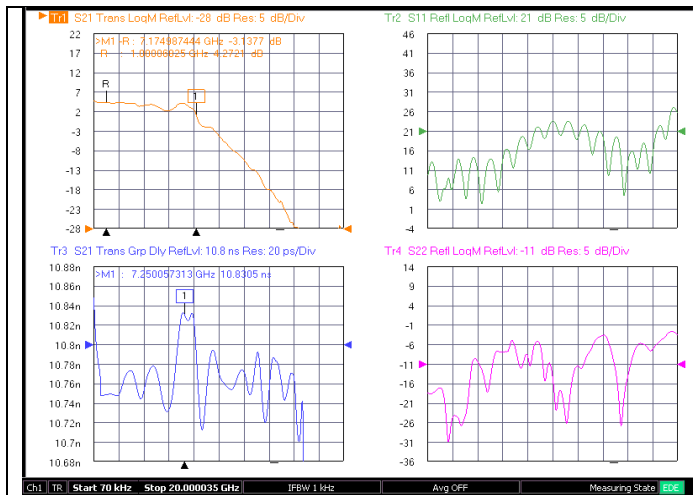
Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range		1570		1610	nm
2	Responsivity	M=1, CW		0.75		A/W
3	Responsivity with Filter	M=1, CW		0.42		A/W
4	Minimum Sensitivity	10.3Gbps, RL=50Ω, BER=1×10 ⁻³ , NRZ, ER=6.42 dB, PRBS=2 ³¹ -1, M _{opt} , λ=1550nm		-30.5		dBm
5	Optical Return Loss		27			dB

6.2, Electrical Characteristics

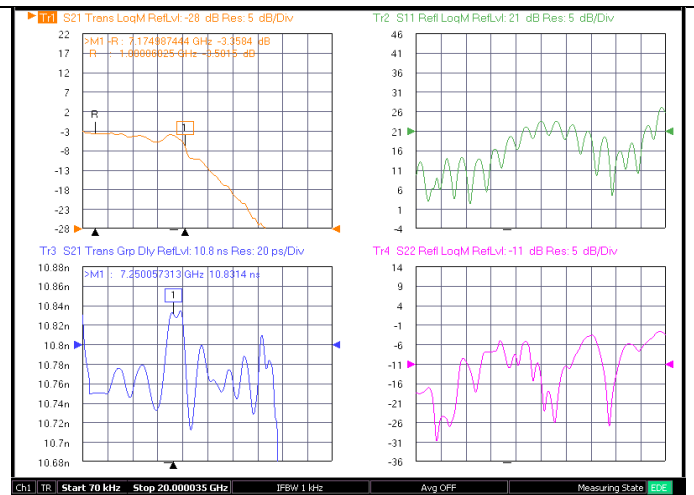
Table 6.2 Electrical Specification

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	TIA Supply Voltage	V _{CC}	3	3.3	3.6	V
2	TIA Supply Current	P _{in} =0μW	40	55	70	mA
3	Operating Voltage	V _{OP} , M=M _{OPT}		0.9×V _{br}		V
4	Trans-impedance	F=200MHz, RL=50Ω, P _{in} =1μW, M=10, differential		2.0		kΩ
5	3dB Bandwidth	@-3dB, M=10,RL=50Ω P _{in} =-20dBm		6.0		GHz
6	Temperature Coefficient of V _{br}	I _d =10μA, T _c =25~75°C		0.03		V/°C
7	Breakdown Voltage	Dark current I _d =10μA	25	34	40	V

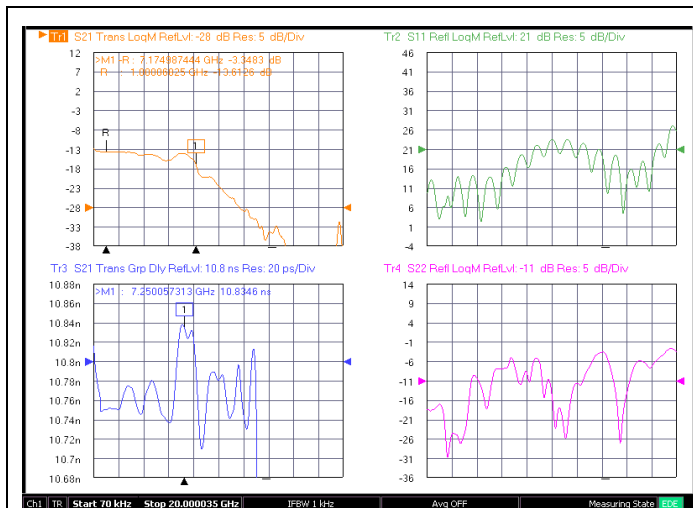
6.3, Measured S-Parameters



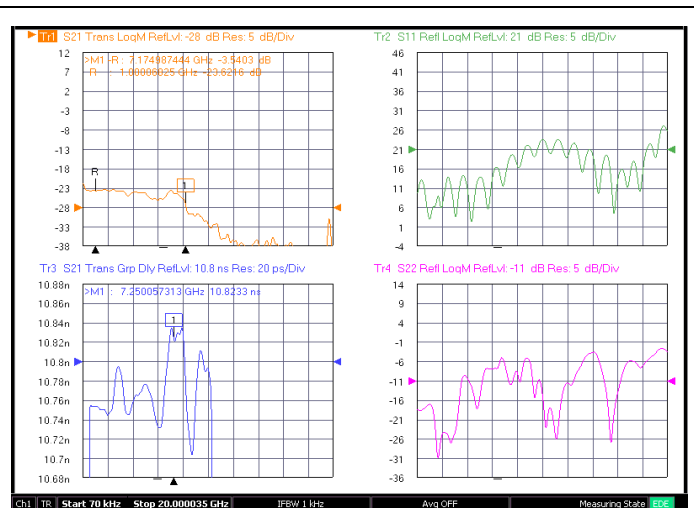
Input power -20dBm



Input power -25dBm



Input power -30dBm



Input power -35dBm

7. Physical Properties

7.1, Mechanical Drawings

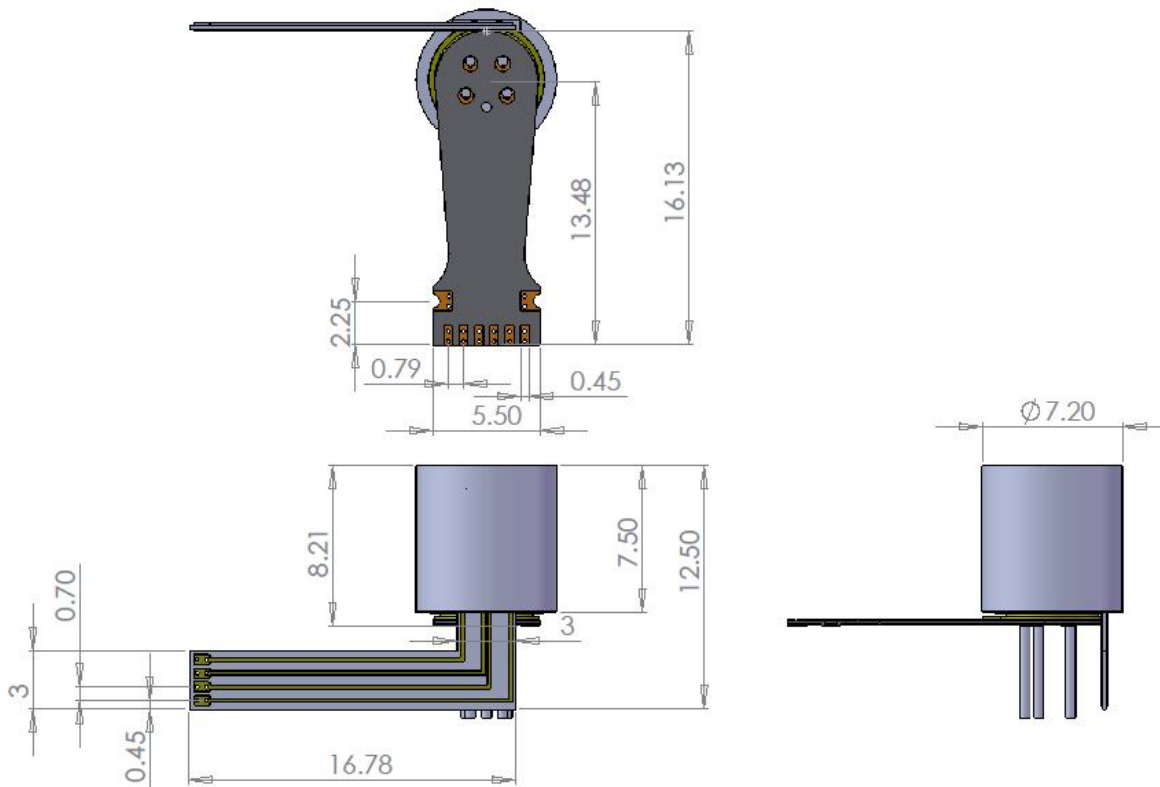
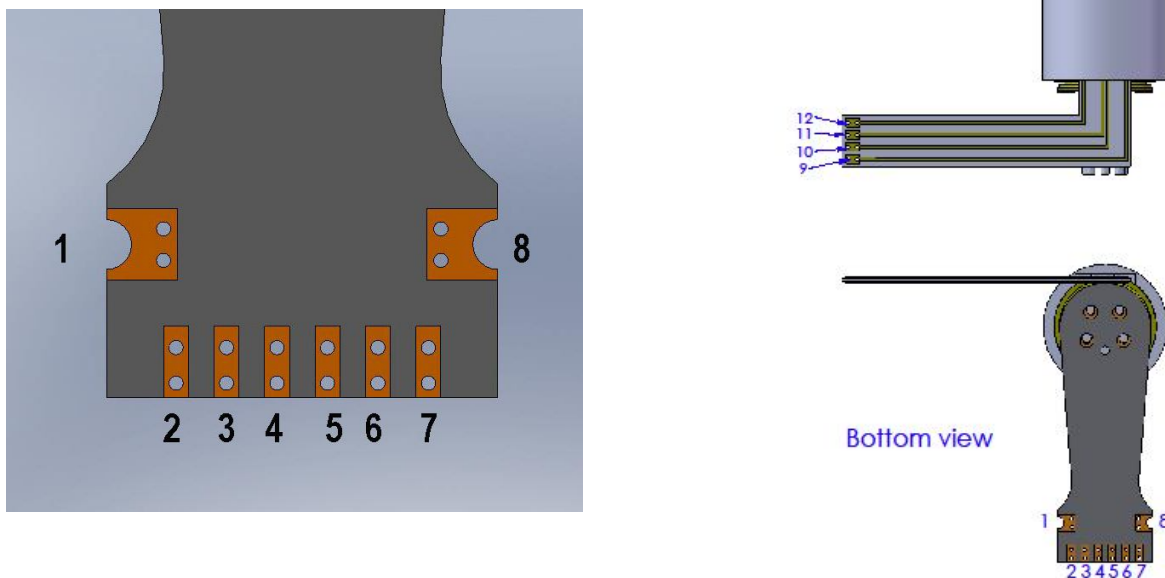


Figure 7.1 Mechanical model of the integrated receiver

7.2, Electrical Interface



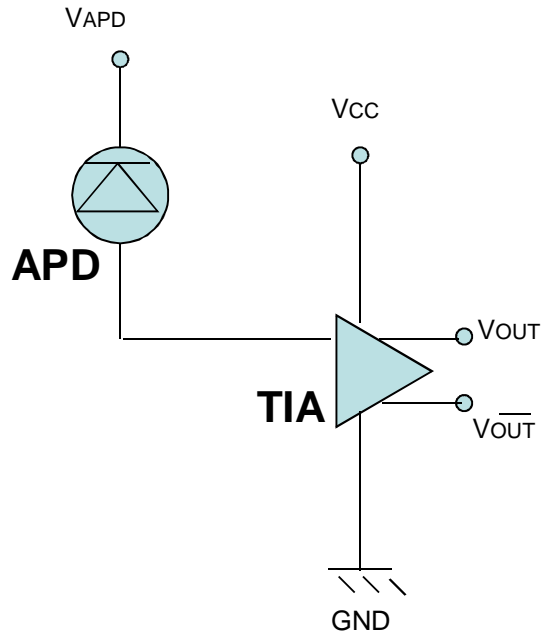


Figure 7.2 Illustration of pin assignment

Table 7.1 PIN Assignment

Pin#	Name	Description
1	NA	
2	V_{CC}	TIA supply voltage
3	Signal Ground	
4	Out	
5	Out-ber	
6	Signal Ground	
7	NA	
8	V_{APD}	
9	Tuner	
10	Tuner	
11	Thermistor	
12	Thermistor	

7.3, Optical input Specification

Table 7.2 input beam specification

Input beam Parameter	Unit	Value	Notes
Collimated Beam Diameter	mm	0.5-1	Measure at $1/e^2$. This parameter will influence the Responsivity.
Collimated Beam Waist Position	mm	TBD	From the front surface. This parameter will influence the Responsivity.
Incident Angle	degree	<3	The angel between input beam and normal of the front surface. This parameter will influence the Responsivity.

7.4, Label Specification

TBD.

8. Ordering Information

Product:	Tunable 10G ROSA
Product Description:	10G Tunable ROSA, APD/TIA, L-band, 100GHz Channel Spacing, 400GHz Tuning Range, LC/UPC Connector
Part Number:	RX-2L2RT704

9. Contact Information

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