USER'S GUIDE

1837 GHz – NIRVANA

High Speed auto-balanced Photoreceiver

CAUTION!

These photodetectors are sensitive to electrostatic discharges and could be permanently damaged if subjected even to small discharges. Ground yourself adequately prior to handling these detectors or making connections. A ground strap provides the most effective grounding and minimizes the likelihood of electrostatic damage

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Warranty

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Document Number 90099917 Rev. A

Introduction

Overview

The Newport Model 1837 auto-balanced photoreceiver consists of two photodiodes followed by RF amplifiers that generate an output voltage proportional to $G_1 \cdot I_1 - G_2 \cdot I_2$. G_1 is a fixed transimpedance while gain G_2 is automatically controlled or manually adjusted *to reject common mode*.
The Quick Start and General Principles sections below give an overview of setting up the photoreceiver and understanding its principles and design. The chapters that follow give detailed operating instructions and specifications.

Balanced photodetection is a commonly used method when an optical measurement requires increased signal-to-noise ratio. A balanced photoreceiver consists of two well-matched photodiodes configured so that their photocurrents subtract and common-mode noise is canceled

To eliminate the problems associated with manually balancing the reference and signal beams the GHz Nirvana 1837 is an auto-balanced photoreceiver with a built-in low-frequency feedback loop that controls the electronic gain of one of the receivers and maintains automatic balance between signal and reference arms.

Quick Start

The following parts are supplied with the Model 1837 auto-balanced photoreceiver:

• Model 0923 3-pin to 3-pin power cable

• Model 0924 3-pin to banana connector power cable

• Model 0907 M-SMA to M-BNC cable

• Model 0927 F-SMB to M-BNC cable (x2)

Electrical cables of greater than 3 meters in length should not be used with the 1837 model

The steps on the following pages describe the basics of setting up and using the photoreceiver. The Operation chapter contains more detailed information.

1. Use one of the supplied power cables to connect the photoreceiver to a 15-volt power source that can supply 200 mA.
For the Newport Model 0901 power supply, use the 3-pin connector-to-3-pin connector cable. For other power supplies, use the 3-pin connector-to banana plug power cable.
When using the 3-pin connector-to-banana plug cable, take care to hook up the banana plugs as follows to avoid damaging the photoreceiver: Red = +15 V, Green = Ground, Black not needed,.

2. Mount the photoreceiver to your optical table. A pair of 8-32 and a pair of M4-threaded holes are located on the bottom of the unit. (Figure 2)
3. Connect the optical source to one or both optical inputs. (Figure 2) Use single mode fiber with FC/APC angle polished connector.

The optical power must remain below the absolute maximum power listed in Table 1.
Exceeding the maximum power can damage thephotodiode and the amplifier.

WARNING

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4. Use the low-frequency M1 and M2 outputs to check and adjust the optical inputs so that the output powers are in the desired 0–1 V range. (Table 1)

5. Finally, connect the RF Output SMA connector to the desired load or instrument via a 50Ω coaxial cable. Set controls to MANUAL and $G_2 = G_1$ first until reading the signal from the RF Output. The use AUTO or MANUAL MODE and G_2 control as desired.

General Principles

The Newport Model 1837 auto-balanced photoreceiver consists of two photodiodes followed by RF amplifiers that generate an output voltage proportional to $G_1 \cdot I_1 - G_2 \cdot I_2$. G_1 is a fixed transimpedance while gain G_2 is automatically controlled or manually adjusted *to reject common mode*.

A functional block diagram of the auto-balanced photoreceiver is shown in Figure 1, and a mechanical drawing is given in Figure 2.

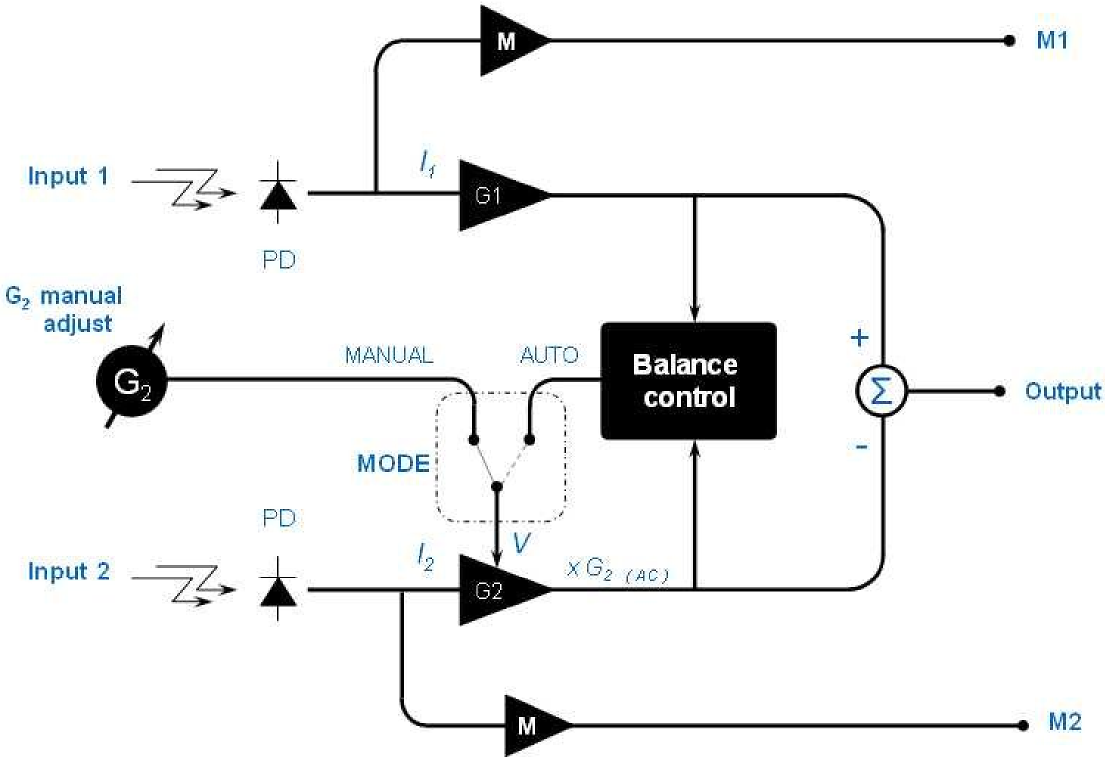

Figure 1: Functional block diagram of the Model 1837. The entire package is shielded to eliminate noise pickup.

Low-frequency Monitor Outputs

In addition to the RF output, the balanced photoreceiver has two low-frequency monitor outputs, M1 and M2. These monitor outputs can be used to help align light onto the photodiodes and to perform low frequency diagnostics. The monitor outputs have SMB connectors, and an SMB-to-BNC cable is provided with the photoreceiver. Monitors M1 and M2 characteristics are given by the technical Table 1 at the end of this manual.

Responsivity and Input Power

The Model 1837 uses a InGaAs photodiodes. Figure 3 shows the typical responsivity of the photodiodes.

To avoid damage to the amplifier, never exceed the input current of 1mA or 1 V at M1, M2 or both

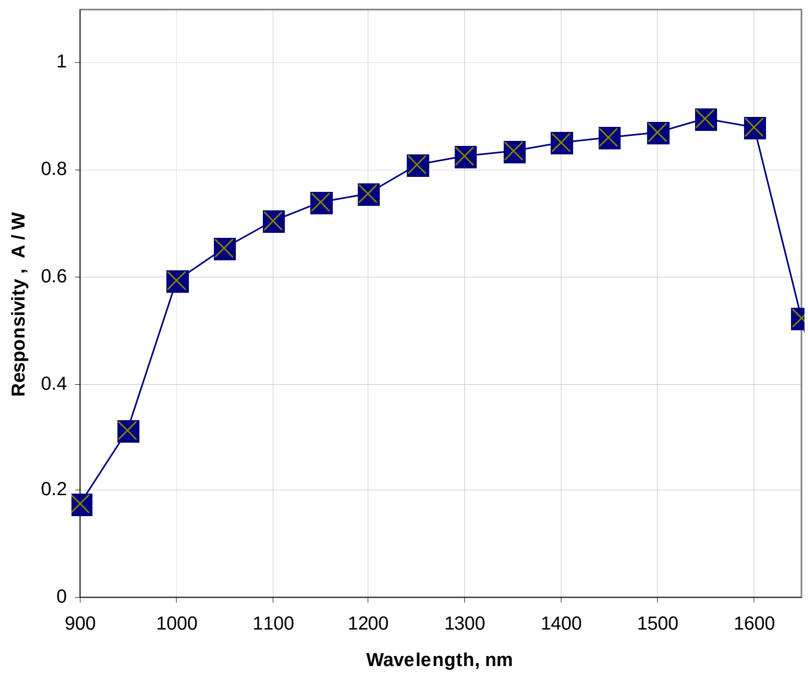

Figure 3: Typical responsivities InGaAs PIN photodiodes in the 1837. The amplifier has a maximum input current of 1 mA or 1-Volt at M1, M2 or both. To avoid damage to the amplifier, never exceed this input current.

Gain, Bandwidth and Noise

The RF amplifiers in Figure 1 present typical AC coupled gains of G_1 and G_2 and amplify photodiodes currents I_1 and I_2. G_1 is fixed to typically 40 000 Volts/Amp AC and G_2 can be automatically or manually set to values larger or smaller than G_1. The amplifier is AC coupled with a 100-kHz low-frequency roll-off.

The RF output stage can typically drive up to 0 dBm at -20dB total harmonic distortion (THD) into a 50-Ω load. To maximize signal fidelity keep the output signal level below -10dB.

The 3dB RF bandwidth exceeds 300 MHz for the Model 1837. Figure 4 shows typical frequency response.

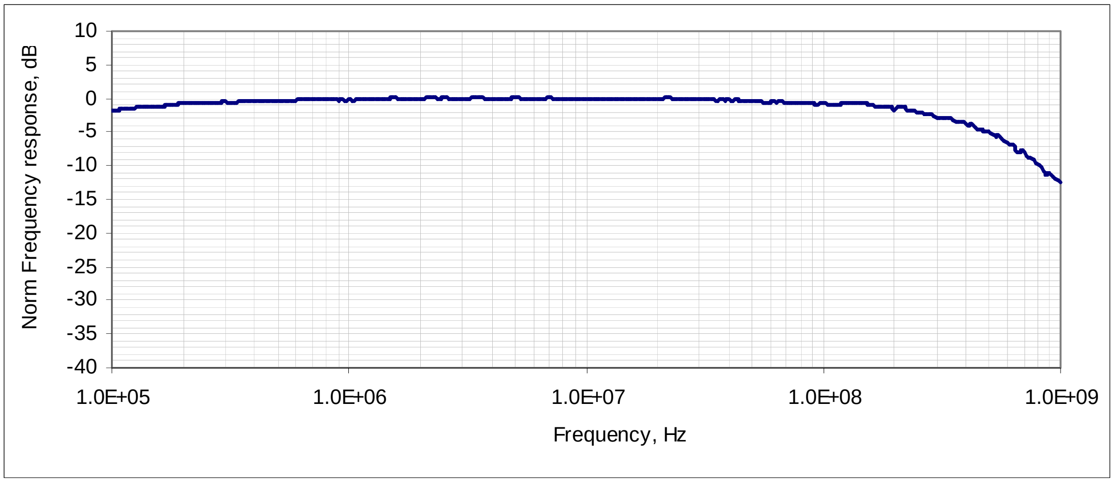

Fig 4 –Typical frequency response of INPUT 1 (G_1 – relative). The FR on INPUT 2 can be adjusted at least +4dB or -4dB with respect to the trace shown.

The noise is frequency dependent and has typical value expressed as noise-equivalent power (NEP) referred to 1837 input and shown on Fig 5.

The output AC voltage plus internal noise from 1837 can be approximated as:

$$\mathrm{OUPUT} \approx \mathrm{G}_1 \sqrt{\left(\mathrm{S} + \frac{\mathrm{N}}{\mathrm{CMRR}}\right)^2 + NEP^2 \cdot BW}$$

, where BW is the noise equivalent bandwidth in Hz of the instrument connected following 1837.

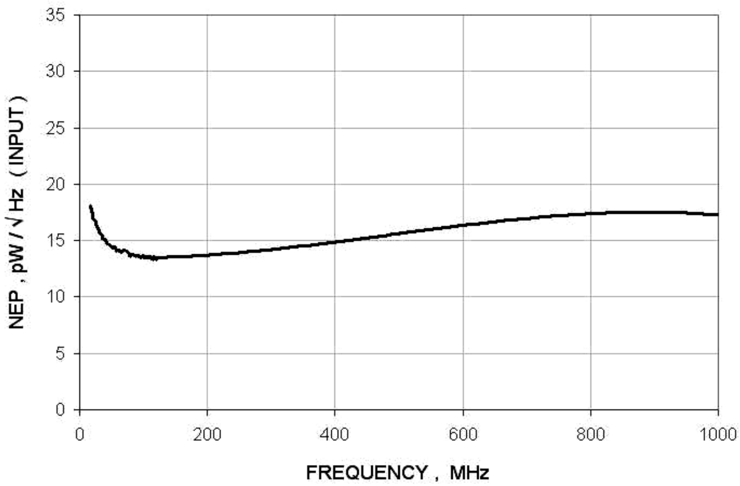

Fig 5 – Input Noise Equivalent Power (NEP) referred to the either INPUT 1, 2 of 1837 for MANUAL mode to 1GHz.

auto-balanced and Manual Balanced Modes

When in auto-balanced Mode (switch to AUTOBAL) 1837 Photoreceiver has a patent pending control logic (Fig 1) that detects signals on Input 1 and Input 2 in the range 30KHz to 1MHz (common mode). By computing the ratio between them it automatically generates a voltage V to control G_2 and equalize $G_2 \cdot I_2$ to $G_1 \cdot I_1$ in that frequency range and suppress it at the output V_0.
In order to properly utilize 1837 the fluctuations in the common mode signal in that frequency range have to exceed about 10uW-p-p in the 30 KHz to 1 MHz range, like amplitude fluctuations from a swept wavelength laser.
When the minimum common mode signal conditions are not met, it is possible to switch to a MANUAL MODE and manually set G_2 through the voltage V.
Figure 6 shows the Common Mode Rejection Ratio – CMRR – when 1837 is used in AUTOBAL mode.
Figure 7 shows the gain range of G_2 compared to G_1 when 1837 is set to MANUAL mode.

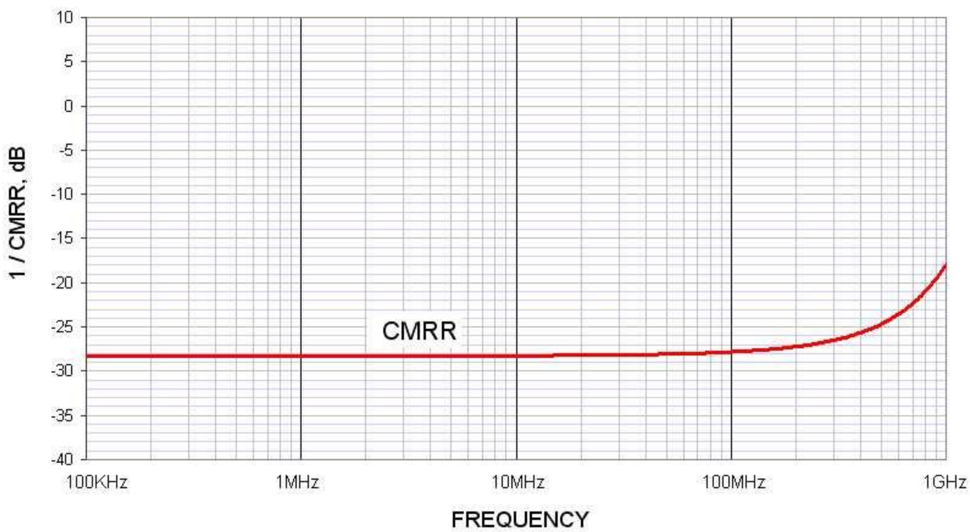

FIG 6 – Typical CMRR for AUTOBAL operation mode in 1837.

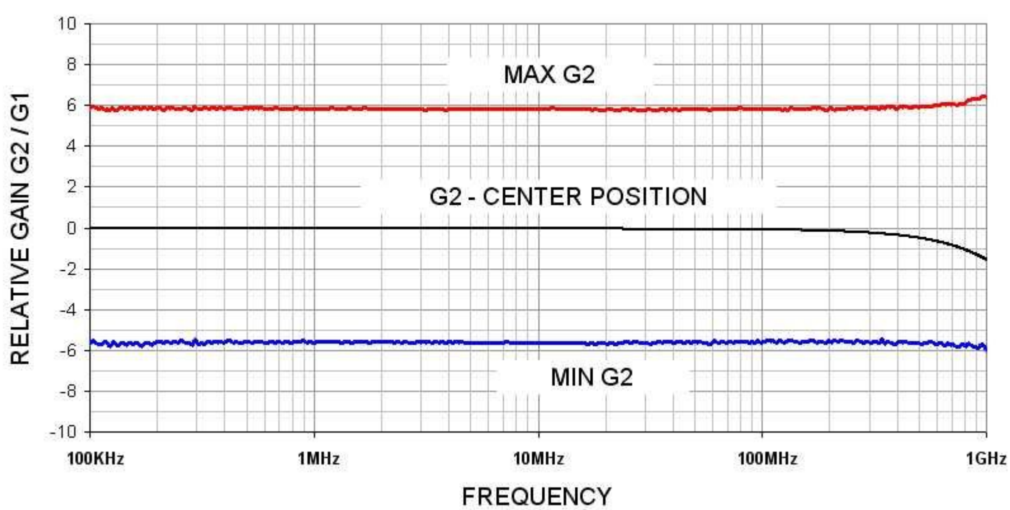

Fig 7 – Gain range for G_2 in MANUAL mode. The frequency flatness of G_2 compared to G_1 is better than 2 dB over the full 1 GHz range.

Operation

Connecting the Power Supply

The balanced photoreceiver's power supply connector is a shielded 3-pin connector. This should be connected to a +15-Volt power supply capable of providing a current of 200 mA.
(We recommend the Newport Model 0901 power supply.)
Two different power cables are shipped with the photoreceiver: a Model 0923 3-pin connector-to3-pin connector cable, for use with the Newport power supply, and a Model 0924 3-pin connector-to banana plug cable, for use with other power supplies.

Using a Newport Power Supply

If you have a Newport Model 0901 power supply, use the Model 0923 3-pin connector-to-3-pin connector power cable to connect the photoreceiver to one of the power supply's 0.3-A 3-pin connector outputs. Be careful to align the notches on the connectors when attaching the cable. If the connectors are not mated correctly or the pins are bent, the photoreceiver may be damaged.

Do not use the power supply's 0.1-A banana-jack output, since it does not provide enough current for the photoreceiver. Note:

Using Another Power Supply

Use the Model 0924 3-pin connector-to-banana plug power cable when working with a power supply other than the Newport Model 0901. Be sure to hook up the banana plugs correctly, or the photoreceiver can be damaged. The convention for the three banana plugs is as follows: Red = +15 V, Green = Ground. Black = not needed.
Be careful to align the notches on the connectors when attaching the 3-pin connector end of the cable to the photoreceiver. If the connector is not mated correctly or the pins are bent, the photoreceiver may be damaged.

Checking the Power Connection

The photoreceiver draws approximately 200 mA on the +15-V line. If the current drawn is 0 mA, the power supply cable may have a bad connection. If the current draw is greater than 200 mA, then the cable could be shorted or there may be an internal problem with the photoreceiver. Contact Newport for support and, if necessary, instructions on returning the unit.

Mounting the Photoreceiver

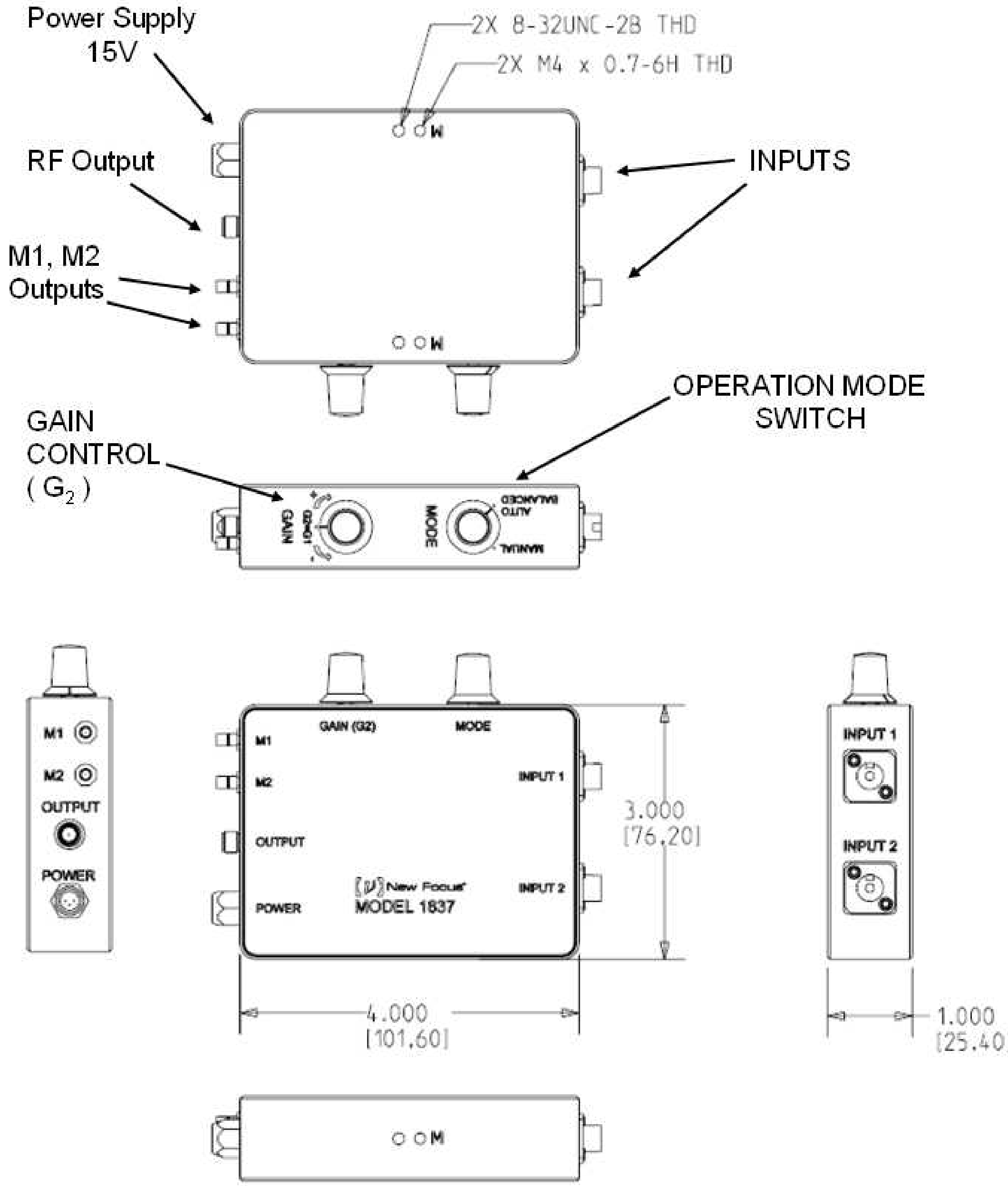

Figure 2: Mechanical drawing of the balanced photoreceiver

The bottom of the photoreceiver has two pairs of holes for mounting it to a post or pedestal. The pair labeled “M” is for mounting with M4-threaded screws. The other pair is threaded for 8-32-threaded screws.

Connecting the Optical Inputs

When connecting the optical inputs, keep the power below the saturation power listed in Table 1. This will keep the RF amplifier operating in the linear region.

The optical power must remain below the absolute maximum power listed in the Table 1. Exceeding the maximum power can damage the photodiode and the amplifier.

WARNING

Figure 8 shows a generic connection schematics for 1837, where a common mode noise N and signal S are present. The output voltage follows a simple rule:

$$\text{INPUT 1 - INPUT 2} = S\left[\frac{1}{2} + \frac{1/2}{\text{CMRR}}\right] + \frac{N}{\text{CMRR}} \approx S + \frac{N}{\text{CMRR}}$$

Set 1837 to MAN mode and adjust gain to center. Then verify outputs M1 and M2 yield similar values and in the range 20 – 1000 mV. Then measure at OUTPUT signal and switch in either AUTO or MAN mode to maximize S / N reading.

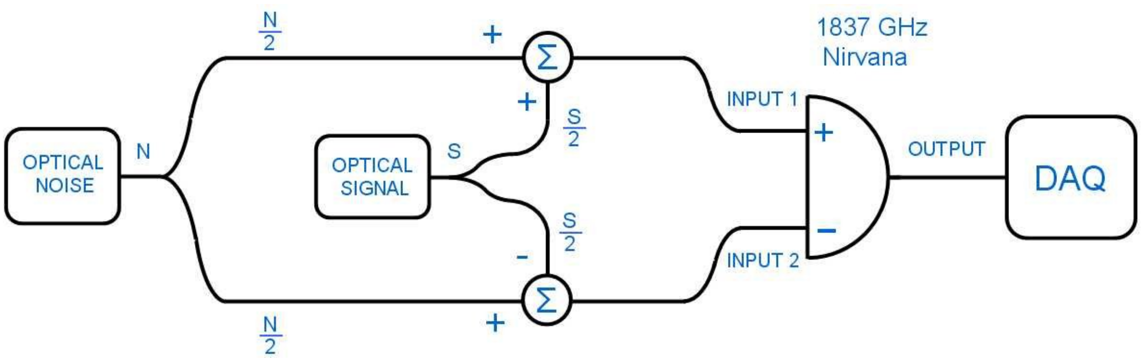

Fig 8 –Connection example for 1837. DAQ: Digital Acquisition System, S: signal, N: common mode noise. OUTPUT voltage does reject noise N and amplifies signal S.

Specifications

1837 GHz Nirvana Rceiver		MIN	TYP	MAX	units
INPUT	Wavelength range	900		1650	nm
	Optical Input 1, 2, Single Mode SMF-28 type	FC / APC			
	Photodiode Responsivity @ 1310 nm	0.75			A / W
	Saturation Power, individual, Input 1, Input 2		1		mW
AC OUTPUT	12-dB Bandwidth		1000		MHz
	3-dB Bandwidth @ λ = 980 nm, 1300 nm	300			MHz
	3-dB Lower Bandwidth (High Pass)		100 KHz		
	G1 - AC-Gain		40 000		V / A
	G2 / G1 - Adj. Ratio - MAN MODE	25 000		65 000	V / A
	G2 / G1 - Adj. Ratio - MAN MODE	0.6		1.6	
	CMRR @ 300MHz	21	25		dB
	CMRR @ 1 GHz		10		dB
	Noise Equivalent Power, NEP @ Input, f > 50 MHz		15	20	$pW/\sqrt{Hz}$
	Output Impedance		50		Ω
	Max RF power @ 100 MHz , 20dB THD		0		dBm
	Electrical Output		SMA		
DC OUTPUT	M1, M2 - monitor DC gain @ load = 1 MΩ		1 000		V/A
	M1, M2 - monitor 3dB Bandwidth		100		KHz
	M1, M2 - Electrical Output	SMB			
OPERATION	Voltage	+ 14	+ 15	+ 16	V
	Current			200	mA
	Connector	3-pin picostyle			
	Temperature		20		°C
	Humidity, non condensing	30		70	%

Table I – Newport 1837 Technical Specifications

Customer Service

Technical Support

Information and advice about the operation of any Newport product is available from our applications engineers. For quickest response, ask for "Technical Support" and know the model number and serial number for your product.

Hours: 8:00–5:00 PST, Monday through Friday (excluding holidays).

Phone: 1-877-835-9620

Support is also available by email and chat

Chat: Connect with us at www.newport.com

Email: tech@newport.com

We typically respond to emails within one business day.

Service

In the event that your device malfunctions or becomes damaged, please contact Newport for a return merchant authorization (RMA) number and instructions on shipping the unit back for evaluation and repair.