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NIRQuest NIR Spectrometers Data Sheet

Description

The NIRQuest512, NIRQuest512-2.2, NIRQuest512-2.5, NIRQuest256-2.1 and NIRQuest256-2.5 Near-infrared Spectrometers are designed for applications that require sensitivity in the near-infrared region, such as tunable laser wavelength characterization and general NIR spectroscopy. The NIRQuest spectrometers can communicate via the Universal Serial Bus.

NIRQUEST-512

The NIRQuest-512 Spectrometer's diffractive grating-based optical bench and 16-bit USB A/D converter are conveniently mounted in the same housing. This integrated design makes the NIRQuest512 a 182 mm x 110 mm x 47 mm small-footprint system and eliminates the need for additional spectrometer-to-A/D converter cabling. A +5 VDC wall transformer (included) is required to operate the system's high-performance InGaAs array detector. The NIRQuest-512 standard grating (NIR3) provides a wavelength range of 850-1700 nm. Five other gratings are available. The usable range is 900-1700 nm.

NIRQUEST512-2.5

The NIRQuest512-2.5 offers better resolution, with a wavelength range of 900-2550 nm using the standard grating NIR1. There are 6 other grating options available.

NIRQUEST512-2.2

The NIRQuest512-2.2 offers better resolution, with a wavelength range of 900-2200 nm using the standard grating NIR2. There are 5 other grating options available.

NIRQuest256-2.1

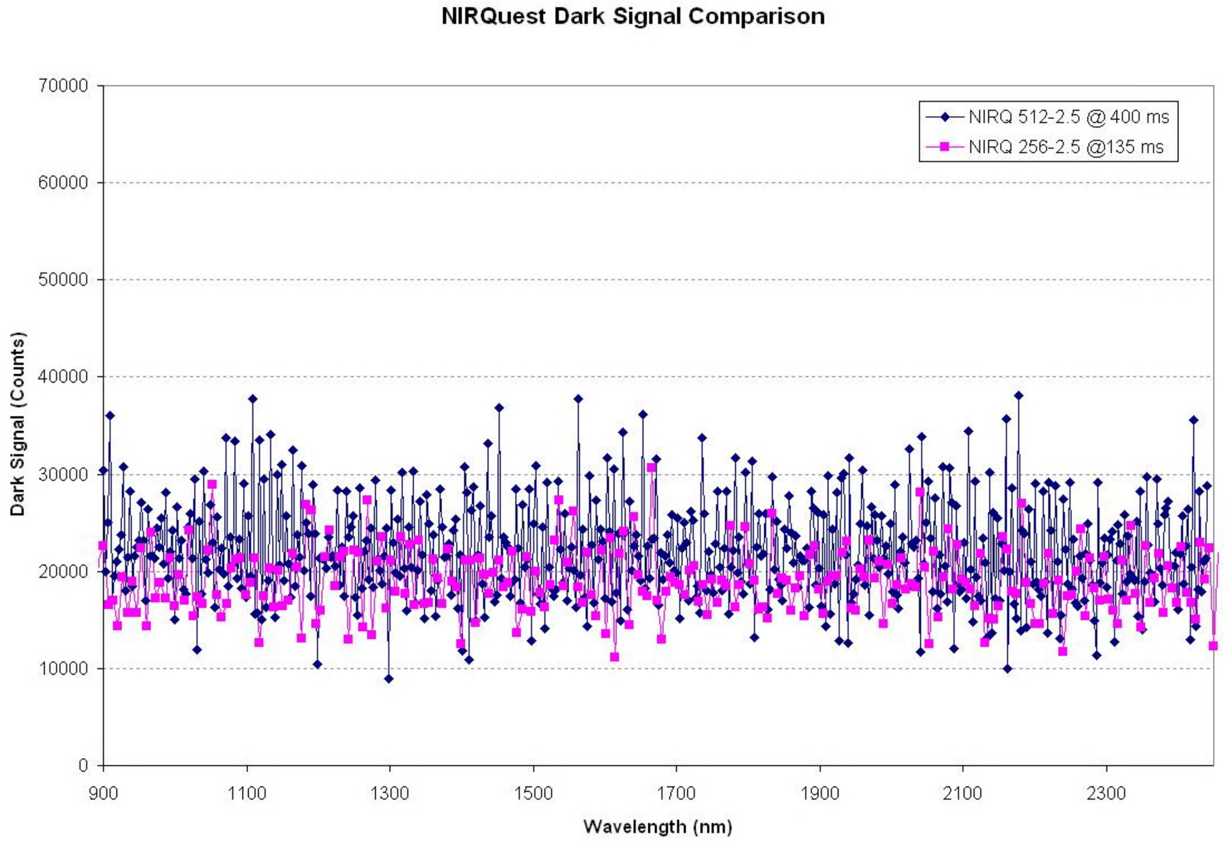
The NIRQuest256-2.1 uses a 256-element InGaAs linear-array detector. With the NIRQuest256-2.1 you have 6 grating options. Grating NIR2, is standard and provides a wavelength range of 900-2100 nm. The usable range is 900- 2050 nm. The NIRQuest256-2.1 acquires data as fast as 5 milliseconds with the USB 2.0 port.

NIRQuest256-2.5

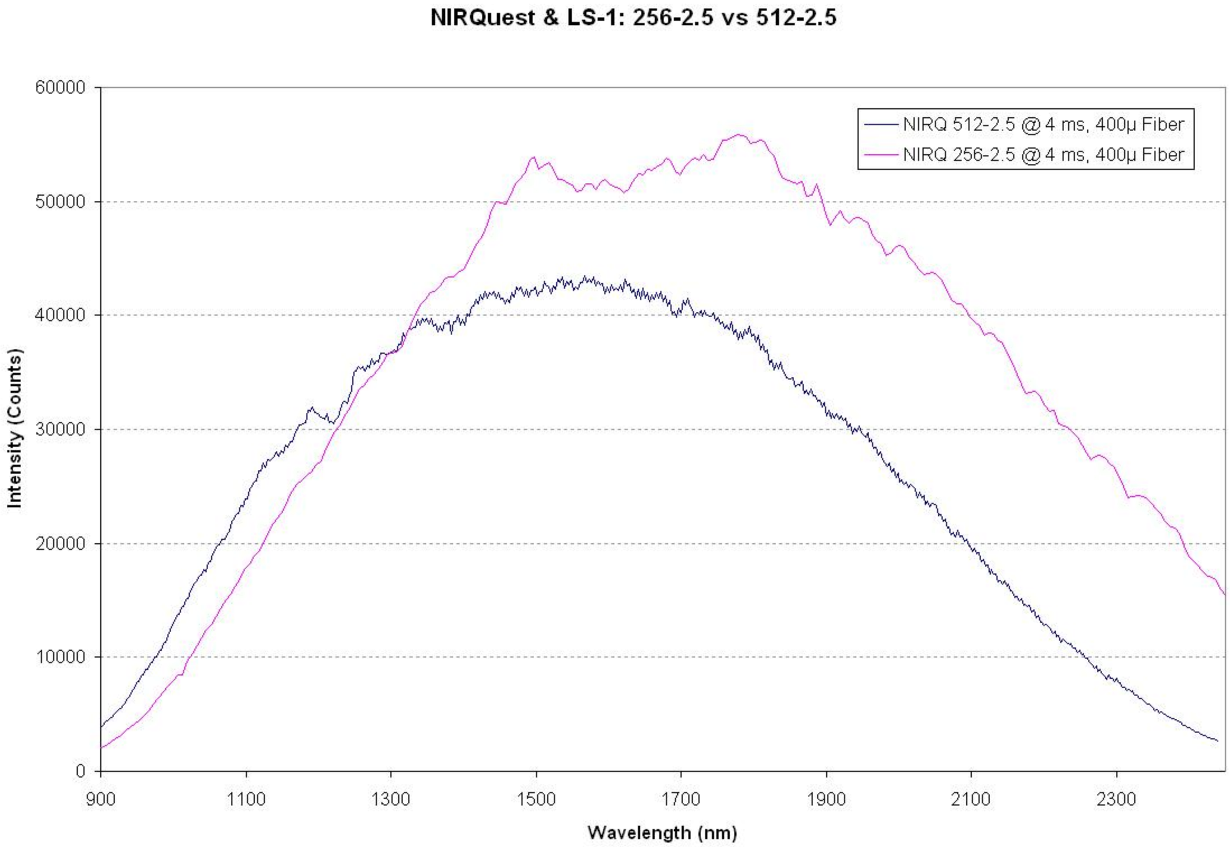
The NIRQuest256-2.5 extends farther into the NIR range, acquiring spectra up to 2.5 µm. The NIRQuest256-2.5 features a temperature-regulated InGaAs detector array, which is internally cooled for optimum signal-to-noise and sensitivity. The NR256-2.5 acquires data as fast as 5 milliseconds. The detector range is 900-2550 nm with a usable range of 900-2500 nm.

When configuring a system for operation out to 2.5µm it's important to consider the following details:

- **Short Integration Times:** In order for the detector to be sensitive out to 2.5µm, the detector's band gap energy must be small. Unfortunately this raises the absolute level of the detectors dark signal. Typical dark signals at 400ms (NIRQuest512-2.5) and 135ms (NIRQuest256-2.5) are shown below.
- **Fiber Selection:** For maximum signal intensity, alternative fiber materials should be used for wavelengths greater than 2.2µm.



Dark Signal Comparison of NIRQuest 512-2.5 and NIRQuest 256-2.5



Relative intensity of NIRQuest 512-2.5 and a NIRQuest256-2.5 Spectrometer with a 25µm slit directly coupled to an LS-1 Light Source with a 400µm fiber

NIRQuest Gratings

The following tables show the NIRQuest gratings available for preconfigured (standard) setups and for all options. Additional grating options, adjustments to starting and ending wavelengths and similar customization may be available. Please contact an Applications Scientist for details.

NIRQuest Gratings for Preconfigured Setups

Spectrometer	Standard Grating	Groove Density (lines/mm)	Spectral Range	Blaze Wavelength	Best Efficiency (>30%)
NIRQuest512	NIR3	150	~800 nm	1100 nm	900-1700 nm
NIRQuest512-2.2	NIR2	100	1150 nm	1600 nm	900-2200 nm
NIRQuest512-2.5	NIR1	75	1425 nm	1700 nm	1075-2500 nm
NIRQuest256-2.1	NIR2	100	1150 nm	1600 nm	900-2050 nm
NIRQuest256-2.5	NIR1	75	1425 nm	1700 nm	1075-2500 nm

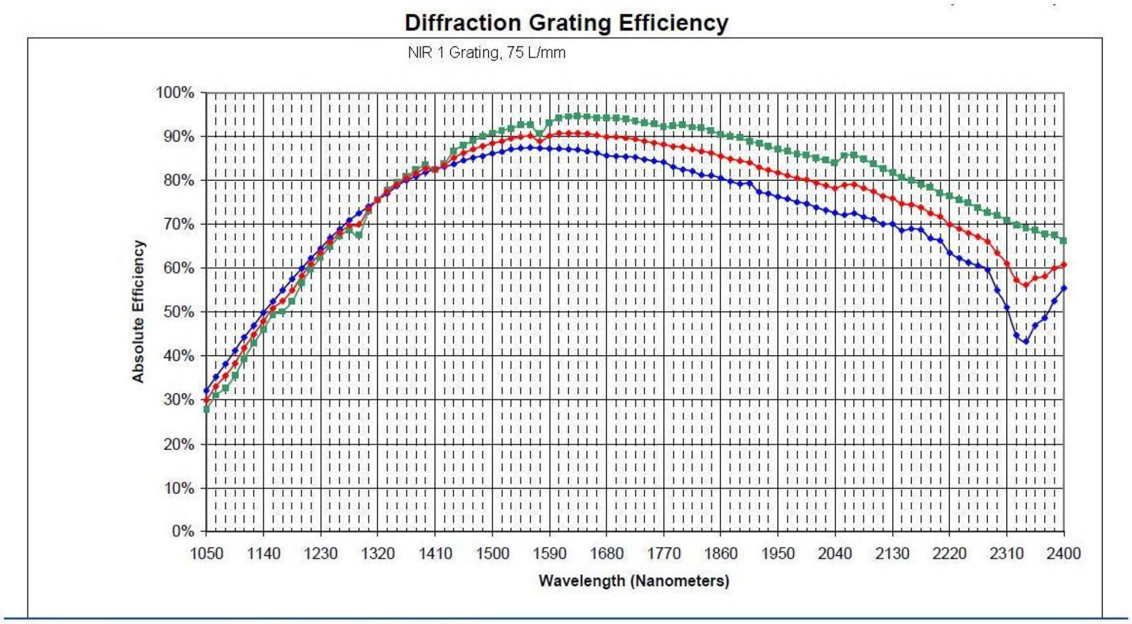
NIRQuest Gratings – All Options

Grating	Intended Use	Groove Density (lines/mm)	Spectral Range*	Blaze Wavelength	Best Efficiency (>30%)
NIR1	NIRQuest512-2.5 NIRQuest256-2.5	75	1600 nm	1700 nm	1075-2500 nm
NIR2	NIRQuest 512-2.2 NIRQuest512-2.5 NIRQuest256-2.1 NIRQuest256-2.5	100	1200 nm	1600 nm	900-2050 nm
NIR3	NIRQuest512, NIRQuest512-2.2 NIRQuest 512-2.5 NIRQuest256-2.1, NIRQuest256-2.5	150	~800 nm	1100 nm	900-1700 nm
NIR10	NIRQuest512, NIRQuest512-2.2 NIRQuest512-2.5 NIRQuest256-2.1 NIRQuest256-2.5	300	350-380 nm	1200 nm	750-2200 nm
NIR11	NIRQuest512, NIRQuest512-2.2 NIRQuest512-2.5 NIRQuest256-2.1 NIRQuest256-2.5	400	240-290 nm	1600 nm	980-2500 nm
NIR12	NIRQuest512, NIRQuest512-2.2 NIRQuest512-2.5 NIRQuest256-2.1 NIRQuest256-2.5	500	160-220 nm	1370 nm	900-2500 nm
NIR13	NIRQuest512, NIRQuest512-2.2 NIRQuest512-2.5 NIRQuest256-2.1 NIRQuest256-2.5	600	100-180 nm	1200 nm	800-2500 nm
NIR14	NIRQuest512	1000	50-90 nm	1310 nm	900-1700 nm

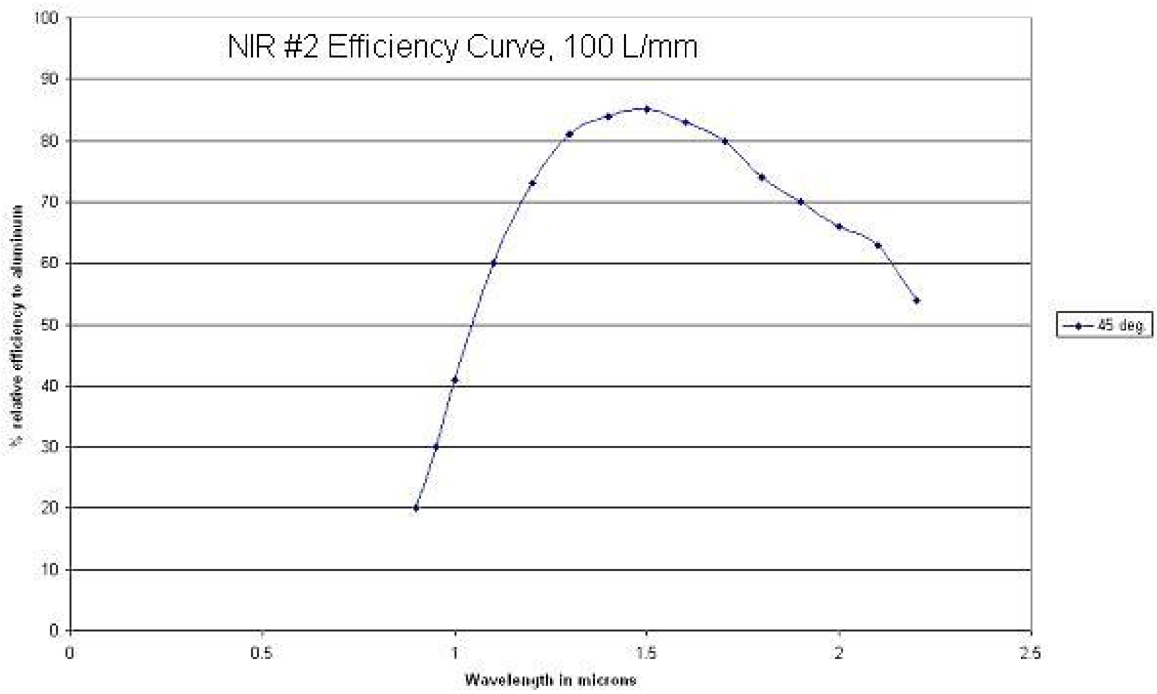
* The spectral range is a function of the starting wavelength; the longer (i.e., the farther out in the NIR) the starting wavelength, the smaller the spectral range possible.

Grating Efficiency Curves

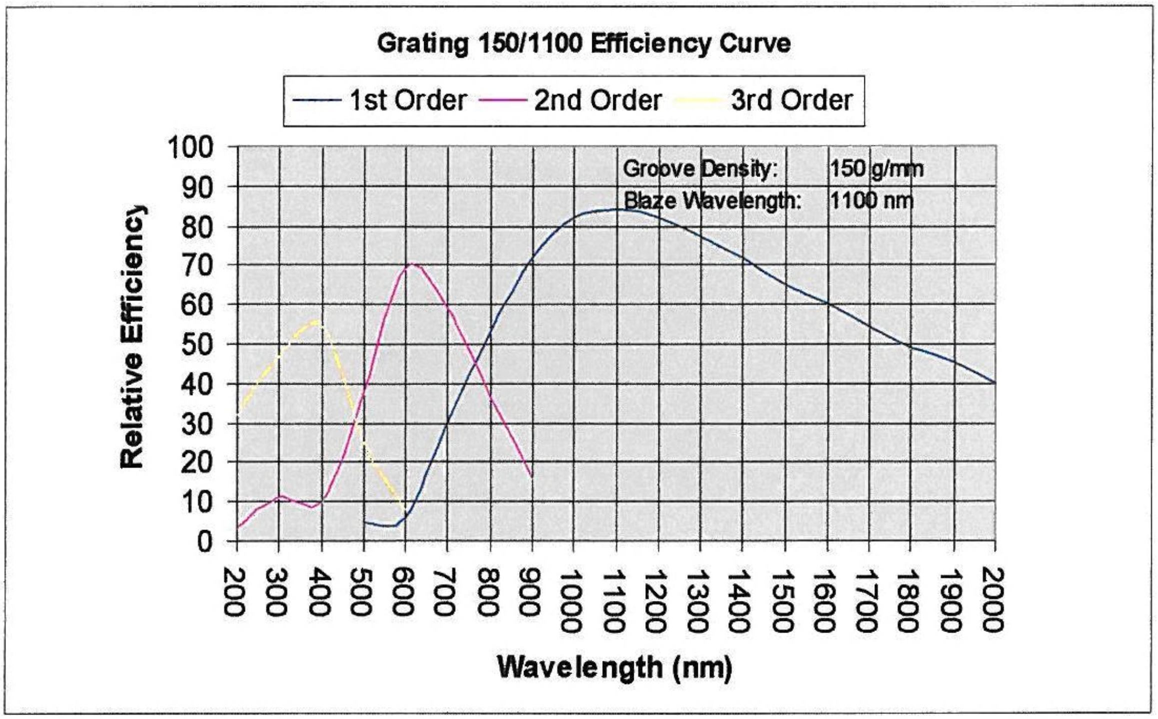
The following graphs show grating efficiency only. System sensitivity is due to several factors, including detector response and grating efficiency.



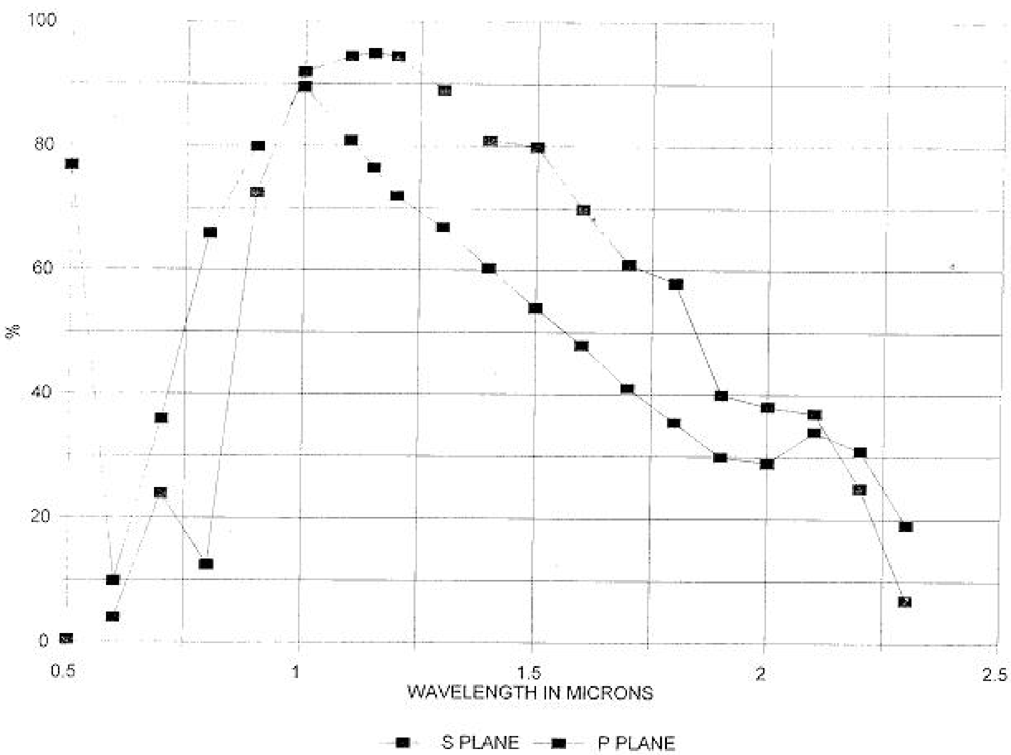
Grating NIR1, 1075 – 2500 nm, 75 l/mm, Blazed at 1700 nm



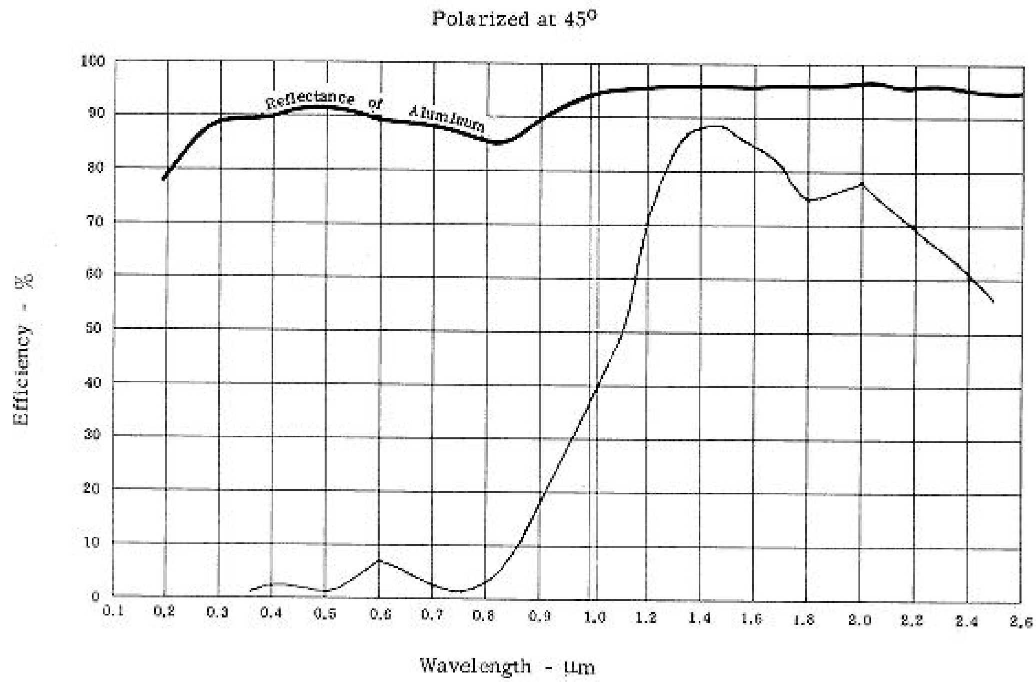
Grating NIR2, 900 – 2050 nm, 100 l/mm, Blazed at 1600 nm



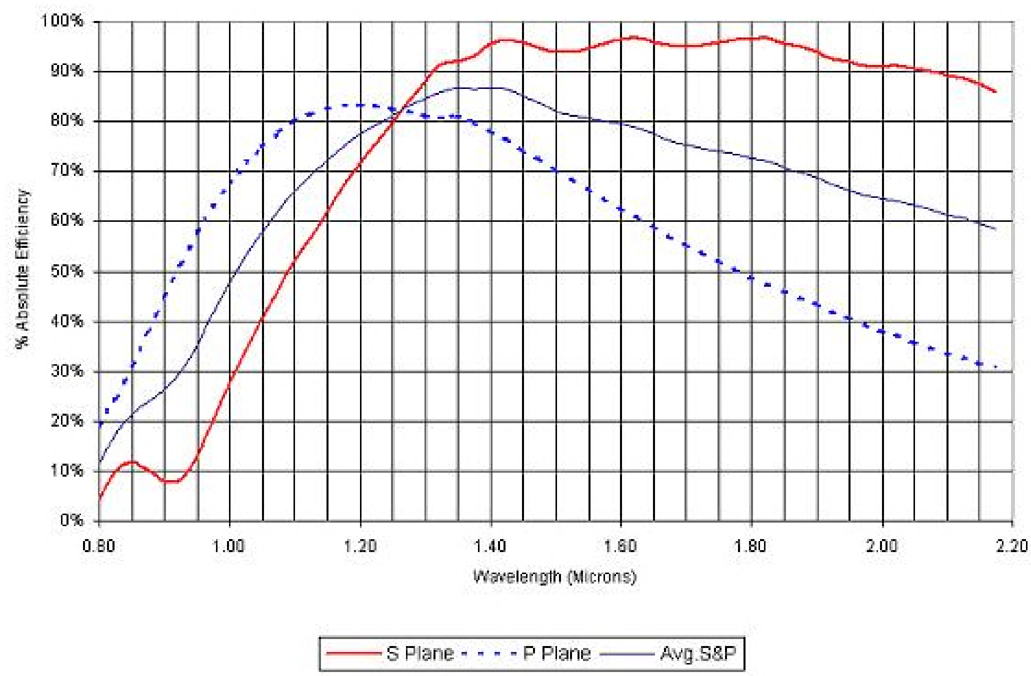
Grating NIR3, 900 – 1700 nm, 150 l/mm, Blazed at 1100 nm



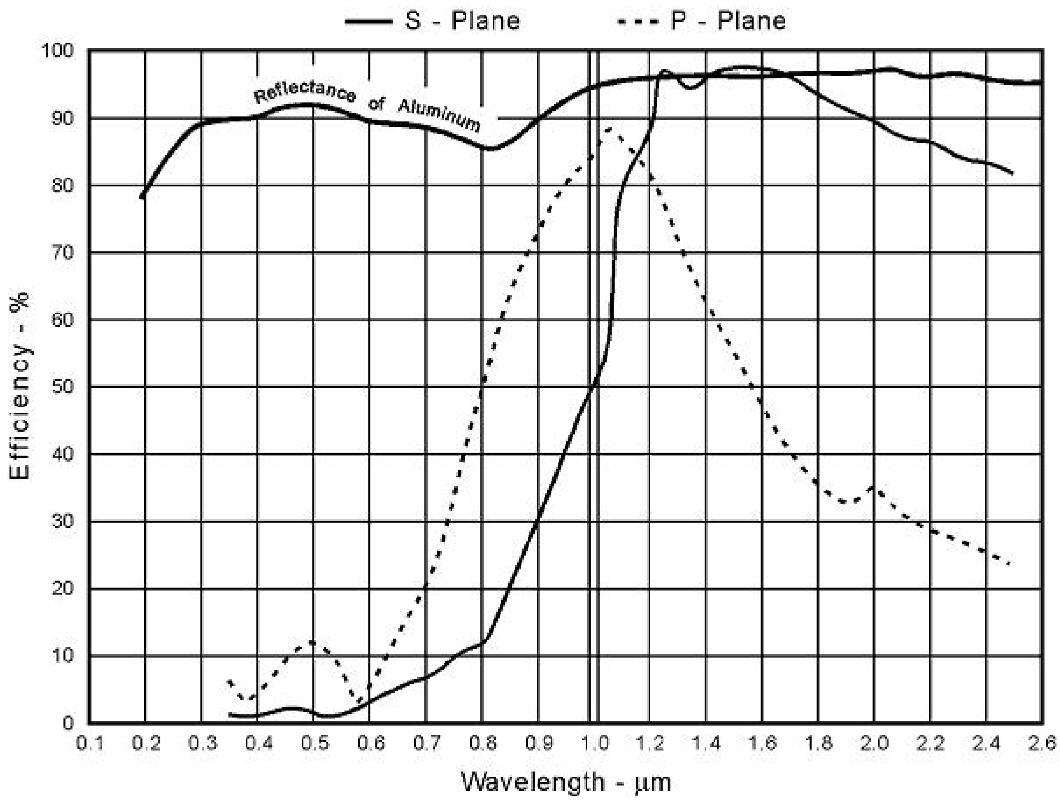
Grating NIR10, 750 – 2200 nm, 300 l/mm, Blazed at 1200 nm



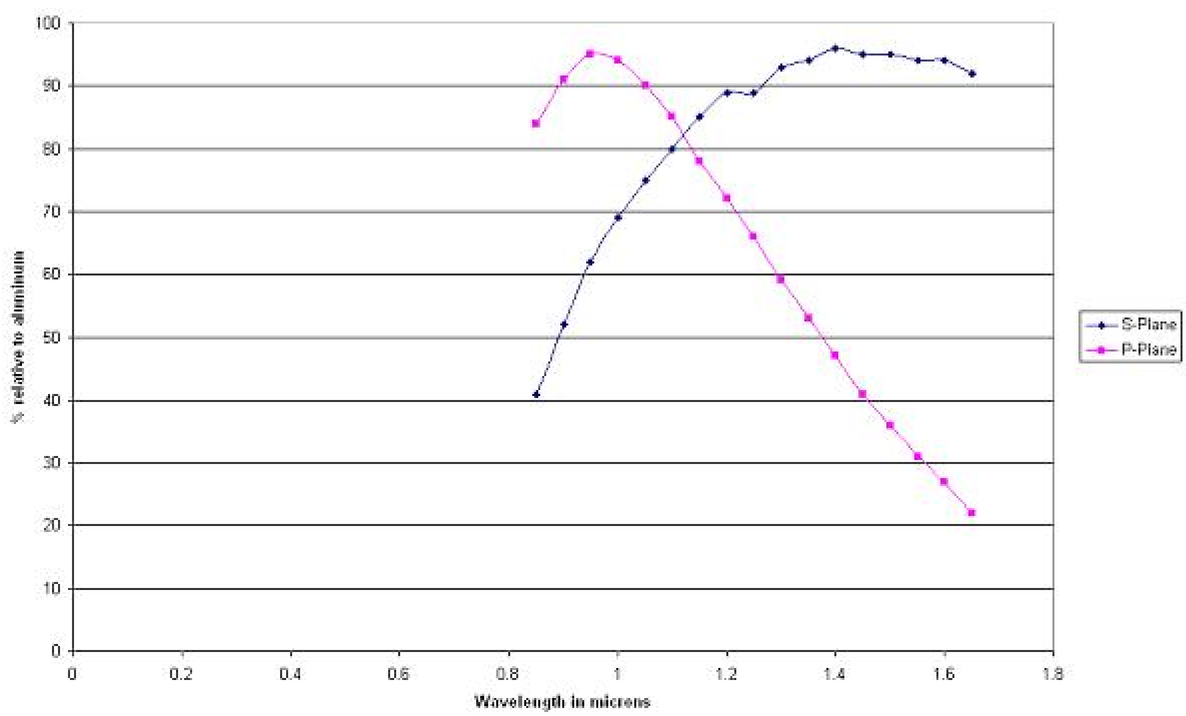
Grating NIR11, 980 – 2500 nm, 400 l/mm, Blazed at 1600 nm



Grating NIR12, 900 – 2500 nm, 500 l/mm, Blazed at 1370 nm



Grating NIR13, 800 – 2500 nm, 600 l/mm, Blazed at 1200 nm

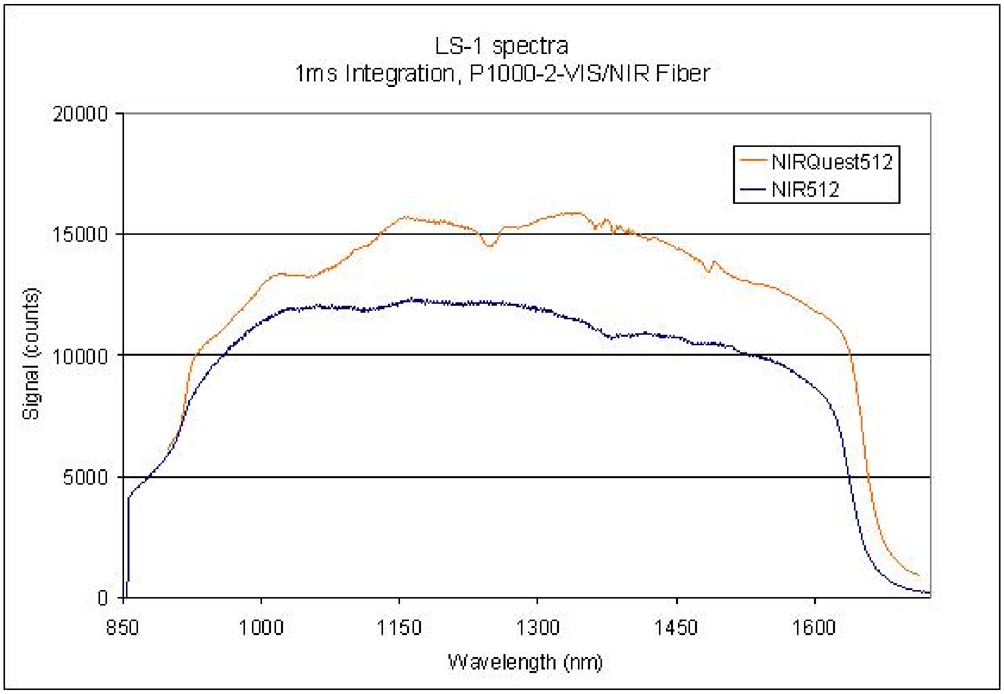


Grating NIR14, 900 – 1700 nm, 1000 l/mm, Blazed at 1310 nm

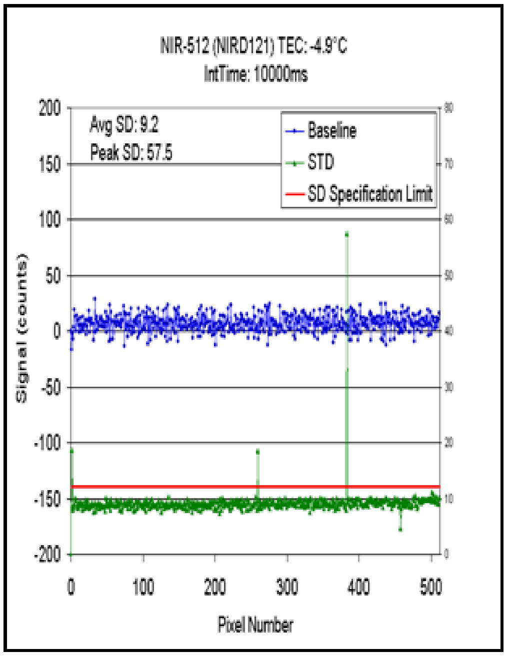
Advantages Over NIR Series Spectrometers

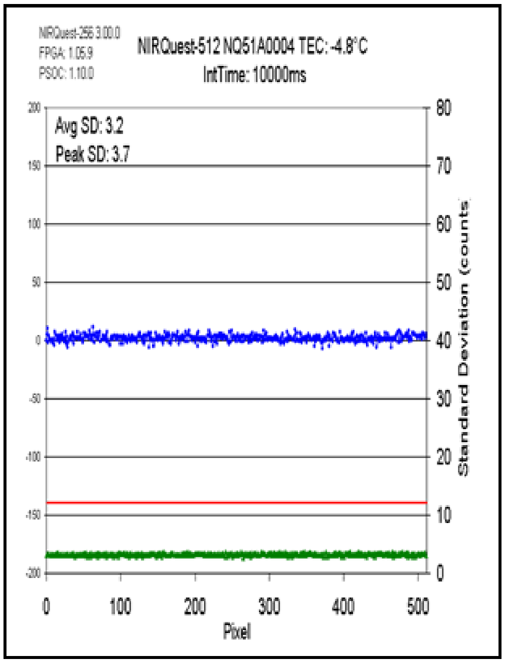
The NIRQuest Spectrometers offer a high-performance optical bench with low-noise electronics and more gratings than have been available in the past. The following list of improved features shows how the NIRQuest offers improved functionality over our previous NIR Spectrometers at a lower cost to you.

- 20 % Higher Throughput. Higher throughput means higher sensitivity and shorter integration times needed. The chart below compares spectra from the NIR512 with the NIRQuest 512.



- 2 to 3 Times Better Noise Performance. This permits integration for longer periods of time and detection of smaller changes in absorbance. The charts below show 3x noise improvement for the NIRQuest512 over the NIR512 at a 10-second integration time.





- Considerably Better Signal-to-Noise Ratio (now >15000:1 at 100 ms). This allows better detection in low light levels, use of a smaller slit size (provides higher optical resolution without sacrificing throughput), and simpler measurement of higher concentration samples.
- True External Trigger with a fixed 1-ms delay after an external event before integration begins.
- Thermoelectric Cooler stabilizes after 1 minute in the NIRQuest 512 vs. 2 minutes in the NIR512.
- More Grating Options are provided (up to 6) to better optimize your application setup.

Features

- Hamamatsu G9204-512 (NIRQuest512), G9206-512W (NIRQuest512-2.2), G9208-512W (NIRQuest512-2.5), G9206-256 (NIRQuest256-2.1), G9208-256 (NIRQuest256-2.5) InGaAs linear array detector
    - Back-thinned for good UV sensitivity
    - MPP operation for low noise
    - TE Cooled
- Spectrometer Design
    - Symmetrical Crossed Czerny Turner
    - 101mm focal length
    - 8 gratings (model-dependent)
    - 6 slit widths
- Electrical Performance
    - 16 bit, 500KHz A/D converter
    - Integration times from 1 ms to 120 seconds

- Embedded microcontroller allows programmed control of all operating parameters and standalone operation
    - USB 2.0 480Mbps
    - Multiple communication standards for digital accessories (SPI, I2C)
- Onboard Pulse Generator
    - 3 programmable strobe signals for triggering other devices
    - Software control of nearly all pulse parameters
- Onboard GPIO
    - 10 user-programmable digital I/Os
- EEPROM storage for
    - Wavelength Calibration Coefficients
    - Linearity Correction Coefficients
    - Absolute Irradiance Calibration (optional)
- Plug-and-play interface for PC applications
- 30-pin connector for interfacing to external products
- CE certification

NIRQuest Optical Resolution for Standard Setups

The following table lists the optical resolution (FWHM) by slit width for standard (preconfigured) setups. Optical resolution will vary by grating range and slit size.

Optical Resolution by Slit Width

Slit	NIRQuest512[1]	NIRQuest512-2.2[2]	NIRQuest512-2.5[3]	NIRQuest256-2.1[2]	NIRQuest256-2.5[3]
SLIT-10	~2.0 nm	~3.0 nm	~4.1 nm	~6.7 nm	~8.3 nm
SLIT-25	~3.1 nm	4.7 nm	~6.3 nm	~7.6 nm	~9.5 nm
SLIT-50	~3.6 nm	~5.4 nm	~7.2 nm	~8.9 nm	~11.1 nm
SLIT-100	~6.6 nm	~9.8 nm	~13.1 nm	~11.2 nm	~13.9 nm
SLIT-200	~12.3 nm	~18.5 nm	~25 nm	~17.9 nm	~22.2 nm

[1] Grating NIR3 used (900-1700 nm)
[2] Grating NIR2 used (900-2050 nm)
[3] Grating NIR1 used (900-2500 nm)

NIRQuest Spectrometer Specifications

	NIRQuest512	NIRQuest512-2.2	NIRQuest512-2.5	NIRQuest256-2.1	NIRQuest256-2.5
PHYSICAL					
Dimensions (mm):	182 x 110 x 47				
Weight (kg):	1.18 (w/o power supply)				
DETECTOR					
Detector:	Hamamatsu G9204-512 InGaAs linear array	Hamamatsu G9206-512 InGaAs linear array	Hamamatsu G9208-512W InGaAs linear array	Hamamatsu G9206-256 InGaAs linear array	Hamamatsu G9208-256 InGaAs linear array
Detector range:	850-1700 nm	900-2200 nm	900-2550	900-2100 nm	900-2550 nm
Useable range[1]:	900-1700 nm	900-2200 nm	900-2500	900-2050 nm	900-2500 nm
Pixels:	512			256	
Pixel size:	25 µm x 500 µm	25 µm x 250 µm		50 µm x 500 µm	
Saturation charge:	30 pC (~188 Me- electrons)				
Defective pixels:	0%	20 pixels, maximum		5%	
OPTICAL BENCH					
Design:	f/4, symmetrical crossed Czerny-Turner				
Entrance aperture (standard):	25 µm				
Entrance aperture (custom options):	10 µm, 50 µm, 100 µm and 200 µm (or no slit)				
Grating options (standard):	Grating NIR3, 150 l/mm, 900-1700 nm	Grating NIR2, 100 l/mm, 900-2050 nm	Grating NIR1, 75 l/mm, 1075-2500 nm	Grating NIR2, 100 l/mm, 900-2050 nm	Grating NIR1, 75 l/mm, 1075-2500 nm
Grating options (custom)[2]:	NIR10, NIR11, NIR12, NIR13 and NIR14	NIR2, NIR3, NIR10, NIR11, NIR12 and NIR13			
Longpass filter[3]:	OF1-RG830 longpass NIR filter (optional)	OF1-RG830 longpass NIR filter (optional)			

	NIRQuest512	NIRQuest512-2.2	NIRQuest512-2.5	NIRQuest256-2.1	NIRQuest256-2.5
2nd Order filter[3]:	N/A	Standard			
Collimating and focusing mirrors:	Gold-coated for enhanced NIR reflectivity				
Fiber optic connector:	SMA 905 to 0.22 numerical aperture single-strand optical fiber				
SPECTROSCOPIC					
Wavelength range:	900-1700 nm w/Grating NIR3	900-2200nm w/Grating NIR2	900-2500nm w/Grating NIR1	900-2050 nm w/Grating NIR2	900-2500 nm w/Grating NIR1
Optical resolution (FWHM)[4]:	~3.1 nm w/25 µm slit	~5 nm w/25 µm slit	~6.3 nm w/25 µm slit	~7.6 nm w/25 µm slit	~ 9.5 nm w/25 µm slit
Signal-to-noise ratio at full signal[5]:	>15000:1 @ 100 ms integration >13000:1 @ 1000 ms integration	10000:1 @ 100 ms integration			7500:1 @ 10 ms integration
A/D resolution:	16-bit				
Dark noise:	6 RMS counts @ 100 ms		8 RMS counts@ 10 ms	6 RMS counts @ 100 ms	8 RMS counts @ 10 ms
	12 RMS counts @ 1000 ms	12 RMS counts @ 250 ms	12 RMS counts@ 30 ms	12 RMS counts @ 250 ms	12 counts RMS @ 30 ms
Dynamic range:	150 x 10^6 (system); 15000:1 for a single acquisition	5 x 10^6 (system); 10000:1 for a single acquisition	3 x 10^6 (system); 7500:1 for a single acquisition	5 x 10^6 (system); 10000:1 for a single acquisition	3 x 10^6 (system); 7500:1 for a single acquisition
Integration time[6]:	1 ms-120 seconds	1 ms-2000 ms	1 ms – 60 ms	1 ms-2000 ms	1 ms-60 ms
Corrected linearity:	>99.8%		99.6%	>99.8%	>99.6%
Estimated Peak Noise Equivalent Power (NEP) (default configuration)	0.5 pW	5 pW	25 pW	5 pW	25 pW
ELECTRONICS					
Power consumption	USB power +5V, 0.5 A maximum; DC input jack +5V, 3 A maximum				
Data transfer speed:	Full scan to memory every 5 ms with USB 2.0 port				

	NIRQuest512	NIRQuest512-2.2	NIRQuest512-2.5	NIRQuest256-2.1	NIRQuest256-2.5
Inputs/ Outputs:	External trigger input + single strobe output				
Breakout box compatibility:	Yes				
Trigger modes:	2 modes (Normal/Free Run + 1-ms External Hardware Trigger)				
Strobe functions:	Yes				
Gated delay:	Yes, with external hardware trigger delay				
Connector:	30-pin connector				
TEMPERATURE & THERMOELECTRIC COOLING					
Temperature limits (environmental):	10-35 ºC (0-90% non-condensing)				
TEC set point (software controlled):	Control at -5ºC (up to 30ºC below ambient)	Control at -20 ºC (up to 45 ºC below ambient)			
TEC stability:	+/-0.5 ºC of set temperature in <1 minute; typical long-term stability +/-0.1 ºC				
COMPUTER					
Operating systems:	Windows 2000/XP and Vista (32-bit only); Mac OS X and Linux w/USB port; any 32-bit Windows OS with serial port				
Computer interfaces:	USB 2.0 @ 480 Mbps; RS-232 (2-wire) @ 115.2 K baud (custom configuration)				
Peripheral interfaces:	I2C inter-integrated circuit; SPI (3-wire)				
WIRELESS/ETHERNET INTERFACE (optional add-on accessory)					
Wireless (Wi-Fi) interface:	Yes, with Remora adapter				
Wired Ethernet interface:	Yes, with Remora adapter				
Wi-Fi range:	25 meters in free space				
Web server:	Works with common browsers				

[1] "Useable range" is defined in the context of the NIRQuest model's detector response and its typical grating response. For example, the 512-element detector has response at 850 nm, but grating response begins at 900 nm. The G9206 256-element detector response is sensitive to TEC temperature, and has response only to 2050 nm when the TEC is set to -20 ºC. The G9208 256-element and 512-element detector has response to 2550 nm, but the grating efficiency drops off at 2500 nm.

[2] See *NIRQuest Gratings* for more information.

[3] Other filter options are available for order-sorting in the NIRQuest256-2.1, NIRQuest256-2.5 and NIRQuest 512-2.5. NIRQuest256-2.5 and NIRQuest 512-2.5 ship with a 2nd-order filter. See an Applications Scientist for details.

[4] Optical resolution (FWHM) depends on grating and slit selection.

[5] SNR will decrease at longer integration times.

[6] Maximum integration times are defined as the longest amount of time one can integrate the spectrometer before the dark level rises to half of full scale.

Electrical Pinout

30-pin Accessory Connector Pinout

Pin orientation

2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29

USB Port Looking at Front of the NIRQuest

Pin #	Function	Input/Output	Description
1	RS232 Rx	Input	RS-232 receive signal. RS-232 functionality is not implemented in software.
2	RS232 Tx	Output	RS-232 transmit signal. RS-232 functionality is not implemented in software.
3	GPIO (2)	Input/Output	A/D trigger
4	N/A	N/A	Reserved
5	Ground	Input/Output	Ground
6	I2C SCL	Input/Output	I2C clock signal for communication to other I2C peripherals
7	GPIO (0)	Input/Output	Acquire spectra (read Enable)
8	I2C SDA	Input/Output	I2C data signal for communication to other I2C peripherals
9	GPIO (1)	Input/Output	FIFO Write
10	Ext. Trigger In	Input	TTL input trigger signal
11	GPIO (3)	Input/Output	Detector SCLAMP
12	VCC or 5VIN	Input or Output	Input power pin– When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications (no TEC power)
13	SPI Data Out	Output	SPI Master Out Slave In (MOSI) signal for communication to other SPI peripherals
14	VCC or 5VIN	Input or Output	Input power pin – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications (no TEC power)
15	SPI Data In	Input	SPI Master In Slave Out (MISO) signal for communication to other SPI peripherals
16	GPIO (4)	Input /Output	Reserved
17	Single Strobe	Output	TTL output pulse used as a strobe signal – Has a programmable delay relative to the beginning of the spectrometer integration period

Pin #	Function	Input/Output	Description
18	GPIO (5)	Input/Output	Detector SODDCLK (inverted)
19	SPI Clock	Output	SPI clock signal for communication to other SPI peripherals
20	Continuous Strobe	Output	TTL output signal used to pulse a strobe – Divided down from the master clock signal
21	SPI Chip Select	Output	SPI Chip/Device Select signal for communication to other SPI peripherals
22	GPIO (6)	Input/Output	Detector SSWITCH (inverted)
23	N/A	N/A	Reserved
24	N/A	N/A	Reserved
25	Lamp Enable	Output	TTL signal driven Active HIGH when the Lamp Enable command is sent to the spectrometer
26	GPIO (7)	Input/Output	Detector SEVENCLK (inverted)
27	Ground	Input/Output	Ground
28	GPIO (8)	Input/Output	Detector SEVENRST (inverted)
29	Ground	Input/Output	Ground
30	GPIO (9)	Input/Output	Detector SODDRST (inverted)

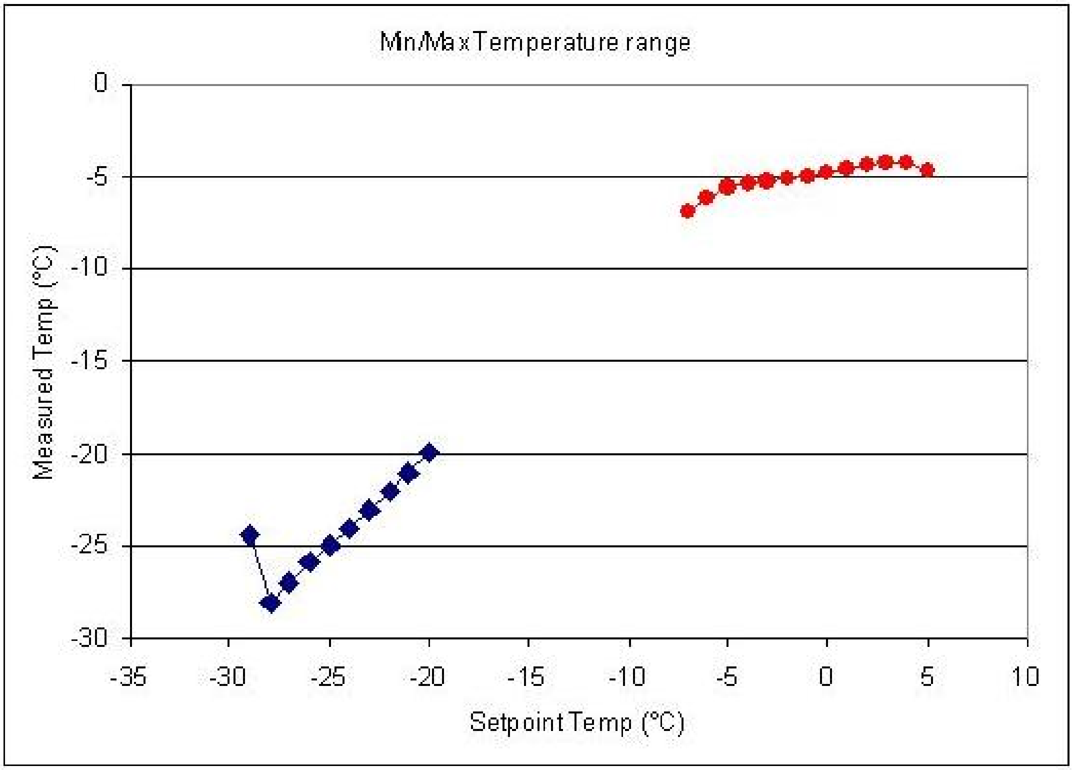
Thermo-Electric Cooler (TEC)

The NIRQuest contains a TE cooled CCD and the electronics to driver it. The drive electronics were designed to only cool the device (no heating possible) and were optimized to generate the best cooling possible. The TE Cooler and electronics provide cooling for 30-43°C below ambient. Thus for an ambient temperature of 23°C, the cooling range is -7 to -20°C. The TE Cooler setpoint is user programmable in increments of 0.1°C over this range.

Tips for Using the TEC

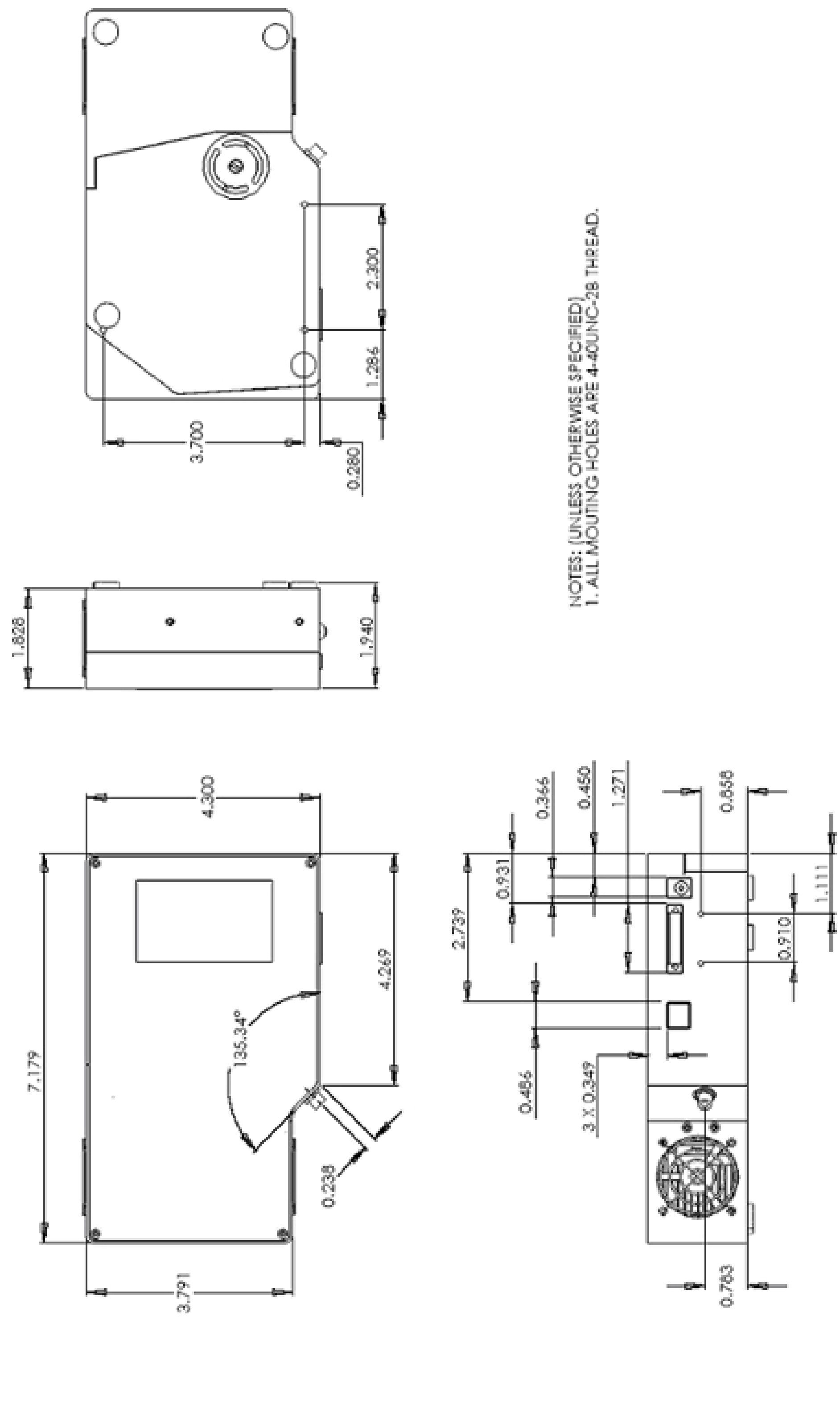
- Ensure that the TEC power is always applied (TEC is enabled via SpectraSuite software) prior to USB power. When you first enable the TEC, wait a second before reading the temperature. If the TEC temperature is not decreasing, disable the TEC in software, wait a second and again enable the TEC. This ensures that the TEC always turns on.
- Don't query the TEC temperature more often than necessary. Doing so may cause the TEC to fail to report the correct temperature (although the TEC still remains in control at the last setpoint temperature). Changing temperature reporting to once a minute (once you've reached setpoint) should avoid the problem.

- Instability in the TEC setpoint temperature can result if trying to control the TEC temperature outside of the available range. A typical TEC plot of the TEC control range (22°C ambient) is shown below. For 22°C ambient, this unit will maintain control within the range -6°C to -28°C. However, if the ambient temperature were 32°C (e.g., as may happen if the spectrometer is installed within an enclosure), the control range would be expected to shift by +10°C (+4°C to -18°C) and the detector temperature would not be stable for a -20°C setpoint.



- When sending commands to the TEC, always wait 100ms between commands.

Mechanical Diagram



Hardware Description

The NIRQuest is controlled by a Cypress FX2LP microcontroller. This device has an 8051 processor core combined with an integrated USB 2.0 peripheral physical layer. Program code is stored in an external flash memory chip, and is loaded into the microcontroller at power-up via an I2C interface.

USB Information

Ocean Optics Vendor ID number is 0x2457. The NIRQuest512's Product ID is 0x1026 and the NIRQuest256 Product ID is 0x1028. The NIRQuest supports USB 2.0 interface which is specified at 12Mbps.

Instruction Set

Command Syntax

The list of the commands is shown in the following table followed by a detailed description of each command. The length of the data depends on the command. All commands are sent to the NIRQuest through End Point 1 Out (EP1). Spectral data are acquired through End Point 2. All other queries are retrieved through End Point 1 In (EP1).

Pipe #	Description	Type	Full Speed Size (Bytes)	Endpoint Address
0	End Point 1 Out	Bulk	512	0x01
1	End Point 1 In	Bulk	512	0x82
2	End Point 6 In (unused)	Bulk	512	0x86
3	End Point 1 In	Bulk	512	0x81

USB Command Summary

EP2 Command Byte Value	Description	Version
0x01	Initialize Device	3.00.2
0x02	Set Integration Time	3.00.2
0x03	Set Strobe Enable Status	3.00.2
0x04	Reserved	3.00.2
0x05	Query Information	3.00.2
0x06	Write Information	3.00.2

EP2 Command Byte Value	Description	Version
0x07	Write Serial Number	3.00.2
0x08	Get Serial Number	3.00.2
0x09	Request Spectra	3.00.2
0x0A	Set Trigger Mode	3.00.2
0x71	Set TEC Controller State	3.00.2
0x0C	Set Detector Gain Mode	3.00.2
0x70	Set Fan State	3.00.2
0x1E	Stop Spectral Acquisition	3.00.2
0x73	TEC Controller Write	3.00.2
0x72	TEC Controller Read	3.00.2
0xFE	Query Status	3.00.2

Command Descriptions

A detailed description of all NIRQuest commands follows. While all commands are sent to EP1 over the USB port, the byte sequence is command dependent. The general format is the first byte is the command value and the additional bytes are command specific values.

Byte 0	Byte 1	Byte 2	…	Byte n-1
Command Byte	Command Specific	Command Specific	…	Command Specific

Initialize NIRQuest

Initializes the device and aborts a scan if in progress. This command should be called at the start of every session.

Byte Format

Byte 0
0x01

Set Integration Time

Sets the NIRQuest's integration time in milliseconds. The acceptable range is 1 – 1,600,000. If the value is less than 1ms then the integration time is set to 1ms.

Byte Format

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
0x02	Integration Time LSW LSB	Integration Time LSW MSB	Integration Time MSW LSB	Integration Time MSW MSB

Set Strobe Enable Status

Sets the NIRQuest Lamp Enable line (DB15 pin 13) as follows. The Single Strobe and Continuous Strobe signals are enabled/disabled by this Lamp Enable Signal.

Data Byte = 0 ➔ Lamp Enable Low/Off Data Byte = 1 ➔ Lamp Enable HIGH/On

Byte Format

Byte 0	Byte 1	Byte 2
0x03	Data byte LSB	Data Byte MSB

Query Information

Queries any of the 19 stored spectrometer configuration variables. The Query command is sent to EP1 and the data is retrieved through EP1 In. When using Query Information to read EEPROM slots, data is returned as ASCII text. However, everything after the first byte that is equal to numerical zero will be returned as garbage and should be ignored.

The 19 configuration variables are indexed as follows:

Data Byte - Description
1 – 0th order Wavelength Calibration Coefficient
2 – 1st order Wavelength Calibration Coefficient
3 – 2nd order Wavelength Calibration Coefficient
4 – 3rd order Wavelength Calibration Coefficient
5 – Stray light constant
6 – 0th order non-linearity correction coefficient
7 – 1st order non-linearity correction coefficient
8 – 2nd order non-linearity correction coefficient
9 – 3rd order non-linearity correction coefficient
10 – 4th order non-linearity correction coefficient
11 – 5th order non-linearity correction coefficient
12 – 6th order non-linearity correction coefficient
13 – 7th order non-linearity correction coefficient
14 – Polynomial order of non-linearity calibration
15 – Optical bench configuration: gg fff sss
gg – Grating #, fff – filter wavelength, sss – slit size
16 – Detector Serial Number
17 – Configuration Parameter Return
18 – Reserved
19 – Reserved

Byte Format

Byte 0	Byte 1
0x05	Data byte

Return Format (EP7)

The data is returned in ASCII format and read in by the host through EP1 In.

Byte 0	Byte 1	Byte 2	Byte 3	…	Byte 17
0x05	Configuration Index	ASCII byte 0	ASCII byte 1	…	ASCII byte 15

Write Information

Writes any of the 19 stored spectrometer configuration variables to EEPROM. The 19 configuration variables are indexed as described in the Query Information. The information to be written is transferred as ASCII information. This command requires ~150ms to complete.

Byte Format

Byte 0	Byte 1	Byte 2	Byte 3	…	Byte 17
0x06	Configuration Index	ASCII byte 0	ASCII byte 1	…	ASCII byte 15

Write Serial Number

Writes the serial number to EEPROM. The information to be written is transferred as ASCII information. This command requires ~150ms to complete.

Byte Format

Byte 0	Byte 1	Byte 2	…	Byte 16
0x07	ASCII byte 0	ASCII byte 1	…	ASCII byte 15

Query Serial Number

Queries the unit's serial number. The Query command is sent to EP1 and the data is retrieved through End Point 1. The information to be read is transferred as ASCII information.

Byte Format

Byte 0
0x08

Return Format

The data is returned in ASCII format and read in by the host through End Point 1.

Byte 0	Byte 1	Byte 2	…	Byte 16
0x08	ASCII byte 0	ASCII byte 1	…	ASCII byte 15

Request Spectrum

Initiates a spectrum acquisition. The NIRQuest will acquire a complete spectrum. The data is returned in bulk transfer mode through EP2 in packets each containing 64 bytes in USB 1.1 mode or 512 bytes in USB 2.0 mode. The total number of bytes returned is twice the number of pixels (2 bytes per pixel) plus one trailing byte. The pixel values are decoded as described below.

Byte Format

Byte 0
0x09

Return Format

The data is returned in bulk transfer mode through EP2 in packets each containing 64 bytes (USB 1.1) or 512 bytes (USB 2.0). There is an additional packet containing one value that is used as a flag to insure proper synchronization between the PC and NIRQuest. Bit 15 has to be flipped before converting to an integer. The pixel values are decoded as described below.

The format for the first packet is as follows (all other packets except the synch packet has a similar format except the pixel numbers are incremented by 256 pixels for each packet). NOTE: Bit 15 has to be flipped for every pixel before converting to an integer.

Packet 0

Byte 0	Byte 1	Byte 2	Byte 3
Pixel 0 LSB	Pixel 0 MSB	Pixel 1 LSB	Pixel 1 MSB

…

		Byte 510	Byte 511
		Pixel 255 LSB	Pixel 255 MSB

Packet 15 – Synchronization Packet (1 byte)

Byte 0
0x69

Set Trigger Mode

Sets the NIRQuest Trigger mode to one of three states. If an unacceptable value is passed then the trigger state is unchanged (Refer to the NIRQuest manual for a description of the trigger modes).

Data Value = 0 ➔ Normal (Free running) Mode
Data Value = 3 ➔ External Hardware Trigger Mode

Byte Format

Byte 0	Byte 1	Byte 2
0x0A	Data Value LSB	Data Value MSB

Set TEC Controller State

Enables/Disables the detectors TEC controller.

Data Byte = 0 ➔ TEC Controller Disabled
Data Byte = nonzero ➔ TEC Controller Enabled

Byte Format

Byte 0	Byte 1	Byte 2
0x71	Data byte LSB	Data Byte MSB

Set Fan State

Description: Enables/Disables the FAN inside the NIRQuest. The fan should run all of the time to insure proper cooling of the electronics and heat sink.

Data Byte = 0 ➔ Fan Off Data Byte = Nonzero ➔ Fan On

Byte Format

Byte 0	Byte 1	Byte 2
0x70	Data Byte LSB	Data Byte MSB

TEC Controller Write

Performs a write command to the TE controller. This command is used to set the detectors TEC set point temperature. The set-point value is a signed 16-bit value that is expressed in tenths of a degree Celsius. For example to set the temperature to –5.0°C a value of –50 or 0xFFCD is sent.

Byte Format Set Point LSB

Byte 0	Byte 1	Byte 2
0x73	Set-point LSB	Set-point MSB

TEC Controller Read

Returns the detector temperature. The TE controller variables are only updated every 2 seconds, thus the calling program should not perform reads more often than this. This command is sent to EP1 and a total of 2 bytes data is retrieved through End Point 1 In.

Byte Format

Byte 0
0x72

Return Format

Byte 0	Byte 1
Temp LSB	Temp MSB

The Detector Temperature is a 16-bit signed value representing tenths of a degree Celsius as described in the TEC Controller Write command.

Query Status

Returns a packet of information, which contains the current operating information. The structure of the status packet is given below.

Byte Format

Byte 0
0xFE

Return Format

The data is returned in Binary format and read in by the host through End Point 1. The structure for the return information is as follows:

Byte	Description	Comments
0-1	Number of Pixels - WORD	MSB | LSB order
2-3	Integration Time - WORD	Integration time in ms – MSB | LSB
4	Lamp Enable	0 – Signal LOW 1 – Signal HIGH
5	Trigger Mode	
6	Request Spectrum	0 – No Spectrum Requested !0 – Spectral Request In progress
7	0	Always 0
8	Spectral Data Ready	0 – Data not yet available !0 – Data is present for transfer
9	0	Always 0
10	Power State	Bit 0: 1 if External 5V is present, 0 otherwise Bit 1: 1 if internal analog circuit is powered, 0 otherwise
11	Spectral Data Counter	Counter representing the last packet number which was loaded and ready for transfer
12	Detector Gain Select	0 – Detector in Low Gain Mode !0 – Detector in High Gain Mode

Byte	Description	Comments
13	Fan & TEC state	Bit 0: 1 if TEC is on, 0 otherwise Bit 1: 1 if Fan is on, 0 otherwise
14 – 15	Reserved	Returns 0

NIRQuest External Hardware Trigger and Single Strobe Performance

The NIRQuest FPGA has been enhanced to support External Hardware Trigger and Single Strobe Output generation. Under External Hardware Trigger Mode, the FPGA will hold off detector acquisition for the following start condition:

1. FX2 Microcontroller ready for new data (ReadEnable).
2. Rising edge on external input ExtTrigIn.
3. Programmed IntegrationDelay + Fixed DetRechgDly Time has elapsed.

The FPGA will also hold off Single Strobe Output generation for the following start condition:

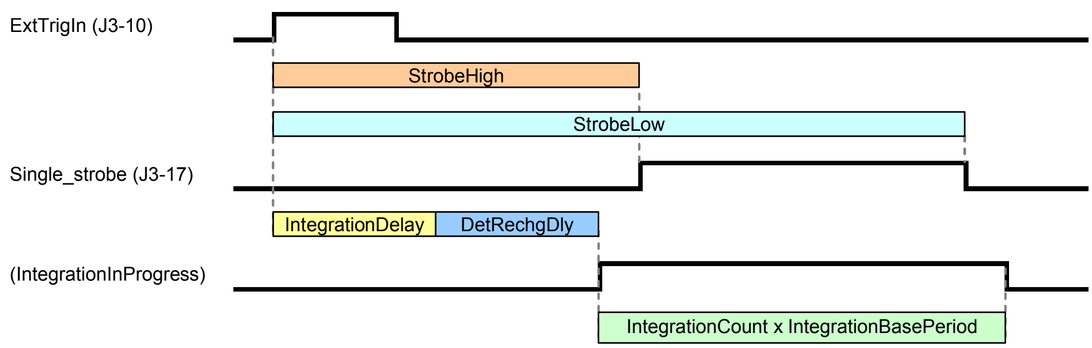
1. FX2 Microcontroller ready for new data (ReadEnable).
2. Rising edge on external input ExtTrigIn.
3. Programmed StrobeHi Time has elapsed before setting Single Strobe high.
4. Programmed StrobeLo Time has elapsed before returning Single Strobe low.

DetRechgDly is a minimum delay required to completely charge all of the detector's pixels before acquisition. This translates into a minimum trigger response time limitation (515 microseconds for NirQuest256 and 1030 microseconds for NirQuest512). The soonest the FPGA can start an acquisition would be the minimum trigger response time after the rising edge on ExtTrigIn.

An application can use the Single Strobe output to synchronize an event (for example, a light flashing) with the actual detector acquisition time. See the figure below:

SPI Register	Register Address	ns/count
IntegrationBasePeriod	0x10	1000
IntegrationCount	0x18	IntegrationBasePeriod
IntegrationDelay	0x28	500
TriggerMode	0x2C	0-Norm, 1-ExtTrig
StrobeHigh	0x38	500
StrobeLow	0x3C	500
LampEnable	0x40	0-LampOff, 1-LampOn

DetRechgDly (256 pixels) - 515 us
DetRechgDly (512 pixels) - 1030 .us



Example:

NIRQuest 256 (256 pixels)
Integration time of 2 ms

EZ-USB command string:

	6A 10 E8 03	(1000 ns/IntegrationBasePeriod)
	6A 18 02 00	(2 IntegrationBasePeriods)
Start Integration 1.015 ms after rising edge of ExtTrigIn	6A 28 E8 03	(1000 x 500 ns + 515 us)
Start SingleStrobe 1.115 ms after rising edge of ExtTrigIn	6A 38 FC 08	(2300 x 500 ns)
Stop SingleStrobe 2.900 ms after rising edge of ExtTrigIn	6A 3C A8 16	(5800 x 500 ns)
Set TriggerMode to "ExtTrig"	6A 2C 01 00	(0-Norm, 1-ExtTrig)
Turn on "LampEnable"	6A 40 01 00	(0-LampOff, 1-LampOn)

Known Issues

CAUTION

Please be sure to download the latest version of SpectraSuite (2.0.140 released June 25, 2009 or later) for full functionality for the NIRQuest Spectrometer. Under certain situations (changing the default TEC temperature or changing the default Gain mode setting), internally stored information in the NIRQuest can be lost if you use an older version of Spectrasuite. Please contact your Ocean Optics representative for more information.

Other issues for the first release of NIRQuest include the following:

- High Gain mode requires independent linearity correction
- TEC Temperature continuous display update causes the scan to pause and can crash the system if the integration time is changed rapidly (e.g., scrolling with up/down arrows).
- TEC Temperature control can be lost after reading the temperature several hundred or several thousand times (and as a result the temperature will no longer be updated correctly). The TEC temperature is still controlled at the last setpoint under these conditions, but to fix the problem you must unplug both the USB and TEC power for 15s before repowering the device.