

# Dual Balanced O/E Converter

$$NEP^{(*1)} < 6 \text{ pW} / \sqrt{\text{Hz}} \text{ at } 100\text{MHz}, 1310\text{nm}$$

DC to 1GHz  
Low Noise

Dual Balanced O/E Converter

- DC to 1GHz
- Low Noise:  $NEP^{*1)} < 6\text{pW} / \sqrt{\text{Hz}}$  at 100MHz, 1310nm
- Best for Medical OCT
- Equipped with 2-input Differential Amplification

\*1) NEP : Noise Equivalent Power Input

## ● Feature of DLP-2

### ① The wide bandwidth from DC to 1GHz and super stable output voltage amplitude

These characteristics have been realized by the innovation of the wide bandwidth amplifier based upon Graviton's exceptional I/V conversion technology. All discrete components are used from the first stage I/V amplifier to the cable driver.

### ② Symmetric characteristic of voltage amplitude

This characteristic has been achieved by cumulative simulation, appropriate device selections and experienced board design.

### ③ Best for medical OCT

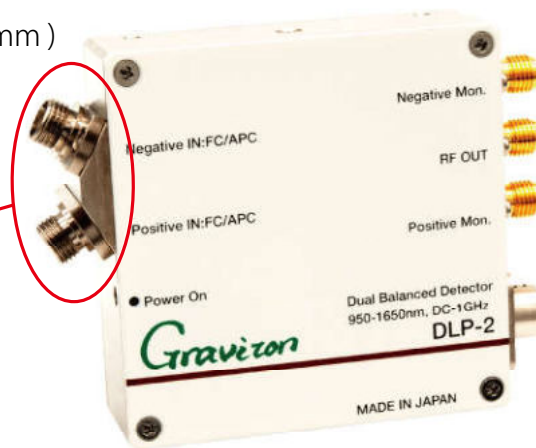
DLP-2 allows you to capture clear images with less noise without sacrificing the resolution by wide range linearity over entire amplitude.

### ④ Compact and Lightweight

Body size: 60mm x 60mm x 22mm  
( Length including connectors: 80mm )

Weight: 0.15 kg

- Two connectors, Positive and Negative, are mounted on the case with the angle of 120 degree.
- InGaAs PDs are inserted inside of the FC connectors.
- This structure allows the positions of the lead wires from two PDs to fix.



## ● Contact us for :

- Inquiry for application of **ultraviolet, visible, and IR** light. Note this DLP-2 is for 1310nm.
- Please specify the conditions for your application.

### ... Sales Performance

More than 600 units of Graviton's dual balanced O/E converters have been sold since the first model\*2) was released to the market in 2014. Most of them have been exported to the north America, primary users are OCT makers and world research institutes. DLP-2 has been developed upon the requests from the market which requires more higher resolution of OCT.

\*2) The first model has two types: DLP-1 for local needs and the BPD-1 for world market.

# Dual Balanced O/E Converter

For medical OCT

~ Performance Data Sheet ~ Model Type : DLP-2 ( DC to 1GHz Version, Narrow Key)

## Noise Density of DLP-2 (Esxxx : Typical Values)

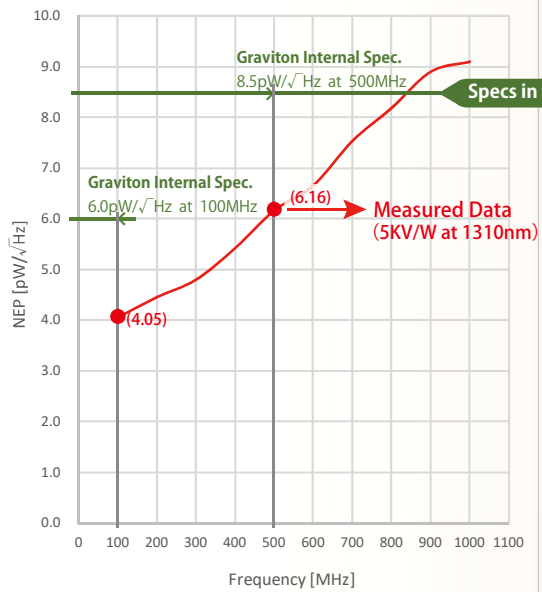
(Spectrum Analyzer : R3465, RBW=5MHz, VBW=5MHz)

Spectrum Analyzer (R3465) Noise Floor			
Frequency [MHz]	Ex-Amp Gain [dB]	Measured [dBm/Hz]	NEP (5KV/W) [pW/√Hz]
100	0.000	-148.0	(3) 1.78
200	0.000	-148.0	1.78
300	0.000	-147.7	1.84
400	0.000	-147.2	1.95
500	0.000	-147.2	1.95
600	0.000	-147.4	1.91
700	0.000	-147.5	1.89
800	0.000	-147.1	1.97
900	0.000	-146.9	2.02
1000	0.000	-146.6	2.09

DLP-2 RF Out (Gain = x1, 5,000V/W at 1310nm)				
Frequency [MHz]	Ex-Amp Gain [dB]	Measured [dBm/Hz]	Measured NEP [pW/√Hz]	True NEP [pW/√Hz]
100	0.000	-140.1	(2) 4.42	<b>4.05 (1)</b>
200	0.000	-139.4	4.79	4.45
300	0.000	-138.8	5.13	4.79
400	0.000	-137.8	5.76	5.42
500	0.000	-136.8	6.46	<b>6.16</b>
600	0.000	-136.2	6.93	6.66
700	0.000	-135.2	7.77	7.54
800	0.000	-134.5	8.42	8.19
900	0.000	-133.8	9.13	8.90
1000	0.000	-133.6	9.34	9.11

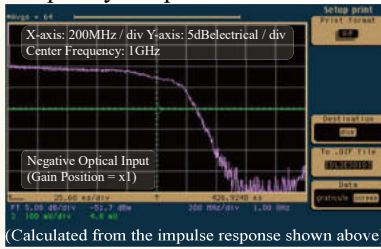
$$① = \sqrt{②^2 - ③^2}$$

## NEP of DLP-2 (ESxxx : Typical Values), Up to 1GHz



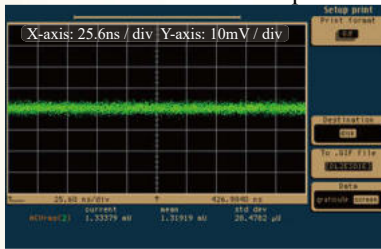
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## Frequency Response



(Calculated from the impulse response shown above)

## Noise Waveform of RF Output



## DC Performance & Noise Level (with SMF-APC)

Item	Specifications	Measured Value	Judgment
Conversion Gain of RF Out (Pos. In, 1310nm, 50ohm Load)	4.500 to 5.500 V/mW	<b>5.002 V/mW</b>	OK
Conversion Gain of RF Out (Neg. In, 1310nm, 50ohm Load)	-4.500 to -5.500 V/mW	<b>-5.041 V/mW</b>	OK
Gain Difference (P-N) / (P+N)	Within +/- 2%	<b>0.38 %</b>	OK
Monitor Gain of P-Mon. Out (Pos. In, 1310nm, Hi-Z Load)	9.00 to 11.00 V/mW	<b>10.42 V/mW</b>	OK
Monitor Gain of N-Mon. Out (Neg. In, 1310nm, Hi-Z Load)	9.00 to 11.00 V/mW	<b>10.54 V/mW</b>	OK
NEP (at 100MHz, 1310nm)	<6.0pW/√Hz	<b>4.77pW/√Hz</b>	OK
NEP (at 500MHz, 1310nm)	<8.5pW/√Hz	<b>6.92pW/√Hz</b>	OK
Wideband Noise of RF Out	<1.5mVrms (50ohm)	<b>1.32 mVrms</b>	OK
Wideband Noise of P-Mon. Out	<0.3mVrms (50ohm)	<b>0.24 mVrms</b>	OK
Wideband Noise of N-Mon. Out	<0.3mVrms (50ohm)	<b>0.25 mVrms</b>	OK
Output Offset Voltage (RF Out)	+/-0.1mV (50 ohm)	<b>0.00 mV</b>	OK
Output Offset (P-Mon. Out)	+/-0.1mV (Hi-Z)	<b>0.00 mV</b>	OK
Output Offset (N-Mon. Out)	+/-0.1mV (Hi-Z)	<b>0.00 mV</b>	OK
Supply Current (+24V)	0.11 to 0.13 A	<b>0.12 A</b>	OK

Descriptions	Specifications	Remarks
Photodetector	Detector Type: InGaAs PIN Optical Inputs: FC/APC (Free Air) Coupling Loss: N/A Operating Wavelength: 1310nm Wavelength Range: 950 to 1650nm Responsivity Typ: 0.97A/W at 1310nm Active Detector Diameter: 0.045mm Optical Back Reflection: N/A Photo Diode Damage Threshold: 2mW	Collecting the light emitted from a Ferrule terminal with a ball lens 0.67A/W at 1060 nm (including FC connector) Feedback resistance value of an initial stage TIA is 1.888Ω. Inverse conversion value from conversion gain. The conversion value at 1060nm is 3.450V/W. The voltage swing range against 50Ω load is ±1V. Estimated NEP value at 1550nm <5.4pW/√Hz
RF OUT	RF OUTPUT Bandwidth (3dB): DC to 1.0GHz Common Mode Rejection Ratio: >25dB (typ. >30dB) RF OUTPUT Transimpedance Gain (50Ω Load): 5.155V/A RF OUTPUT Conversion Gain (50Ω Load): 5.000V/W at 1310nm RF OUTPUT Power at 1dB compression (50Ω Load): typ. +10dBm RF OUTPUT Coupling: DC Coupling RF OUTPUT Impedance: 50Ω Minimum NEP (30kHz to 100MHz): <6.0pW/√Hz at 1310nm Overall Output Voltage Noise: <1.5mVrms (50Ω) DC Offset: <±0.1mV (50Ω)	
MONITOR OUT	MONITOR Output Impedance: 50Ω MONITOR Output Bandwidth (3dB): DC to 100MHz MONITOR Output Conversion Gain (Hi-Z Load): 10V/mW at 1310nm MONITOR Output Voltage Swing (Hi-Z Load): max. 10V Overall Output Voltage Noise: <0.3mVrms DC Offset: <±0.1mV (50Ω)	The conversion value at 1060nm is 6.9V/mW
General	Electrical Outputs: SMA Jack DC Power Supply: ±12V or +24V (Floating), 130mA Operating Temperature Range (Non-Condensing): 5 to 35°C Storage Temperature Range: -40 to 70°C Dimensions (W x H x D): 60mm x 60mm x 22mm Weight: 0.15Kg	As GND voltage in the device is produced by the internal circuit, GND loop is hardly produced outside of the device.

Note: The above specifications are subjected to change without prior notice for product improvement.

