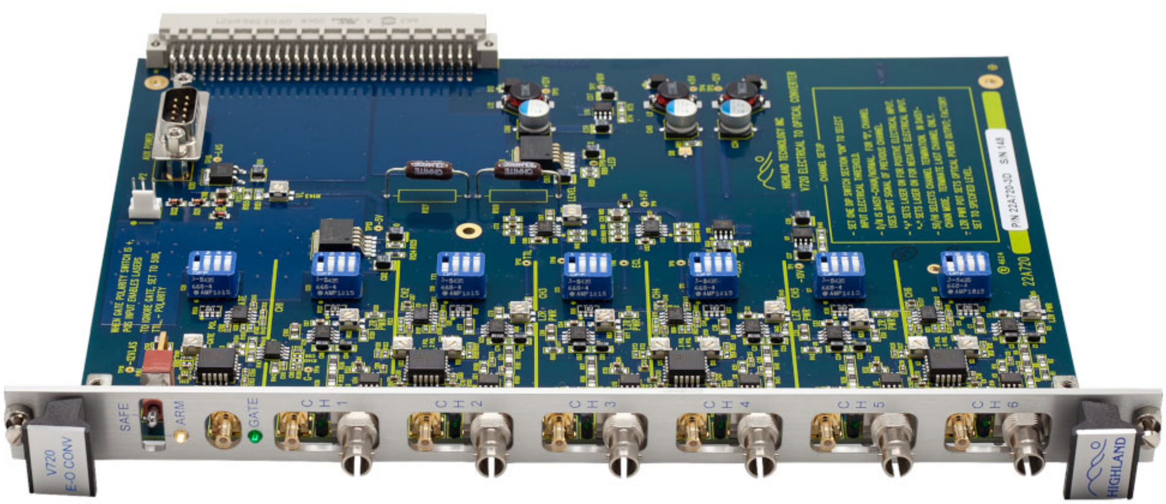
HIGHLAND TECHNOLOGY

V720
6-CHANNEL VME
ELECTRICAL-TO-OPTICAL
CONVERTER



Technical Manual

October 17, 2023

650 Potrero Avenue San Francisco, CA 94110 www.highlandtechnology.com tel: 415 551-1700 fax: 415 551-5129

Copyright © Highland Technology
650 Potrero Avenue, San Francisco, CA 94110
Phone 415-551-1700 • Fax 415-551-5129
www.highlandtechnology.com

NOTICE

HIGHLAND TECHNOLOGY, INC. PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

(Disclaimer of expressed or implied warranties in certain transactions is not allowed in some states. Therefore, the above statement may not apply to you.)

This manual may contain technical inaccuracies and/or typographical errors. Changes are periodically made to this manual which are incorporated in later editions. Highland Technology, Inc. may make changes and improvements to the product(s) and/or programs described in this publication at any time without notice.

This product has finite failure rates associated with its hardware, firmware, design, and documentation. Do not use the product in applications where a failure or defect in the instrument may result in injury, loss of life, or property damage.

IN NO EVENT WILL HIGHLAND TECHNOLOGY, INC. BE LIABLE FOR DAMAGES, INCLUDING LOST PROFITS, LOST SAVINGS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF OR INABILITY TO USE SUCH PRODUCT, EVEN IF HIGHLAND TECHNOLOGY, INC. OR AN APPROVED RESELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR FOR ANY CLAIM BY ANY OTHER PARTY.

Table of Contents

1 Introduction

The V720 is a six-channel logic-level electrical to optical converter. It is useful for sending fast digital signals over extended distances, exploiting the advantages of fiber-optic cable: low attenuation over distance, wide bandwidth, and freedom from ground loops and EMI.

Features of the V720 include:

- Six channel logic-level electrical-to-optical converter
- Accepts TTL, ECL, NIM, or arbitrary digital levels
- 850 nanometer, 1310 nanometer, or 1550 nanometer versions available
- ST or FC connectors available
- Outputs 1 milliwatt optical level into 62/125 micron fiber or 9/125 micron fiber
- Propagation delay below 2 nanoseconds
- Jitter below 12 picoseconds RMS
- Flexible input switching allows channels to share inputs for single-in/multiple-out fanout applications
- Usable in a VME rack, or standalone with available external power supply
- Compatible with Highland models V730 and J730 optical-to-electrical receivers

LASER SAFETY WARNING: **The V720 includes six 1 mW Class-1M lasers capable of C-W output. Avoid direct visual or magnified contact with these lasers.**

Turn the laser-enable switch off when removing protective caps, and always apply caps when a laser is not terminated with a fiber-optic cable connector.

ESD WARNING: **The high-speed semiconductors used in the V720 are subject to damage by electrostatic discharge. Observe standard static protection procedures in handling and using this product.**

2 Specifications

FUNCTION	Six channel logic-level electrical-to-optical converter
INPUTS	Six logic levels, one GATE input on SMB connectors Inputs accept TTL, ECL, NIM, or adjustable level Switchable input polarity and 50 Ω/ HiZ termination Maximum safe input common-mode range: -2 to +3 volts Maximum peak input differential-mode range: ±4.5 volts
PROPAGATION DELAYS	Single Channel Electrical to light out: 1.4 ns, typical Daisy chained: add 350 ps per chained channel, typical Gate to optical out: 7.5 ns, typical
OUTPUTS	Dash -1 version: Six 850-nm VCSEL lasers, ST connectors Suitable for 62/125µ multi-mode fiber Dash -3 version: Six 1310-nm FP lasers, ST connectors Suitable for 9/125µ single-mode fiber Dash -5 version: Six 1550-nm FP lasers, ST connectors Suitable for 9/125µ single-mode fiber Dash -11 version: Six 850-nm VCSEL lasers, FC connectors Suitable for 62/125µ multi-mode fiber Dash -13 version: Six 1310-nm FP lasers, FC connectors Suitable for 9/125µ single-mode fiber Dash -15 version: Six 1550-nm FP lasers, FC connectors Suitable for 9/125µ single-mode fiber
BANDWIDTH	DC to 180 MHz repetition rate
RISETIME	Optical out: < 250 ps, 10 to 90%
JITTER	< 12 ps RMS, typical (V720 + V730 combination)
OPTICAL POWER	Factory-set to 1 mW ±15% Typically adjustable < 200 µW to > 1200 µW
OPERATING	0 to 60ºC; extended MIL/COTS ranges available

TEMPERATURE	
CALIBRATION INTERVAL	One year
POWER	Standard VME supplies: + 5V: 400 mA, typical +12V: 200 mA, typical - 12V: 1400 mA, typical
CONNECTORS	Gold plated SMB logic and GATE jacks ST or FC optical output receptacles D9 male power jack
INDICATORS	LEDS: Amber ARM, green GATE, six individual green channel trigger indicators
PACKAGING	6U single-wide VME module The V720 uses only power from the VME bus and passes all grant signals

3 Theory of Operation

The block diagram of the V720 is shown in Figure 1.

3.1 E/O Circuits

There are six electrical-to-optical converter circuits, each consisting of an input comparator, polarity switch, and gated laser driver. Lasers are ST-mounted: 850-nm VCSELs (dash -1 version),1310-nm Fabry-Perots (dash -3 version), 1550-nm Fabry-Perots (dash -5 version), or, FC-mounted: 850-nm VCSELs (dash -11 version), 1310-nm Fabry-Perots (dash -13 version), 1550-nm Fabry-Perots (dash -15 version). The lasers are capable of coupling at least 1 mw into a 62/125 micron multimode fiber cable (850-nm version) or 9/125 micron singlemode fiber cable (1310-nm and 1550-nm versions).

Each channel has an SMB coaxial connector for electrical input, an ST or FC fiber output connector, and a small green LED. The LED reflects the on/off state of the input signal and laser drive; it may not light visibly at very low laser duty cycles. The LED is active even if the SAFE/ARM switch is set to disable power to the lasers.

3.2 Gate Input

A master gate input allows all lasers to be disabled under control of an external electrical input. A miniature toggle switch is also provided to allow power to be removed from all lasers.

Switches are provided to allow each electrical input to be 50 Ω terminated or left open. Switches provide for paralleling multiple inputs in a daisy-chain string to allow one input to control multiple lasers.

If the gate polarity switch is set ccw to "+", a positive voltage (above selected threshold) on the GATE connector enables lasers.

To operate the V720 with no GATE input, set the gate threshold to TTL, termination 50 Ω, and gate polarity to "-".

The green GATE LED will illuminate when lasers are enabled.

3.3 Mechanical Layout

Figure 2 is a mechanical layout drawing of the V720, showing switch and connector locations and standalone-mode mounting holes.

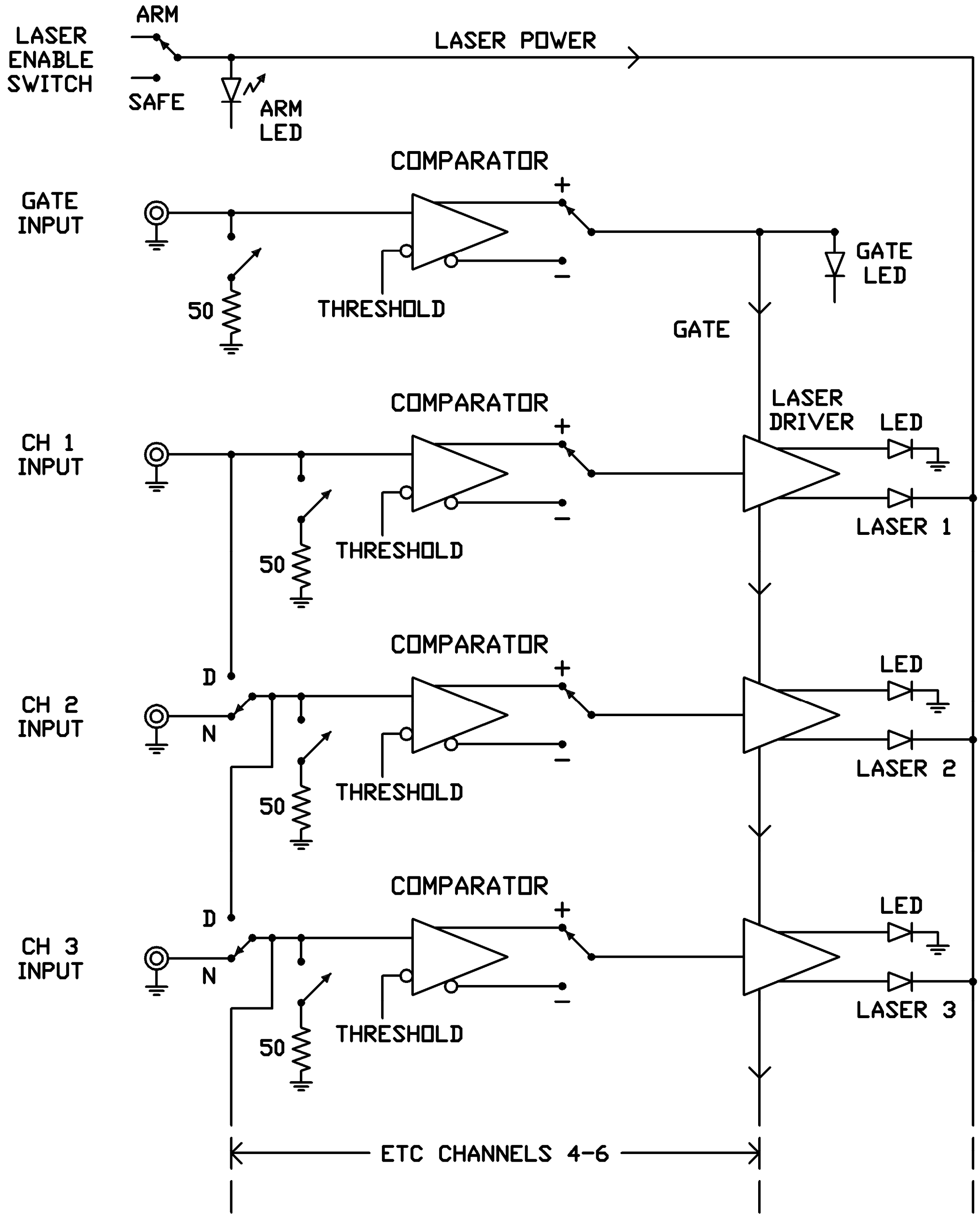


Figure 1. V720 Block Diagram

4 Installation

4.1 Switch Settings

Before installing the V720 in a VME crate, various on-board switches should be set.

Two kinds of switches are used, DIP and rotary.

Four-position dip switches are used to select input threshold levels. To select a level, set only one switch section ON by pressing the side of the switch near the labeled logic level. Use a toothpick or paperclip, NOT a pen or pencil.

Option switches appear similar to single-turn trimpots. To assert a setting, rotate the switch with a small screwdriver so that the slot in the switch points to the marked setting.

4.2 Channel Settings

Each electrical-to-optical channel has four switches, one DIP and three rotary, except that Channel 1 omits the daisy-chain switch.

4.2.1 Input Logic Level Switch

The GATE input and each of the six E/O channels has a 4-section DIP switch that selects the threshold for its electrical input. The switch sections are labeled on the circuit board: TTL ECL NIM and ADJ. Set only one of these switch sections ON to select the desired logic level. Voltage thresholds are:

TTL	+1.40V
ECL	-1.35V
NIM	-0.40V
ADJ	adjustable, -2.5 to +2.5 volts

A common ADJ trimpot and associated test point are provided for setting the ADJ threshold level.

4.2.2 Input Termination

The GATE input and each of the six E/O channels has a termination select switch. If the switch is set to the "50" position (counter-clockwise), the input is terminated by a 50 Ω resistor to ground. If rotated clockwise to the HiZ position, the input is unterminated and will have an input impedance above 20 kΩ.

If an input is driven by a source-terminated signal, destination termination may not be needed.

If multiple channels are daisy-chained, only the last channel in a chain is generally terminated.

4.2.3 Normal/Daisy-chain

All channels except Channel 1 have a daisy-chain control switch. In daisy-chain mode, an input is applied to channel "N" and subsequent channels (N+1, N+2...) are set to daisy-chain mode, with only the last channel in the chain terminated. An electrical input applied to channel "N" will operate the lasers on all channels in the chain, with an added delay of about 350 picoseconds per channel.

Any number of channels from 2 to 6 may be chained, and multiple chains are allowed. To set a channel as a daisy-chain slave, rotate its selector switch to the "D" (cw) position. The first channel in a chain, or any channel not chained, should be set to the "N" (normal, ccw) switch position.

4.2.4 Channel Polarity

Each channel and the GATE input has a dedicated polarity switch.

E/O channels will activate their lasers when an electrically positive input is received and their polarity switch is set to the "+" position. If the switch is set to "-", an electrically low input produces light. Note that NIM levels are generally active-low, so a NIM channel would typically be used in "-" mode.

The GATE circuit will enable all lasers if its input is electrically positive (ie, above the threshold setting) and its polarity switch is "+". In the "-" setting, this sense is reversed, and a low input enables lasers.

4.2.5 Output Power Adjustment

Each optical output has a laser power setting trimpot, labeled "LZR". It is factory set for 1 mW power coupled into a 62/125 micron multimode fiber (dash -1, -11 versions) or 9/125 micron singlemode fiber (dash -3, -5, -13, -15 versions). Power is adjustable if a different power level is desired or to reduce laser mode jumps and associated jitter in systems with long cables and high back-reflection levels.

4.2.6 Default Settings

The factory default settings are:

All channel polarity switches "+", active-high inputs.

All channel termination switches ccw, "50", terminated.

All normal/daisy-chain switches ccw, "N", normal.

All input level DIP switches set to TTL.

The GATE polarity is set to "-", which enables all lasers with no signal connected to the GATE input.

4.3 Laser Power Switch

A front-panel switch allows laser power to be disabled. If the switch is moved to the leftward “ARM” position, lasers are enabled and the yellow ARM LED illuminates; in the rightward “SAFE” position, all laser power is removed.

4.4 Installation in VME Crate

The V720 may be installed in any slot in a VME crate. It uses only standard VME power supplies, and does not interface to the VME data lines except to pass all bus grant signals.

Turn crate power off before installing or removing the V720. The front-panel hold-down screws must be tight before applying crate power.

4.5 Non-VME Use

The V720 may be used standalone, without a VME crate. Mounting holes are provided for securing the module to a grounded metal surface, and a DB9 male connector is provided on the board for applying DC power.

See Figure 2 for mounting dimensions.

DB9 male connector (P2) pinout is:

Pin	Function
1	GROUND
3	-12 V
4	+12 V
5	+12 V
6	GROUND
7	+5 V
8	+5 V
9	GROUND

The redundant +5 V and GROUND pins may be used to reduce cabling voltage drops on long runs. The module mounting holes are connected to GROUND, and it is recommended that these holes be securely fastened to an earth-grounded metal mounting surface.

The Highland Model J192 Power Supply is available for direct connection to P2. This allows standalone use, or may be used to make on-board adjustments outside of the VME crate.

5 Typical Performance

The following figures are oscilloscope waveforms depicting typical V720 performance. The laser signals were analyzed using a BCP model 310B Si APD detector and a Tektronix 11802 sampling scope with SD-22 (12 GHz) sampling head. Pulses were generated with a Highland Model P400 Benchtop Digital Delay and Pulse Generator. Jitter was measured using the 11802 calibration pulse as the V720 electrical input.

Figure 3 shows a typical optical output pulse (dash -1 version). Note that pulses have some aberrations due to mode shifts in the laser and back-reflections within the fiber system. For best timing, a detector should be fast and discriminate on the light pulse rising edge.

Figures 8 – 10 demonstrate a method of eliminating pre falling-edge overshoot that can manifest on optical outputs before the laser-On to laser-OFF transition. Ordinarily a transient optical overshoot won't affect the normal functioning of a downstream optical-to-electrical link, as the receiver's threshold is typically set below the light source's pulse plateau. The following procedure explains how to minimize V720 laser output overshoot for critical applications:

1.) Rotate the relevant V720 channel polarity switch to the "-" position.

2.) Invert the polarity of the electrical trigger source for the relevant channel(s). The overall effect is a double negative, maintaining the overall V720 input / output Boolean correspondence.

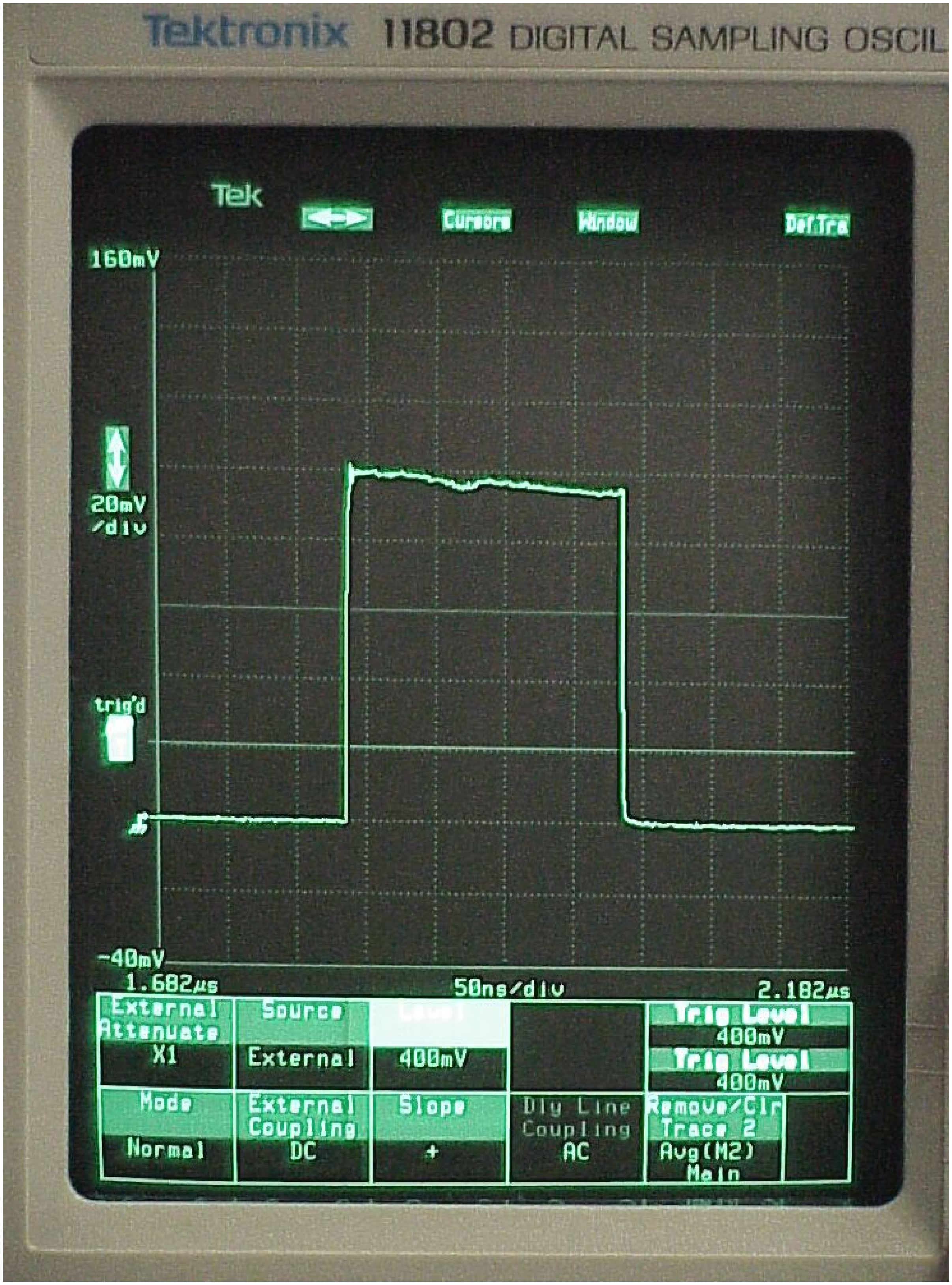


Figure 3. Typical Optical Output Pulse (dash -1 version)

Figure 4 shows typical optical pulse risetime. Displayed risetime is limited by the silicon avalanche diode detector, and is probably below 250 picoseconds.

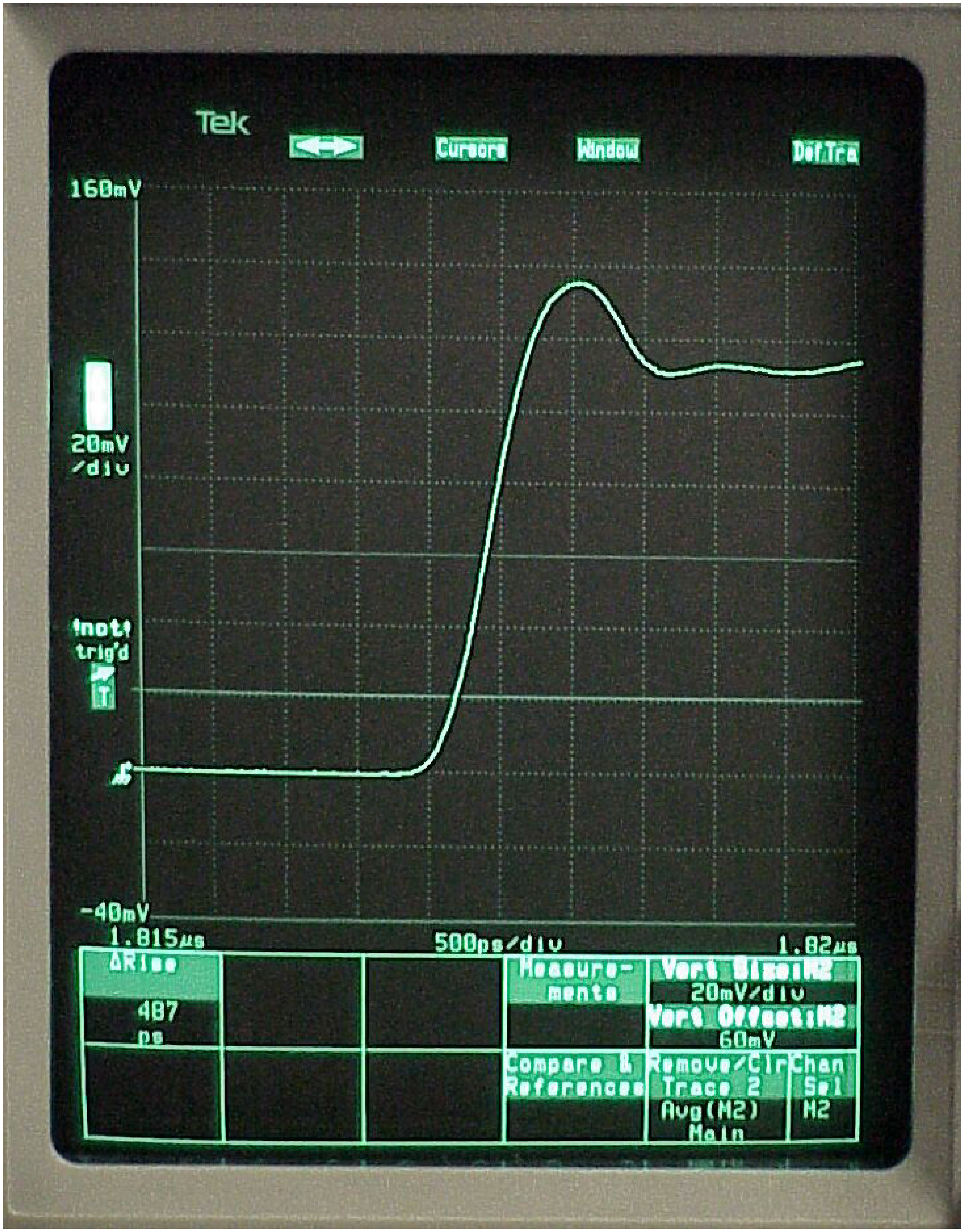


Figure 4. Typical Optical Pulse Risetime (dash -1 version)

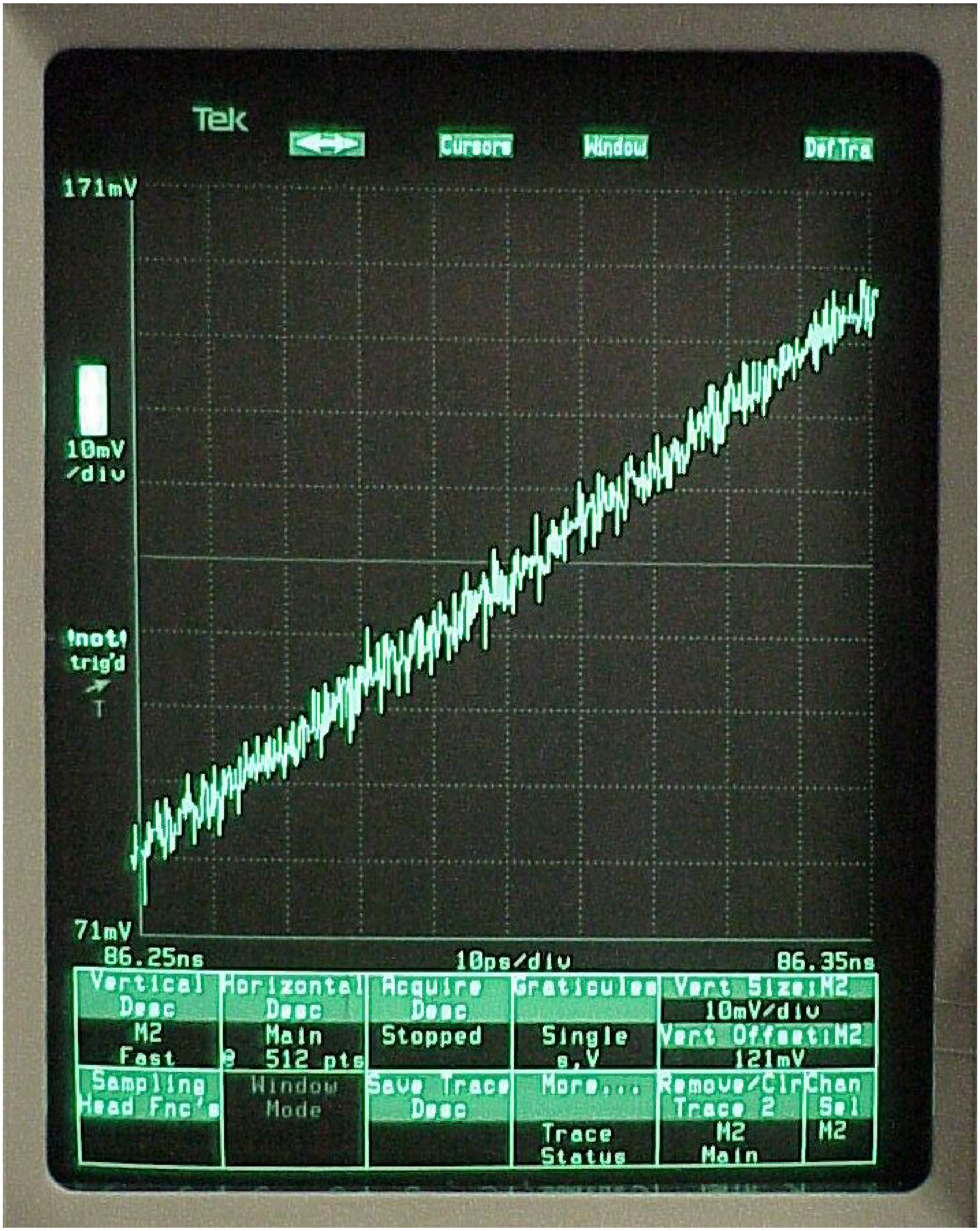


Figure 5. Rising-Edge Jitter (dash -1 version)

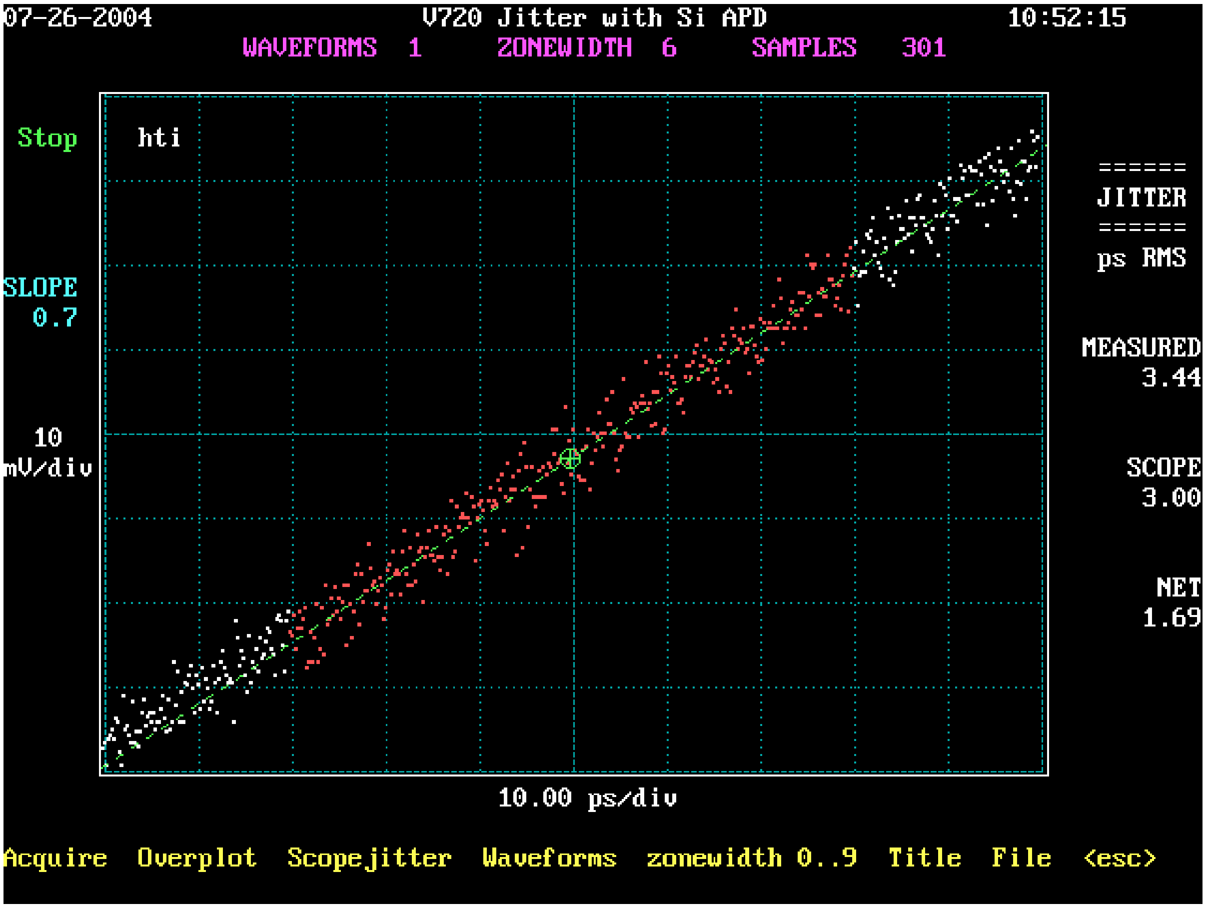


Figure 6. RMS Jitter Analysis Using the JAX.EXE Program (dash -1 version)

Figure 7 is the laser diffusion pattern at the ST connector exit. Because the laser has a ball lens with a focal point within the ST housing, escaping light is wide-angle and diffuse.

Figure 7. Laser Diffusion Pattern at the ST Connector Exit (dash -1 version)

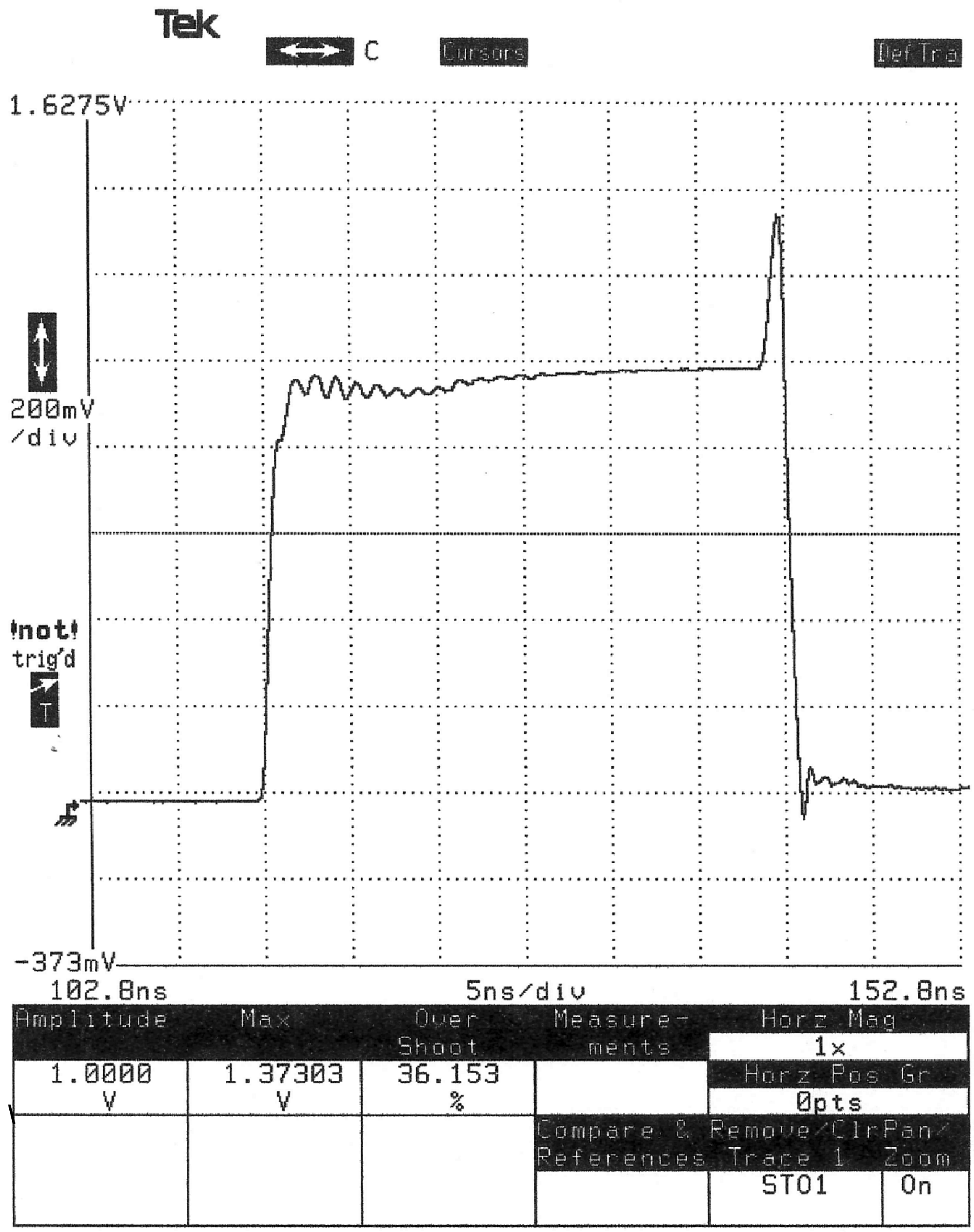


Figure 8. Pre falling-edge laser output overshoot (dash -1 version)

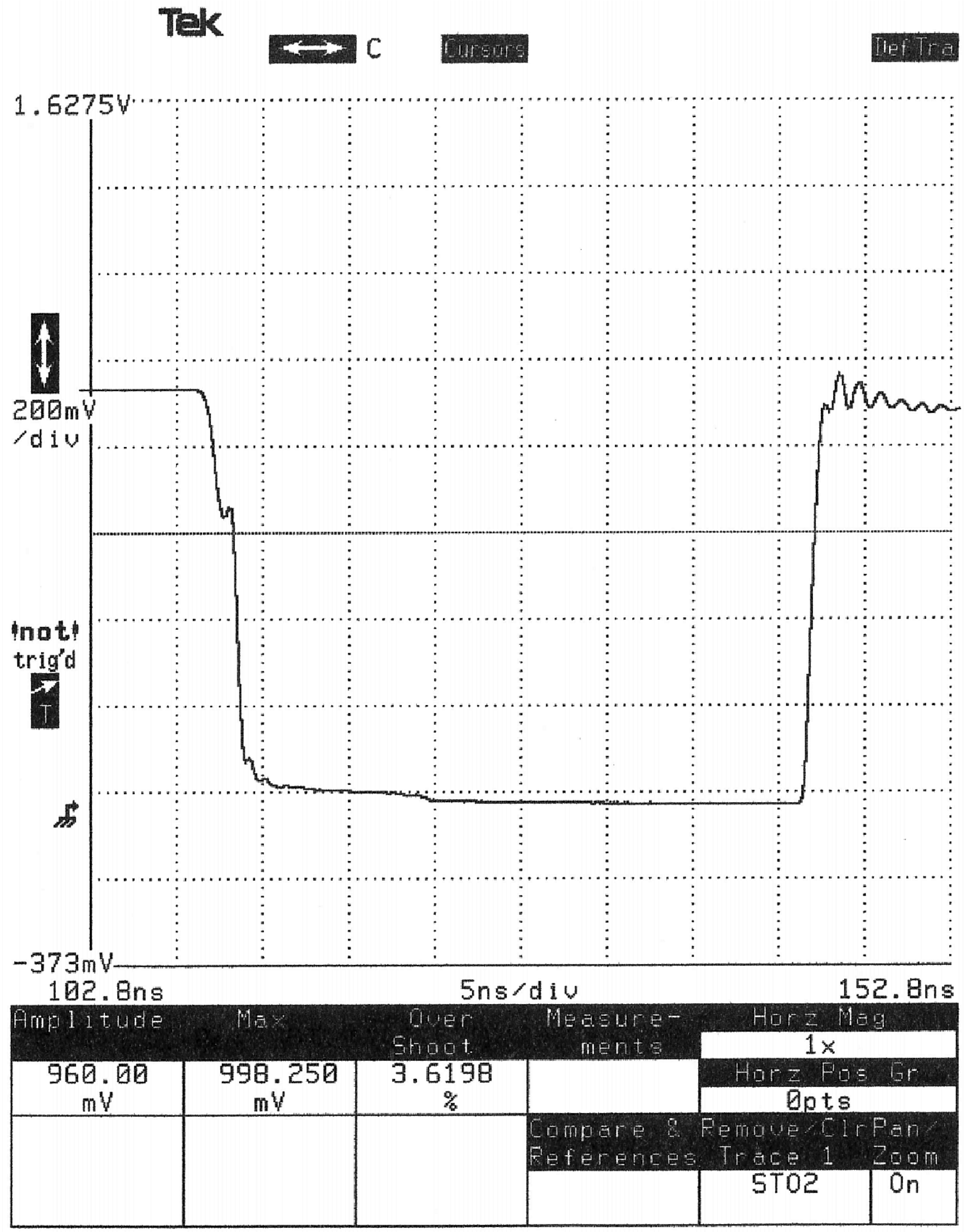


Figure 9. Laser output with "-" polarity (POL) setting (dash -1 version)

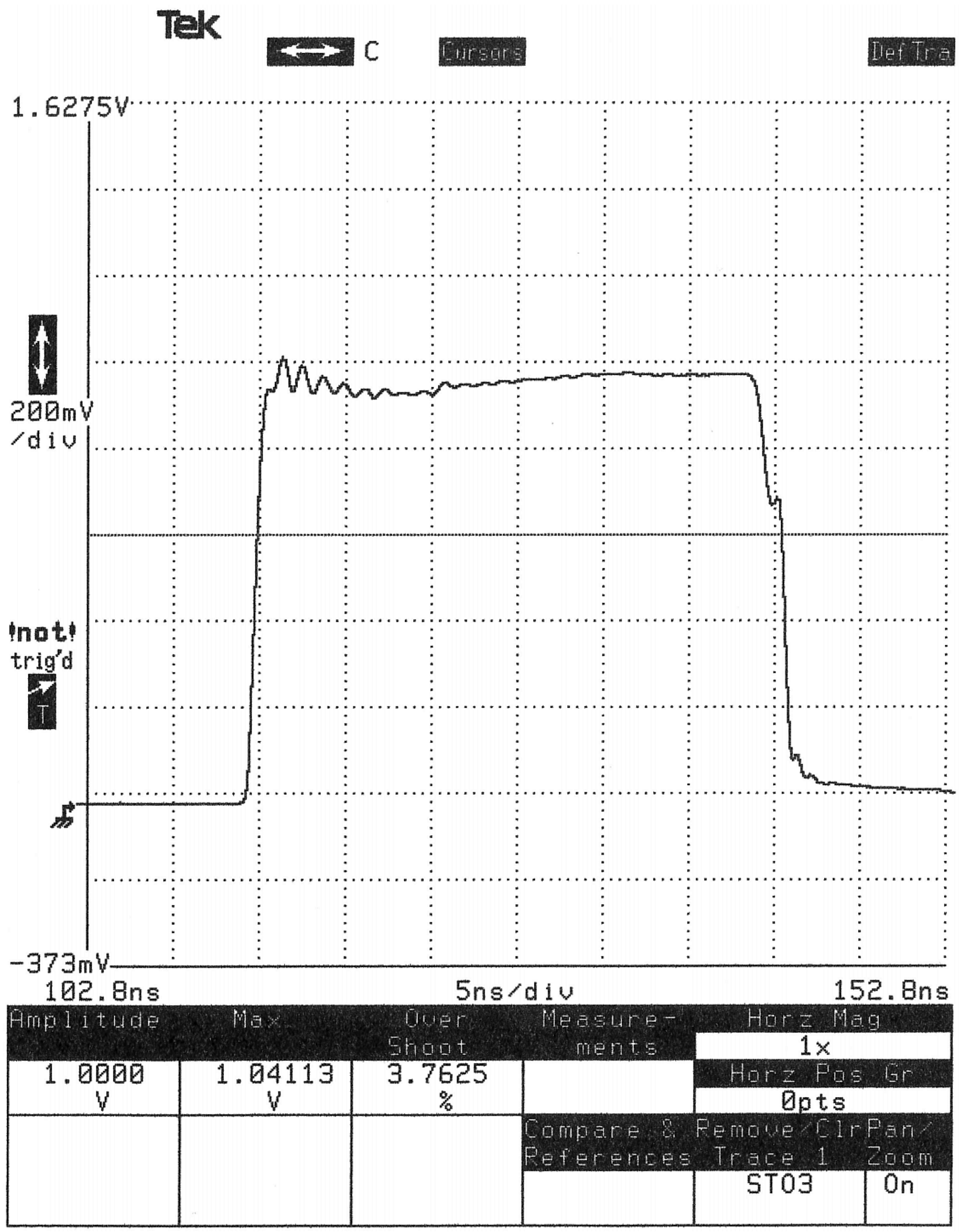


Figure 10. Non-inverted laser output with "-" polarity (POL) switch setting and inverted trigger source polarity (dash -1 version)

6 Fiber Notes

The V720 modules are available equipped with 850-nm VCSEL (dash -1, -11), 1310-nm Fabry-Perot (dash -3, -13), or 1550-nm Fabry-Perot (dash -5, -15) laser sources. 850-nm versions are designed to use standard 62/125 um graded-index multimode glass fiber cables with either ST connectors (dash -1) or FC connectors (dash -11). 1310-nm and 1550-nm versions are calibrated using graded-index singlemode glass fiber cables with ST connectors (dash -3, -5) or FC connectors (dash -13, -15).

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 lodge within the laser/detector housings and produce long-term degradation.

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

Multimode fiber propagation delay is typically about 0.66 C, or about
5 nanoseconds/meter, 1.5 nanoseconds per foot. Prop delay varies with temperature and is roughly +15 PPM per degree C but may vary considerably depending on the fiber and jacketing.

Communications-grade multimode fiber will have losses in the vicinity of 3 dB/km at 850-nm. Singlemode fiber losses are less, about 0.5 dB/km at 1310-nm and 0.25 dB/km at 1550-nm. A connector pair may add 1 dB loss. The V730 receive threshold can be reduced to accommodate fiber loss or splitters, at the cost of additional jitter.

7 Versions

V720-1: 850 nm 6-channel VME electrical-to-optical converter with ST connectorization

V720-3: 1310 nm 6-channel VME electrical-to-optical converter with ST connectorization

V720-5: 1550 nm 6-channel VME electrical-to-optical converter with ST connectorization

V720-11: 850 nm 6-channel VME electrical-to-optical converter with FC connectorization

V720-13: 1310 nm 6-channel VME electrical-to-optical converter with FC connectorization

V720-15: 1550 nm 6-channel VME electrical-to-optical converter with FC connectorization

8 Customization

Consult factory for information about additional custom versions.

9 Hardware Revision History

Revision D	May 2011
Revision C	Jul 2008
Revision B	Apr 2007
Revision A	Apr 2003 Initial PCB release

10 Accessories

J41-1:	3' SMB to SMB cable
J41-2:	6" SMB to SMB cable
J42-1:	3' SMB to SMA cable
J53-1:	3' SMB to BNC cable
J53-2:	6" SMB to BNC cable
J192-1:	stand-alone power supply