Instruction Manual

Model 106H/155H/158H
Optical Module

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WARRANTY

Berkeley Nucleonics Corporation warrants all instruments, including component parts, to be free from defects in material and workmanship, under normal use and service for a period of one year. If repairs are required during the warranty period, contact the factory for component replacement or shipping instructions. Include serial number of the instrument. This warranty is void if the unit is repaired or altered by others than those authorized by Berkeley Nucleonics Corporation.

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1064 NM OPTICAL MODULE

MODEL 106H

Graphic (Model 106H)

The Model 106H is one of a series of output plug-in modules that provide electrical and optical pulses when installed in the Model 6040 mainframe.

This particular module provides optical pulses of 1064 nm wavelength at peak levels to 50 mW at rates to 2 kHz.

SECTION 1

SPECIFICATIONS

MODEL 106H CHARACTERISTICS

Timing Characteristics

Rep Rate:	0.01 Hz - 2 kHz.
Delay:	0 - 640 s (Single Pulse operation), 500 μs - 640 s (Double Pulse operation).
Width:	Four fixed output widths, 10 ns, 15 ns, 20 ns and 25 ns (contact factory for custom widths).

Output Characteristics

LIGHT OUT

Source:	Laser diode.
Wavelength:	1064 nm.
Spectral Width:	4 nm typical, 10 nm max.
Power Level:	50 mW max., 5 mW min. (Peak level). Baseline level is fixed at zero.
Power Level Resolution:	0.2 mW.
Extinction Ratio:	∞
Pulse Adjustment Range:	(Max. pulse size: min. pulse size) 10 dB,
Rise Time:	3ns.
Fall Time:	5ns.
Insertion Delay:	20 ns typical (between mainframe TRIG OUT and LIGHT OUT; see Figure 1-1).
Jitter:	100 ps rms (between mainframe TRIG OUT and LIGHT OUT).
Connector:	SMA 100/140 um glass fiber.

PULSE OUT

Amplitude:	+5 V into 50 ohms.
Transition Times:	1.5 ns.
Insertion Delay:	10 ns typical (between mainframe TRIG OUT and module PULSE OUT; see Figure 1-1).

SPECIFICATIONS

Modes

The Model 106H can operate under the following mainframe Mode.

PULSE	Conventional pulse generator operation with rate, delay, width (four width selections) and single/double pulse operation controlled by the 6040 mainframe.

Module Memory Control

Nonvolatile memory (RAM and ROM) stores front panel settings and determines the allowable signals, modes and units.

STORAGE:	Ten complete settings can be saved in module memory and retrieved by the mainframe. The setting in memory 0 is automatically transferred into the mainframe upon insertion of the module,

General

DIMENSIONS:	3.75" W × 4.9" H × 10" D (95 mm × 124 mm × 254 mm).
WEIGHT:	2 lbs, net (0.9 kg); 7 lbs, shipping (3.2 kg).
AMBIENT TEMPERATURE:	0° - 50° C operating temperature (32° -112° F). Specifications apply 10° - 40° C (50° -104° F).

SECTION 2

OPERATING INFORMATION

FEATURES

The Model 106H plug-in module provides a 1064 nm laser diode optical output source for the Model 6040 Universal Pulse Generator, The 106H operates only in the Pulse Mode of the 6040 mainframe. It supplies flat-topped pulses with fast rise and fall times and adjustable Peak level. Baseline level is fixed at zero (no light output).

Pulse timing is generated by the mainframe. The pulse width may be chosen from four fixed selections: 10 ns, 15 ns, 20 ns, or 25 ns (contact the factory for alternate width choices). A delay can be specified with respect to an internal trigger occurring at a selected repetition rate or with respect to an externally supplied trigger signal (TRIG IN). In addition. Single Cycle operation allows the user to trigger the instrument manually, using a pushbutton (or using remote programming). In each case a trigger out signal (TRIG OUT) is provided by the 6040 for reference (see Figure 1-1). Double Pulse operation, producing both an initial and delayed pulse out of the same jack, may be selected for any trigger choice.

For all of these timing options both optical and electrical outputs are provided. The module PULSE OUT jack provides electrical pulses coincident with the optical output (LIGHT OUT). These +5 V (into 50 ohm) pulses have the same width as the optical pulses produced (even when the module is provided with alternate width options). The mainframe PULSE OUT jack also supplies +5 V electrical pulses that correspond to the optical output pulses, provided the standard width selections (10 ns, 15 ns, 20 ns, or 25 ns) are being used. Refer to Figure 1-1 for timing diagrams of these outputs.

For more detailed information on the characteristics of the Pulse Mode and hov to control the module from the mainframe, see the Specifications section and the 6040 manual.

General

POWER UP

When power is applied to the 6040 mainframe with a 106H module installed, the instrument settings from the module's memory 0 are activated. The mainframe automatically checks what type of plug-in module is in place and loads the appropriate parameters. The LCD, after shoving the mainframe's software version number and performing a memory check, will display "106H Ver. x.x" where "x.x" is the version number of the module.

Module Installation

The module must be installed with mainframe power off. A module can be damaged or have its memory corrupted if inserted or removed from the mainframe with the power on. To install the module, simply slide it in and tighten the mount screw knob.

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Safety Precautions

Laser light emitted from the end of a connected light fiber is invisible. Fibers should be terminated in a system which will not allow human exposure to this radiation. Do not stare into the beam or into a beam from a reflecting surface. Use of controls or adjustments or performance procedures other than those specified herein may result in hazardous exposure. Safety labels attached to the module are shown in Figure 2-1.

Always keep the LIGHT OUT connector covered with the dust cap when a fiber is not attached in order to avoid hazardous exposure and to keep the connector as clean as possible.

Warm Up Requirements

No warm up period, other than that necessary for the mainframe itself, is required.

TROUBLESHOOTING

Follow the procedure in the Troubleshooting section of the 6040 manual. Make sure that the module is seated correctly in the mainframe. If the module's memory has been corrupted, a cold boot will put the module's default settings into effect (as described in the Cold Boot paragraph in the 6040 manual). Table 2-1 gives the default settings for the 106H module.

The Quick Test procedure for the mainframe may be applied to the 106H by selecting the Pulse Mode and following the test sequence using the module's LIGHT OUT connector and an optical detector in place of the mainframe's PULSE OUT.

Front Panel Descriptions

LED INDICATOR

The front panel LASER ACTIVE LED turns on when the instrument is in a state that can produce a light output.

CONNECTORS

Two connectors appear on the 106H module front panel.

LIGHT OUT provides the optical output from the module. A100/140 μm fiber with an SMA connector is required (the unit can be configured for other connectors; consult the factory for details). To keep dust out of the connector when a fiber is not attached, a dust cap is provided.

OPERATING INFORMATION

Table 2-1. 106H Module Default Settings.

MODE:	Pulse
TRIG:	Single Cycle (with other values set as follows) Internal Trigger Rate = 1 kHz. External Trigger Threshold = 0.00 V Trigger Slope +
TIMING:	Delay = 1 μs Width = "1" Single Pulse
LEVEL:	Peak = 50.0mW
GPIB/RS232:	GPIB Address = 6 Baud Rate = 1200 Full Duplex Remote Enabled

PULSE OUT provides an electrical output from the module corresponding to the optical output from LIGHT OUT.
When LIGHT OUT is active, PULSE OUT goes to +5 V (into 50 ohm); when LIGHT OUT is off, PULSE OUT is at zero volts (see Figure 1-1).

Rear Panel Description

The rear panel of the 106H module has a mounting screw (for installation into the mainframe), one 40-pin edge connector, and one SMA connector.

The 40-pin connector allows the 6040 mainframe to control and communicate with the module and also supplies the power to the module.

The SMA (snap-on type) connector receives the high speed pulse generator DRIVE signal from the mainframe, This signal is an ECL version of the mainframe's front panel PULSE OUT.

OPERATING INFORMATION

Mainframe Operation

This section presents information on how to operate the Model 6040 Universal Pulse Generator with the Model 106H optical module installed. Only the details that are specific to the module are described. For an overall description of how to use the mainframe with plug-in modules, please refer to the 6040 manual.

Front Panel Programming

When operating the instrument from the front panel, certain control keys have module dependent action, as indicated in the 6040 manual. The aspects of these keys, and the menus they control, that are not general to the mainframe will be listed here.

An overall chart of the menu keys, showing which menu selections are available for this module, is given in Table 2-2.

Table 2-2. Menu Keys for the 106H Module

MODE Menu
- Pulse

TRIG Menu
- Single Cycle
- Internal Trigger (and Rate)
- External Trigger (and Threshold)
- External Trigger Slope

TIMING Menu
- Delay
- Width
- Single/Double Pulse

LEVEL Menu
- Peak

{MODE} The Mode menu for the 106H has only the Pulse Mode available In this Mode, flat-topped pulses of specified Width, Peak level and Delay are produced.

{TRIG} The Trigger source and parameter menu has five menu items Single Cycle, Internal Trigger (and Rate), External Trigger (and Threshold), and External Trigger Slope.

Internal Trigger Rate is adjustable from 0.01 Hz to 2 kHz.

External Trigger allows the instrument to accept user-supplied triggers at rates from zero to 2 kHz. For external triggers exceeding 2 kHz, the instrument will internally limit the rate and will supply output pulses (and TRIG OUT pulses) at a 2 kHz rate. The External Trigger Threshold is adjustable over the 6040's entire range.

{TIMING} The Timing parameter menu has three selections: Single/Double Pulse. Delay, Width, a Single/Double Pulse.

Delay determines the time duration between the mainframe TRIG OUT pulse and the PULSE OUT and LIGHT OUT pulses (see Figure 1-1).

In Single Pulse operation, Delay may be specified over the entire timing range of the mainframe, from zero delay to a delay of 640 seconds. The time interval between the leading edge of the output pulse (mainframe PULSE OUT and module PULSE OUT or LIGHT OUT) and the TRIG OUT pulse will be equal to Delay plus the insertion delay.

In Double Pulse operation, Delay may range from 500 us to 640 seconds. Two identical pulses are provided from each output (mainframe PULSE OUT, module PULSE OUT and LIGHT OUT). The leading edge of the initial pulse, which occurs at the zero delay position, and the leading edge of the second pulse are separated by the selected Delay.

Width allows the user to select one of four fixed pulse widths for the output: either 10 ns, 15 ns, 20 ns or 25 ns (or from an alternate set of widths ordered from the factory). The desired width is selected by pressing 1, 2, 3, or 4 (corresponding to 10 ns, 15 ns, 20 ns or 25 ns respectively) followed by the ENTER or EXEC key (if alternate widths have been supplied, 1, 2, 3, and 4 correspond in order to increasing pulse widths). Pressing 0, followed by ENTER or EXEC, will result in zero output from the LIGHT OUT jack, the module PULSE OUT jack, and the mainframe PULSE OUT jack; the mainframe, however, will continue to produce TRIG OUT pulses.

{LEVEL} The Level parameter menu for the 106H has only the Peak Level available.

Peak Level selects the output power level for the optical pulses. This level may be adjusted between 5 mW and 50 mW in 0.2 mW steps. No light output is present between pulses.

{UNITS} This key is not used with the106H module (and has no effect).

FUNCTION KEYS {A}, {B}, {C} These keys are not used with the 106H module (and have no effect).

Remote Programming

The remote programming commands that are specific to this module correspond to the module dependent front panel commands, as described in the previous section. Consult the 6040 manual and the above section for details on controlling the instrument with remote programming. The Module Status command, the only command that is specific to the module, is not used with the 106H and will return an undefined value.

SECTION 3

THEORY OF OPERATION

General

CIRCUIT DESCRIPTION

Module Interface

The module is controlled by the mainframe via signals received on the 40-pin connector, P8 (see Table 3-D. Signals QADO-QAD7 are multiplexed with data and address. QA8-QA12 are no multiplexed address lines.

Table 3-1. PS, Module Interface Signals

Signals(s)	Pin#	Description
QAD0-QAD7	8-1	8 multiplexed data/address line
QA8-QA12	16-12	5 address lines
QRD	11	Module read
QWR	10	Module write
QALE	9	Address Latch Enable (demux QAD0-QAD7)
PLUGIN	18	Enables module interface circuits
RESET	17	System reset
MOD DIS	19	Disables module
+5 V	26, 28	+5 V supply
-5.2 V	34, 36	-5.2 V supply
+12 V	37, 39	+12 V supply
-12 V	38, 40	-12 V supply
THE	27	+3 V supply
GND	35, 29-33	Ground
	20-25	Unused

QALE, a quiet bus signal, is used to latch the lower eight address lines, LA0-LA7 (QADO-QAD7), into the octal latch, Z4. These are distributed to *26,* a nonvolatile RAM, to Z5, a 2764 EPROM, and to Z8, an 8255 Parallel Peripheral Interface 1C (PPI). Table 3-2 gives the memory map for the module.

Z6, the nonvolatile RAM, is used for saving panel settings using the STORE and RECALL keys.

Z5, the EPROM, contains the module ID. and parameter boundaries used by the microprocessor to set up the operation of the system (module and mainframe).

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Z8, the PPI, is used to control the output level and width selection. PA0-PA7 control Z7 (an 8-bit DAC) which sets the power level of the light pulse. Port B is not used. PC0-PC3 are used to select one of four different preset widths, and PC4 is a software disable.

QRD and QWR control the direction of data flow to and from the mainframe, respectively.

RESET is used at power up to initialize ZS, the 8255 PPI.

MOD DIS allows the user to disable the output of the plug-in via the mainframe rear panel MODULE DISABLE connector.

Laser Drivers

Z7 is an 8-bit DAC whose full-scale current is set at 2 mA by R9. Z13-1 produces a voltage swing of 7,5 V as the programming to Z7 varies from zero to full scale. R91, via R92, biases Z13-1 to a negative voltage (approximately -2.5 V). R4 provides an adjustable gain (to Z13-7) for the entire range of voltages at Z13-1. R93 provides a second adjustable gain; however, this path only operates on the negative levels from Z13-1. The net affect is that the gain is in creased as the voltage at Z1 3-1 goes more negative than ground, R94 provides a third gain adjustment that operates on the positive levels from Z13-1

R5 is used to set the output of Z13-7 at the desired (negative) level. The voltage at Z13-7 is applied to the gates of a pair of FETs, Q13 and OH. These FETs function as voltage variable resistors that shunt current around the laser as required to control the optical output. The triple slope gain characteristic provided by CR1 and CR7 is required to linearize the control of the optical output power.

The drive current for the laser (LD1-5, LD1-9) is generated by one of four high current avalanche pulse generators. One of these is shown as Q12A. A common high voltage supply serves all four circuits, only one of which is used at a time. The circuits are identical except for the length of the pulse-forming "clipping" lines, CL2A and CL3A. The output pulse width is selected by applying power and triggers to the appropriate generator.

A negative-going current pulse of approximately 10 amps appears at the collector of Q12A. Its width is twice the length of the delay line, CL2. A small trigger transformer couples a short (10 ns) trigger from Q16A to Q12A and determines the trigger width.

Z9 gates steer the triggers to the desired trigger transistor and also enable one of the high voltage opto-isolators which in turn applies the -350 V to the appropriate avalanche transistor. "1 of 4" enable logic is provided by Z8.

THEORY OF OPERATION

The CL2A and CL3A clipping lines are normally open and store very little energy. Even if they became shorted, the current is limited by R40 to a level well below the laser's maximum rating. As an additional precaution, the high voltage supply itself (PSD is only capable of 2 mA.

Q7 receives the DRIVE signal from the mainframe, amplifies and translates it to CMOS levels for Z9 and Z1 1. Z1 1 provides some disable logic that allows either an internal disable (from the bus decoders) or MOD DIS (from the rear panel connector) to inhibit the generation of triggers and force the amplitude to zero by turning the amplitude control transistors on. When no inhibiting is present, the LASER ACTIVE light is illuminated.

Q1 generates a pulse whose width is approximately equal to that of the optical pulse and whose amplitude is +5 V into 50 ohms.

Table 3-2. Plug-In Module Memory Map

Memory Range	
C000-C777	Z5, I.D.ROM
C800-CFFF	Unused
D000-D7FF	Z6, Nonvolatile RAM
D800-DFFF	I/O
D800-D9FF	Z8,82C55 PPI
D800	Port A (Peak level)
D801	Port B (unused)
D802	Port C (Width Select, Disable)
D803	Control
DA00-DFFF	Unused

SECTION 4

MAINTENANCE AND CALIBRATION

MAINTENANCE

Light Output Connector

For satisfactory performance, proper care in the use of the optical components is necessary. There must be no contamination to interfere with the passage of light through the fiber end connections and the bulkhead connector. The following procedures should be observed.

1. Avoid connecting and disconnecting the optical cable as much as possible.

2. Keep the connectors absolutely clean.

3. Keep the output bulkhead connector and the user's connector capped when not in use.

CALIBRATION

General

The Model 106H is an optical pulse generator whose output is controlled by the 6040 mainframe. Digital data is applied to a DAC, Z7, whose full scale current is set to 2 mA by R9, This produces a 7.5 V swing at Z13-1. This point (Z13-D will be referred to as "TP-A" in what follows. The second half of Z13 generates a voltage for the gates of the control FETs, Z13 and Z14. The relation between this gate voltage and the actual optical power out is quite nonlinear. The goal of this calibration procedure is to introduce the appropriate compensating nonlinearities so that the actual output power and displayed power are in agreement.

It is recommended that the calibration of the 106H module be verified every 12 months. The instrument requires no warm up period exceeding that of the 6040, for which ten minutes is suggested.

Equipment Required

- Optical detector calibrated at 1064 nm (EG&G FFD-100 or equivalent).

- 100 MHz bandwidth oscilloscope (Tektronix 485 or equivalent). (Steps 7 through 14 may also be performed using the BNC 6100 Optical Power Meter.)

- 3 1/2 digit (or better) DVM.

MAINTENANCE AND CALIBRATION

PROCEDURE

WARNING: *Do not attempt to adjust R3. This control has been factory set for accurate wavelength. If the laser is defective, return the module to the factory.*

1. Set the displayed Peak level to 15 mW.
2. Select Internal Trigger with a 2 kHz rate.
3. Set the Width to 25 ns (width #4),
4. Set TP-A (Z13-l) to- 0.3V with R91.
5. Set the measured optical power to 15 mW with R5 (be sure all fiber optic connections are clean).
6. Set the displayed Peak level to 30 mW. Record the measured optical power.
7. Set the displayed Peak level to 35 mW. Record the measured optical power.
8. Repeat steps 6 and 7 while adjusting R4 until the measured change is 5 mW.
9. Set the displayed Peak level to 5 mW. Record the measured optical power.
10. Set the displayed a Peak level to 10 mW, Record the measured optical power.
11. Repeat steps 9 and 10 while adjusting R93 until the measured change is 5 mW.
12. Set the displayed Peak level to 45 mW. Record the measured optical power.
13. Set the displayed Peak level to 50 mW. Record the measured optical power.
14. Repeat steps 12 and 13 while adjusting R94 until the measured change is 5 mW (measured) optical power with displayed power at 5, 10, and 20. 30, 40, and 50 mW. If agreement is worse than ±5 % of reading in the 5-20 mW region, change the initial displayed Peak level in step 1 so that it is near the region of worst disagreement, and repeat the calibration procedure (starting with step 1).