



HIGHLAND TECHNOLOGY

# MODEL J240 PULSE GENERATOR



## Technical Manual

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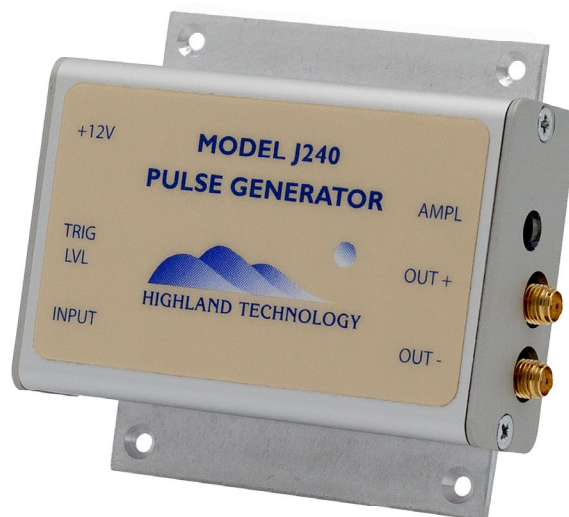
# **1 Introduction**

This is the technical manual for the Highland Model J240 Pulse Generator.

The J240 is an externally-triggered pulse generator with complementary outputs.

Features of the J240 include:

- User-adjustable amplitude from 0 to 750 millivolts nominal
- Generates fast complementary outputs
- Available 140 ps FWHM Gaussian output pulse width (-1 version)
- Adjustable output rectangular pulse width (-2 and -3 versions only)
- Risettime / falltime 65 picoseconds, nominal
- Adjustable trigger threshold and output amplitude
- Operates from standard 12-volt power supply
- Compact extruded anodized aluminum enclosure is supplied with mounting flange
- Ideal source for time-domain device model extraction



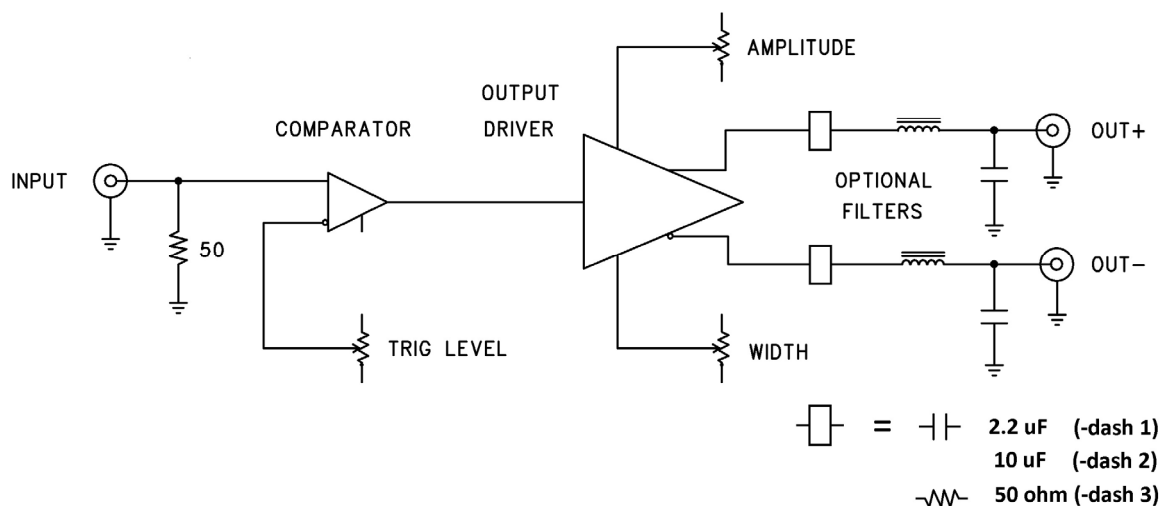
## 2 Specifications

FUNCTION	Externally-triggered complementary-output pulse generator
TRIGGER	Rising-edge trigger, 50 $\Omega$ input impedance Threshold is user adjustable from -4 to +4 volts Threshold test point is provided
PROPAGATION DELAY	1 ns, nominal
OUTPUT	Versions -1 and -2: User adjustable 0 to $\pm 750$ mV (nominal, $\pm 675$ mV, min) peak into 50 $\Omega$ loads; AC-coupled 5 $\Omega$ nom. source per output Version -3: User adjustable 0 to 375 mV (nominal, 340 mV, min) peak-peak LVDS into 50 $\Omega$ load; DC-coupled 50 $\Omega$ nom. source per output VoH = +1.15 V (nominal, fixed) VoL = +1.15 V to +0.75 V (nominal, adjustable)
BANDWIDTH	DC to 1 GHz repetition rate
RISETIME	65 ps, nominal (20% to 80%)
FALLTIME	65 ps, nominal (20% to 80%)
PULSEWIDTH	Factory adjusted to 140 ps FWHM, nominal (J240-1) J240-2 and -3 widths follow the input
JITTER	< 10 ps RMS
OPERATING TEMPERATURE	0 to 60°C
CALIBRATION INTERVAL	One year
POWER	+12 volts at 150 mA, max J12 12 volt power supply adapter furnished
CONNECTORS	Gold plated SMA input and output jacks Trigger Threshold level test point 2.1 mm X 5.5 mm barrel power connector
INDICATOR	LED: green power

PACKAGING	3.3" (L) x 2.1" (W) x 0.9" (H) extruded anodized aluminum enclosure J732 mounting flange included
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### 3 Theory of Operation

The equivalent circuit diagram of the J240 is shown below.



The trigger level is adjustable using the TRIG LVL pot. A test point is provided to measure the level, using a high-impedance DVM referenced to case ground. The trigger level should normally be set to the mid-point of the input signal swing. An external DC block should be used if input AC coupling is required.

The J240-1 version output driver generates a 140 picosecond FWHM nominal Gaussian pulse, fine-adjustable using the WIDTH pot. The output coupling caps are present.

The J240-2 version output driver follows the input. The output coupling capacitors are present.

The J240-3 is a DC-coupled signal follower providing LVDS outputs when each output is terminated with 50  $\Omega$  to ground, or 100  $\Omega$  differentially.

#### 3.1 Output Connections

SMA output connectors must be properly torqued and each complimentary output must be individually terminated with 50  $\Omega$  to ground, or differentially terminated with 100  $\Omega$ . The 65 picosecond nominal output edges can be degraded by external coaxial cables. For example, three feet of RG174 cable has a risetime of about 75 picoseconds. The equivalent bandwidth of fast-switching output signals require RF coax and terminations rated for 18 GHz or better for optimal performance. Short (less than 6 inch) hardline or semi-hardline cables are recommended.

The J240-1 and J240-2 outputs are AC-coupled with a low output impedance, each intended to drive a 50  $\Omega$  coaxial cable terminated by 50  $\Omega$  (see Figure 1).

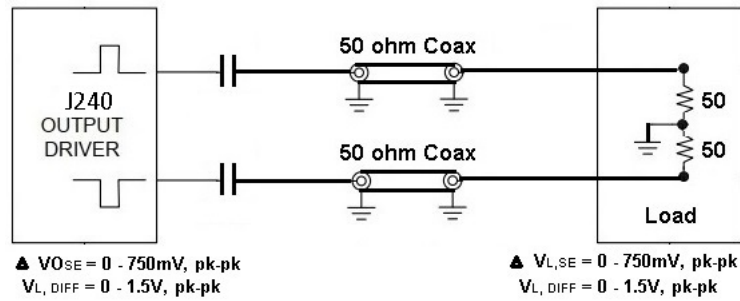


Figure 1: Standard termination configuration (non LVDS version)

### 3.2 Gaussian Pulse Mode

The J240-1 version sources 140 picosecond FWHM complementary Gaussian pulses at the rising edge of the trigger input. The AMPLITUDE trimpot adjusts the amplitude from zero to 750 mV, nominal.

Because the J240-1 outputs are AC-coupled, the average DC output is zero, so there is some baseline shift at high duty cycles. OUT+ baseline shifts negative and OUT- shifts positive by about 90  $\mu\text{V}/\text{MHz}$  of trigger rate.

The J240-1 has a nominally 5  $\Omega$  output impedance and is designed to drive a 50  $\Omega$  load.

If the load is mismatched and generates undesirable reflections, users may add a 3 dB or 6 dB SMA attenuator at the J240 output to reduce reflections with a corresponding reduction in amplitude.

### 3.3 Pulse Follower Mode

The J240-2 version outputs complementary signals which follow the input signal.

The AMPLITUDE trimpot adjusts the pulse amplitude from zero to 750 mV, nominal.

J240-2 outputs are AC-coupled, the average DC output is zero, so there is some baseline shift at high duty cycles. OUT+ baseline shifts negative and OUT- shifts positive by about 90  $\mu\text{V}/\text{MHz}$  of trigger rate.

If the load is mismatched and generates undesirable reflections, users may add a 3 dB or 6 dB SMA attenuator at the J240 output to reduce reflections with a corresponding reduction in amplitude.



### 3.4 LVDS Pulse Follower Mode

The J240-3 version outputs complementary signals which follow the input signal. Each output has a nominal  $50\ \Omega$  source impedance and provides adjustable LVDS levels into  $50\ \Omega$  terminations. Coupling is DC throughout.

The AMPLITUDE trimpot adjusts the pulse amplitude from zero to 375 mV, nominal.

#### 3.4.1 LVDS considerations

The J240-3 complimentary outputs are DC-coupled, each providing a  $50\ \Omega$  nominal source impedance.  $50\ \Omega$  coax is used to individually transmit signals from the J240-3 to an LVDS receiver. Two methods of termination are recommended, depending on whether the LVDS receiver has an internal termination.

#### 3.4.2 Common-ground termination, Hi-Z LVDS receiver

A high-impedance (Hi-Z) LVDS receiver won't properly terminate the  $50\ \Omega$  coax signal lines, requiring placement of external resistors. Each single-ended line may be terminated at the receiver with discrete  $50\ \Omega$  resistors to ground, or  $50\ \Omega$  feed-thru RF coax terminations (see Figure 2).

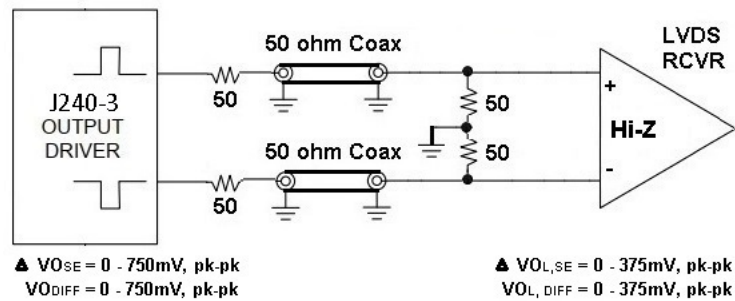


Figure 2: Single-ended external LVDS termination

Alternatively, a Hi-Z receiver may be differentially terminated with a floating  $100\ \Omega$  resistor across the signal lines (see Figure 3).

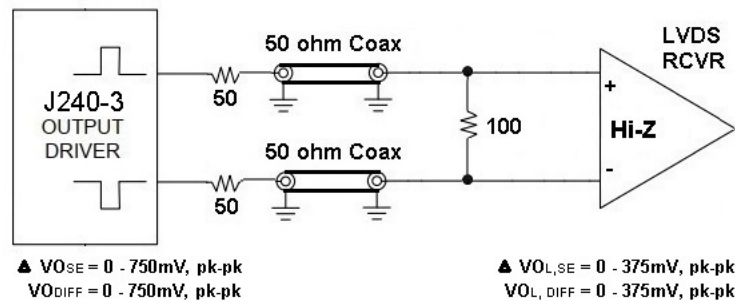


Figure 3: Floating differential LVDS termination

### 3.4.3 Internal differentially-terminated LVDS receiver

Some LVDS receivers include an internal, floating 100  $\Omega$  termination resistor between the inputs (see Figure 4). External resistors are not recommended with this arrangement, as the sum of the two individual 50  $\Omega$  signal lines optimally matches the receiver's floating 100  $\Omega$  input impedance.

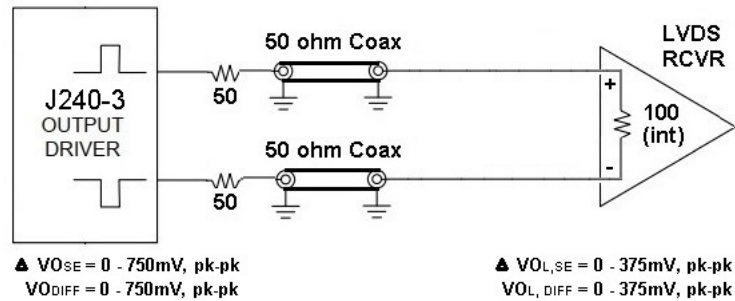


Figure 4: Differential LVDS termination configuration

Adding external 50  $\Omega$  resistors to ground, or an external 100  $\Omega$  resistor across the input of an internally terminated receiver, will result in reduced signal swing and increases signal reflections in the transmission lines (see Figure 5 and Figure 6).

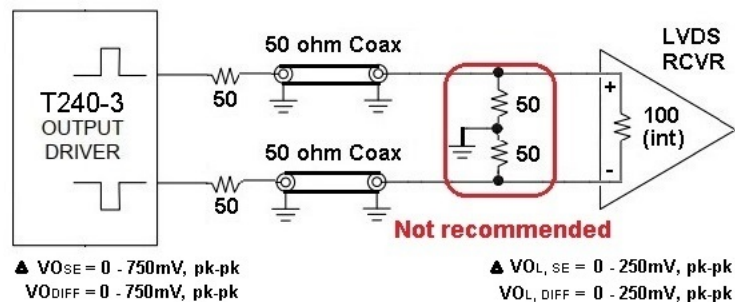


Figure 5: Doubly terminated receiver with external single-ended resistors

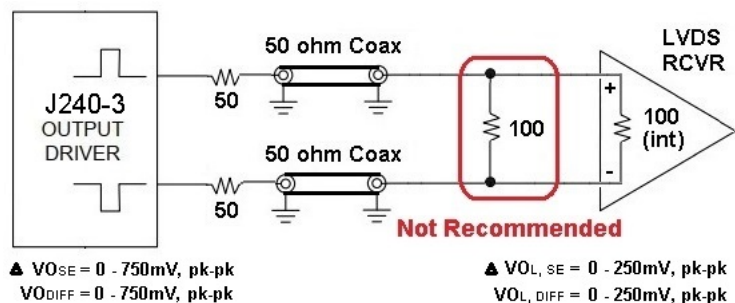


Figure 6: Doubly terminated receiver with external differential resistor

### **3.5 Mounting and Grounding**

It is recommended that the J240 be securely mounted to a grounded metal surface. It may be mounted from below with 4-40 machine screws, or from above using the mounting flange furnished.

If the mounting flange is not used, the box can be bolted to a mounting surface using the four tapped 4-40 holes on the bottom. Screws **MUST NOT** penetrate more than 0.100 inches into the enclosure.

See section 5 for dimensions.

## 4 Typical Performance

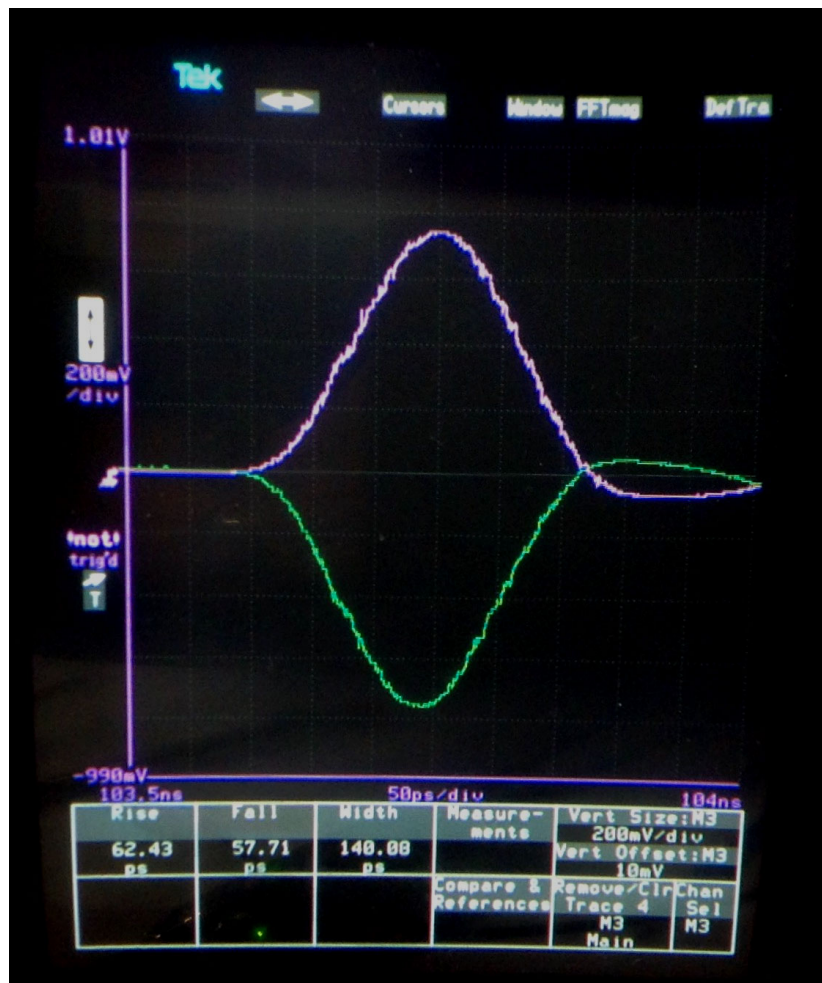
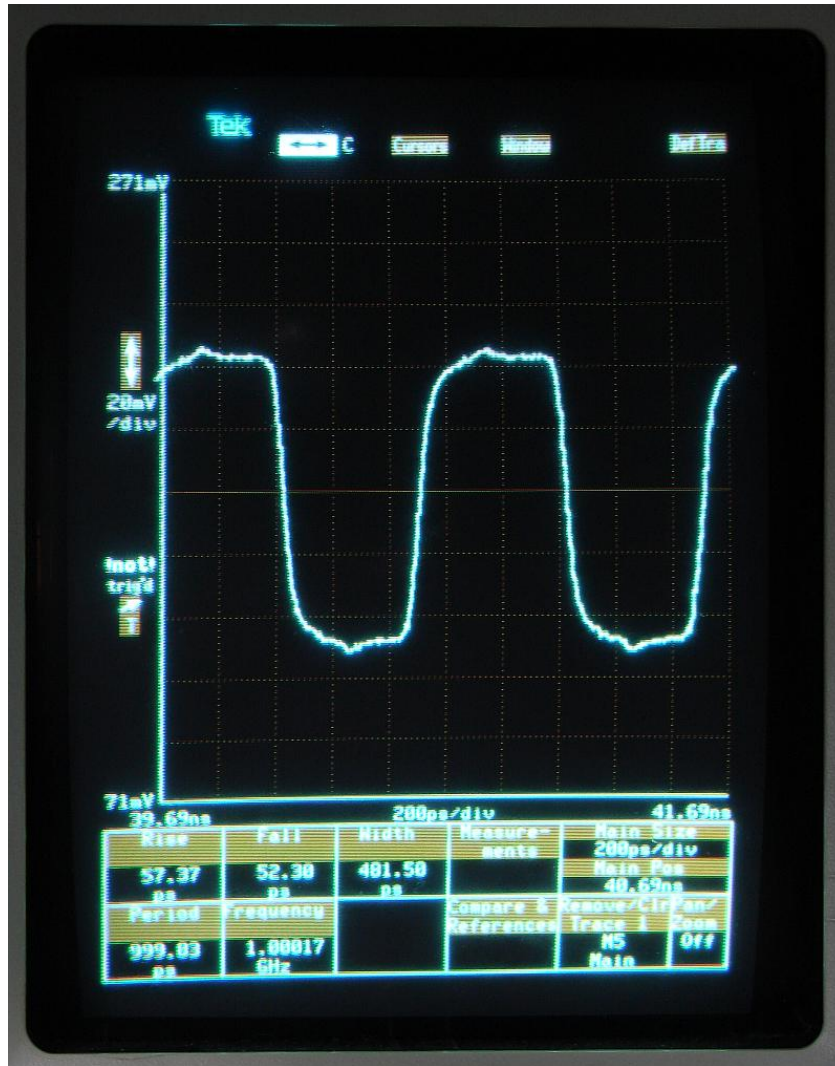


Figure 7: J240-1 Complementary Gaussian pulses  
(Pulse widths are 140 ps FWHM adjusted for scope bandwidth)



**Figure 8: J240-2 1 GHz Output**  
 (Indicated rise = 57 ps, fall = 52 ps using 28 ps scope)

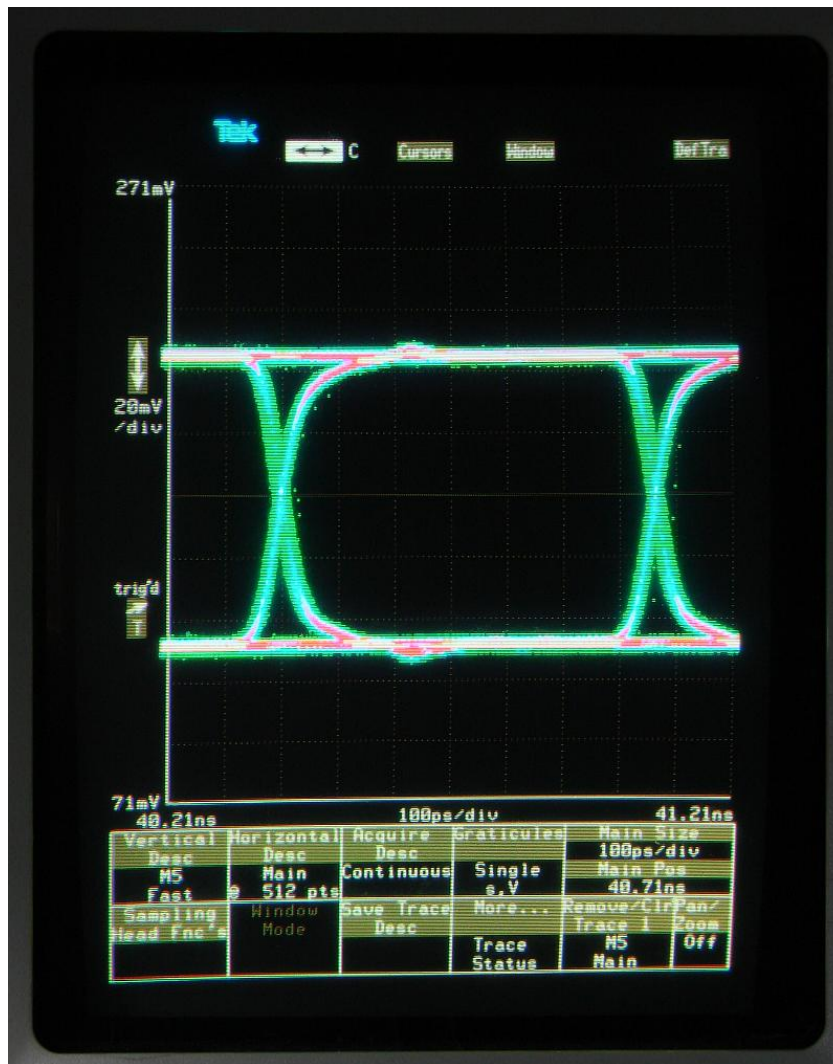
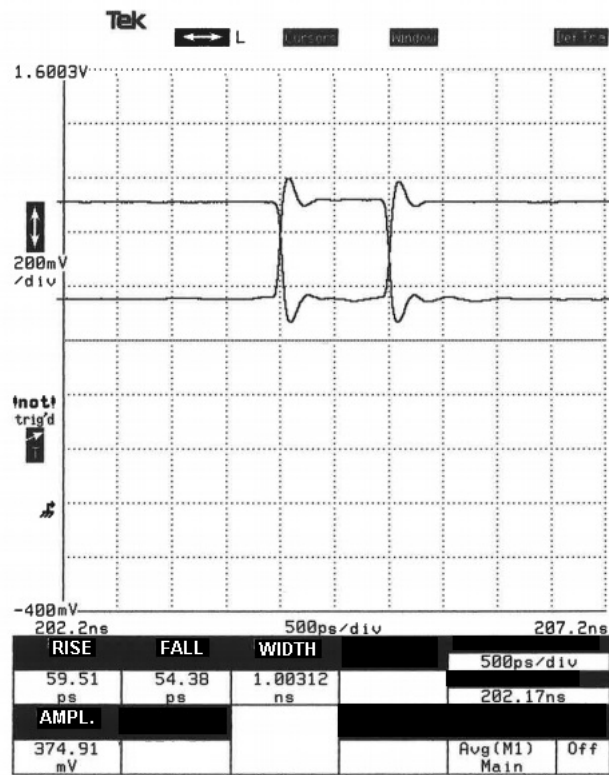


Figure 9: J240-2 Eye diagram, pseudo-random data at 1.5 GBPS



**Figure 10: J240-3 Pulse Response, LVDS Output**  
(Indicated rise = 60 ps, fall = 54 ps using 28 ps scope)

## 5 Dimensions

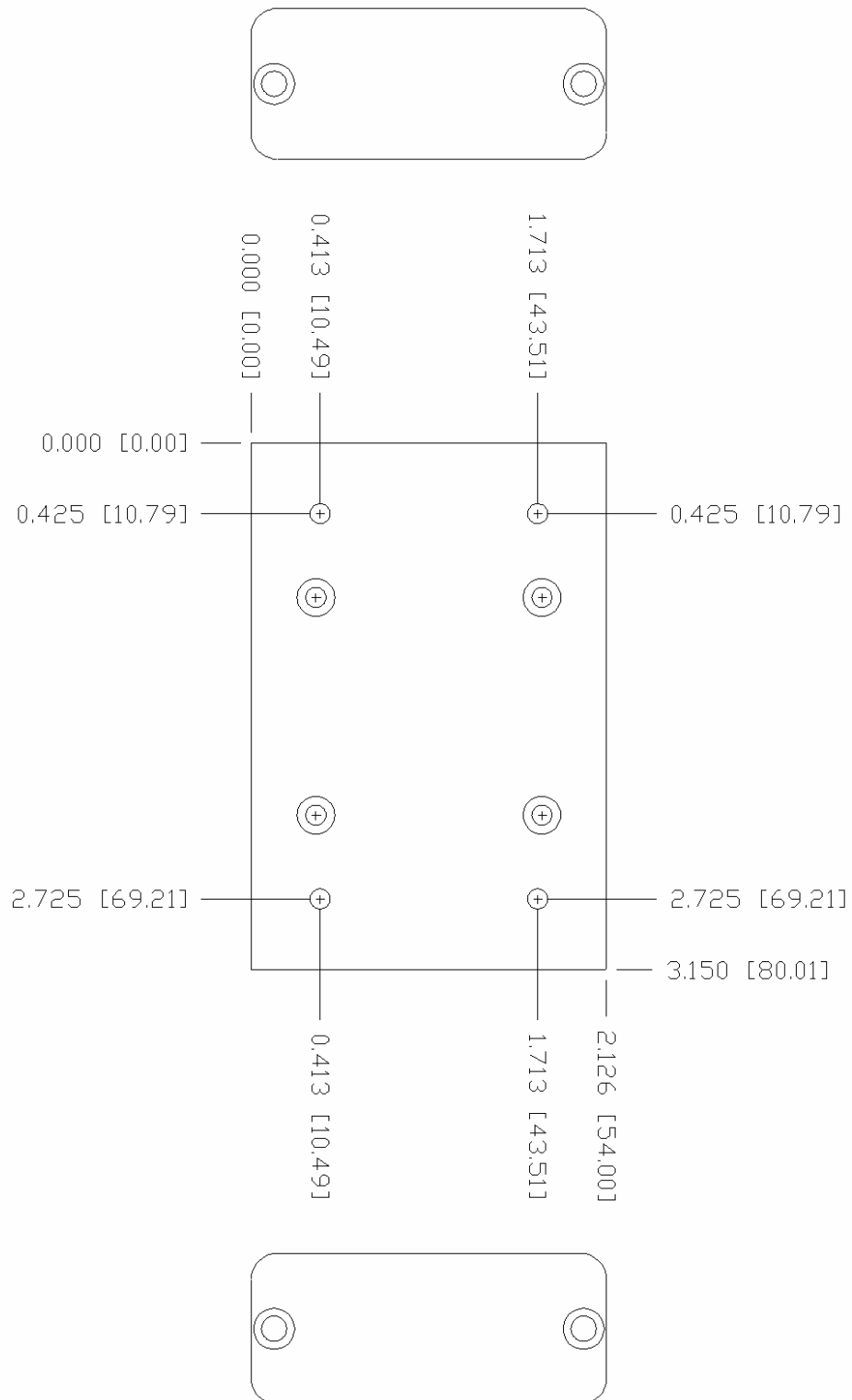
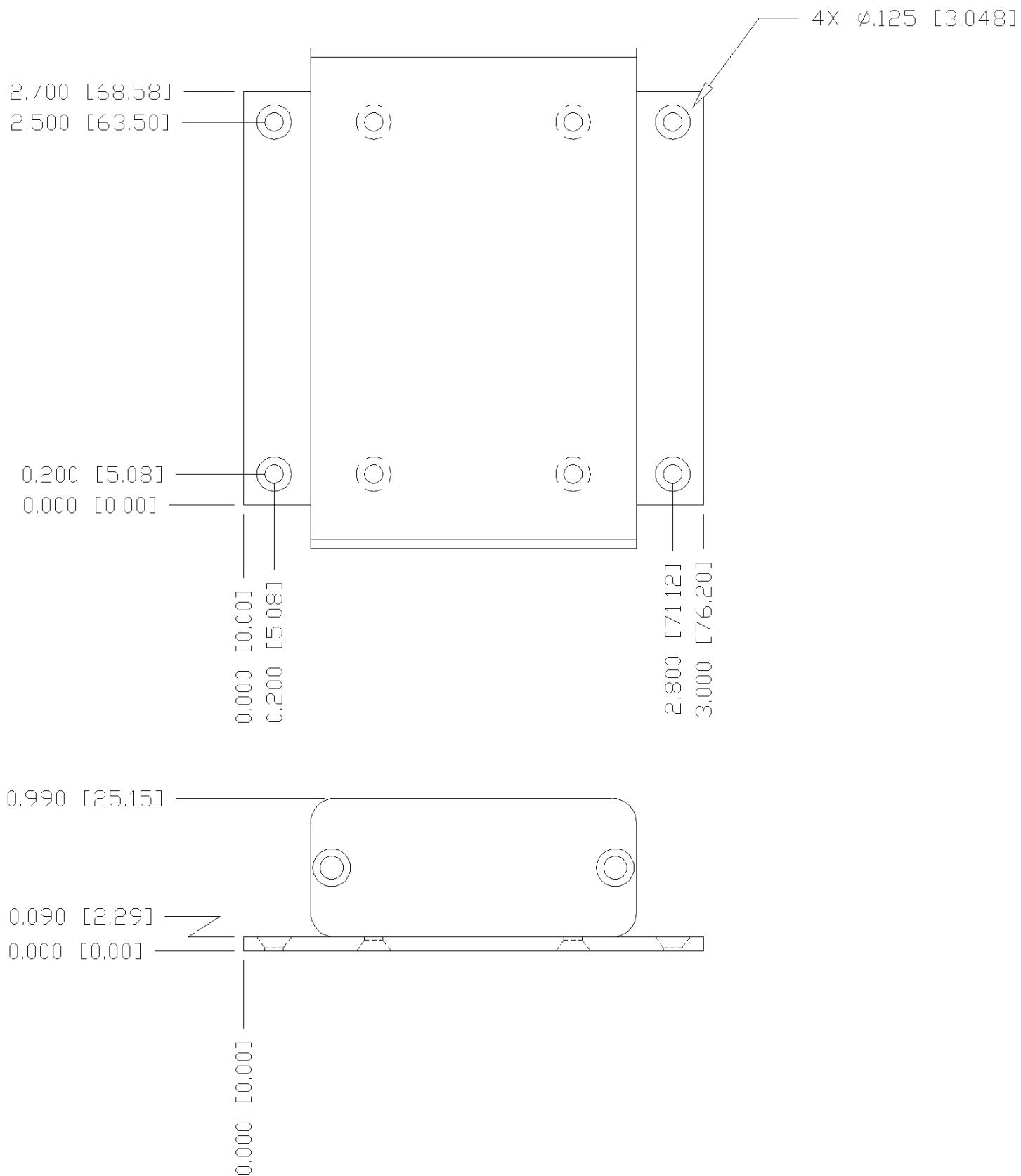


Figure 11: Enclosure Dimensions





**Figure 12: Dimensions with Mounting Flange**

## 6 Versions

- J240-1 single-channel compact pulse generator with 140 ps nominal Gaussian pulse outputs and rising-edge trigger
- J240-2 single-channel compact pulse generator/input follower with 75 ps nominal 10:90 rise/fall time
- J240-3 single-channel compact pulse generator/input follower with 75 ps nominal 10:90 rise/fall time LVDS



J240-1 Top and Signal Endplate



J240-2 Top and Signal Endplate

## 7 Customization

Consult factory for information on additional custom versions.

## ***8 Hardware Revision History***

Revision B	Sep 2014 Functionally equivalent to Revision A.
Revision A	Aug 2009 Initial PCB release

## ***9 Accessories***

J12-1:	12 volt power supply (furnished with purchase)
J27-1:	2.1 x 5.5 mm barrel to pigtail power cable
J42-1:	3' SMB to SMA cable
J44-1:	3' SMA to SMA cable
J48-1:	50 ohm SMA terminator
J53-1:	3' SMB to BNC cable
J53-2:	6" SMB to BNC cable
J732-1:	Mounting flange (furnished with purchase)