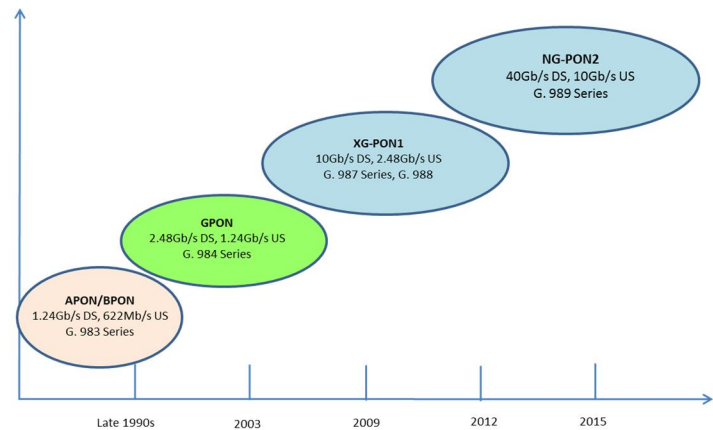
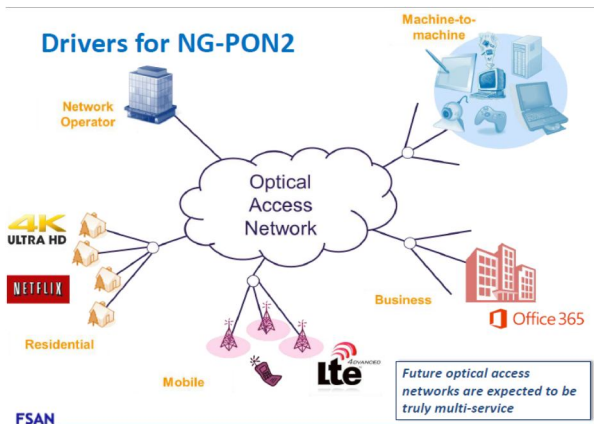


# Tunable 10Gb/s ROSA for NG-PON2

## 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.



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  $\geq 64$  ONUs per port (256 ONUs or more also of interest)
- Max loss  $\geq 29$ 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.

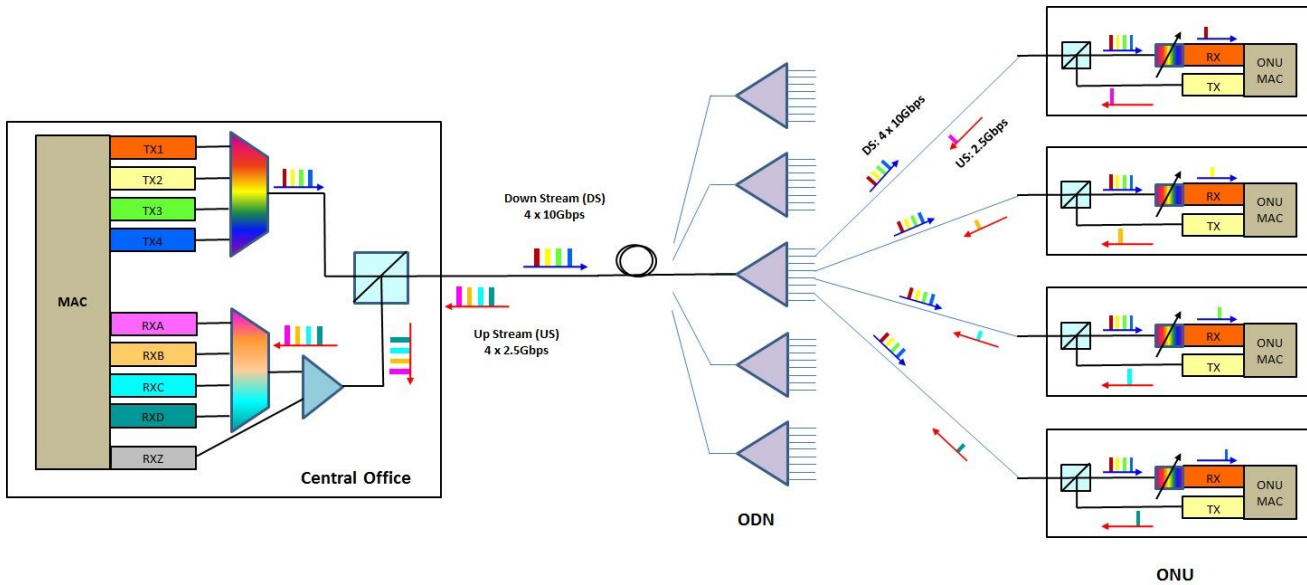


Figure 3, 10Gb/s Tunable ROSA for colorless ONU in NG-PON2

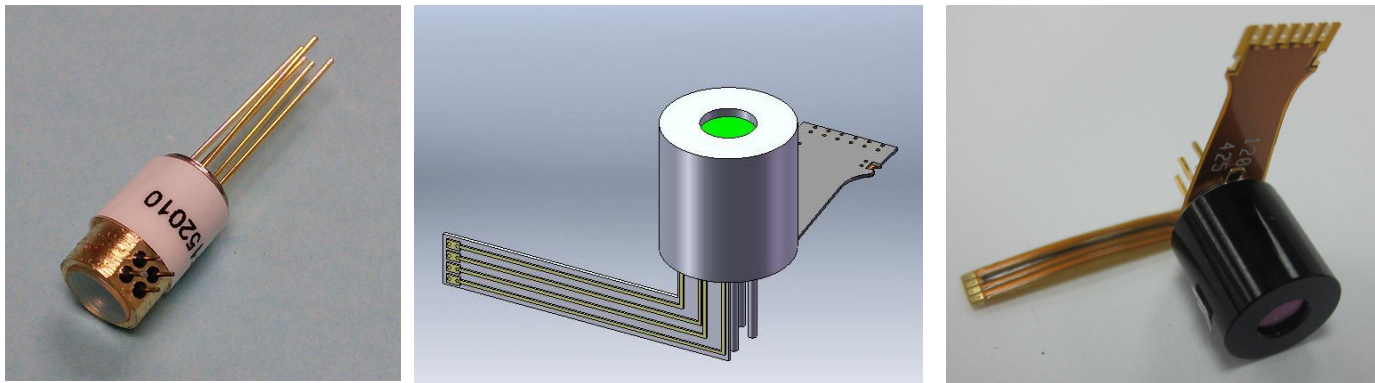


Figure 4, Optoplex's 10G Tunable ROSAs for NG-PON2

### Features

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

### Applications

- Digital fiber optic receiver for access networks for telecom
- 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 <sup>1)</sup>	°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

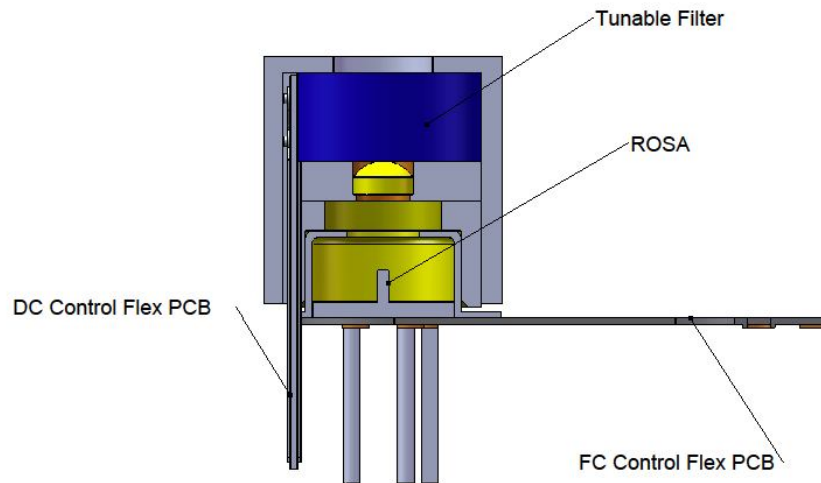
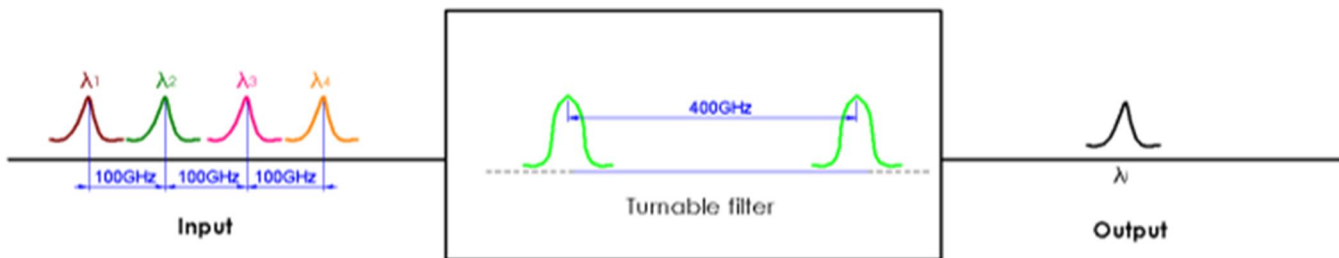


Figure 4.1 Functional block diagram of 10G Tunable ROSA

## 5. Tunable Filter Specifications

### 5.1, Functional Block Diagram of Tunable Filter



#### Description:

- $\lambda_x$  ( $x=1$  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

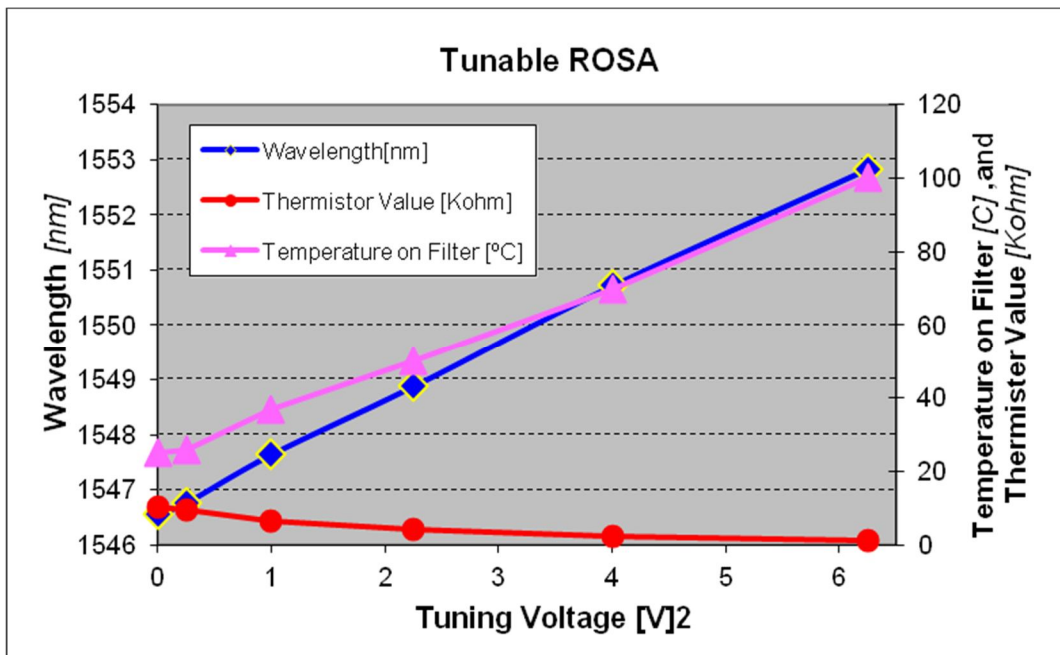
Table 5.1 Tunable Filter Specification

Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range <sup>1)</sup>		1600		1625	nm
2	Tunable Filter Insertion Loss				2.5	dB
3	Wavelength Tuning Range <sup>2)</sup>	-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) 1600 ~ 1625nm 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

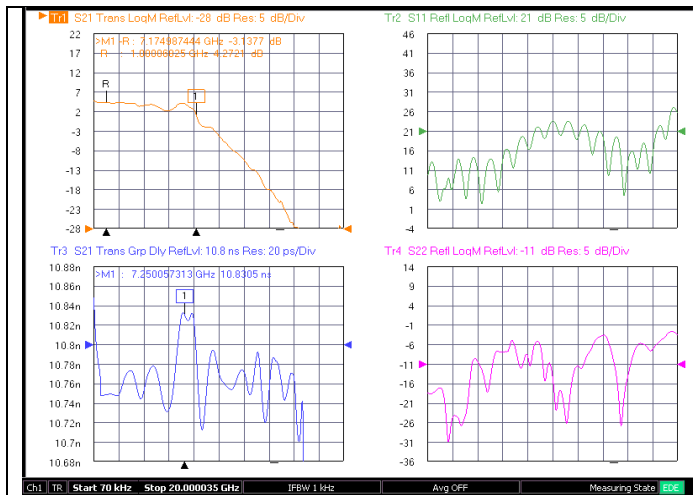
Item	Parameter	Comments	Min	Typ.	Max	Unit
1	Operating Wavelength Range		1525		1565	nm
2	Responsivity	M=1, CW		0.75		A/W
3	Responsivity with Filter	M=1, CW		0.42		A/W
4	Minimum Sensitivity	10.3Gbps, RL=50Ω, BER=1×10 <sup>-3</sup> , NRZ, ER=6.42 dB, PRBS=2 <sup>31</sup> -1, M <sub>opt</sub> , λ=1550nm		-30.5		dBm
5	Optical Return Loss		27			dB

### 6.2, Electrical Characteristics

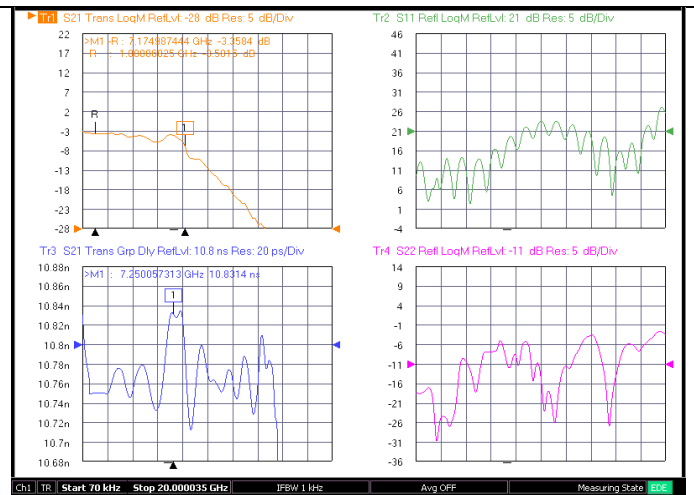
Table 6.2 Electrical Specification

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

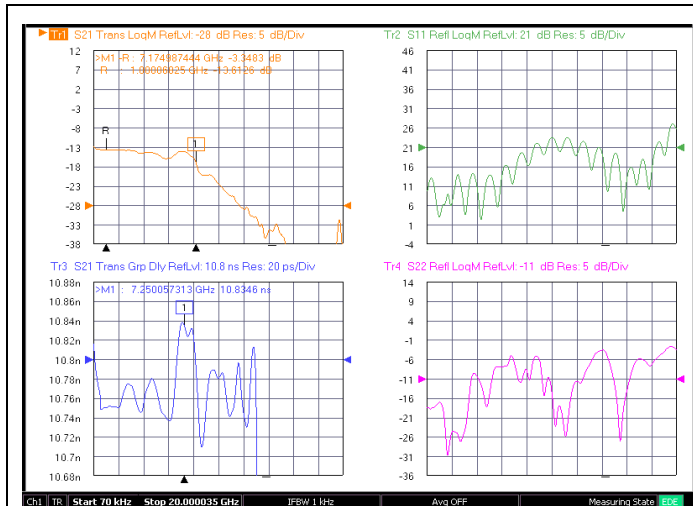
### 6.3, Measured S-Parameters



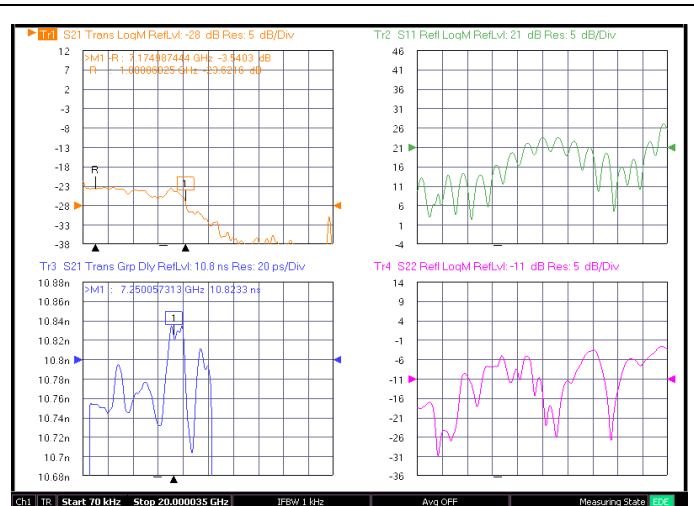
Input power -20dBm



Input power -25dBm



Input power -30dBm



Input power -35dBm

## 7. Physical Properties

### 7.1, Mechanical Drawings

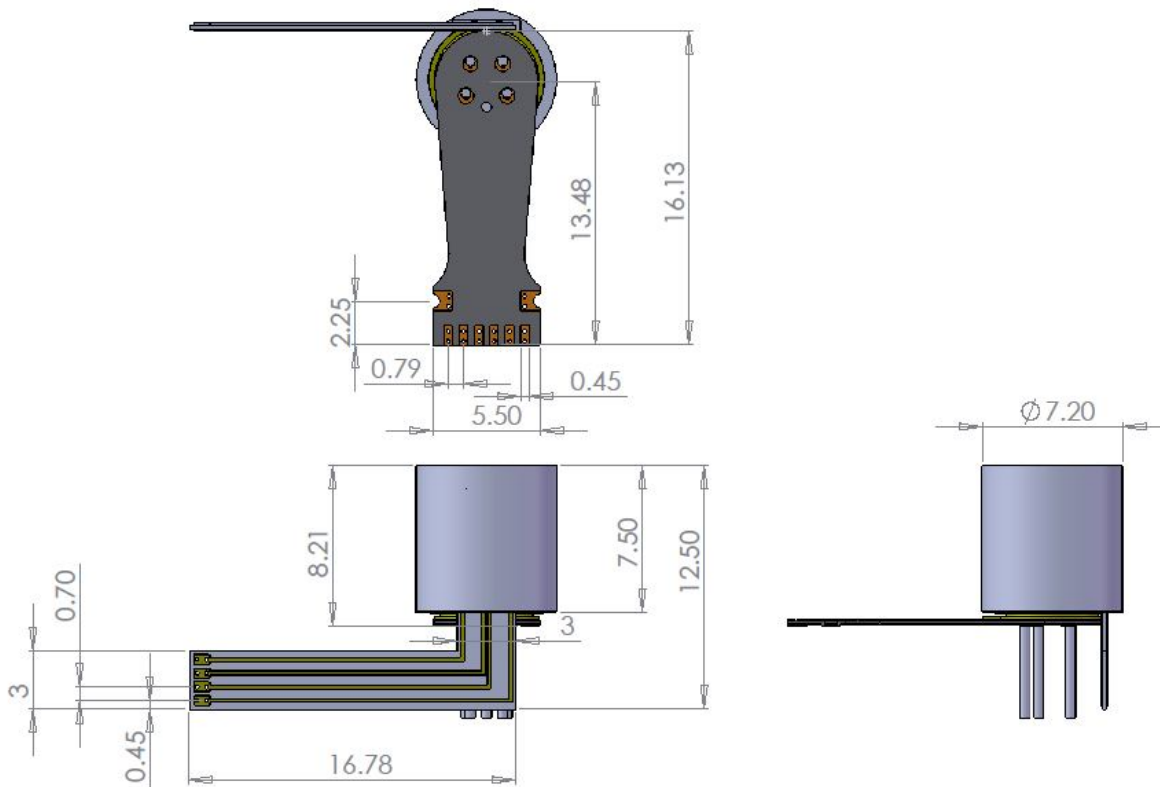
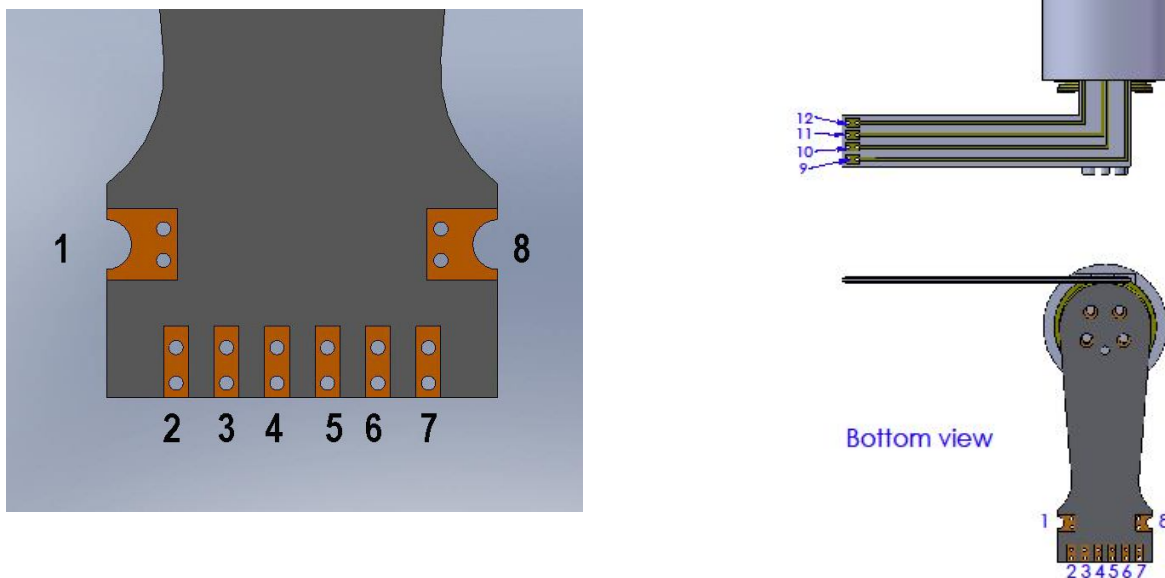


Figure 7.1 Mechanical model of the integrated receiver

### 7.2, Electrical Interface





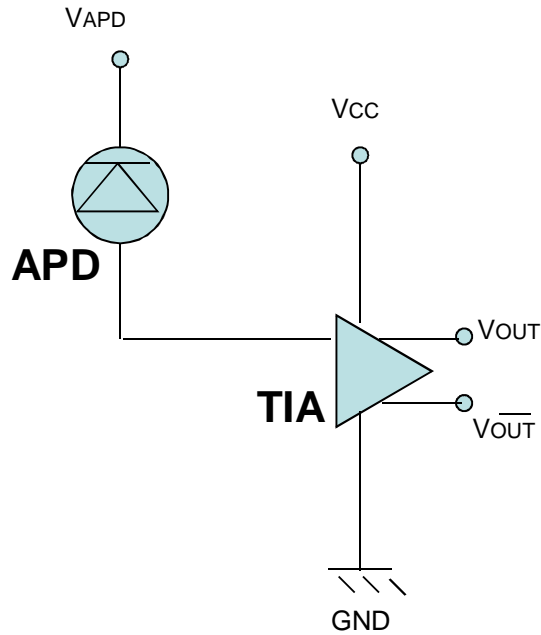


Figure 7.2 Illustration of pin assignment

Table 7.1 PIN Assignment

Pin#	Name	Description
1	NA	
2	V <sub>CC</sub>	TIA supply voltage
3	Signal Ground	
4	Out	
5	Out-ber	
6	Signal Ground	
7	NA	
8	V <sub>APD</sub>	
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, C-band, 100GHz Channel Spacing, 400GHz Tuning Range, LC/UPC Connector
Part Number:	<b>RX-2C2RT701</b>

## 9. Contact Information

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