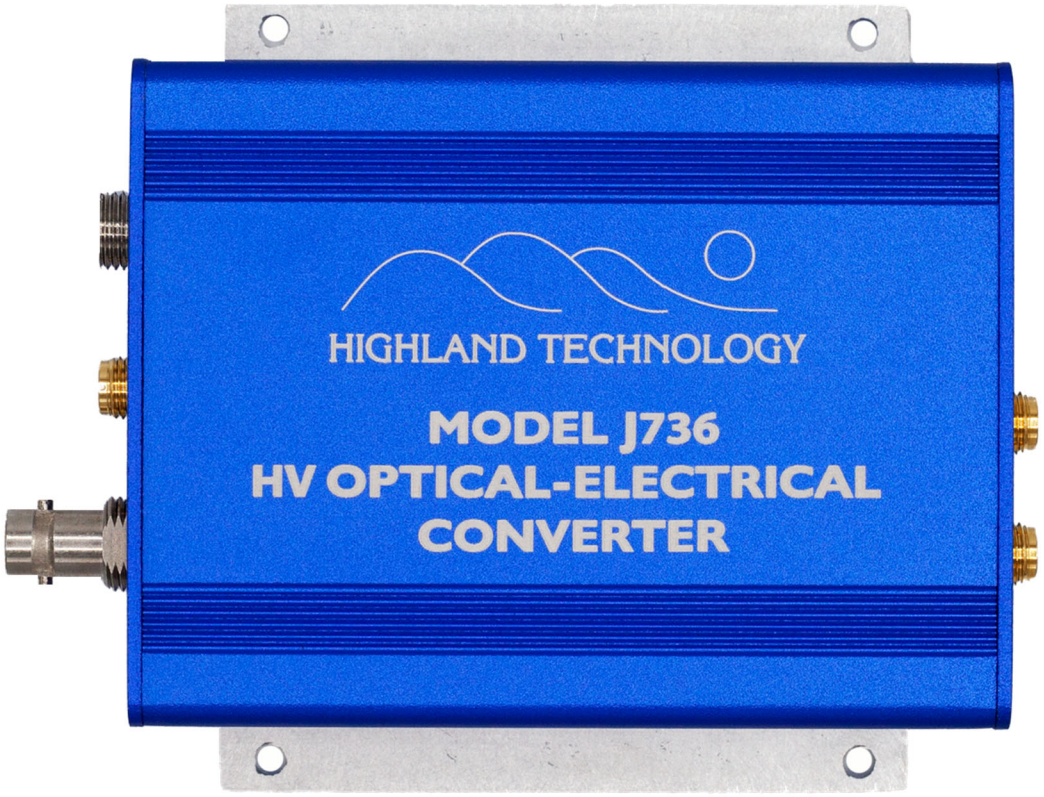
HIGHLAND TECHNOLOGY

Model J736

High Voltage Optical to Electrical Converter



Technical Manual

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1 Introduction

This is the technical manual for the Highland Model J736, a compact single-channel, high-voltage optical-to-electrical converter.

The J736 accepts a fiberoptic input and generates a high-voltage, DC-coupled, 50-ohm digital output when the input exceeds an adjustable optical power threshold. It includes monitor outputs for the analog optical input and high-voltage output. The J736 is useful for distributing pulse, logic and trigger signals over long distances without the losses and noise problems associated with coaxial cables.

Features of the J736 include:

- Small, rugged, high-voltage optical-to-electrical converter allows the o/e transition to be located wherever most convenient
- Manual adjustment of o-e discriminator threshold and output pulse voltage
- Clean, fast, DC-coupled 50-ohm pulse output, adjustable from 0.8 volts to 20 volts
- 1 nanosecond typical rise/fall, < 2 nanosecond minimum width, up to 15 MHz pulse rate
- Logic link jitter typically below 20 picoseconds RMS when used with companion J720 or J724 electrical/optical converters
- Excellent laser, laser stack, optical modulator, PIN diode, or SiC gate driver

2 Specifications

All specs are typical unless noted

FUNCTION	Single-channel high-voltage optical-to-electrical converter
OPTICAL INPUT	850 nm nom wavelength, ST fiber connector, J736-1 version 1310nm nom wavelength, ST fiber connector, J736-3 version 1mW nom optical power in Threshold adjustable 100 μW to 2 mW, factory set to 300 μW
PROPAGATION DELAY	Light in to HV electrical out < 10 ns, typ
PULSE RATE	DC to 15 MHz, absolute max
DIGITAL OUTPUT	DC coupled, SMA connector 50 ohm source impedance, zero volt baseline Pulse adjustable from +0.8 to +20 volts for standard J736-1 and J736-3 versions (0.4 to 10 volts into 50 ohm load) Optional faster rise/fall versions available
RISE / FALL TIME	Analog O-E monitor: 2 ns typ HV output: 1 ns typ
JITTER	< 20 ps RMS, J720 + J736
MONITOR OUTPUTS	DC coupled, SMA connector Analog: 50 ohm source impedance 100 mV per mW optical power into Hi-Z load 50 mV per mW into external 50 ohm load HV: 50:1 attenuated output pulse monitor, 50 ohm source impedance 100:1 into external 50 ohm load
POWER IN	+24 VDC, 100 mA + average load current 2.1 mm x 5.5 mm barrel receptacle, center positive J24 24 volt wall-plug universal-input power supply furnished
OPERATING TEMPERATURE	0°C to 60°C, non-condensing Built-in thermal shut-down

CALIBRATION INTERVAL	One year
INDICATORS	Green LED: Power, Blue LED: Rising edge trigger
PACKAGING	Aluminum enclosure, 2" x 3" x 1" J732 mounting flange included

3 Theory of Operation

The J736 block diagram is presented in Figure 1. It incorporates a GaAs or InGaAs photodiode detector, a fast transimpedance amplifier, an adjustable comparator, and the high performance T577 GaN output driver. The J736 design and bandwidth is optimized for minimum jitter when driven by a J720, J724, V720, or compatible e/o converter.

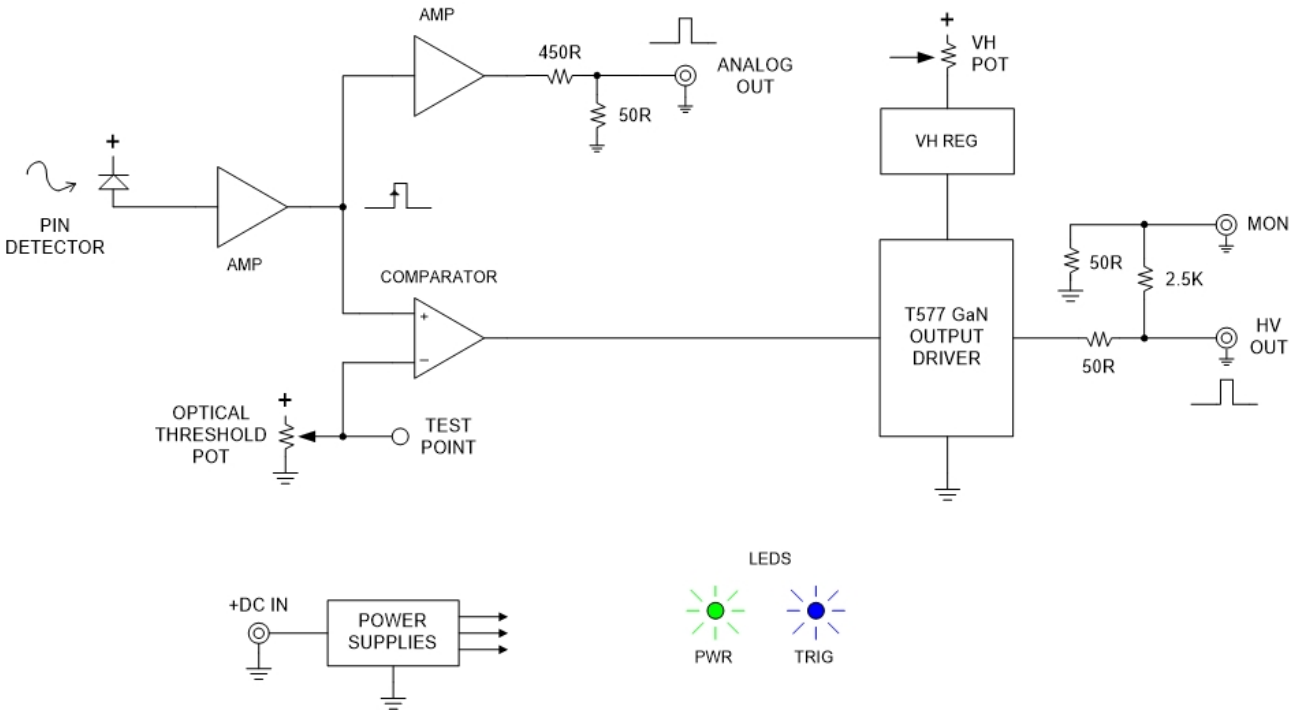

Figure 1: J736 Block Diagram

The digital HV output goes logic high when incoming optical power exceeds the comparator's threshold setting. The o-e conversion comparator threshold is scaled 1 volt per milliwatt into a Hi-Z load, such as a DVM, and adjusted using the THR trimpot and test point.

Peak output voltage is determined by the VH trimpot setting, as measured with a DVM at the adjacent test point. Measure test point voltages against any of the cover securing screws or the fiberoptic connector shell, all of which are grounded and circuit common.

4 User Settings and Operation

The input o-e threshold and output HV level are adjusted with trimpots. Test points are provided to facilitate adjustments using a DVM.

Figure 2 below shows typical digital HV OUT and analog OMON output pulses generated by the J736, driven by a Highland Model P400 Digital Delay/Pulse Generator and a J720 Electrical/Optical Converter delivering a 1 milliwatt optical pulse. The digital HV voltage level is about 10 volts and the analog level is about + 50 millivolts. Both signals were measured by a 50 ohm oscilloscope, and would be 2:1 greater if driven into high-impedance loads. The J736 analog output waveform is fairly representative of the actual optical pulse shape.

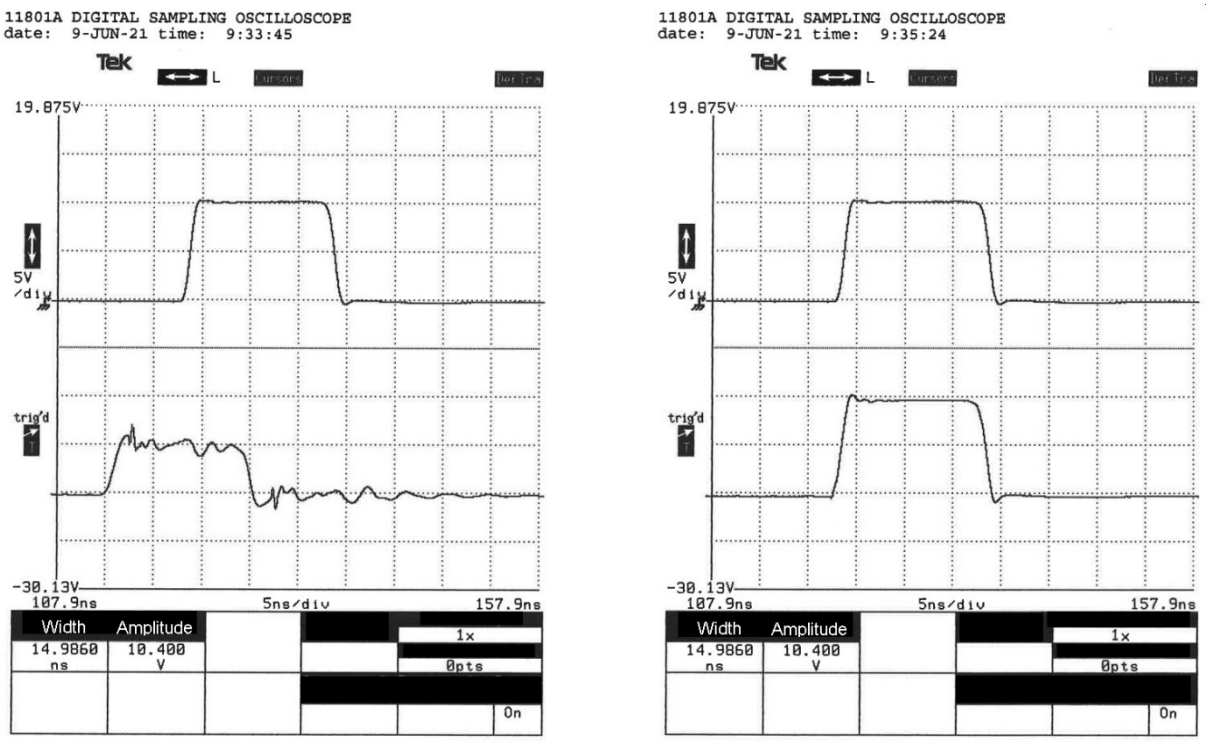

Figure 2: Typical HV (upper), OMON (lower left), VMON (lower right) waveforms

4.1 Optical Input and Threshold

The comparator threshold is factory-set to 300 microwatts (300 millivolts at the test point) and is adjustable from below 100 microwatts to greater than 2 milliwatts. A setting of about 30 percent of expected optical pulse power is recommended. Too high or too low a setting can result in excess jitter or unreliable operation.

To adjust the optical threshold pot, one can advance the pot and test point voltage such that the digital output is marginal, then reduce the test point voltage to 1/3 of that marginal value.

One can also view the analog monitor signal to determine actual incoming power. Scaling is nominally 100 millivolts per optical milliwatt as viewed on a hi-Z scope, or 50 millivolts per milliwatt into a 50 ohm scope. Once peak power is known, the threshold test point can

be set to 1/3 peak power using the scaling 1 volt per optical milliwatt into a hi-Z load. Note that the optical analog output is affected by the HV output switching, resulting in ringing and spikes. These artifacts occur after the output stage has transitioned to a logic-high state and don't affect the HV output.

4.2 HV Output

The output is a 50 ohm source from the GaN output stage. The base level is zero volts or slightly negative and the pulse high level is set by the VH trimpot. On the standard J736 version, an external 24 volt power supply is used and the pulse output is adjustable from +0.8 volts to +20 volts into a high impedance (source terminated) load, or +0.4 volts to +10 volts into an external 50 ohm load.

The output duty cycle is limited by the power capability of the internal power supplies and the output stage. The J736 will shut down if the supplies are overloaded, the box overheats, or if computed power dissipation in the 50 ohm equivalent source resistance exceeds about 4 watts. The green PWR LED will go off when overload is sensed, and the unit will resume operation after a recovery delay. The J736-1 can sustain 100 % duty cycle up to 20 volts output, namely 10 volts into an external 50 ohm load. Low impedance loads, shorts or lasers for example, will not damage the unit but can invoke shutdowns at high duty cycles.

Limit pulse repetition rate to 15 MHz or less to prevent damage to the output stage.

The pulse output stage is the Highland T577 GaN driver subassembly. It can make DC-coupled sub-ns pulses, from a baseline of +-5 volts. It is available as an OEM product; see Figure 3 below.

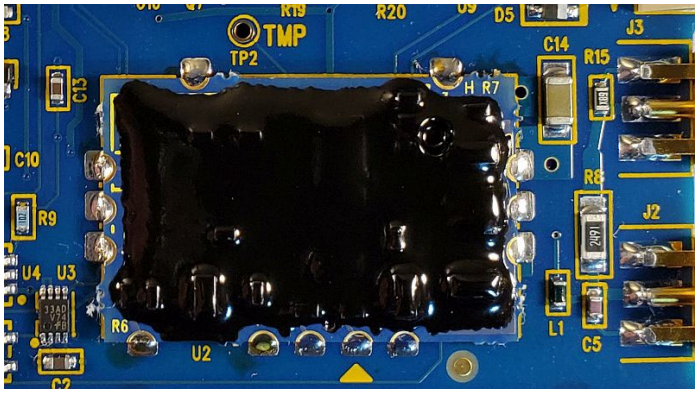

Figure 3: T577 GaN driver subassembly

4.3 HV Monitor Output

The VMON output may be used to set the output level without disconnecting the load. It is 1/50 of the actual voltage at the output connector, measured with a hi-Z scope, or 1/100 into a 50 ohm scope.

4.4 LEDs

The green PWR LED indicates normal operation and the blue TRIG LED indicates triggers accepted. The PWR LED will go off briefly if overload is sensed.

4.5 Power

The J736-1 and J736-3 versions require +24 volts DC. The Highland J24 wall-wart is furnished. Current requirement is typically 100 milliamps plus average load current.

The model J27 locking cable is available for use with other power supplies.

4.6 Mounting and Cooling

The J736 is furnished with the J732 mounting flange attached; see Figure 4.

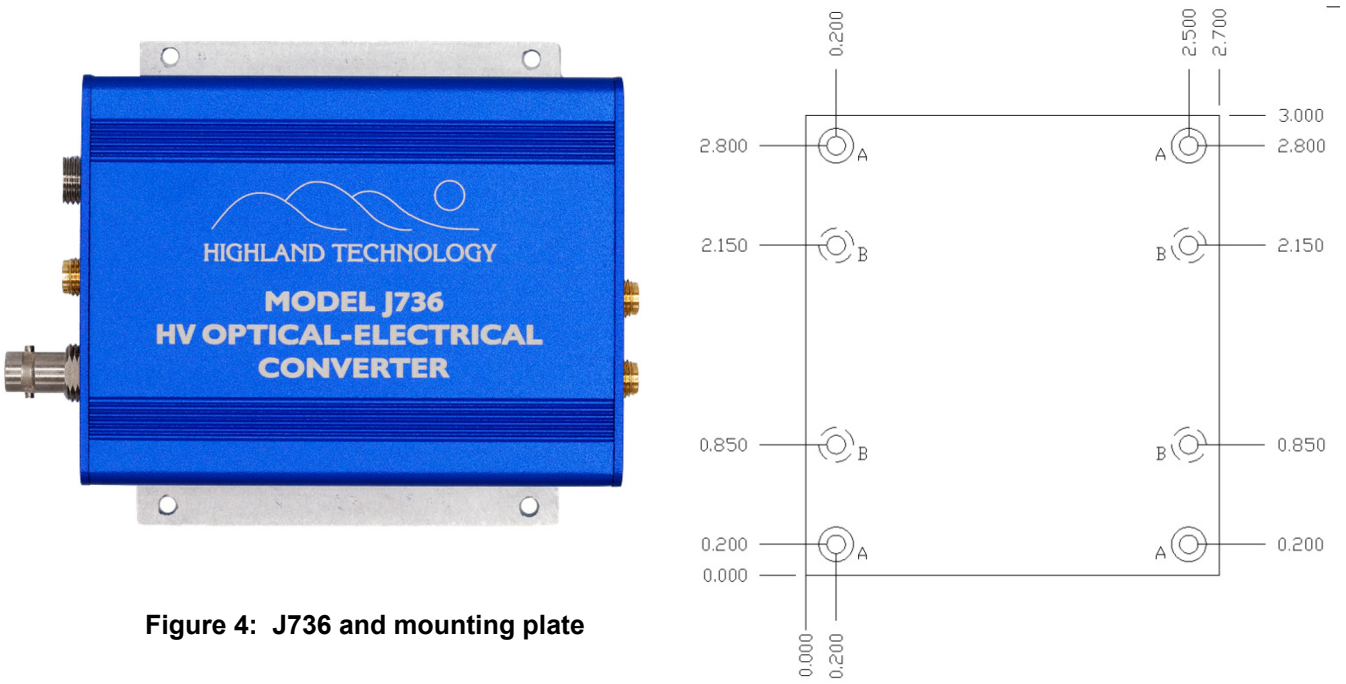

Figure 4: J736 and mounting plate

The J736 is secured with 4-40 screws through the four holes B-B. The four outer holes A-A can be used to mount the flange to a surface with 4-40 hardware.

The screws from the flange, or from any other mounting arrangement, must not penetrate the J736 enclosure more than 0.1 inches. Consult factory about custom mounting or packaging.

The J736 requires convection or conduction cooling (air-flow, or mounting to a metal surface) to achieve rated pulse outputs. It does not need special cooling at 10 % or lower pulse duty cycles when loaded by 50 ohms.

CAUTION: The J736 case temperature could exceed 60 °C at high outputs without cooling.

5 Typical Output Waveforms

Figures 5 through 7 below demonstrate typical output pulse behavior of a J736 into 50 ohms, for VH settings of 2 volts, 10 volts, and 20 volts, respectively.

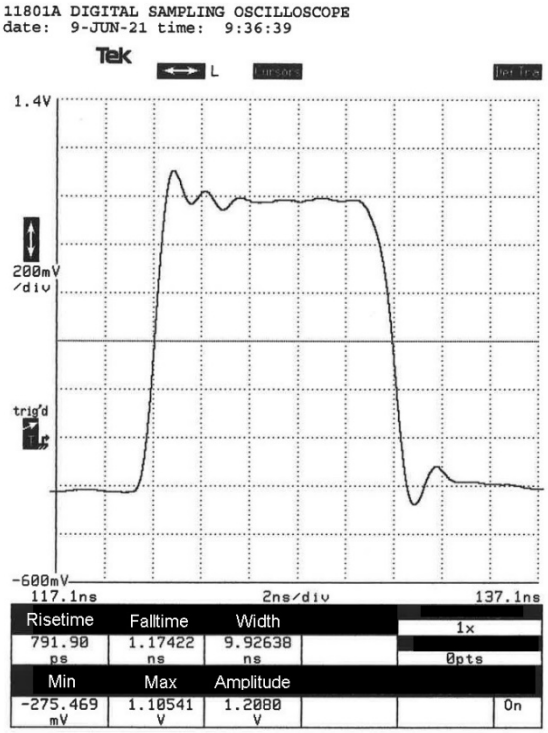

Figure 5: 1 volt pulse into 50 ohms

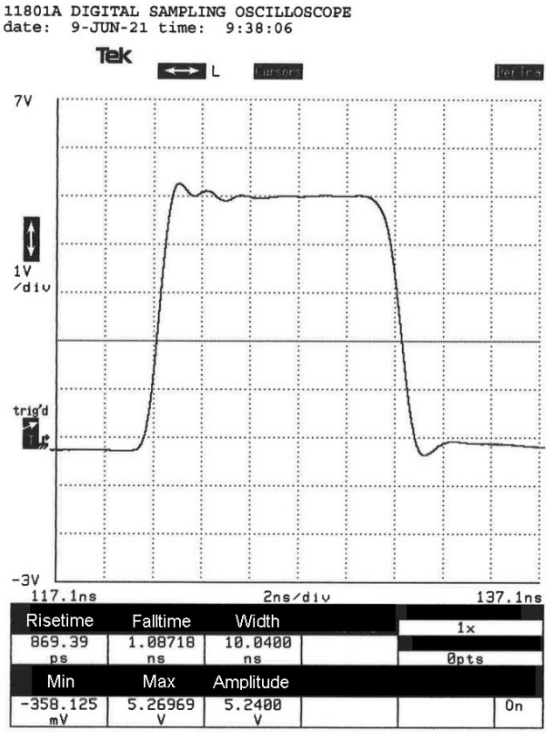

Figure 6: 5 volt pulse into 50 ohms

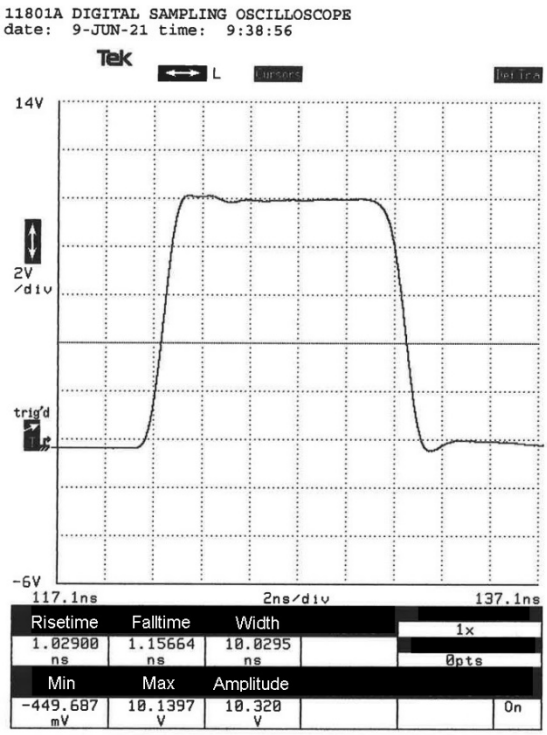

Figure 7: 10 volt pulse into 50 ohms

Figures 8 and 9 below are typical zoomed-in rising edges. Observed jitter is mostly due to the combined jitter of the P400 DDG, J720 E/O and 11801A oscilloscope.

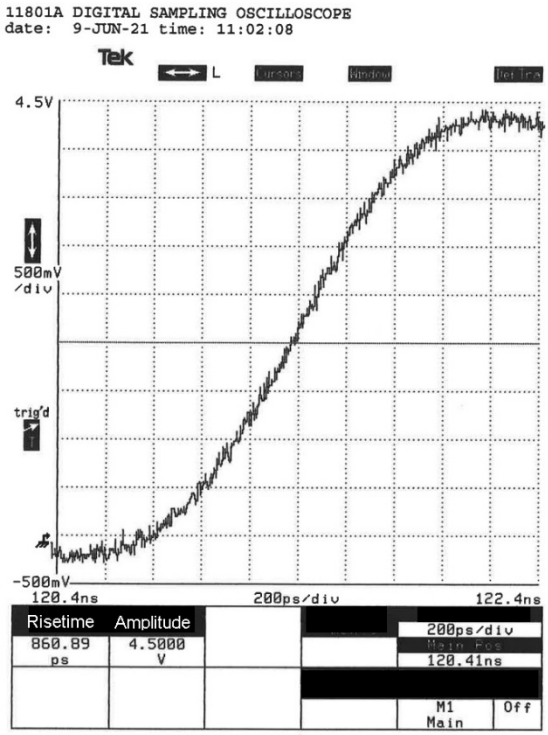

Figure 8: 861 ps risetime (10%-90%)
4 volts into 50 ohms
200 ps/div, unsmoothed

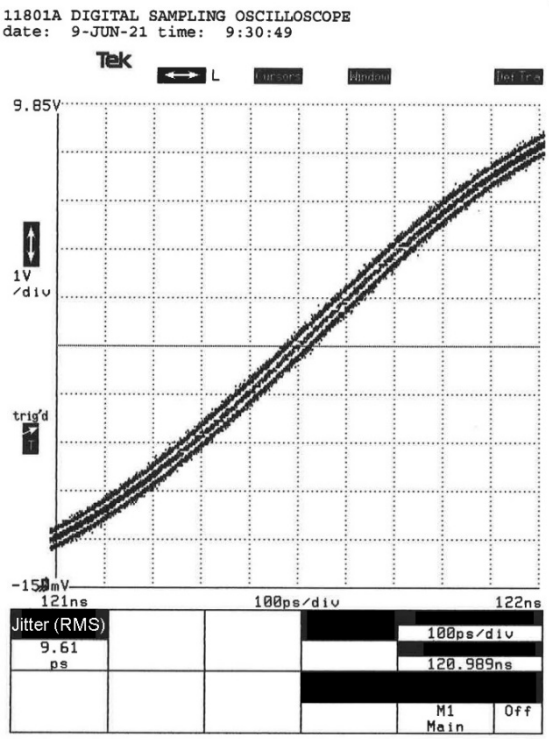

Figure 9: Rising edge jitter into 50 ohms
13 second accumulation
9.61 ps, RMS (observed)

6 Fiber Notes

The J736-1 operates at 850 nanometers and uses a GaAs PIN diode detector in an ST connector housing. It should be used with standard 62/125 micron, ST connectorized, graded-index, multimode glass-fiber cables. Please refer to Figure 10 below for the GaAs photodiode's nominal wavelength response curve.

The J736-3 version uses an InGaAs photodiode and is typically used with 1310 and 1550 nanometer sources. It should be used with standard 9/125 micron, ST connectorized, graded-index, singlemode, glass-fiber cables. Please refer to Figure 10 below for the InGaAs photodiode's nominal wavelength response curve.

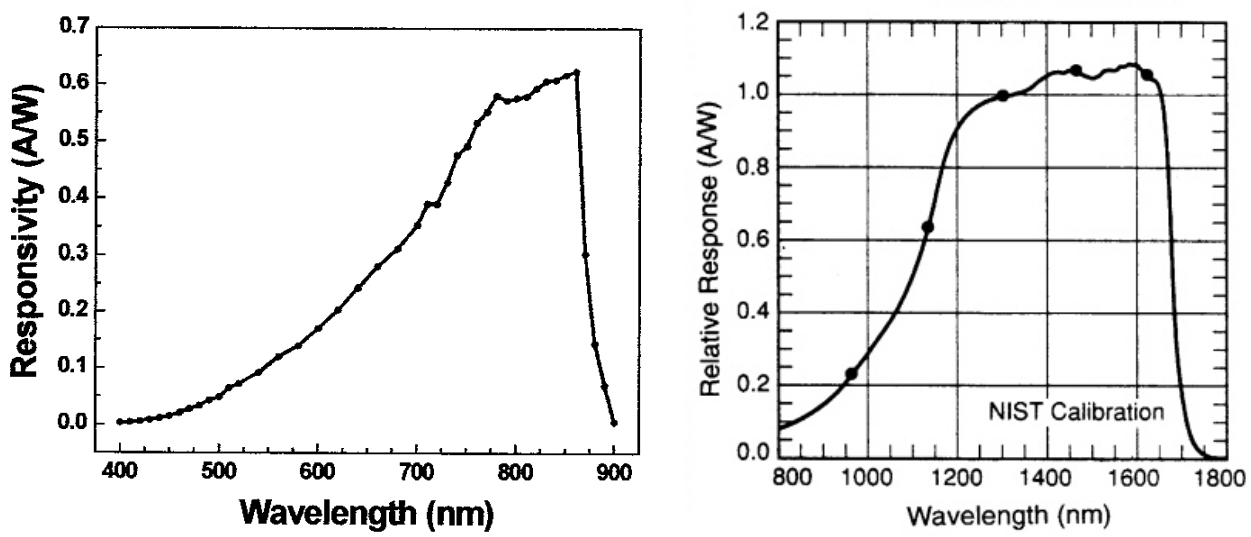

Figure 10: 850 nm GaAs detector response (left); 1310-1550nm InGaAs response (right)

Fiber connectors should be kept clean and covered with protective caps when not in use, and should be cleaned with an approved fiber wipe before each use. Dust and other contaminants may not only result in immediate coupling problems, but may also lodge within the laser/detector housings and produce long-term degradation.

Do not bend the fibers to a radius below 1 inch.

Multimode fiber propagation delay is typically about 0.66 c, or about 5 nanoseconds per meter (1.5 nanoseconds per foot). Propagation delay varies with temperature and is roughly +15 PPM/ºC but may vary depending on the fiber and jacketing.

Communications grade multimode fiber will have losses in the vicinity of 3 dB per kilometer at 850 nanometers. A connector pair may add 1 dB loss. The receiver threshold can be reduced to accommodate fiber loss or splitters, at the cost of additional jitter. A receive threshold of perhaps 300 microwatts will generally result in good system performance when the J736 receives inputs in the 800 microwatt to 1000 microwatt range.

Dispersion results in a degradation of optical pulse risetime with distance; expect risetime loss of up to several nanoseconds per kilometer for graded-index multimode fiber.

Singlemode fiber will typically have losses and dispersion that are a small fraction of those of multimode fiber.

7 Versions

Model	Part Number	λ nm	Connector	Output
J736-1	21A736-1	850	ST	20 volts max
J736-3	21A736-3	1310 / 1550	ST	20 volts max

8 Customization

Consult factory for information about additional custom versions.

The T577 GaN output driver is available as an OEM subassembly. Highland also offers standard and custom laser drivers, delay generators, and timing controllers.

9 Hardware Revision History

Revision A October 2020

Initial PCB release

Revision B August 2022

Functionally equivalent to Revision A.

10 Accessories

J24-1: 24 volt 1.2 amp power supply (included with purchase)

J27-1: 2.1 x 5.5 mm barrel to pigtail power cable

J44-1: 3′ SMA to SMA cable

J59-1: 3′ ST to ST fiberoptic cable (multi mode simplex)

J61-1: 3′ ST to ST fiberoptic cable (single mode simplex)

J732-1: mounting flange (included with purchase)