Operation Manual and Specifications

NPM3100

Version: OM_10-2018v6

Figure 1. NPM3100

The Quaesta Instruments NPM3100 Series of Neutron Pulse Monitors (NPMs) is intended for use with proportional neutron detectors, including Helium-3 (He3), Boron Trifluoride (BF3), Boron-lined types and others. The NPM3100 is a low power consumption, digital device with integrated high voltage, digital counter, multichannel analyzer (MCA), and data logger. It is capable of autonomously counting and analyzing proportional detector signals, producing neutron pulse height spectra, and generating *list mode* data.

The NPM3100U, USB version, communicates via a USB interface for device configuration and data transmission. A TTL output is used to signal neutron counts. Additionally, a TTL input can be configured to log external TTL pulses and/or transmit then through the TTL output along with internal neutron counts. This *daisy chain* operation is useful in detector arrays.

The NPM3100E, Power over Ethernet version, communicates via an Ethernet interface. This device can operate in conjuction with an external clock that allows timing synchronization among an array of NPMs.

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3 Overview and Hardware

3.1 Customer Support

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MANUAL REVISION INFORMATION:
Version 1: Feb 16 2015
Version 2: Sept 10 2015
- Added and cleaned up Tables for Command Description and Quick Reference
- Cleaned up Appendices related to NPM3100U interfacing. Added description of Teraterm Pro setup and connection.
- Numerous other additions

Version 3: May 12, 2016
Version 4: Jun 10, 2016
- Revised ListMode Data description

Version 5: Oct 6, 2017
Version 6: Oct 12, 2018

3.2 General Safety Information

Do not operate the hardware in a manner not specified in this document and in the user documentation. Misuse can be hazardous. If the hardware is damaged, the safety of the device may be compromised. If you suspect damage, return the device to Quaesta Instruments for repair or replacement.

Clean the hardware with a soft, nonmetallic brush or cloth. Make sure that the hardware is completely dry and free from contamination before returning it to service.

3.3 High Voltage Warnings

The hardware has a high voltage output (HN connector) that operates up to 2500VDC (depending on the HV option selected at time of purchase). Never touch the HN Connector's center pin with your hand or other probing device. Never operate the hardware with the high voltage (HV) connector exposed. HV levels of 70V DC and higher can pose a shock hazard.

Use an approved connector plug or cap or attach to an approved high voltage proportional tube before turning on or applying power to the device.

Care should be taken to not short the HN connector center pin (HV) to the HN connector metal housing (GND). This may damage the device electronics.

The HV level cannot be measured with a standard voltmeter. Attempting this is hazardous. Contact Quaesta Instruments if you need to make direct measurements of the high voltage. The high voltage level is measured internally by the device and this information can be obtained through communication with the device.

3.4 Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) as stated in the product specifications. These requirements and limits are designed to provide reasonable protection against harmful interference when the product is operated in its intended operational electromagnetic environment. This product is intended for use in commercial and industrial locations. There is no guarantee that harmful interference will not occur in a particular installation or when the product is connected to a test object. To minimize the potential for the product to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation

4 Section 1: NPM3100 Device Overview

4.1 Device Architecture

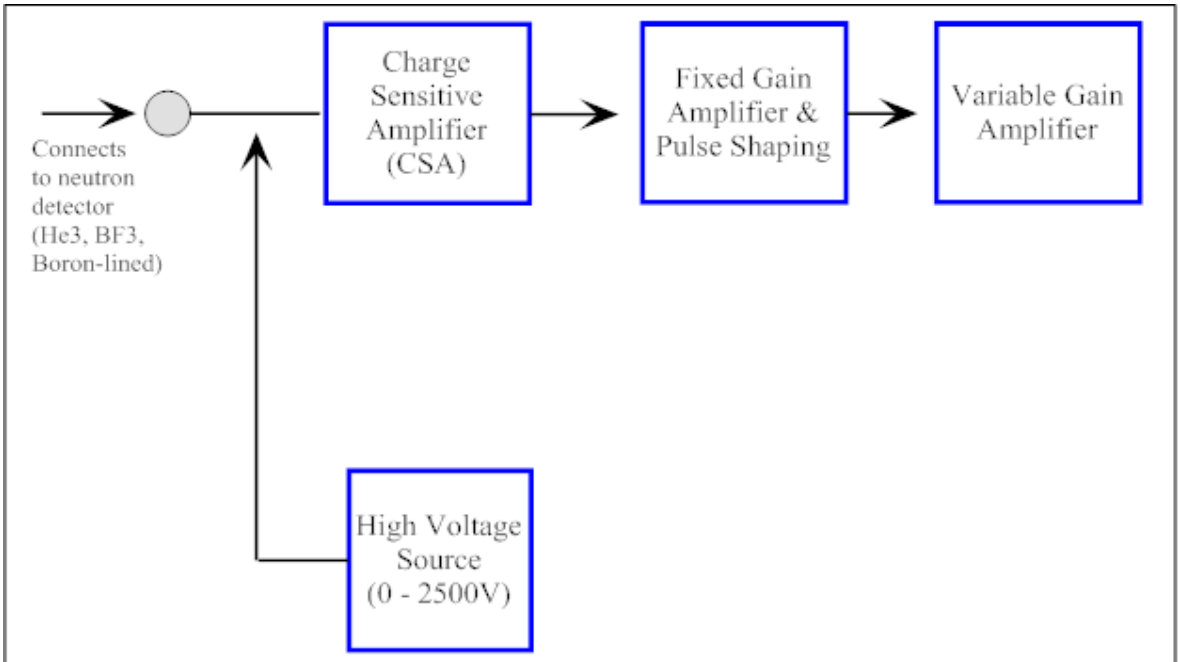
The NPM3100 series neutron pulse monitors are digital, microcontroller based devices. They include two primary sections: a high voltage and analog amplifier section, and a digital waveform capture and analysis, and communications section. Firmware in the microcontroller is used to produce a variety of outputs and functions. Therefore, this NPM3100 series is able to offer many features, and they are a flexible platform for rapid development of new ones. A Command Set controls all device operation from configuration of operational parameters to transmission of data from the NPM. A terminal window program (such as Tera Term Pro) can be used to communicate with and control the device from a command line using the device's Command Set. Additionally, some devices have a GUI software interface to control the device. At a device interface level, this GUI software utilizes the same Command Set which a user can enter from a terminal window. Throughout this user manual, examples of commands from the device Command Set and how they would appear in a terminal interface window (program) are shown as examples.

4.2 Analog section

The high voltage supply is actively controlled, stable and has low noise. The analog section (**Figure 2**) includes a low-noise charge sensitive amplifier, pulse shaper, fixed gain amplifier, and a variable gain amplifier. The incoming charge pulse from the neutron detector is shaped, amplified and buffered. The signal pulses from some neutron detectors are quite small, containing on the order of a few femtoCoulombs of charge; therefore, low noise amplification of these signal pulses is critical.

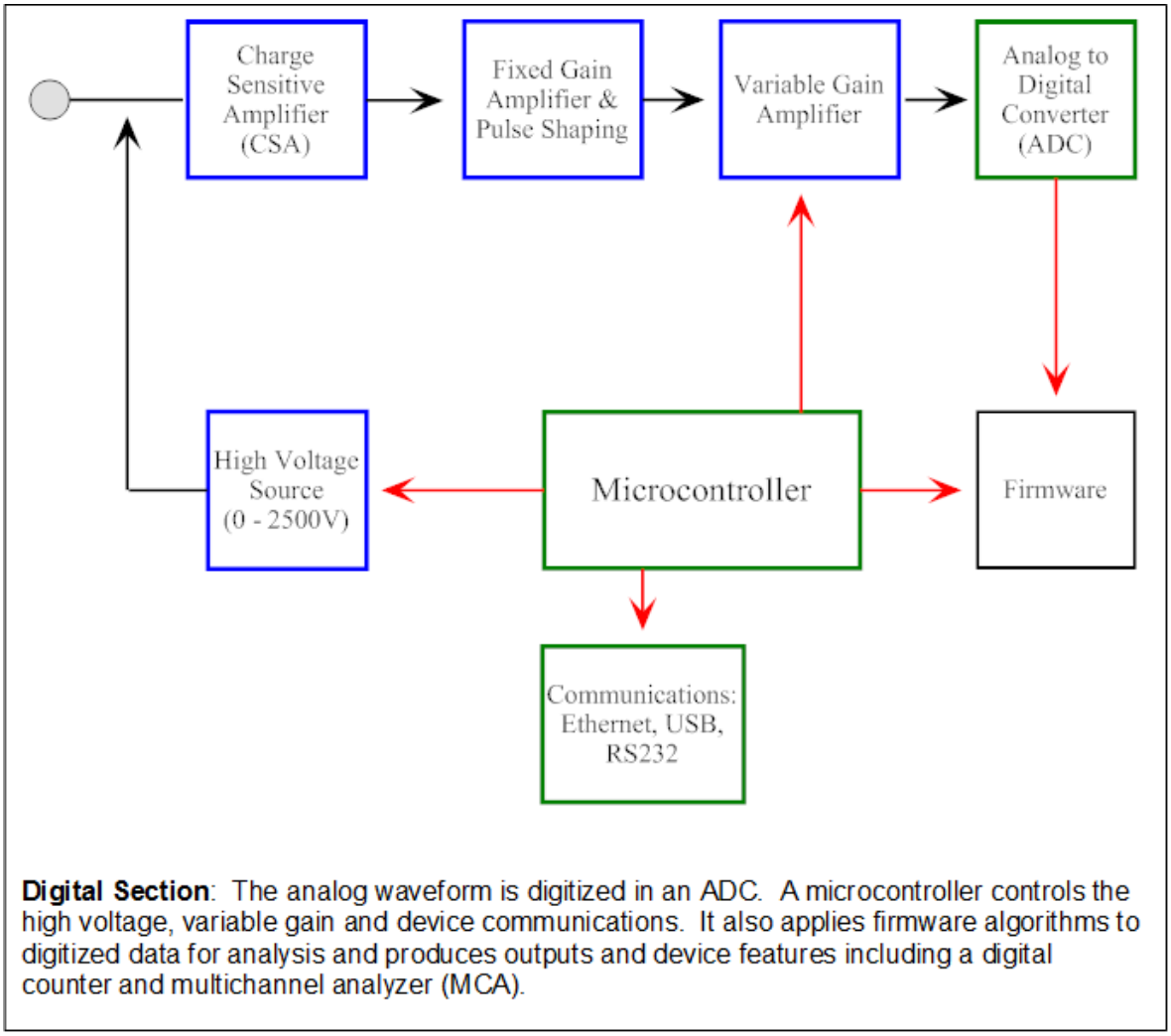
4.3 Digital section

The digital section (**Figure 3**) includes a microcontroller, analog-to-digital converter (ADC), communications chip, real-time clock and SD card(s). The analog shaped pulse is digitized in the ADC. The microcontroller applies various firmware algorithms to the digitized pulse for analysis. For example, the detector signal pulse height is measured and compared to the digital discriminator levels to determine if a signal pulse is valid. Other functions such as a digital counter, multichannel analyzer (MCA), data logger and device communications are managed by the microcontroller.



Analog Section: The input to the NPM includes a stable high voltage source and a charge sensitive amplifier (CSA). The integrated charge pulse is shaped and a variable gain amplifier provides an adjustable gain range of 1 – 20 to the user.

Figure 2. Analog Section.



Digital Section: The analog waveform is digitized in an ADC. A microcontroller controls the high voltage, variable gain and device communications. It also applies firmware algorithms to digitized data for analysis and produces outputs and device features including a digital counter and multichannel analyzer (MCA).

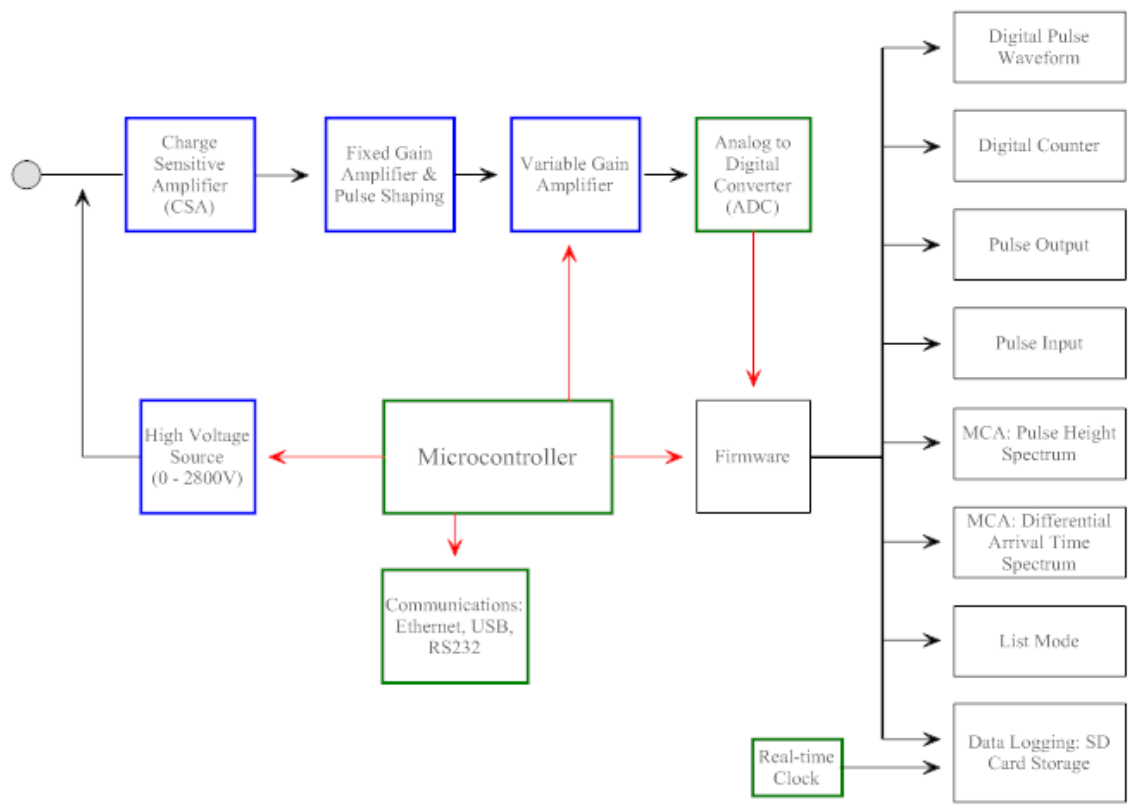
Figure 3. Digital Section.

4.4 Outputs and Functions (Overview)

A range of outputs and functions (**Figure 4**) are available for the NPM3100 series. Generally, these are controlled by the device Command Set. Outputs and Functions include:

4.4.1 Digital Pulse Waveform:

The shaped signal waveform is digitized by an ADC. This digitized waveform (256 points with 125*nsec* timing resolution) may be accessed by the Pulsewave command which causes the NPM to print the next retrieved waveform to the output of its communications line. Pulse Waveform does not operate asynchronously, but is prompted only by a command. A GUI application may be used to display the digital shaped waveform.



Outputs and Functions: A range of outputs and functions are available on various NPM models. Examples of outputs include a TTL pulse or the digitized shaped pulse waveform. Features include a digital counter or multichannel analyzer to produce detector pulse height spectra. The microcontroller based architecture of the NPM is flexible and permits custom functions to be implemented in firmware.

Figure 4. Outputs and Functions.

4.4.2 Digital Discriminator:

A digital upper and lower discriminator may be specified by the user. When a pulse height is measured, it is compared to these two discriminator levels and is considered a valid neutron count if it falls between them.

4.4.3 Digital Counter:

When a valid neutron count is measured, an internal digital counter is incremented (> 4 billion counts). A query command allows the user to download digital counts and an elapsed time indicating the length of time in which the counts have accumulated. The time returned here has a resolution of only 1 second. Higher timing resolution can be achieved by using the Datalogging feature of the device (to precisely and periodically sample the counts). The user may also control the interval of sampling precisely by utilizing an external timer to control the query of counts information.

Set the ***TTLCounter*** parameter to a value of 1 to activate the counting of TTL Input pulses.

Note: List Mode data allows the user to timestamp individual pulses to 500 nanosecond resolution

4.4.4 Pulse Output:

The NPM3100U model has a standard TTL Output line (SMA connector) that may be configured to emit a TTL pulse under two conditions:

a. TTL output pulse emitted with each neutron count.
b. TTL output pulse emitted with each input TTL pulse (pulse forwarding).
c. TTL output pulse with each neutron count and with each input TTL pulse (pulse forwarding)

See the ***TTLOutWidth*** and ***TTLMode*** parameters to configure the Digital Pulse Output behavior.

4.4.5 Pulse Input:

The NPM3100U has a standard TTL Input line (SMA connector) that may be configured to count and log external input pulses with frequencies as high as 40MHz. As mentioned above in section 4.4.4, an external TTL pulse can cause the TTL Output to emit a TTL pulse, effectively transmitting the external TTL pulse through the NPM. This capability is useful in array applications in which multiple NPMs are connected in series, in a ‘daisy-chain’ fashion.

See the ***TTLOutWidth*** and ***TTLMode*** parameters to configure the Digital Pulse Output behavior.

4.4.6 Temperature & Humidity Sensor:

An optional temperature and humidity sensor may be installed in all NPM models as a diagnostic tool for monitoring the device environment.

4.4.7 MCA: Pulse Height Spectrum:

The NPM has a multichannel analyzer function that measures the signal strength or 'height' of each neutron signal pulse and is able to store the number of counts for each pulse height in a histogram. The user may specify the number of bins in this pulse height spectrum, or histogram. The number of bins must be one of the following: 64, 128, 256, 512, or 1024. Each bin can record over 4 billion counts. The user may use the Command Set to specify the number of bins in the histogram. Additionally the user may query the current accumulated histogram or zero the histogram at any time . If the Datalogging option is selected, the user may configure the time period at which the histogram is periodically recorded. For further details, see Section 6.6.7 .

4.4.8 Differential Arrival Time Spectrum:

The NPM can measure the time between successive neutron counts and record these times in a Differential Arrival Time spectrum, or DT Histogram. The Delta T time per DT histogram bin size is user selectable in 1 *usec* levels. This function is useful in neutron coincidence counting. For further details, see Section 6.6.8 .

4.4.9 Data Logging:

The NPM has a real-time clock and can record device data, repeatedly, for a user specified period of time. The user also selects what type of data is recorded. Logged data is recorded to an internal SD card in FAT32 file format. Data which can be logged include: the number of neutron counts, temperature, humidity, external TTL input pulse counts. The Pulse Height Spectrum histogram may also be logged.

4.4.10 List Mode Data Logging:

NPM3100 series devices can sample and record the pulse height and arrival time of **each** individual neutron count with 500*nsec* resolution. This function has value in applications involving both individual NPMs and arrays of NPMs such as often used in Nuclear Non-Destructive Assay (NDA) tools.

5 NPM3100 Technical Specifications

5.1 Mechanical Specifications NPM3100U & NPM3100E

Physical Components	NPM3100U Device
Dimensions	1in OD x 4.4in length (2.54cm OD x 11.2cm). Cylindrical profile.
Enclosure Finish	Anodized aluminum (blue).
High Voltage Connector	Options: -HN Male with Swivel Nut or HN Female. -SHV Male or Female. -MHV Male or Female. -Pigtails with HV cabling and HN, SHV, or MHV terminations may also be provided.
Communication Connector	Micro USB.
LED	Indicator LED (red) on rear panel.
TTL Input	SMA Connector, Female, threaded.
TTL Output	SMA Connector, Female, threaded.

Table 1: NPM3100U Mechanical Specifications

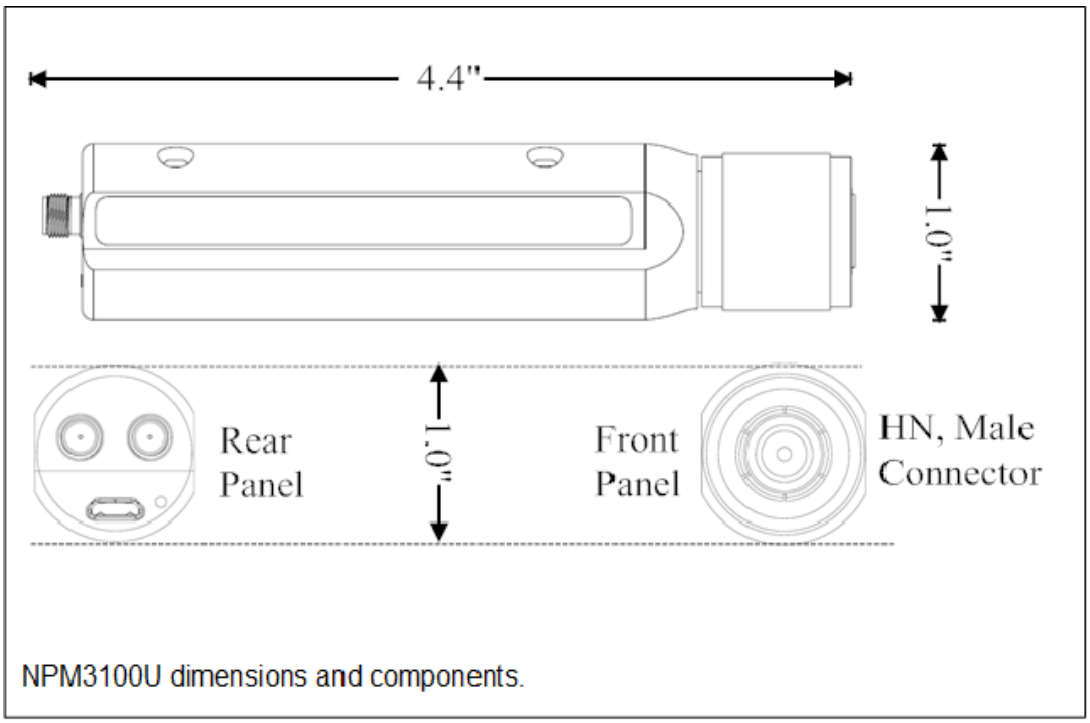


Figure 5. NPM3100U Device Dimensions

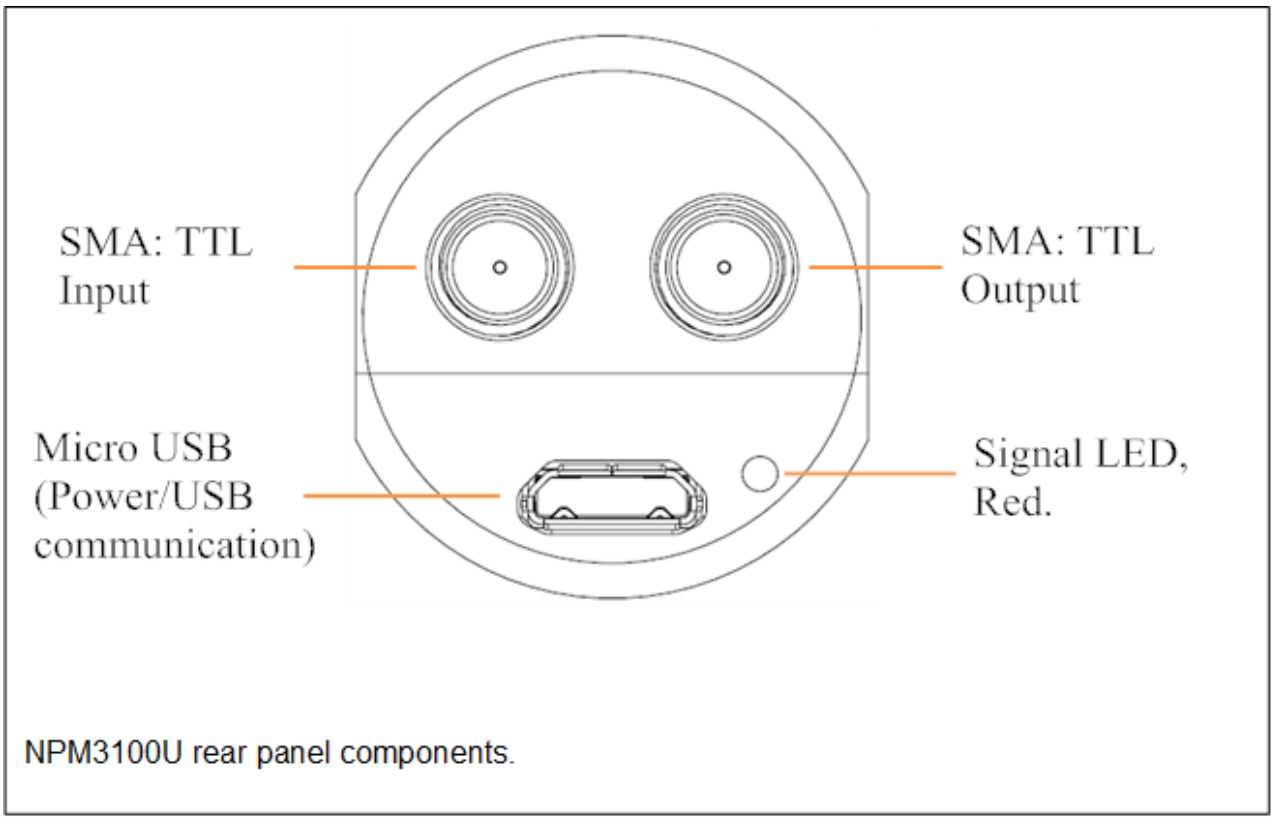


Figure 6. NPM3100U Rear Panel

Physical Components	NPM3100E Device
Dimensions	1in OD x 5.2in length (2.54cm OD x 13.2cm). Cylindrical profile.
Enclosure Finish	Anodized aluminum (blue).
High Voltage Connector	Options: -HN Male with Swivel Nut or HN Female. -SHV Male or Female. -MHV Male or Female. -Pigtails with HV cabling and HN, SHV, or MHV terminations may also be provided.
Communication Connector	Power over Ethernet
LED	Indicator LED (red) on rear panel.

Table 2: NPM3100E Mechanical Specifications

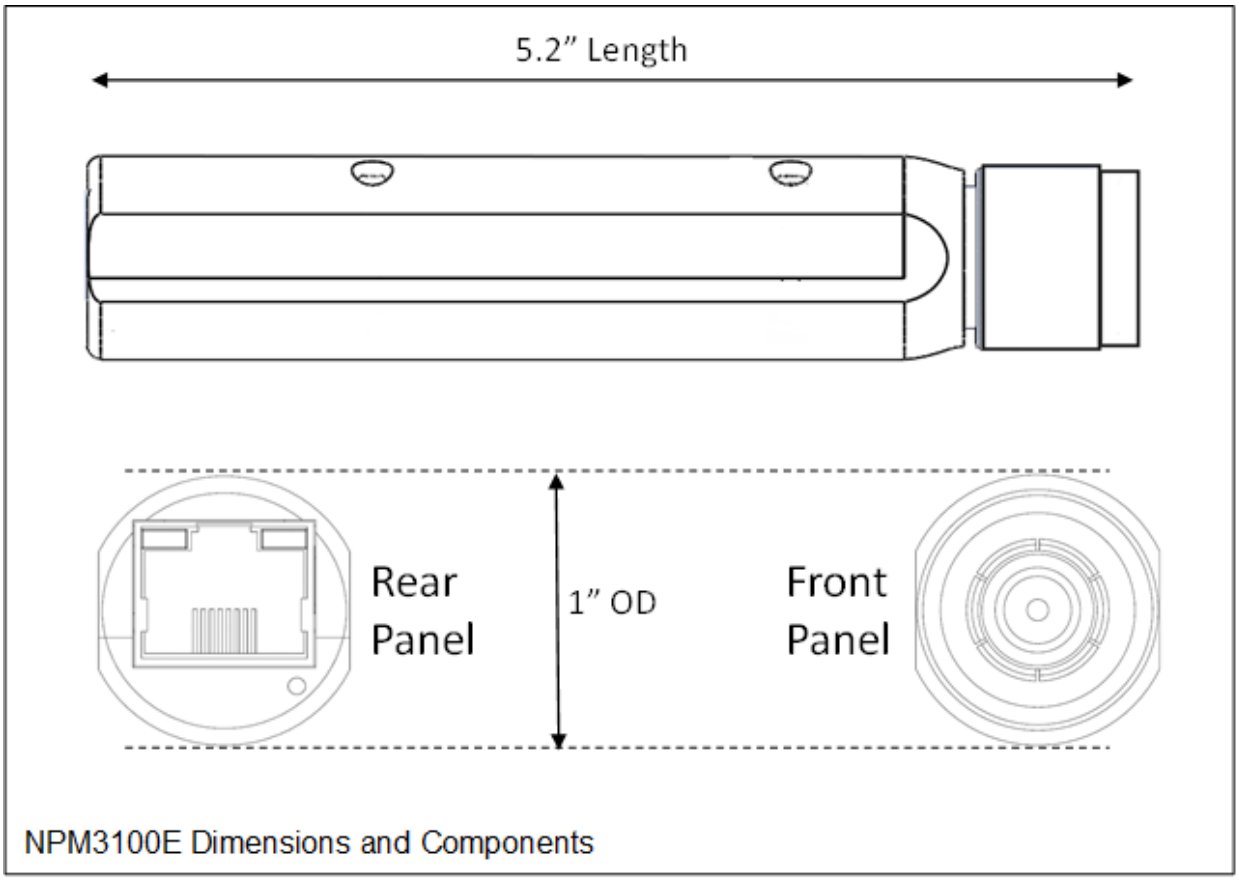
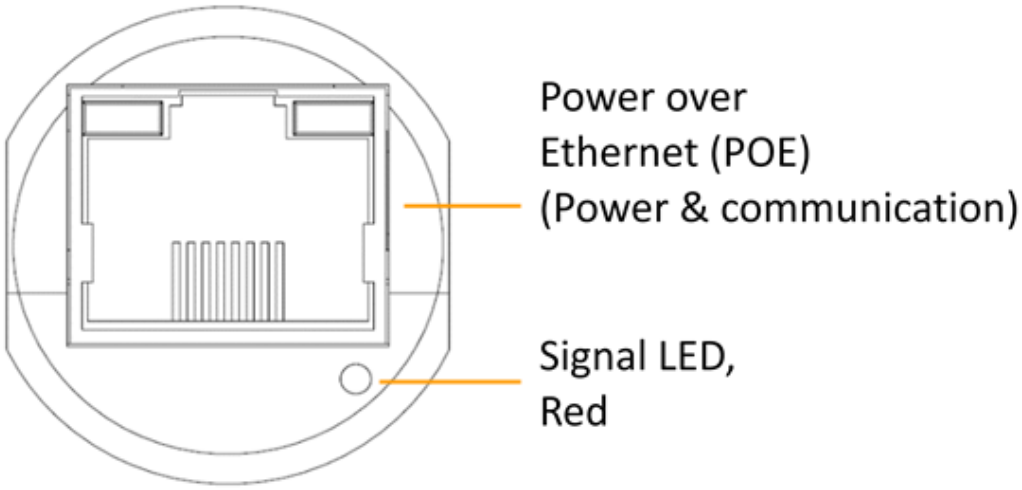


Figure 7. NPM3100E Device Dimensions.



NPM3100E rear panel components

Figure 8. NPM3100E Rear Panel

NPM3100E (side view). The male HN connector with slip nut allows for attachment to gas tube detectos without the need to rotate the NPM or the detector.

Figure 9. NPM3100 side view.

5.2 Electronic Specifications

Analog Components	
High Voltage (HV)	0v (HV off) or 150V to 2,800V. RMS noise 0.010V. HV level user adjustable. Step size 1V.
Charge Sensitive Amplifier (CSA)	Integrates input charge pulse and converts to voltage. Sensitivity: 1V / pC or custom.
Pulse Shaping Electronics	Pulse shaping time constant 1μs to 10μs (consult Quaesta when ordering). Pulse shaping decay time 10μs to 100μs (contact Quaesta Instruments to select)
Deadtime	Minimum Deadtime between successive counts, 15μs to 100μs. User selectable to 6000μs maximum.
Neutron Counting Rate	100kHZ for 1μs shaping time constant; 33kHz for 3μs shaping time constant, 10kHz for 10μs shaping time constant
Amplifier Electronics	User selectable gain range 1 to 20; 0.1 step size.

Table 3: Analog Components

Digital Components	
Microcontroller & Timer	ARM Processor
Nonvolatile memory	Up to 128Gb.
Analog-to-Digital Converter (ADC)	12 bit
Temperature & Humidity Sensor	Temperature: range -40C to 124C; resolution 0.01C; accuracy +/- 0.1C. Humidity: range 0 to 100% RH; resolution 0.03% RH; accuracy +/- 3%.
NPM3100U ONLY	*TTL Input / Output available on NPM3100U only*
TTL Output	Output TTL pulse triggers with neutron counts. 25ns to 16ms pulse width (user selectable).
TTL Input Mode 1	Digital counter mode. NPM counts pulses on the TTL input line and logs them independently from neutron counts. 13ns pulse width minimum, 1MHz maximum.
TTL Input Mode 2	Digital pulse feed through. NPM detects pulse on TTL input and transmits a pulse on the TTL output line independently from TTL output pulses corresponding to neutron counts. For 'daisy chain' operation of NPMs. 13ns pulse width minimum, 1MHz maximum rate.

Table 4: Digital Components

Environmental Operation	
Temperature	-40C to +80C
Humidity	80%, noncondensing

Table 5: Environmental Operation

6 Device Operation

The NPM3100 device is configured and controlled via a custom Command Set. Users can interact with a NPM3100E device through commands issued from a computer using (1) a terminal interface application such as *Tera Term Pro* or (2) custom interface software interface such as a GUI application. A software interface, such as a GUI, uses the same Command Set that the user can enter directly in a terminal window.

A detailed description of all device commands is found in *7. Device Command Set.*

The Command Set interacts with the NPM in two primary ways:

1. Configuring or controlling the NPM by 'writing' device operational parameters.
2. Querying or reading device operational parameters or device data.

6.1 Interactive versus Autonomous Operation

Generally, the NPM may be operated either interactively or autonomously.
During interactive operation, a user will send commands to the NPM to configure, control or read information from it. Interactive operation is possible using a terminal interface or custom interface software, and presumes the use of a computer.

A user may also configure the NPM to operate autonomously, without only power required.

Autonomous operation is often used in Unattended or Remote monitoring. If the NPM is selected with the Datalogging option, the NPM can be configured to periodically sample and record neutron counts, external TTL pulses (if using the NPM3100U device), Temperature and Humidity, and Pulse Height spectrums. The periodic recording of the Pulse Heigh spectrums allows the detector system health to be monitored. Once the NPM is fully configured, it need not be connected to a computer or external hardware device. The NPM only requires power, and it will log data according to its instructions. Logged data can be stored on SD Card(s) for later retrieval, and the device can operate independently in this fashion for an indefinite period of time.

Autonomous operation of the Detector system to which the NPM is attached can also be implemented through custom interface software or hardware which periodically queries or controls the NPM. For example, Quaesta offers a hardware data logger (model DL2100) that controls up to 16 Quaesta NPM devices. This data logger will manage NPM configuration settings, automatically download and store data from NPMs, transmit data via telemetry, and perform other functions.

6.2 Standard Operational Parameters

The NPM has a variety of operational parameters that the user can both configure and view using the Command Set. These parameters are stored in nonvolatile EEPROM and are retained even when the device is turned off or rebooted.
Commands and parameters are not case sensitive.

Standard Operational Parameters include:

1. **High Voltage:** The high voltage value can be both written (or set) and read by the ***Voltage*** command.

2. **Maximum High Voltage**: The maximum allowed high voltage value can be both written and read by the ***MaxVoltage*** command. Of course, the maximum high voltage setting cannot be greater than the maximum voltage of the high voltage supply in the device, which is either 2000V or 2500V.

3. **Gain**: The gain value of the variable gain amplifier in the analog section of the device can be both written and read by the ***Gain*** command.

4. **Lower Discriminator**: The value of the lower discriminator can be both written and read by the ***Lowerdisc*** command. The lower discriminator value is given in terms of bin number within the pulse height spectrum. The minimum lower discriminator value is bin is 1/32 of the Number Of Bins (i.e., Bin 4 when the device is configured with the ***Nbins*** parameter equal to 128), and the maximum value is equal to the value of the upper discriminator minus one.

5. **Upper Discriminator**: The value of the upper discriminator can be both written and read by the ***Upperdisc*** command. The upper discriminator value is given in terms of bin number within the pulse height spectrum. The minimum upper discriminator value is equal to the lower discriminator value plus one, and the maximum value is equal to the maximum bin number in the pulse height spectrum histogram -1. i.e., for ***Nbins*** = 128.

6. **Number of Bins in Histogram**: The number of bins in the pulse height spectrum histogram may be both written and read by the ***NBins*** command. The histogram can have the following number of bins: 64, 128, 256, 512, 1024.

7. **Deadtime**: The NPM is constantly scanning its input for pulses and comparing the voltage of the pulse profile to the Lower Discriminator value. When a pulse contains a voltage level higher than that corresponding to the Lower Discriminator value, the NPM captures the waveform, measures its signal strength or pulse height, and, if it is a valid neutron count, then it increments the digital counter value. While all of this is happening, the NPM is not ready to receive another neutron signal pulse, and subsequent neutron counts are 'locked out' and cannot be counted during this time. This lockout time is referred to as the Deadtime of the device. The minimum

Deadtime of the NPM varies across NPM models. For the NPM3100 series, the user can configure the Deadtime to be any value from the minimum Deadtime of 15 *usec* to 6*msec* (6000*usec*). The Deadtime can be both written and read by the ***Deadtime*** command.

8. **Timing Resolution of Differential Arrival Time Spectrum**: The Differential Arrival Time Spectrum is a histogram of the arrival times of successive neutron counts. This histogram is fixed at 1000 bins each with the same duration in time. Using the ***DtRes*** command, the user can select or view the duration of these bins with allowed Delta T resolutions of 1*usec*, 10*usec*, 100*usec*, 1000*usec*, and 10000*usec*. The Differential Arrival Time Spectrum may be retrieved via the ***DtHgm*** command

9. **Shaped Pulse Waveform Display Format**: When a neutron shaped pulse waveform is digitized in the ADC, this waveform is automatically output (streamed to the output interface). The shaped waveform output by default has 256 points (125*nsec* time spacing), which spans 32*usec*. The user can request the output waveform or a subset of its 256 points. Using the ***PulseWave*** command, a number of samples on the shaped waveform (as digitzed by the A/D converter) can be displayed for the next incoming pulse.

10. **Peakmode Display Format:** Using the ***Peakmode*** command, the user can enable Peakmode output, which displays summary information for each incoming pulse as they arrive, including the neutron pulse count number and the assigned Bin # of the Pulse in the accumulating Pulse Height spectrum. The Differential arrival time (time since previous pulse) is also displayed in the text output. ***Peakmode*** is typically only used for diagnostics and quick device setup.

11. **Pulse Height Spectrum Histogram**: The signal pulse height spectrum histogram is accumulated and stored in memory by the NPM, and can be queried or retrieved using the ***Hgm*** command. The format in which this histogram is displayed is controlled by the ***HgmMode*** command. The number of bins utilized in the pulse height spectrum histogram is configured through the ***Nbins*** parameter.

12. **TTL Input and TTL Output**: Some models of NPMs (such as the NPM3100U serires) have the capability to output a proper TTL pulse when neutron pulses are detected and/or external TTL input pulses are received. The external TTL Output and TTL Input configuration can be controlled using the ***TTLMode*** and ***TTLWidth*** prameters.

13. **LED Mode**: All NPM models have a signal LED on the rear panel that can be configured to pulse with each valid neutron count; the LED may also be turned off. Configuration of the LED is controlled by the ***LEDMode*** command.

6.3 Data Logging Operational Parameters

The NPM has an optional internal data logging feature for all models. The user can configure certain aspects of the data logging including the type of device data to be logged and the time interval.

Data Logging Operational Parameters include:

1. **Data Logging Record Interval**: Under data logging, the user selects the time period for which device data is logged. This logging time interval is called the Record Period. The primary data logged in this interval is the neutron counts but other quantities may also be stored. The Record Period can be configured and its current setting displayed using the ***RecordPeriod*** command.

2. **Logging the Pulse Height Spectrum**: The pulse height spectrum can also be logged. However, it is logged on a different time interval which is an integer multiple of the Record Period. The reason for the different logging time intervals is that, quite often, a user will find it convenient to log total neutron counts and the pulse height histogram on different time scales, primarily because for low count rates, some time is required to produce a well-defined spectrum. The command ***RecordsPerHGM*** is used to specify the histogram logging time interval.

3. **Sensor Data Logging**: The NPM has an optional internal temperature and humidity sensor. Data from this sensor may be included with or excluded from the logged data using the commands ***LogTemp*** and ***LogHum***.

4. **Printing and Saving Logged Data**: Data which is selected to be logged during the RecordPeriod can be both printed to the device output and/or saved to the device SD Card(s). The ***PrintDat*** and ***LogDat*** commands control whether or not logged data is printed and/or saved.

5. **Printing and Saving Pulse Height Histograms**: The Histogram data which is logged every user specified, integer multiple of the Record Period can be both printed to the device output and/or saved to the device SD Card(s). The ***PrintHGM*** and ***LogHGM*** commands control whether or not logged histograms are printed and/or saved.

6.4 Display of Operational Parameters

Any device operational parameter setting can be displayed by using its associated command. However, the ***Info*** command automatically displays the settings of the most common operational parameters as well as other useful device information. The ***Info*** command is used, typically, in an interactive fashion from a terminal interface window program such as Tera Term or Hyperterminal.

Note: the Command is not case sensitive.

The command ***Info*** yields a response from the NPM shown in **Figure 10**. General information includes the device model number and version, serial number, firmware version and a user selectable name for the device. The configuration settings for the standard and data logging operational parameters are also displayed. The user may quickly see, for example, the set values for high voltage, gain and lower discriminator.

```
info

Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version    1.0.8
BootLoader Version 2
Model               NPM3100
Model Version       USB
Serial Number       NU015
Time Constant       3us
Name                Name
Identifier          15

***NEUCHROMETER PARAMETERS***
Voltage Set         0
Voltage Measured    0.0
MaxVoltage          2500
Gain                3.5
DiscLow             10
DiscHigh            127
DeadTime            30
PeakMode            0
LEDMode             1
TTLOutMode          1
TTLOutWidth         100
TTLCounter          1
PulseSim(uS)        50000
nBins               128
HgmMode             2
DtResolution        1

***LOGGER PARAMETERS***
RecordPeriod(Sec)   60
NewFilePeriod       Day
RecordsPerHGM       60
PrintDAT            0
PrintHGM            0
LogDAT              0
LogHGM              0
LogTemp             1
LogHum              1
LogTTL              1
ListSectors         1
Current Time        2015/08/27 15:18:23
```

Figure 10. INFO Command Output for the NPM3100U device

Another command for displaying useful device information is the ***Menu*** command. This command causes the NPM Command Set, with a brief explanation of each command, to be printed to the device output in text format. This is not a detailed description of the Command Set, but it is often useful as a quick reference during interactive operation of the NPM.

6.5 Display of Data

Commands can be used to display device configuration parameters and also device data, including things like the digital counter values, temperature and the pulse height spectrum. Examples of data display in a terminal window are shown in **Figure 11** and **Figure 12**.

```
query
125, 65
```

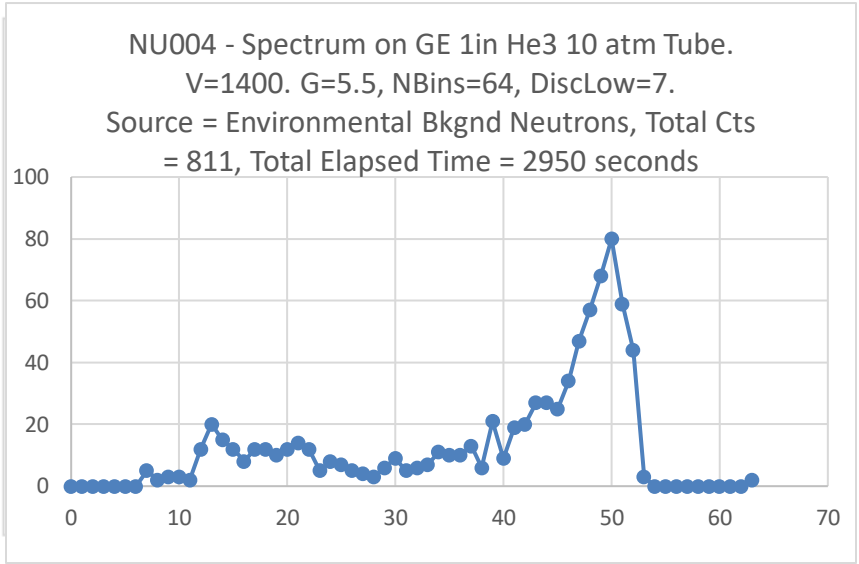
(The query command prints the number of counts and the elapsed time in seconds since the digital counter was initiated. Using the ***Counts*** command gives the same result but zeroes the count value and timer. The reported elapsed time has 1 second resolution).

```
temperature
25, 13
```

(The ***Temperature*** command causes the NPM to read the temperature and humidity values from the internal sensor and print both values, respectively, to the output).

Figure 11. QUERY and TEMPERATURE Command Examples

```
Hgm
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,5
8,2
9,3
10,3
11,2
12,12
13,20
.
.
.
.
43,27
44,27
45,25
46,34
47,47
48,57
49,68
50,80
51,59
52,44
53,3
54,0
55,0
56,0
57,0
58,0
59,0
60,0
61,0
62,0
63,2
Total=811,2950
```



The hgm command prints the current pulse height spectrum histogram (64 bins in this example) to the output. The user can specify this format to some extent. In the pictured format, the histogram bin number and associated count value are printed as pairs. The total counts across the histogram and the time frame for data collection (respectively) are printed at the end of the histogram.

Figure 12. HGM (Histogram) Command and Output Example

6.6 Outputs & Functions

The Outputs and Functions of the NPM3100 are discussed in more detail in this section.

6.6.1 Digital Pulse Waveform:

The shaped signal waveform is digitized by an ADC. Once a valid neutron count is detected based upon the lower discriminator setting, the signal waveform is stored in memory until a subsequent neutron is detected. The waveform is accessed by the ***PulseWave*** command that causes the NPM to print the waveform to its output in text format. The default digitized waveform consists of 256 data points with 125*nsec* temporal spacing. The Pulse Waveform output does not operate asynchronously, but is prompted only by a command. For some models, a GUI application is able to display the shaped waveform.

6.6.2 Digital Discriminators:

A digital upper and lower discriminator may be specified by the user. These values are given in terms of bin number which is related to the pulse height spectrum histogram. The user specifies the number of bins in this histogram which spans the full dynamic range, in voltage, of the amplifier output. For the lower discriminator, the minimum allowed bin value is 1/32 of the ***Nbins*** value. The upper discriminator must be larger than the lower discriminator. Generally, the NPM counts signal events between the upper and lower discriminator values, inclusive of the end points. However, if the upper discriminator is set to the maximum bin number or the maximum minus one, this disables the upper discriminator, and all signal pulses equal to or greater than the lower discriminator value are counted as valid neutron events. Set the Lower Discriminator with the ***LowerDisc*** command and the Upper Discriminator with the ***UpperDisc*** command.

Since the discriminators are digital, custom multiple regions of interest may be produced by using multiple discriminators spanning different regions of the spectrum. This requires custom device firmware. Call to discuss your specific application.

6.6.3 Digital Counter:

When a valid neutron count is measured, an internal digital counter is incremented (up to > 4 billion counts). The ***counts*** command causes the device to output the number of neutron counts and the associated elapsed time interval to its output. The accumulated counts and accumulated elapsed time is zeroed. To ***query*** command outputs the number of accumulated neutron counts and accumulated elapsed time *without* zeroing the counts and elapsed time. The resolution of the timer associated with this feature is 1 second. This is not intended as a high temporal resolution digital counter. However, higher temporal resolution can be achieved by utilizing the autonomous Datalogging

feature of the NPM to periodically sample, internally record and/or output the NPM data with precise timing controlled by the NPM's internal high resolution timer. Additionally, an external computer or control device with its own high resolution timer can periodically query the NPM data utilizing an external computer or control device.
As an example of such an external control device, Quaesta makes a DL2100 series data logger that will connect to certain Quaesta NPM devices, and can query and timestamp neutron counts with its own high resolution timer.

6.6.4 TTL Output:

The NPM3100U has a TTL Output that can be configured to send out a TTL pulse with each valid neutron count, or with each TTL pulse on the device's TTL Input, or both. The physical TTL Output line is a threaded female SMA connector on the rear panel of the device. The TTL Output can be configured using the ***TTLMode*** and ***TTLWidth*** command. The TTL Output may be turned off or on. And the length of the TTL pulse may be selected The TTL Output has 50 ohm output impedance and is designed to interface with digital pulse counters that have 50 ohm input impedance.

6.6.5 TTL Input:

The NPM3100U has a TTL Input that can measure TTL pulses from an external source. The physical TTL Input is a threaded female SMA connector on the rear panel of the device. This input can detect and count pulses at up to 20*MHz* rates. The input can be configured to do nothing (off), to count external TTL pulses and log this information, to trigger the TTL Output to transmit a TTL pulse with each TTL input pulse measured, or both log and transmit external pulses. External TTL pulses with pulse widths from 25*nsec* to ymsec can be measured. The TTL input is 50ohm terminated.

6.6.6 Temperature & Humidity Sensor:

An optional temperature and humidity sensor may be installed in all NPM models as a diagnostic tool for monitoring the device environment. Temperature and humidity values may be queried upon command, and they may also be logged if the data logging option is enabled with the device. The commands use to query this sensor are ***Temperature*** and ***Humidity***.

6.6.7 MCA: Pulse Height Spectrum:

The variable gain amplifier amplifies the shaped waveform. This analog waveform is digitized into a user selectable but discrete number of levels or bins, settable through the ***Nbins*** command parameter; allowed values of ***Nbins*** are 64, 128, 256, 512 and 1024 bins. A typical choice is 128 bins which provides for effective monitoring of the Detector system health for most proportional neutron detector configurations. An algorithm measures the signal strength or 'pulse height' of the digital shaped waveform in units of bin number for each valid neutron count. The NPM has a multichannel analyzer function which means it is able to store the number of neutron counts at each signal strength or bin number. These count values for each bin are stored in an array called the neutron pulse height spectrum, which is a histogram. This histogram can

record over 4 billion counts per bin. The command ***nBins*** is used to specify the number of bins in the histogram from the allowed list of discrete values. The command ***Hgm*** prints the current histogram to the device output according to the histogram configuration parameters specified in the ***HgmMode*** command.

The pulse height spectrum of a proportional neutron detector such as a Helium-3, BF_3, B-10 lined detector is an energy spectrum of the charge pulses developed in the detector during a neutron detection event. However, this signal pulse height spectrum does not reflect the actual energy spectrum of the neutrons themselves, that is, the pulse height does not represent the kinetic energy of the neutrons being measured by the detector. A proportional neutron detector or counter counts neutron detection events and gives only count rate information; it is a not a neutron energy spectrometer. However, the pulse height spectrum is an invaluable tool when working with proportional neutron counters, allowing for easy setup and and continous monitoring of the health of the detector system.

The device Pulse Height Spectrum Histogram provides for the following advantages.

a. Setup: Optimal configuration of a proportional neutron counter involves a few important items: selecting the high voltage and gain such that the pulse height spectrum is within the dynamic range of the amplifier and is well-defined; selecting the lower and upper discriminators to maximize signal-to-noise by counting all available neutrons and eliminating electronic noise and gamma ray counts.
b. Diagnostics: Over time, the properties of the gas detector or electronics can change which can lead to degraded performance. Moisture ingress, extreme environments (cold, heat, vibration, etc) may affect the device operation. Device degradation or failure will be evident in the pulse height spectrum, often before the problem becomes severe. The ability to quickly and easily view the pulse height spectrum is a valuable diagnostic tool to ensure proper operation of the detector and electronics system. The diagnostic process can even by automated by software that monitors changes in the shape of the spectrum. Pulse Height spectrums can be logged internally on the NPM device for later retrieval and review.
c. Ease-of-use: Without direct access to the underlying pulse height spectrum, that is, without a multichannel analyzer, one must infer the configuration of the detector. The most common method is the so-called ‘HV plateau’ method in which the underlying pulse height spectrum is inferred by creating a graph of the detector count rate versus the high voltage value for fixed gain and lower discriminator settings. The plateau method can be very time consuming especially for measuring low neutron fluxes and low count rate. Properly setting up and optimizing detector operation is more straight forward and extremely easy with the MCA capability. Detector systems can be realiably and repeatably set up in a matter of minutes, with no radiation source.

6.6.8 MCA: Differential Arrival Time Spectrum:

The NPM can measure the time between successive neutron counts and record these times in a Differential Arrival Time Spectrum, or DT Histogram. The number of bins in this DT histogram is fixed at 2048 bins. When a neutron count is measured, a timer is initiated. This timer measures the time until the next neutron count. The measured time is digitized into a discrete histogram with 1000 bins. The timing resolution of these bins is configured by the user with the ***DtRes*** command and can have the values 1, 10, 100, and 1000 *usec*. The differential arrival time spectrum is used in neutron coincidence counting. . Since 1000 histogram bins are used in the Differential Arrival Time histogram, the Differential Arrival Time Histogram spans differential arrival times of 1000 x the ***DtRes*** value. i.e. a DtRes of 10 *usec* will have DT bins ranging from 10 *usec* to 10000 *usec* (10 msec), and a DtRes of 10000 *usec* wave DT bins ranging from 10000 *usec* to 10,000,000 *usec* (10 seconds). Neutron pulses with Differential Arrival times > 1000 x DTRes will be accumulated in the highest Bin (i.e. Bin 999). The bins range from 0 to 999.

Note: The timing reolution of Differential Arrival Times can be limited by the deadtime or lockout time which refers to the shortest successive measurement interval of the device. Typical deadtime for the NPM devices are on the order of 10 x the Time Constant employed in the Charge Sensitive and Pulse Shaping Amplifier portions of the NPM device. For a 3 *usec* shaping time constant – often used with 1 inch or smaller diameter tubes, the Deadtime or Lockout time for the NPM is on the order of 30 *usec*. This means pulses closer than 30 *usec* cannot be resolved. For larger diameter 2in or larger tubes, a 10 *usec* shaping time constant is often used. In this case the Deadtime or Lockout time is on the order of 100 *usec*. See ***Deadtime*** discussion.

6.6.9 Data Logging & List Mode Data Logging

The Data Logging and List Mode Data Logging functions are powerful features of the 3100 series NPMs. (Note that all NPM models offer data logging, but only the 3100 series products offer List Mode Data Logging).

Data Logging data is categorized into 3 data types: (1) DAT data, (2) HGM data and (3) LST data. The following discussion includes information about and terminology associated with these data types, their files and directories, and data logging in general.

6.6.9.1 DAT Data

1. DAT data is device data that is measured during a fixed, user specified, time period and then recorded at the end of this recording time period.
2. The recording time period for DAT data is called the Record Period, and DAT data is recorded at the end of every Record Period.

3. The length in time of the Record Period is specified by the ***RecordPeriod*** command.
4. When Data Logging is initiated, the NPM will measure and record the user specified DAT data every Record Period, over and over, until it is directed to stop or the device power is removed.
5. Which data is to be recorded as DAT data is somewhat user configurable.
    a. Neutron counts are always included when DAT data is logged.
    b. The real-time clock value (date & time) is always included when DAT data is logged.
    c. Temperature can be selected for logging.
    d. Humidity can be selected for logging.
    e. Supply Voltage can be selected for logging.
6. DAT data is stored in files called DAT files that have the .DAT file extension.
7. The Active DAT file is the one that the NPM is currently writing logged DAT data to, continuously, every Record Period.
8. When a DAT file is created under the Data Logging function, it becomes the Active DAT File, and it is given a name that is related to the real-time clock value at the moment when the file is created. Later, the file may be renamed by the user.
9. The Active DAT file is created at the beginning of a data logging sequence, and it is assigned a file name associated with the real-time clock value at this moment.
10. DAT files are FAT 32 files.
11. DAT files are stored in a FAT 32 directory on the SD Card or Cards called the DAT directory.
12. The DAT directory is created by the NPM if Data Logging is enabled. When the NPM starts up, it searches the directories of the SD Card or Cards. If the DAT directory is not present, then a DAT directory is created by the NPM.
13. NPMs with Data Logging enabled are shipped with SD Cards that have a DAT directory. However, the user can delete the DAT directory from an SD. If the device model contains an external SD card, the user can remove the existing SD card and insert a new SD card. In such cases, upon start up, the NPM will automatically create a DAT directory on its SD Card or Cards if it is not already present.
14. The portion of DAT data written to a DAT file every Record Period is a called a DAT Data Record. Every Record Period, a new DAT Data Record is appended to the end of the Active DAT file.
15. The information contained in a DAT file is a file header, called the DAT File Header followed by a series of DAT Data Records.
16. Data Logging can continue for a long time, and the DAT file can become large. A new Active DAT file can be created after a user specified time interval, called the New File Period, which must be longer than the Record Period. For, example, a new Active DAT file can be created every day or longer.
17. The length in time of the New File Period is specified using the ***NewFilePeriod*** command.

6.6.9.2 HGM Data

1. HGM data is graphical, histogram data that is measured during a fixed, user specified, time period and then recorded at the end of this recording time period.
2. The recording time period for HGM data is called the Histogram Period, and HGM data is recorded at the end of every Histogram Period.
3. The Histogram Period must be an integer multiple of the Record Period and is specified by the command RecordsperHGM.
4. When Data Logging is initiated, the NPM will measure and record the user specified HGM data every Histogram Period over and over until it is directed to stop or the device power is removed.
5. HGM data, which is not user configurable, includes (in order):
    a. The current DAT Data Record.
    b. The neutron Pulse Height Spectrum Histogram that has been developed during the current Histogram Period.
    c. Total histogram counts (summed over all bins) and total elapsed time (the Histogram Time).
6. HGM data is stored in files called HGM files that have the .HGM file extension.
7. The Active HGM file is the one that the NPM is currently writing logged HGM data to, continuously, every Histogram Period.
8. When an HGM files is created under the Data Logging function, it becomes the Active HGM File, and it is given a name that is related to the real-time clock value at the moment when the file is created. Later, the file may be renamed by the user.
9. The Active HGM file is created at the beginning of a data logging sequence, and it is assigned a file name associated with the real-time clock value at this moment.
10. HGM files are FAT 32 files.
11. HGM files are stored in a FAT 32 directory on the SD Card or Cards called the HGM directory.
12. The HGM directory is created by the NPM if Data Logging is enabled. When the NPM starts up, it searches the directories of the SD Card or Cards. If the HGM directory is not present, then a HGM directory is created by the NPM.
13. NPMs with Data Logging enabled are shipped with SD Cards that have an HGM directory. However, the user can delete the HGM directory from an SD. If the device model contains an external SD card, the user can remove the existing SD card and insert a new SD card. In such cases, upon start up, the NPM will automatically create a HGM directory on its SD Card or Cards if it is not already present.
14. The portion of HGM data written to a HGM file every Histogram Period is a called a HGM Data Record. Every Histogram Period, a new HGM Data Record is appended to the end of the HGM file.

15. The information contained in an HGM file is a file header, called the HGM File Header, followed by a series of HGM Data Records.
16. Data Logging can continue for a long time, and the HGM file can become large. A new Active HGM file can be created after a user specified time interval, called the New File Period, which must be longer than the Histogram Period. For, example, a new Active HGM file can be created every day or every week.
17. The length in time of the New File Period is specified using the ***NewFilePeriod*** command.

6.6.9.3 LST Data

1. LST data is device data that is recorded not based on a recording time period but based on an event, a neutron count.
2. LST data is recorded every time a neutron count occurs for a user specified maximum number of counts.
3. When List Mode Data Logging is initiated, the NPM measures and records LST data for every neutron count event until List Mode logging is stopped or the user specified maximum number of neutron counts is reached.
4. For LST data, which data types are to be logged, is not user configurable. Data types includes (in order):
    a. A label or tag that specifies the particular NPM from which the data was generated.
    b. The pulse height of each neutron counted.
    c. A time stamp for the event.
5. LST data is stored in files called LST files that have the .LST file extension.
6. The Active LST file is the one that the NPM is currently writing logged LST data to, continuously, during the List Mode Data Logging session.
7. When an LST file is created under the List Mode Data Logging function, it becomes the Active LST File, and it is given a name that is related to the real-time clock value at the moment when List Mode Data Logging is finished. Later, the file may be renamed by the user.
8. LST files are FAT32 files.
9. LST files are stored in a FAT32 directory on the SD Card called the LST directory.
10. The LST directory is created by the NPM if Data Logging is enabled. When the NPM starts up, it searches the directories of the SD Card. If the LST directory is not present, then an LST directory is created by the NPM.
11. NPMs with List Mode Data Logging enabled are shipped with an SD Card that has an LST directory However, the user can delete the LST directory from an SD. If the device model contains an external SD card, the user can remove the existing SD card and insert a new SD card. In such cases, upon start up, the NPM will automatically create a LST directory on its SD Card or Cards if it is not already present.
12. The portion of LST data written to a LST file after every neutron count is a called an LST Data Record. For every neutron detection event, a new LST Data Record is appended to the end of the Active LST file.
13. The information contained in an LST file is simply a list of LST Data Records in sequential order. The LST file has no file header.
14. List Mode Data Logging does not operate continuously. When List Mode Data Logging is finished, the Active LST file is closed.

6.6.9.4 Data Logging Procedure

The Data Logging function records user selected device data. The NPM has a real-time clock and battery that will keep proper time even when the device is not powered. To log data, the user must:

1. Ensure the date and time settings of the device are correct. If not, they can be set using the ***Time*** command.
2. Select the data logging timing using the ***RecordPeriod*** command. If the Record Period is one hour, then the number of neutron counts and the temperature during this interval, for example, are recorded every hour.
3. Select the Histogram Period for logging the pulse height histogram.
4. Configure the Data Logging function to record the desired data, and ensure data to be logged has the desired format. The user chooses the data to be recorded such as neutron counts and temperature.
5. Data Logging is initiated by selecting DAT or HGM data to be printed to the output, saved on SD card(s) or both. The DAT and HGM data records are independently specified with respect to printing and saving.

Once data logging is initiated the NPM will operate independently and record data according to its configuration. The NPM does not need to be connected to a computer. However, printing data to its output will not be of use if the NPM is not connected to an external device to receive the data. In any case, the NPM can log data to its SD card(s) for later retrieval. SD card data can be accessed and downloaded via the NPM when connected to a computer.

Both DAT and HGM data types are stored in FAT32 file format in a directory on the SD card(s), each in their own subdirectory. The user can view and manipulate the file structure with familiar commands such as ***dir*** (show directory), ***cd*** (change directory), and ***Del*** (delete).

6.6.10 List Mode Data Logging Procedure

List Mode is another data logging function, however, in List Mode the NPM is able to time stamp **each individual neutron count** rather than logging measured values within specified time windows. The data recorded in this mode for each neutron count is:

a. Pulse height (digitized in 2048 bins)
b. Time of count (500*nsec* resolution)
c. NPM identifier tag (for array applications with multiple NPMs)

When Logging data in List Mode:

1. The user first specifies the number of Pulses to be logged in ListMode using the ***ListMax*** command.

2. Acquisition is initiated by the ***ListMode=1*** command, and will continue automatically until the specified number of pulses have been recorded or the ***ListMode=0*** command is entered to stop acquisition, whichever comes first.
3. Data acquired is stored as binary data to the internal SD Card in FAT32 file format in a directory named LST. The data file generated is given a name related to the date and time (taken from the real-time clock) during file creation.

Logged files in directories DAT, HGM and LST can all be read directly from the SD Card(s). List Mode Logging is available for the 3100 series NPMs which have only an internal SD card which is not physically accessible by the user. So, List Mode data must be read from the SD Card through the NPM device itself. *The* ***ListView*** command allows the user to download a List Mode data file and to select the format of the downloaded data in text, hexadecimal or binary formats.

The ***ListStatus*** command will report the current pulse number in the LIstMode acquisition sequence.

More information about the Data Logging and List Mode functions is available in section 7, the Device Command reference section. More information about the directory and structure of all logged data is given in section 6.7, Data Logging: Directory Structure, Data Format and SD Card Storage.

6.7 Data Logging

6.7.1 Directory and File Structure for NPM

NPM3100 devices have an internal SD card that is not removable by the user. If the Data Logging of List Mode Logging option is enabled for any NPM, an SD Card and a real-time clock battery is included.

For NPM models that come with an external SD card slot, if the user inserts a new (properly formatted) external SD Card into the device, the NPM will automatically create its standard directory structure on the new card when it powers up for the first time with the new card.

NPM3100 devices with Data Logging enabled have 3 primary directories for storing logged data. These are called DAT, HGM and LST.

The internal SD card is designated by 0: and the external SD card (if applicable) is designated by 1:. Access to the file system is provided through commands similar to the PC DOS file and directory management commands, i.e., ‘dir’,’cd’,’0:’,’1:’,’getcwd‘, etc.

Displaying a directory of the internal SD card will appear similar to **Figure 13**.

```
0:
0:/  Internal SD Card
dir
D---- 2013/05/11 20:41          0 DAT
D---- 2013/05/11 20:41          0 HGM
D---- 2013/05/11 20:41          0 LST
   0 File(s),          0 bytes total,    3 Dir(s)
```

NPM Standard Directory of Files for DAT, HGM and LST files.

Figure 13. File Directory Structure

The NPM has 3 types of data that it records under its Data Logging and List Mode Logging functions. These are DAT, HGM and LST data types, and the files that store

them are referred to as DAT, HGM and LST files, respectively. Each data type is stored in its own directory in the Standard Directory for Logged Data.

6.7.1.1 Data Types

DAT files are used to store DAT data, in text format. For DAT files to be saved to the SD Card during data logging, the LogDAT configuration parameter must be set to 1 (LogDAT=1). See

DAT Directory and File Contents**,** section 6.7.2**.**

HGM Files are used, primarily, to store histogram (graphical) data, in text format. The data logging configuration, and the duration of data logging will determine both the size and number of histogram graphs stored in a single HGM data file. For example, if Nbins has been set equal to 1024, then each histogram will have 1024 data points. The format of the histogram data is also user specified. It can include just 1024 bin counts that are printed in the order of ascending bin number. Or the histogram data can include data pairs with the histogram bin number followed by its associated neutron count value separated by a comma. See examples of histogram data format in **Figure 14**. For HGM files to be saved to the SD Card during data logging, the LogHgm configuration parameter must be set to 1 (LogHgm=1). See **HGM Directory and File Contents**, section 6.7.3.

Data Logging for DAT or HGM files will begin whenever the parameter LogDAT or LogHGM is set equal to 1, and logging will cease if these parameters are set equal to 0. Device parameter settings are stored in nonvolatile EEPROM and are saved when powering down and recalled when powering up. When the device powers up, if either parameter is already set equal to 1, then DAT or HGM files will be created and data logging will begin immediately for the associated data type. If both are set to 1 on power up, then their file names will be very similar since the file name involves the real-time clock value at the time of creation of the logging file. Of course, they will have different file extensions, .DAT and .HGM.

LST files are used to store LST data in binary format. The size of the LST file is determined by the neutron count rate and the length of time for which LST logging is allowed to proceed. Generally, file size is predetermined by the number of neutron counts selected for logging if it is allowed to proceed to completion. However, LST logging can be terminated early by the ListStop command. See **LST Directory and File Contents,** section 6.7.4)**.**

```
Hgm
0
0
0
0
0
0
1
1
2
1
3
3
5
7
7
Etc.
```

```
Hgm
0,0
1,0
2,0
3,0
4,0
5,1
6,1
7,2
8,1
9,3
10,3
11,5
12,7
13,7
Etc.
```

Two examples of the same histogram data set in different formats, single column (HgmMode=1) and and double column (HgmMode=2).

Figure 14. Histogram Format Types

6.7.2 DAT Directory and File Contents

The user can view the Directory of DAT files stored on SD Card(s) using the NPM's directory command, Dir (**Figure 15**).

```
0:/
getcwd
0:/DAT
dir
D---- 2013/05/11 20:41          0 .
D---- 2013/05/11 20:41          0 ..
----A 2013/05/31 23:59      58911 NPM1_130531.DAT
----A 2013/06/01 23:59      91609 NPM1_130601.DAT
----A 2013/06/02 23:59      91609 NPM1_130602.DAT
----A 2013/06/03 23:59     707119 NPM1_130603.DAT
----A 2013/06/04 01:20      97467 NPM1_130604.DAT
----A 2013/07/01 12:20       1253 NPM1_130701.DAT
   6 File(s),   1047968 bytes total,    2 Dir(s)
0:/DAT Internal SD Card
```

Some directory commands and their outputs are demonstrated. Once inside the DAT directory, the Dir command displays all DAT files by name.

Figure 15. DAT Directory Example.

The latest DAT file created in the example in **Figure 15** as the name 'NPM1_130701.DAT'. The NPM1 prefix is a user specified name that can be given to a particular NPM. The 130701 indicates the date of file creation, July 1, 2013.

The DAT directory contains files with time series of recorded data in text format. A generic text header with NPM parameter configuration information is written at the top of each file (**Figure 16**). The last line of this generic file header contains the date & time, data record number (Index) and the column headers or titles for the data that is to be logged in the file. For example, the column title 'Cnts' applies to the data column containing neutron counts. If data logging has been configured to record temperature, then a column with the title 'DegC' will be present, and so forth. When logged DAT data is recorded each Record Period, it is appended to the active DAT logging file each time.

Figure 17 shows the Datalogging Parameters portion of the DAT file header with annotations.

```
type 0:/DAT/NPM1_130701.DAT

Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version    X.1.0.1
Model               NPM3100
Model Version       ETH
Serial Number       NE0001
Name                NPM1
Identifier          1

***Neuchrometer PARAMETERS***
Voltage Set         1450
Voltage Measured    1449.9
MaxVoltage          2100
Gain                3.0
DiscLow             10
DiscHigh            127
DeadTime            40
PeakMode            0
LEDMode             1
PulseSim(uS)        OFF
nBins               128
HgmMode             2
DtResolution        100

***LOGGER PARAMETERS***
RecordPeriod(Sec)   30
NewFilePeriod       Day
RecordsPerHGM       120
PrintDAT            1
PrintHGM            0
LogDAT              1
LogHGM              1
LogTemp             1
LogHum              1
ListSectors         2
Current Time        2013/07/01,12:20:00

YY/MM/DD,HH:MM:SS, Index,      Cnts, DegC,Rhum

13/07/01,12:20:30,    73,       404, 29.9,24.3
13/07/01,12:19:04,    74,       437, 29.9,24.3
13/07/01,12:19:34,    75,       404, 29.9,24.3
13/07/01,12:20:04,    76,       408, 29.9,24.3
13/07/01,12:20:34,    77,       428, 29.9,24.2
```

DAT File Header

DAT file for NPM3100U device showing full header and 5 appended DAT Data Records.

Figure 16. DAT File Example.

```
***LOGGER PARAMETERS***

RecordPeriod(Sec)   30     →  Time period of DAT data logging in seconds.

NewFilePeriod       Day    →  Period for creation of new DAT, HGM files under logging.

RecordsPerHGM       120    →  Selects Histogram Period as multiple of the Record Period.

PrintDAT            1      →  Selects DAT data to be printed to output every Record Period.
                              ( 1 / 0 indicate data printed or not printed, respectively).

PrintHGM            0      →  Selects HGM data to be printed to output every Histogram Period.
                              ( 1 / 0 indicate data printed or not printed, respectively).

LogDAT              1      →  Selects DAT data to be saved to SD card every Record Period.
                              ( 1 / 0 indicate data saved or not saved, respectively).

LogHGM              1      →  Selects HGM data to be saved to SD card every Histogram Period.
                              ( 1 / 0 indicate data saved or not saved, respectively).

LogTemp             1      →  Selects temperature sensor data to be saved to Active DAT file
                              every Record Period. ( 1 / 0 indicate data saved or not saved,
                              respectively).

LogHum              1      →  Selects humidity sensor data to be saved to Active DAT file
                              every Record Period. ( 1 / 0 indicate data saved or not saved,
                              respectively).

ListSectors         2      →  Number of sectors (512 bytes, 64 records) of LST Data to save
                              under List  Mode Logging.

Current Time        2013/07/01,12:20:00    →  File creation time.

YY/MM/DD,HH:MM:SS, Index,       Cnts, DegC,Rhum    →  This line shows the time,
                                                       the record number  (Index) and the
                                                       column headings for DAT data.
```

Example: On July 1, 2013 an NPM3100U device with the data logging option is powered on at 12:20:00. Data Logging parameters are automatically retrieved from nonvolatile EEPROM and displayed as indicated in the figure. This example does not display the full DAT file header only the portion of it associated with Data Logging configuration parameters.

Figure 17. Data Logging Parameters in File Header with Annotations

The contents of the NPM1_130701.DAT can be viewed by using the **Type** command (**Figure 16**). The Type command followed by the file name prints the full contents of the file to the output in text format.

The DAT file header includes NPM device information, standard and data logging parameter configurations, date & time and data column titles in the last row of the file header. Note that much of the header is similar to the output of the Info command used to query the NPM for basic device information and current configuration parameters.

Column titles indicate that neutron counts, temperature and humidity are all being logged. In the example in **Figure 16**, five DAT data records (indexes 73 – 77) have been appended to this DAT file after the header. This indicates that 5 Record Periods have elapsed since data acquisition began.

Since the NewFilePeriod parameter is set for 1 day, then at the beginning of each new day, a new DAT file will be created with a name associated with the date of the day on which it is created. This new file will become the active data logging DAT file and DAT data will be appended to this file every Record Period until yet another active DAT logging file is created on the following day, and so forth.

6.7.3 HGM Directory and File Contents

The HGM directory contains HGM files with a time series of histogram data in text format. The user can view the Directory of HGM files stored on SD Card(s) using the NPM's directory command, Dir (**Figure 18**).

```
0:/
getcwd
0:/HGM
dir
D---- 2013/05/11 20:41         0 .
D---- 2013/05/11 20:41         0 ..
----A 2013/05/31 23:59     58911 NPM1_130531.HGM
----A 2013/06/01 23:59     91609 NPM1_130601.HGM
----A 2013/06/02 23:59     91609 NPM1_130602.HGM
----A 2013/06/03 23:59    707119 NPM1_130603.HGM
----A 2013/06/04 01:20     97467 NPM1_130604.HGM
----A 2013/07/01 12:20      1253 NPM1_130701.HGM
   6 File(s),   1047968 bytes total,    2 Dir(s)
0:/HGM Internal SD Card
```

Some directory commands and their outputs are demonstrated. Once inside the HGM directory, the Dir command displays all HGM files by name.

Figure 18. HGM Directory Example.

The latest HGM file created has the name 'NPM1_130701.HGM'. The NPM1 prefix is a user specified name that can be given to a particular NPM. The 130701 indicates the date of file creation, July 1, 2013.

The histogram data is the neutron pulse height spectrum for the gas detector.
A generic text header with NPM parameter configuration information is written at the top of each file (**Figure 19**). *This is exactly the same as the header in the DAT files*. The last line of this generic file header contains the date & time, data record number (Index) and the column headers or titles for the DAT data that is to be logged in the DAT file. For example, the column title 'NPM_Cnts' applies to the data column containing neutron counts. If data logging has been configured to record temperature, then a column with the title 'DegC' will be present, and so forth. When HGM data is recorded every user selected Histogram Period, this data is appended to the HGM file after the header.

The contents of the NPM1_130602.HGM can be viewed by using the ***Type*** command (see **Figure 20**). The Type command (within the HGM directory) followed by the file name prints the full contents of the file to the output in text format. The HGM file header includes NPM device information, standard and data logging parameter configuration,

date & time and data column titles in the last row of the file header. Note that much of the header is similar to the output of the Info command used to query the NPM for basic device information and current configuration parameters. Column titles indicate that neutron counts, temperature and humidity are all being logged in the active DAT file. Since the NewFilePeriod parameter is set for 1 day, then at the end of the current day, a new HGM file will be created with a name associated with the date of the day on which it is created. This new file will become the active data logging HGM file and HGM data will be appended to this file every Histogram Period until yet another active HGM logging file is created on the following day and so forth.

The actual histogram data is appended to the HGM file after the header. Each Histogram Period includes, in order (see **Figure 19** and **Figure 20**):

1. The current DAT record at the time of writing the HGM data.
2. The histogram in the selected format.
3. The total number of neutron counts in the histogram and the acquisition time for the histogram in seconds.

After each Histogram Period, the HGM data record with these 3 elements is appended to the file sequentially. Including the Current DAT record may be useful in cases in which a user wants to know the device parameters such as humidity and temperature for which a particular histogram was collected.

The HGM file header contains useful information. Under the Logger Parameters section, the user can see which file types are being printed or saved, and which DAT data is being logged. The Record Period for logging DAT data is displayed along with the number of Record Periods per logging of HGM data. Note that the Histogram Period is the time between logging of HGM data. And the Histogram Period = RecordsperHgm x RecordPeriod in seconds. In **Figure 19**, the Record Period is 60 seconds and the Histogram Period is 60 Record Periods or 3600 seconds (1 hour). So, in this example, a new HGM data record is appended to the active HGM file every 1 hour.

The New File Period configured by the NewFilePeriod parameter command indicates how often a new, active HGM file is created while logging HGM data. For example, this might happen once a day.

The Current Time parameter indicates the real-time clock value for which this particular HGM file was created. Since the date and time are used to create the file name, this value will be evident in the file name.

```
type 0:/DAT/NPM1_130701.HGM

Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version    X.1.0.1
Model               NPM3100
Model Version       USB
Serial Number       NU0001
Name                NPM1
Identifier          1

***Neuchrometer PARAMETERS***
Voltage Set         1450
Voltage Measured    1449.9
MaxVoltage          2100
Gain                3.0
DiscLow             10
DiscHigh            127
DeadTime            40
PeakMode            0
LEDMode             1
PulseSim(uS)        OFF
nBins               128
HgmMode             2
DtResolution        100

***LOGGER PARAMETERS***
RecordPeriod(Sec)   60
NewFilePeriod       Day
RecordsPerHGM       60
PrintDAT            1
PrintHGM            0
LogDAT              1
LogHGM              1
LogTemp             1

LogHum              1
ListSectors         2
Current Time        2013/07/01,12:18:04

YY/MM/DD,HH:MM:SS,   Index,     Cnts, DegC,Rhum

13/07/01,13:18:06,  1860,      5939, 35.8,20.1

0,0
1,0
2,0
..
100,93
101,54
126,0
127,0
```

HGM File Header

HGM period is 1 hour (60 sec x 60)

HGM Data Record

File Header for HGM files with NPM3100U device. A partial HGM Data Record is displayed.

Figure 19. HGM File Example.

```
Type 0:/DAT/NPM1_130602.HGM

YYYY/MM/DD,HH:MM:SS, Index,  NPM_Cnts, DegC,Rhum          [Last Line of Header]

2013/06/02,00:30:33,  1860,      5939, 35.8,20.10         [DAT Data Record at Time of Hgm #1]
0,0
1,0
2,0
..
100,1512                  [Histogram 1]
101,434
126,0
127,0

Total=5939,3600           [Total Histogram Counts and Time]

2013/06/02,01:30:33,  1900,      6150, 35.6,20.30         [DAT Data Record at Time of Hgm #2]

0,0
1,0
2,0
..
100,1752                  [Histogram 2]
101,494
126,0
127,0

Total=6437,3600           [Total Histogram Counts and Time]
```

HGM data printed to device output. Only the last line of the file header is shown. Two HGM data sets taken sequentially are displayed. Extra spaces have been inserted for clarity. Each set includes the current DAT data, the histogram and the total counts and time for the histogram. The Recordperiod here=90 seconds and the RecordsperHgm parameter was set to 40. Histograms are thus stored to the SD card every 3600 seconds (hourly).

Figure 20. HGM Data Printed with Type Command To Terminal

Histograms are sampled and written in a format selected by the ***HgmMode*** parameter and the ***nBins*** parameter (section 0). In the example in , the histograms are displayed in two columns. Column 1 is the histogram bin number and column 2 is the total counts in that bin for the current Histogram Logging Period.

A recorded histogram can be plotted (**Figure 21**). In this example, the shape is that of a textbook Helium-3 spectrum and indicates that the detector tube and electronics are behaving normally. See Helium-3 Detector Spectra, **section 8.1.**

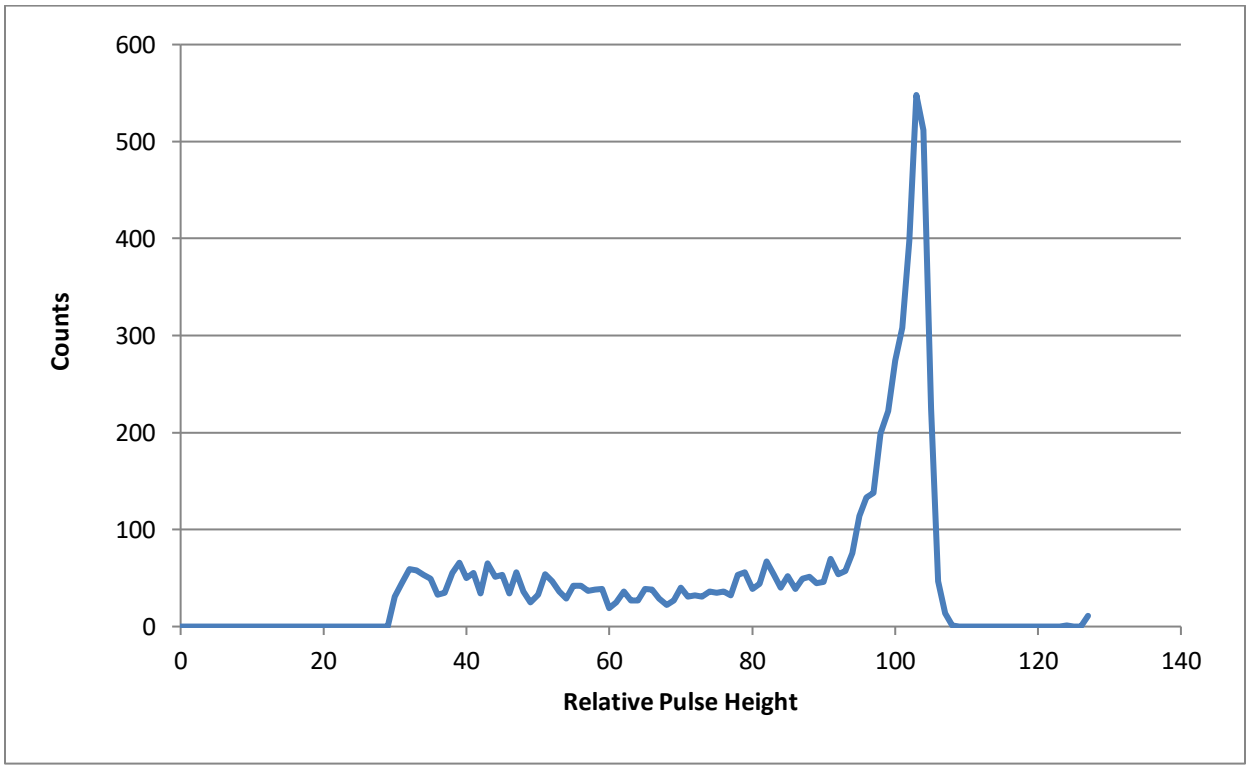


Figure 21. Helium-3 Detector HGM (Pulse Height Spectrum)

6.7.4 LST Directory and File Contents (for ListMode datalogging)

The LST directory contains files with time series of recorded data that can be viewed in a user selectable format: text, hexadecimal or binary.

The user can view the Directory of LST files stored on the internal SD Card using the NPM's directory command, Dir (**Figure 22**).

```
0:/
getcwd
0:/LST
dir
D---- 2013/05/11 20:41         0 .
D---- 2013/05/11 20:41         0 ..
----A 2013/05/31 23:59     58911 NPM1_130531.LST
----A 2013/06/01 23:59     91609 NPM1_130601.LST
----A 2013/06/02 23:59     91609 NPM1_130602.LST
----A 2013/06/03 23:59    707119 NPM1_130603.LST
----A 2013/06/04 01:20     97467 NPM1_130604.LST
----A 2013/07/01 12:20      1253 NPM1_130701.LST
   6 File(s),   1047968 bytes total,    3 Dir(s)
0:/LST Internal SD Card
```

Some directory commands and their outputs are demonstrated. Once inside the LST directory, the Dir command displays all LST files by name.

Figure 22. LST (ListMode Data) Directory Example

The List Mode data file does not contain a header as the DAT and HGM files do. The LST files contain only the List Mode data. Unlike data logging of DAT and HGM data in which the data file is created before data acquisition, for List Mode data logging, the List Mode data is acquired, and then at the end a file is created. The name of the file is associated with real-time clock value at the time of file creation.

For every Pulse, List Mode data includes the pulse height, the time and a tag that identifies the particular NPM with which the data was acquired. The ListView command reads LST files from the internal SD card of the 3100 device and prints it in the user selected format to the output. An example of List Mode data format is given in **Figure 23**, where the ListView command was used to display the ListMode data.

The first column is just a label for the data record, and the following 3 columns are the data. Each data record or row corresponds to a single neutron detection event. In text format, the data is 3 comma delimited numbers. The first number identifies the NPM with which the data was taken. This can be used to tag a detector within an array. The second number is the measured pulse height for the data record digitized into 2048 parts. The third number is the time in seconds. While the timing resolution shown in

Figure 3 is 125nsec, the modern generation of NPM3100 devices has a timing resolution of 500nsec

```
listview npm_unit#1_1502211956.lst

     0,  1,1414,0.000001200
     1,  1,1412,0.020001125
     2,  1,1412,0.040001125
     3,  1,1412,0.060001125
     4,  1,1412,0.080001125
     5,  1,1414,0.100001125
     6,  1,1412,0.120001125
     7,  1,1413,0.140001125
```

The ListView command applied to a LST file causes the NPM to write the binary LST data to the output in a text format.

Figure 23. List Mode Data viewed with the ListView Command.

6.7.4.1 List Mode Data Format

Each binary LST file consists of a series of 8 byte LST data records..

LST Record

Byte Number	Data Type	Data
0-4	Unsigned	Timestamp, in units of 100 nanoseconds
5	Unsigned	NPM Identifier, useful when arrays of NPMs on detectors are used
6-7	Unsigned	Pulse Amplitude

Table 6: LST Data Format (Binary format)

All data is in Little Endian byte order, i.e. Least Significant Byte is first. The binary list mode record format cannot be changed by the user. i.e., the number of bytes in each pulse record will always be 8 bytes. Contact Quaesta Instruments if a custom LST data record format is desired.

6.8 Device Interface

An NPM3100 user has several options for communicating with the device through its communcations interface.

1. A Quaesta Instruments GUI allows for viewing and setting of Device parameters. Contact Quaesta or visit http://www.quaestainstruments.com.
2. A Terminal Emulation application program such as Tera Term Pro or Windows Hyperterminal may be used to interactively interface to the NPM. This is accomplished via the Windows Virtual COM port.
3. The user may write his own RS232 interface application for communicating with the device.

6.8.1 Terminal Interface NPM3100U

6.8.1.1 NPM3100U Terminal Interface Communication

The NPM3100U interface will present itself in Windows as a Virtual COM port, i.e., USB Serial Port. See Ctrl Panel -> Device Manager, as in **Figure 24**. The 'Ports' section will list the NPM3100U interface as a USB Serial Port. Older Windows versions (Windows XP) may need to download and install FTDI drivers from the FTDI website (http://www.ftdichip.com/Drivers/VCP.htm).

After the Virtual COM port (COM 12 in **Figure 24**) is assigned by Windows, PC applications can communicate to the NPM3100U device a standard RS232 interface device.

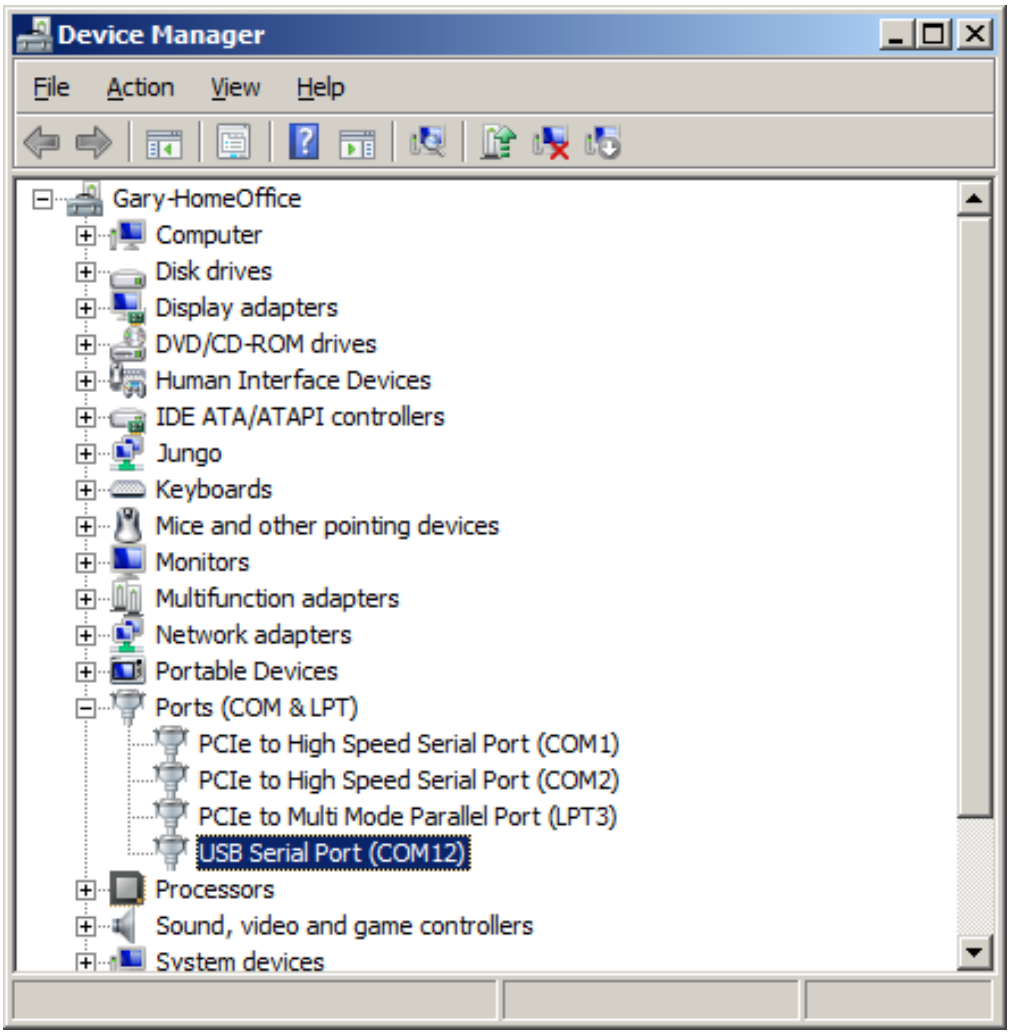


Figure 24. Device Manager and COM Port Assignments

NPM3100U COM Port Settings:

Baud Rate:	115200
Data Bits:	8
Parity:	NO Parity
Stop Bit:	1
Flow Control:	None

6.8.1.2 NPM3100U Teraterm Pro Terminal Configuration

Tera Term Pro is a very good, freely available Terminal Interface program which can be used to interface directly to the NPM3100U device. Other terminal interface programs which provide for RS232 connectivity can also be used, such as Windows Hyperterminal or PuTTY. Settings similar to those described for Tera Term Pro should be used.

The latest version of Tera Term Pro can be downloaded from:
http://ttssh2.sourceforge.jp/index.html.en

After install, the Tera Term Pro window of the form in **Figure 25** will appear as in

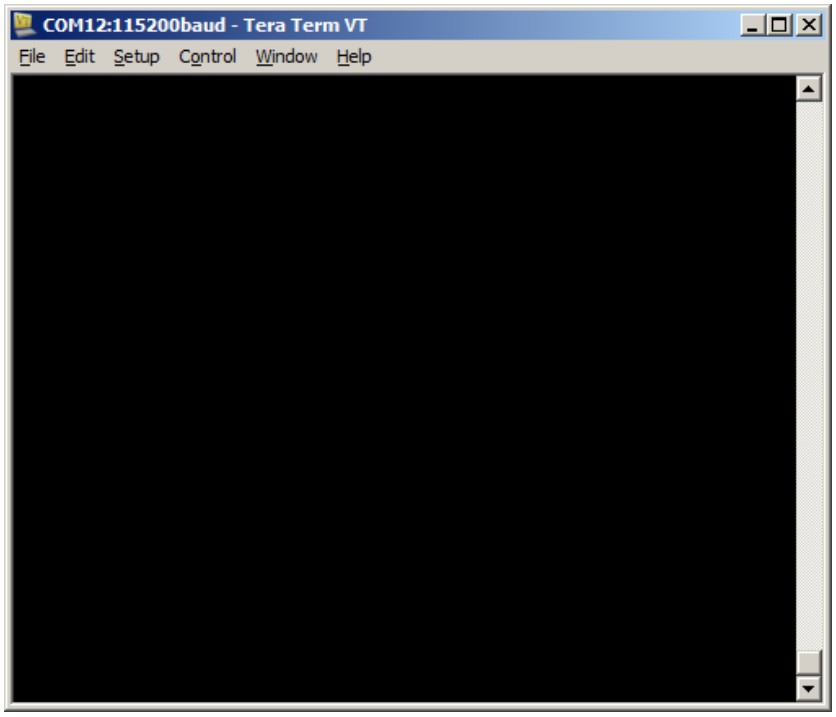


Figure 25. Teraterm Pro Main Window.

Open a new connection (File->New Connection), as in **Figure 26** and select the USB Virtual COM port corresponding to the attached NPM3100U device.

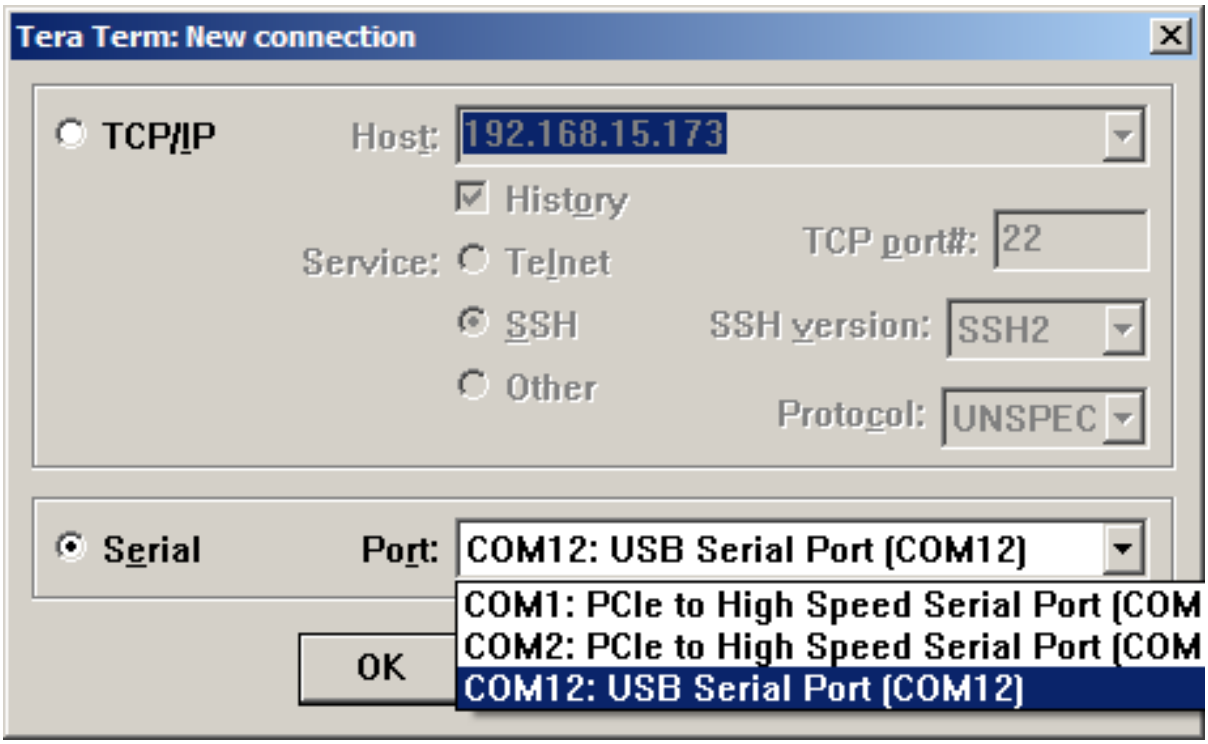


Figure 26: Virtual COM Port Selection

Configure the Terminal through the menu Setup-> Terminal. See **Figure 27**. The New-line configuration Transmit option must be set to CR+LF. Other suggested configuration options are shown in **Figure 27** as well.

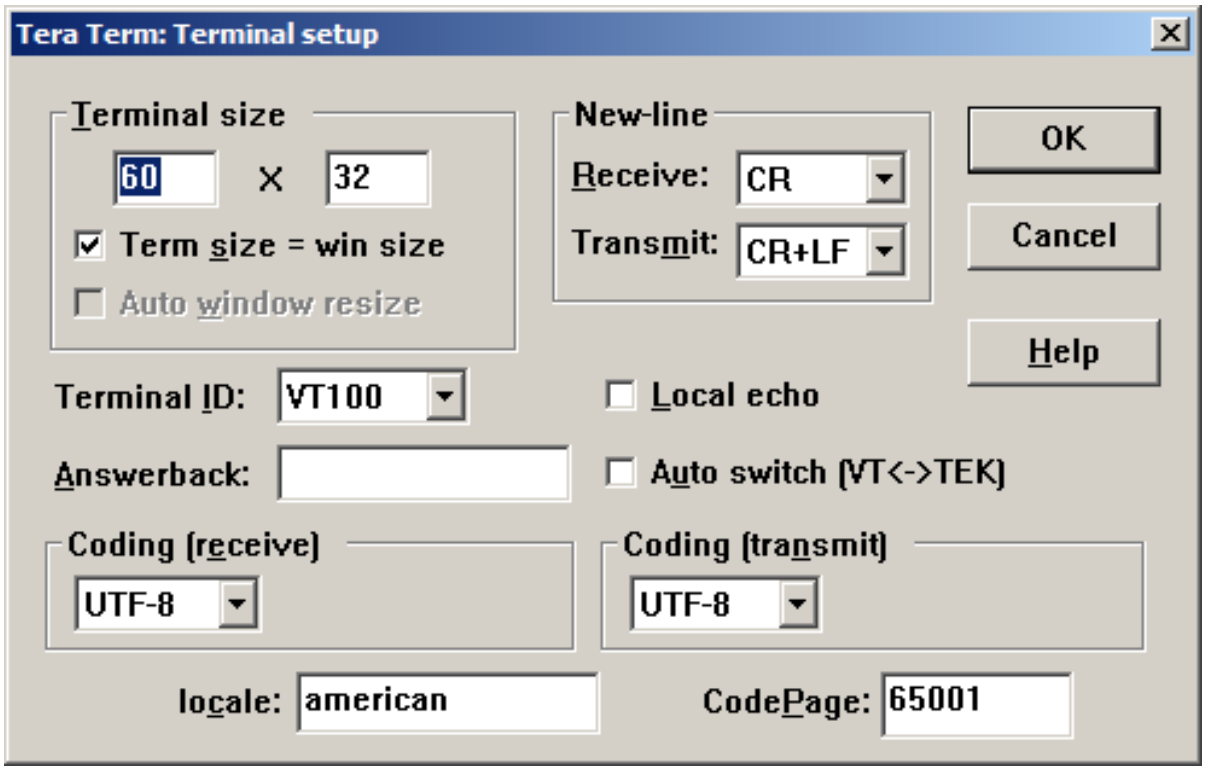


Figure 27: Terminal Window Configuration

Configure Tera Term's Serial Port settings through the menu Setup -> Serial Port. (See **Figure 28).**

Serial Port Settings are: 115200 baud, 8 Data bits, No Parity, 1 Stop Bit, and No Flow Control.

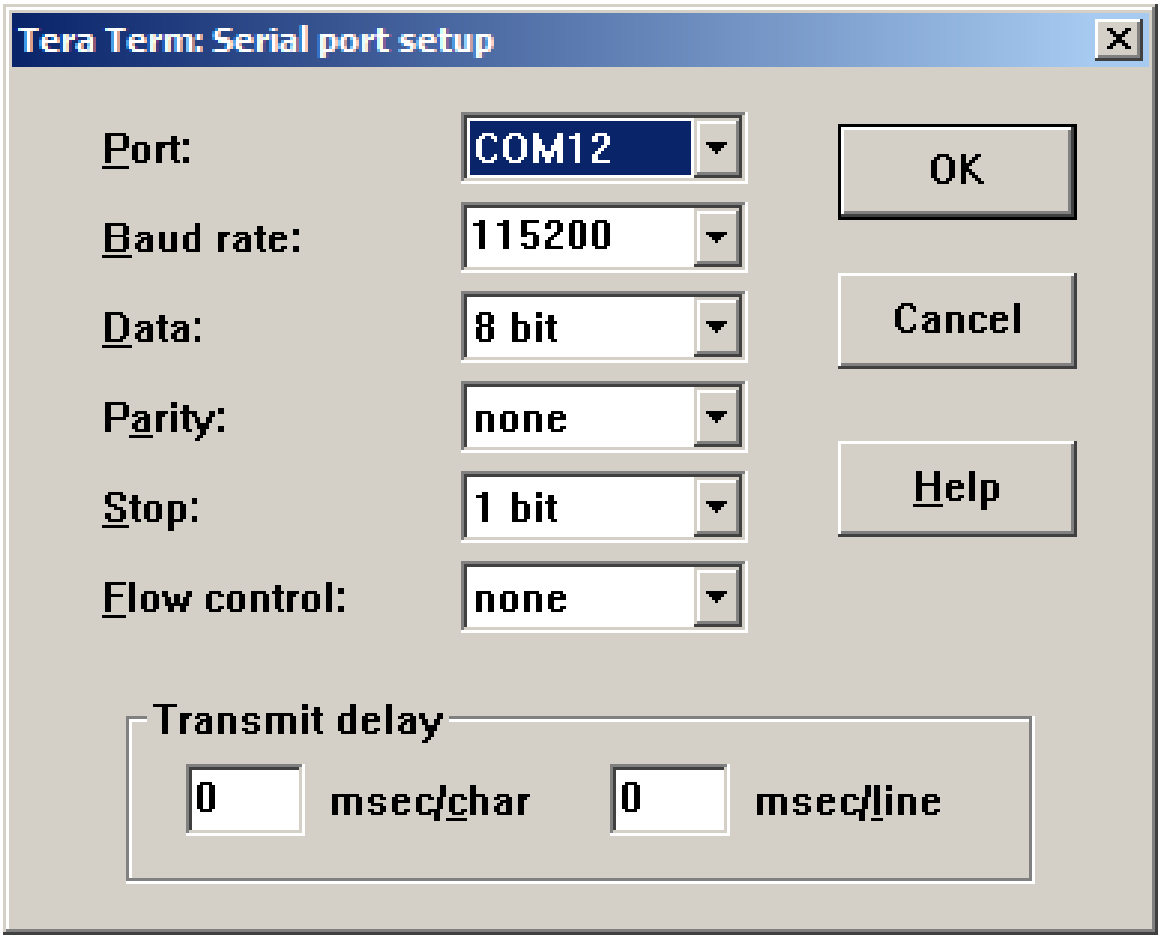


Figure 28: Serial Port Settings

6.8.2 Terminal Interface NPM3100E

6.8.2.1 NPM3100E Network Configuration

Knowledge of the NPM3100E device IP address is required in order to make the first connection to the NPM3100E device. By default, all NPM3100E devices ship with an IP address in the 192.168.15.XXX address range. The NPM3100E IP address at the time of shipping is provided on a removable label affixed to the device. The default factory TCP port # is 10001.

.

> *Note: Both the device IP address and the TCP port are configurable by the user.*
>
> *Caution should be used when changing the IP address and/or TCP port # of the NPM3100E device as the device can become unreachable.*
>
> *For Directions on configuring the NPM3100E IP address, See* ***6.8.2.3*** **Searching for an NPM3100E device**
>
> A Quaesta Instruments "QIDeviceDiscovery" GUI Application is available which can be used to search for NPM3100E devices accessible through an Ethernet user's network.

The following steps can be used when making a direct connection to the NPM3100E, bypassing any larger area network.

<u>Step 1.</u> A Power Over Ethernet (POE) switch or adapter is required in order to power the NPM3100E device properly and provide Ethernet connectivity. See **Figure 29**.

<u>Step 2.</u> Configure the PC to use an IP address in the same subnet as the NPM3100E.

Details:
Windows 7 Settings
Open "Network and Sharing Center" from the Control Panel "Network and Internet Window". See **Figure 30** and **Figure 31**.

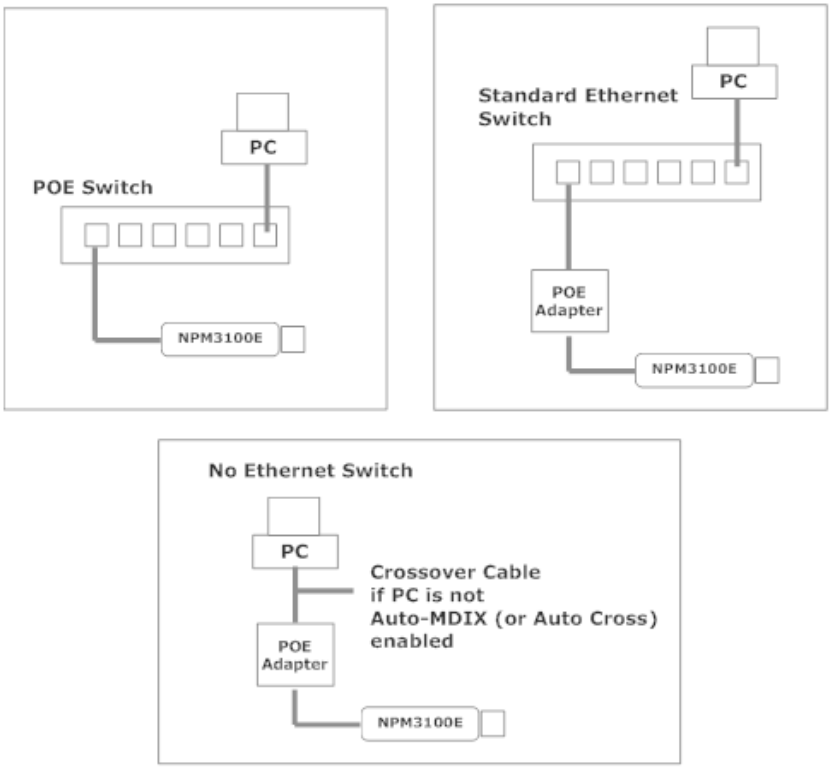


Figure 29: Power Over Ethernet (POE) Connection Configurations

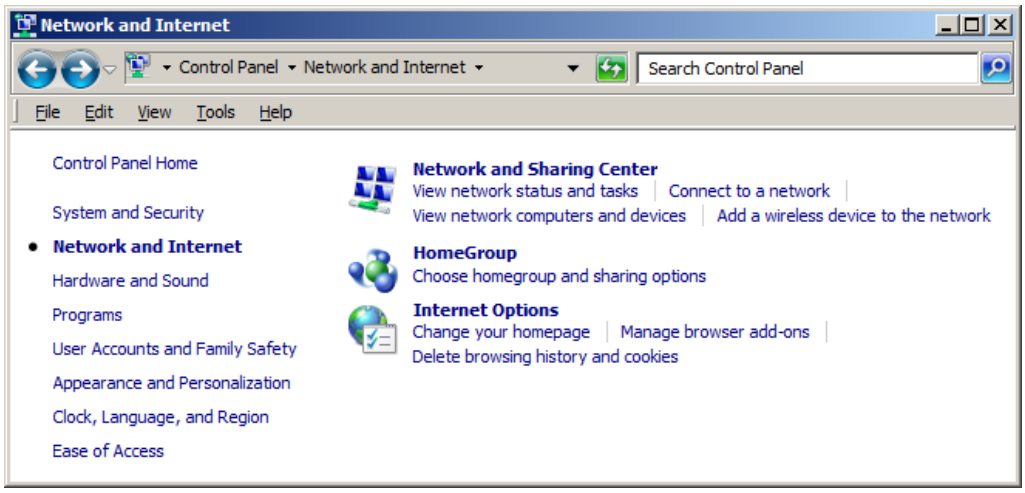


Figure 30: Control Panel Network and Internet

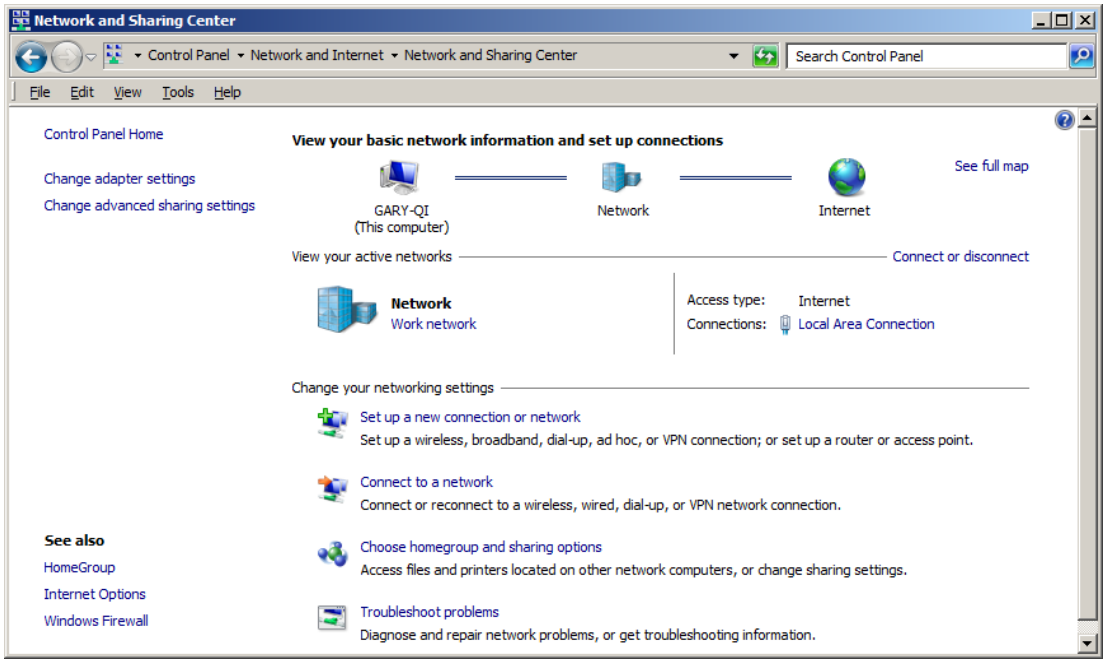


Figure 31: Network and Sharing Center

Select the Local Area Connection as found in the Network panel of **Figure 31**. A Local Area Connection Status window of the form shown in **Figure 32** will be displayed.

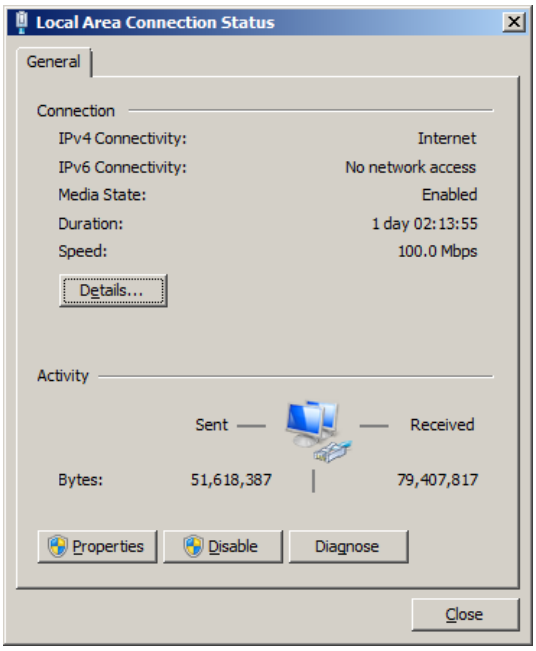


Figure 32: Local Area Connection and Status Window

Select the Properties command button and then “Internet Protocol Version 4 (TCP/Ipv4)” on the Local Area Connection Properties window. See **Figure 33**.

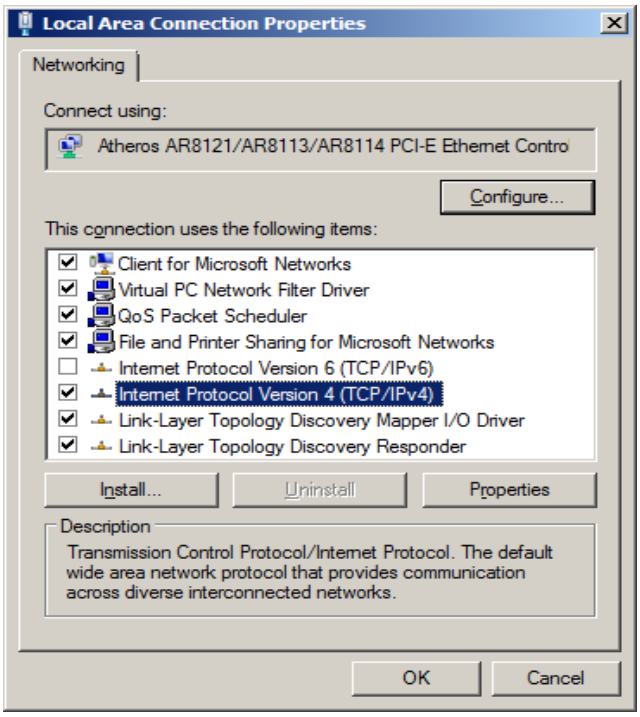


Figure 33: Local Area Connection Properties Window

Select the "Properties" command button of **Figure 33** to arrive at a TCP/Ipv4 properties Window as in **Figure 34.** Select the "Use the following IP address radio button."

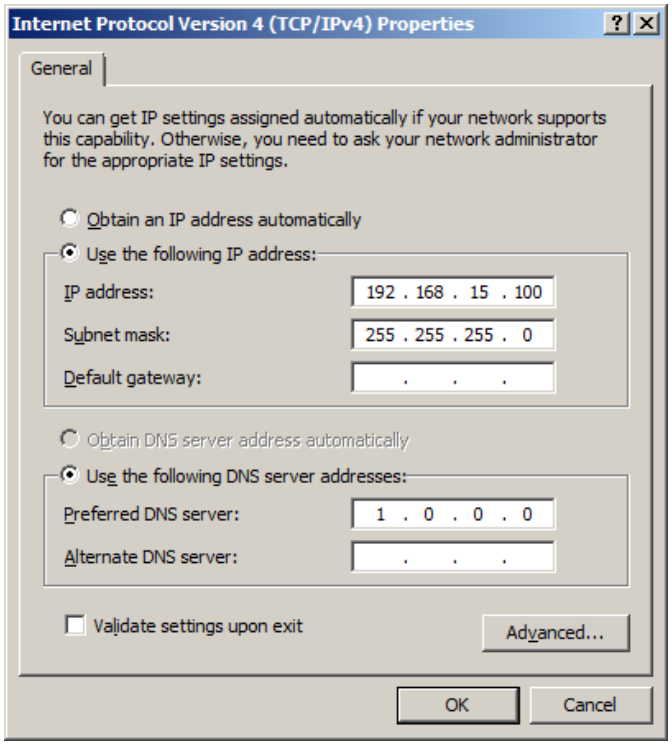


Figure 34: TCP/IP Properties Configuration.

Configure the IP address with an IP address on the same subnet as the NPM3100E device. **Figure 34** shows the PC configured to have an IP address of 192.168.15.100 and a subnet mask of 255.255.255.0.

NPM3100E devices by default ship with IP addresses in the 192.68.15.XXX range, and thus will be able to communicate with a PC configured as in **Figure 34** here.

6.8.2.2 NPM3100E Terminal Configuration

The NPM3100E device can be accessed via a Terminal interface application. Suggested applications include Tera Term Pro and PuTTY, both freely available applications.

Quaesta recommends Tera Term Pro which can be downloaded at http://ttssh2.sourceforge.jp/index.html.en.

If using a Tera Term Pro version later than version 2.3, the user should edit the Tera Term.ini file (found in the Tera Term Pro installation directory) and set the parameter EnableLineMode=off. This will allow characters to be transmitted and echoed back from the device as the characters are typed. If EnableLineMode=on, the terminal program will buffer the characters until a CR is entered, at which time the entire line of data will be sent to the NPM.

On Windows 7 machines, the Tera Term.ini file is generally located by default in the install directory “C:\Program Files (x86)\TeraTerm2” directory.
The Tera Term.ini file can be edited via a text editing program such as Notepad.
Search for “EnableLineMode” and set to **OFF**, as indicated below in **Figure 35Figure 35**.

Tera Term.ini file excerpt:

```
…
…
; Disable wheel to cursor translation when Control-Key is pressed.
DisableWheelToCursorByCtrl=on

; Line at a time mode
EnableLineMode=off

; Popup menu
EnablePopupMenu=on

; "Show menu bar" command
EnableShowMenu=on
….
….
```

Figure 35. Teraterm INI File Setup

After launching the Teraterm Pro application, a simple main window as shown in **Figure 36** may appear.
Select File->New Connection to make a new connection and open a window of the form shown in **Figure 37**.

Select a TCP/IP connection and type in the NPM3100E device IP address.
Type in the TCP port# for the NPM3100E device (The default factory configured NPM3100E TCP port # is 10001).

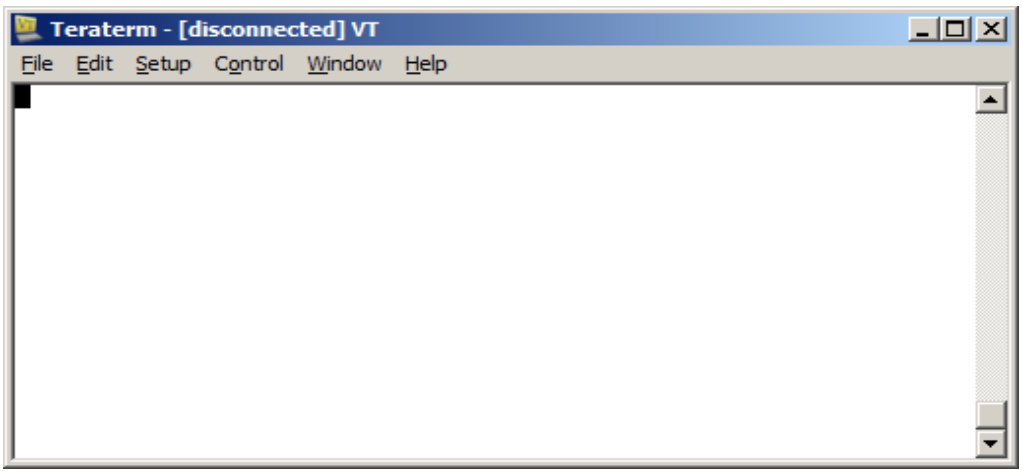


Figure 36: Tera Term Pro Main Window

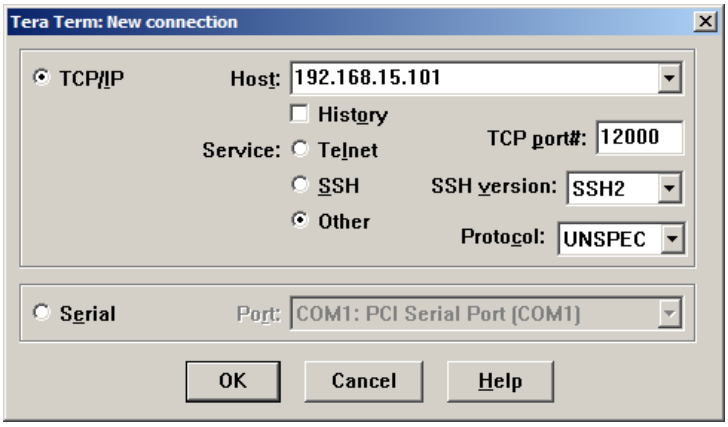


Figure 37: Tera Term Pro TCP/IP Configuration

From the main Tera Term Window, select the menu Setup-> Window. You can set the title and the number of lines in the Scroll Buffer, as in **Figure 38**.

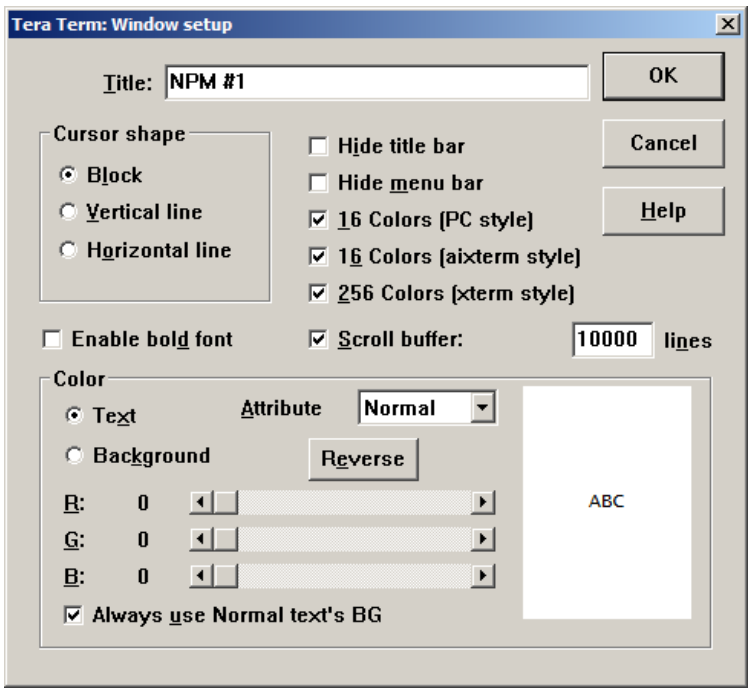


Figure 38. Teraterm Terminal Window Setup

Again from the main Tera Term Window, select the menu Setup-> Terminal

Allowing the Tera Term window to be resized is convenient (Tera Term=win size).
Set the New-line conditions as in the GUI window (**Figure 39**). Terminal ID is VT100.

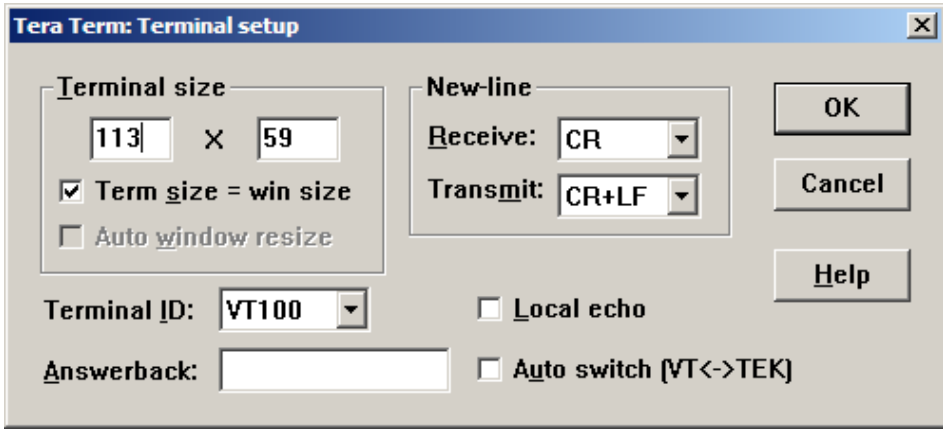


Figure 39: Tera Term Pro Terminal Setup

6.8.2.3 Searching for an NPM3100E device

A Quaesta Instruments "QIDeviceDiscovery" GUI Application is available which can be used to search for NPM3100E devices accessible through an Ethernet user's network.

The GUI allows the user to discover devices, set IP addresses, and Upgrade firmware. Contact Quaesta Instruments for details.
The Description of this Software is in Progress.

6.8.2.4 Configuring the NPM3100E IP Address through the Terminal Interface

The NPM3100E device IP Address and TCP/IP Port # are both configurable via a TCP/IP Terminal interface application.

Directions for making first-time TCP/IP connections to the NPM3100E device and for configuring Tera Term Pro can be found in sections **6.8.2.1** and **6.8.2.2**.

Default factory shipped NPM3100E device IP addresses lie in the range 192.168.15.XXX and the default factory shipped NPM3100E device TCP/IP Port# is 10001.

To change the IP address or configure the TCP/IP Port#, first make a connection to the NPM3100E device. Note that after making IP address or TCP Port #' changes, these changes will not take effect until the NPM3100E device is rebooted or power cycled.

Current operating and configuration parameters can be displayed using the ***info*** command, as in **Figure 40**.

Figure 40 This will show the current IP address and TCP Port #.

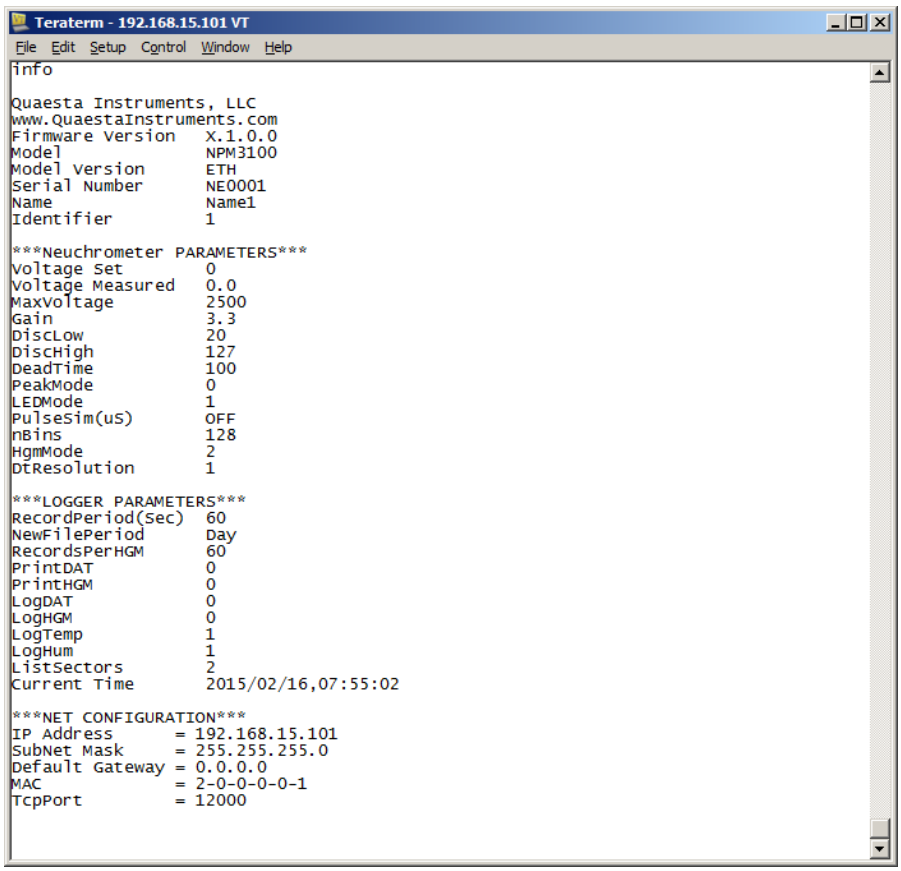


Figure 40: Terminal output of 'info' command

Setting the NPM31000E IP Address

To change the IP Address, type IPAddress = XXX.XXX.XXX.XXX where XXX.XXX.XXX.XXX is the chosen new IP Address. Since changing the IP Address can make the device unreachable if the user misplaces or loses this IPAddress, the NPM3100E device will respond with a query to make sure you want to change the IP Address. You must type YES (in capital letters) in order for the IP Address to be reconfigured. If YES is typed in response, then the NPM3100E device will record the newly desired IP Address in EEPROM.

Implementation of the new IP Address will **not** occur until power cycle or reboot of the NPM3100E device.

Example:

```
ipaddress=192.168.15.102

You are sure you want to change the IP Address to:
192.168.15.102 ?
```

```
If yes, record the new IP Address and enter 'YES'
YES
New IP Address will take effect after Reboot
192.168.15.102
```

Changing the NPM31000E TCP Port #

> **Note:** The user is strongly recommended to make notes of any changes to the NPM3100E TCPPort and other network settings. Certain settings can make the device unreachable via TCPIP. In such cases the user is recommended to make use of the Quaesta Instruments QIDeviceDiscoveryTool GUI.

Changing the NPM31000E TCPPort used for TCPIP communication can make it significantly more difficult to search for and find an NPM3100E device on the network if the IPAddress information or TCPPort information is lost by the user.

6.8.3 Graphical User Interface (GUI)

6.8.3.1 Windows GUI Application

A Windows graphical user interface (GUI) software package is in development for Communication with NPM3100E and NPM3100U devices.

6.8.3.2 NPM3100E Web Browser GUI

The NPM3100E has a built-in web browser interface that can be used within common web browser tools such as Firefox or Chrome. To access the Web Interface, go to http://XXX.XXX.XXX.XXX where XXX.XXX.XXX.XXX is the device's IP address. Make sure the device is reachable from your PC. Contact your network admiistrator if you need help viewing, setting, and/or understanding your PC's network settings such as the Subnet Mask and Gateway settings.

6.8.4 RS232 (Virtual COMPort) Interface

Users may write their own interface application for communicating with and controlling Quaesta Instruments' NPM3100U devices through use of the Windows Virtual COMPort funcitionality. The NPM3100U device can then be interfaced with software making use of standard RS232 interface functions. The Command Set is made available in this User Manual with a complete description of each command. Quaesta staff are alsoavailable for technical support in this regard.

6.8.5 FTDI USB Driver Support

Users may also communicate directly with the NPM device via FTDI's driver. Example code can be provided. Contact Quaesta Instruments for details.

6.9 Array Applications

6.9.1 NPM3100U

The NPM3100U has a TTL Input and a TTL Output which are accessed via two SMA connectors on the rear panel of the device.

The TTL Input can be configured to:

1. Log input pulses from an external device along with neutron events measured internally.
2. Generate a TTL pulse on the TTL Output whenever a pulse is measured at the TTL Input. (The input TTL pulse is transmitted directly through to the TTL Output line).
3. Or both

The TTL Output can be configured to transmit a TTL pulse whenever a neutron is counted by the device. Thus, the TTL Output line may transmit pulses whenever the NPM measures a neutron pulse (internally) **or** whenever it measures a TTL pulse at its TTL Input.

The ability of the NPM to transmit external pulses allows it to be used in array applications in a common 'daisy-chain' configuration (**Figure 41**). A series of NPMs is connected via their TTL Input and Output lines. The TTL Output of one NPM is attached to the TTL Input of another NPM in a series. The result is that all neutron counts at every NPM in the array are transmitted along a single line. This line could be connected to an external digital counter. Or the final NPM in the line could act as a digital counter and data logger for the entire array.

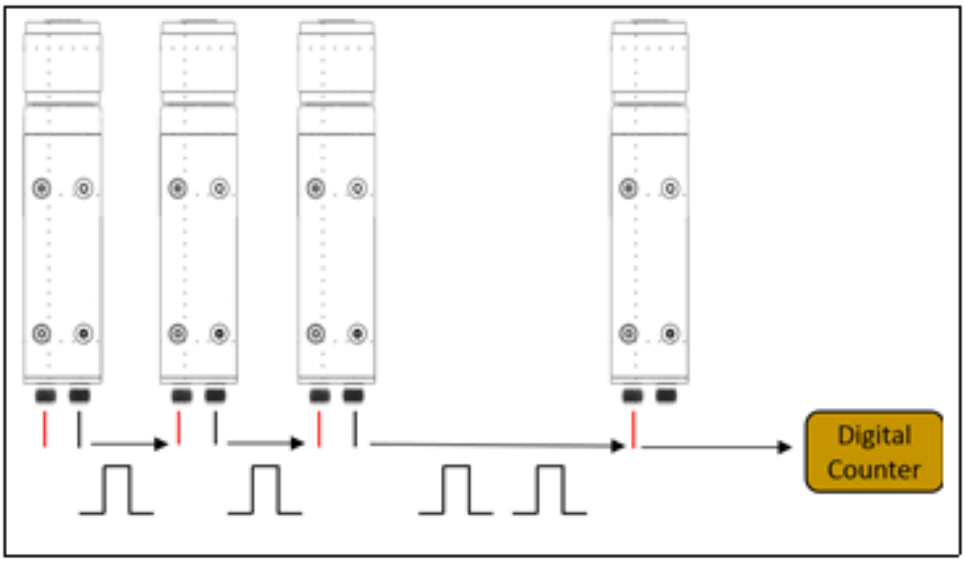


Figure 41. NPM3100U Array Application.

6.9.2 NPM3100E

The NPM3100E device includes features intended for array applications including List Mode data acquisition and external clock synchronization capabilities. Each NPM3100E in an array can measure and time-stamp neutron events with 500*nsec* resolution. Since the internal clocks among an array of NPMs do not operate with exactly the same frequency, then timing among the devices in an array can become increasingly less accurate over time. For example, if two clock frequencies are different by one part per billion, then in 500 second, the relative time between the clocks will differ by 500 nanosecond. Thus, in 10s of minutes of time, the clock error will surpass the 500*nsec* timing resolution capability of the NPMs.

This precision timing issue is resolved by permitting all NPMs in an array to operate off the same external clock. In this mode of operation, all NPMs stay perfectly synchronized even over long time periods. The NPM3100E is able to receive an external clock signal on its Power over Ethernet connector. Quaesta supplies a hardware device, the ES3100, designed to interface between a standard POE switch and an array of NPMs. The ES3100 injects a clock pulse onto the POE line which is inserted into each NPM. The external clock pulse perfectly synchronizes all NPMs in the array. See **Figure 42**.
For array applications, the NPM3100E can operate using an external clock. Quaesta's ES3100 array synchronization tool interfaces between a POE switch and an array of NPMs. It injects a clock pulse on the POE line, and this clock pulse is used to synchronize the timing across the array. NPMs in this configuration can produce List Mode data and maintain 500*nsec* timing resolution over indefinite time periods.

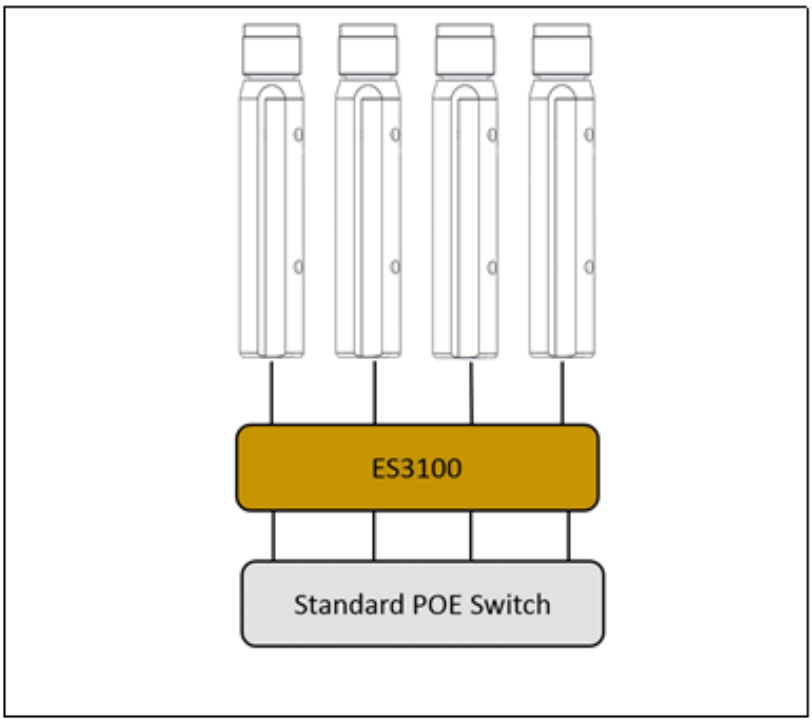


Figure 42. NPM3100E with Array Time Synchronization

7 Device Command Set

A thorough description of the NPM3100U Command Set is included in this section.

Commands are sent to the NPM in text format via either the Ethernet interface (NPM3100E devices) or USB interface (NPM3100U devices). Commands should be terminated with a Carriage Return or a Carriage Return + Linefeed character sequence (i.e. CR or CR+LF). NPM3100 output issued as a result of these commands will be returned as text via the same interface.

Terminal emulators such as Tera Term Pro or Windows Hyperterminal can be configured to communicate with NPM3100E devices via TCPIP or NPM3100U devices via USB. Configuration of these terminal emulators is covered in section 6.8.

Alternatively GUI applications provided by Quaesta Instruments can be utilized to communicate with the NPM3100 devices. The GUI applications make use of the basic NPM3100 series interface commands identified in this section.

General Command Set notes:

Commands are not case-sensitive (i.e. they are case-insensitive).
The device Command Set includes three general types of commands:

C – Control Commands
R – Read Commands
R/W -- Read/Write Parameter Commands (i.e., the parameter is both readable and writeable)

Control commands can be activated by simply typing the name with any required arguments, i.e. ‘reboot’.

Read parameters and commands can be queried by simply typing the name (i.e., ‘Gain’).

Write parameters can be written or set by using an equal sign (i.e. ‘Gain=3.8’).

All commands must be terminated with a Carriage Return + Linefeed (CR + LF) sequence.

Command descriptions are organized by functionality and “subsystem” in the following subsections.

7.1 Miscellaneous Device Commands and Parameters

Command Quick Reference Table

Name	Type	Operation
Name	R/W	Name of the NPM device
Menu	R	Report all available commands
Help	R	Report all available commands
Info	R	Report device identification and parameters
Sdev	R	Noise Standard Deviation
Uptime	R	Seconds since device startup
Reboot	C	Reset the system

Table 7: Miscellaneous Commands

Name *R/W The user assigned name of the NPM device*

Each NPM can have an unique Name assigned by the user. The Name can consist of a string of alphanumeric characters and is limited to 16 characters. Entering "Name" without an argument will display the current Name.

Example:
Name= NPM_Unit#1
NPM_Unit#1

Menu *R Display a list of all user availabe commands*

The Menu command causes a (nearly complete) list of device commands to be Printed to the device output.

Help *R Display a list of all user availabe commands*

Identical to the *Menu* command.
See section **D.1 NPM3100U Menu Command Output** for an example of the *Help* (*Menu*) command output.

Info *R Report device identification and parameters*

Provides the Firmware Version, Model, Model Version, and Serial Number, followed by a list of the current NPM operating parameters. An example of the output is shown below.

```
Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version   X.1.0.1
Model              NPM3100
Model Version      ETH
Serial Number      NE0001
Name               NPM_Unit#1
Identifier         1

***Neuchrometer PARAMETERS***
Voltage Set        1450
Voltage Measured   1450.1
MaxVoltage         2100
Gain               3.0
DiscLow            10
DiscHigh           127
DeadTime           50
PeakMode           0
LEDMode            1
PulseSim(uS)       0
nBins              128
HgmMode            2
DtResolution       100

***LOGGER PARAMETERS***
RecordPeriod(Sec)  60
NewFilePeriod      Day
RecordsPerHGM      5
PrintDAT           0
PrintHGM           0
LogDAT             0
LogHGM             0
LogTemp            1
LogHum             1
ListSectors        5
Current Time       2015/02/20,13:06:12

***NET CONFIGURATION***
IP Address      = 192.168.15.101
SubNet Mask     = 255.255.255.0
Default Gateway = 0.0.0.0
MAC             = 2-0-0-0-0-1
TcpPort         = 12000
```

Sdev *R* *Noise Standard Deviation*

Sdev is typically used by Quaesta factory personnel during initial device testing to test the electronic noise floor level of the NPM device. *Sdev* rapidly samples the ADC output of the Analog input electronic chain. A burst of 4096 samples is acquired and the RMS value of the ADC readings is reported, along with the max ADC value and the mean ADC value. Using *Sdev=N* will acquire *N* bursts of 4096 samples and average the *Sdev* results over the *N* bursts. Note that the noise floor of the device will depend on the gain.

Example:
For Gain=20

```
sdev=100
NoiseRMS=  12.162  NoiseMAX=  22  NoiseMEAN= -5
```

The Sdev result can be converted to MCA Histogram Bin numbers. The noise floor Bin can be calculated approximately by using the formula

(Noise Floor Bin#) = NoiseMax *(nBins/2048)

where nBins is the number of bins used in the MCA histograms. In the example above, the Noise Floor Bin# is approximately Bin 2 for nBins=128.

Uptime *R* *Number of seconds since device startup.*

Reports the number of elapsed seconds since device startup.

Reboot *C* *Reboot (restart) the system firmware.*

Reboot the system firmware. The firmware will reset, and the device will then start up just as it does after a Power Cycle sequence. The reboot sequence begins immediately, at which time the Firmware bootloader begins. The bootloader will run for 10 seconds during which time a series of question marks will be printed to the output. When loading new firmware, upload must be initiated within this time frame.

Note that any TCP Port connections, including Web Browser connections, will be disconnected after a *Reboot* command. Thus the user will have to reconnect to the device after the *Reboot* if it has an Ethernet interface.

7.2 NPM Commands and Parameters

The NPM commands and parameters described in this section are parameters specific to the Neutron Pulse Module electronics operation.

Command Quick Reference Table

Name	Type	Operation
Voltage	R/W	High Voltage Supply value in Volts (250 to MaxVoltage)
MaxVoltage	R/W	Maximum allowed High Voltage (0 to HV range maximum, Model version specific, ie NPM3100E-2.5kV)
Gain	R/W	Amplifier Gain (1.0 to 20.0)
DiscLow or LowerDisc	R/W	Lower Discriminator (Neutron Pulse Threshold)
DiscHigh or UpperDisc	R/W	Upper Discriminator
DeadTime	R/W	Pulse detection dead-time or “lockout” time (μsec)
PeakMode	R/W	Pulse peak display mode - not typically used (0 or 1)
PulseWave	R/W	Display waveform of the next received pulse
LEDMode	R/W	LED activation mode (0 or1)
Counts	R	Report and zero the total neutron pulse counts
Query	R	Report the total neutron pulse counts without zeroing
Cps	R	Report the counts per second
ZeroCounts	C	Zero the neutron pulse counter
TTLOutMode	R/W	Configures the TTLOut Feedthrough of TTLInput
TTLOutWidth	R/W	TTLOutput pulse width for Neutron Generated Pulses
TTLCounter	R/W	Disables and Enables the external TTLInput counter (0 or 1)
TTLCounts	R	Display and Zero the TTLInput counter and elapsed time
TTLQuery	R	Display and Not Zero the TTLInput counter and elapsed time
ZeroTTLCounts	C	Zeroes the TTLInput counter and elapsed time
PulseSim	R/W	Pulse Simulation Period in *usec*

Table 8: NPM Commands

Voltage *R/W* *High Voltage Supply value (Volts).*

Each NPM has an internal high voltage power supply which can be set to any Voltage between 250 Volts and 2000 Volts. The *Voltage* is set with an integer value and is regulated to a precision of 0.1 Volt. Entering a *Voltage* greater than the *MaxVoltage* parameter is not allowed and will result in the *Voltage* being set to *MaxVoltage*. Entering "*Voltage*" without an argument will display the currently measured voltage and the desired *Voltage* .

Example:
```
voltage=1300
1300
```

The voltage will ramp slowly to the new voltage (typically will take approximately 20 seconds for voltage to ramp from 0 to 1000V and stabilize):

```
voltage
Measured/Set: 1300.1/1300
```

MaxVoltage *R/W* *Maximum Allowed High Voltage*

The *MaxVoltage* parameter is a safeguard which helps prevent accidentally setting the Voltage to a level higher than would be considered safe for the neutron detector tubes being used with the NPM. For example, perhaps the user desires to experiment with a variety of voltages when using a particular tube, but wishes never to exceed a maximum voltage. *MaxVoltage* can be set to the maximum allowable voltage that is recommended for the tube. Entering "*MaxVoltage*" without an argument will display the current MaxVoltage value.

Example:
```
MaxVoltage= 1800
1800
```

Gain *R/W* *Amplifier Gain.*

The neutron pulse module amplifier *Gain* can be set to any value between 1.0 and 20.0 with a resolution of 0.1. Typically, the *Gain* will be set according to the requirement for a particular detector tube. A *Gain* producing pulse heights of roughly 75-80% of the full scale range of the amplifier is often ideal for most applications. For example, if the Nbins parameter is set to 128, the user may desire to select a *Gain* that causes the majority of pulses to produce peak heights of approximately 100. The pulse heights can easily be observed in real-time by setting *PeakMode=1*. Alternately, the pulse height histogram can be viewed to determine the height of the majority of the pulses. Entering "*Gain*" without an argument will display the current *Gain* value. Note that changing the High Voltage will also introduce gain into the electronic system. The appropriate *Gain* value will thus also depend on the HV value.

Example:
```
Gain= 5.7
5.7
Gain
5.7
```

LowerDisc
Or *R/W* *Neutron Pulse Detection Lower Threshold*
DiscLow

The *DiscLow* or *LowerDisc* discriminator value determines the pulse height (in histogram Bin numbers) below which a pulse is not counted. This is typically used to filter out gamma ray pulses or low level electronic noise. The units of *DiscLow* are in bin numbers. So for example, if Nbins=128 then a *DiscLow* value of 32 would prevent pulses that have a height of less than 25% (32/128) of full scale from being counted. Entering *DiscLow* without an argument will display the current *DiscLow* value.

Example:
```
DiscLow= 30
30
DiscLow
30
```

UpperDisc
or *R/W* *Neutron Pulse Detection Upper Threshold*
DiscHigh

The *DiscHigh* or *UpperDisc* parameter prevents pulses with heights above a threshold level (in histogram Bin numbers) from being counted. The units of *DiscHigh* are in bin numbers. For example, if Nbins=128, then a *DiscHigh* value of 120 would prevent pulses that have a height greater than 93% (120/128) of full scale from being counted. This can be used to eliminate coincident events or spurious noise pulses which can have exceedingly large pulse heights.

The Maximum value of the *DiscHigh* parameter is (Nbins-1). If set to the maximum value, the Upper Discriminator is disabled and full scale (saturated ADC) pulses will be registered.

Entering "*DiscHigh*" without an argument will display the current *UpperDisc* value.

Note on Histogram reporting:
The UpperDisc parameter filters pulses with amplitudes greater than the UpperDisc value from being recorded in the total counts parameter. However, the UpperDisc parameter does not affect the recorded histograms. i.e, when an UpperDisc value is set, the recorded <u>Histogram</u> will still tally counts in bins higher than this value. This is done so that users can still observe and monitor the overall pulse height distribution and monitor high amplitude pulses even when the user does not want to count them. High amplitude pulses can be an indicator of spurious counts or high voltage breakdown in the detector tube, connector, or NPM electronics.

Example:
```
DiscHigh= 125
125
```

DeadTime *R/W* *Neutron pulse detection "lockout" time*

The DeadTime parameter specifies the minimum time interval or "lockout time", in microseconds, during which two co*nsec*utive pulses can be detected. DeadTime can sometimes be useful for screening out semi-coincident pulses wherein two briefly spaced pulses occur due to a single common event. For example, if an event is known to cause multiple counts to be generated within a specific time period, the DeadTIme parameter can be adjusted to a value equal to or greater than this time period as a way to eliminate the secondary pulses. For current generation devices, the smallest allowable DeadTime is 30us for units with pulse shaping Time Constants of 3*usec* and the longest allowable DeadTime is 6000us. This corresponds to maximum counting rates of 33kHz and 167 Hz respectively. Entering "DeadTime" with no argument displays the current value.

Note: DeadTime in neutron counting devices is sometimes referred to as a "Lockout Time."

Example:
```
DeadTime= 2000
2000
```

PeakMode *R/W* *Pulse peak display mode.*

PeakMode provides a method for observing peak pulse height information about individual detected neutron pulses as they occur, in real-time. If PeakMode is set to a value of 1, only the pulse height (peak of the pulse) information is displayed. Entering "PeakMode" without an argument will display the current PeakMode value.

Example:
```
PeakMode= 1
1
```

A typical pulse peak-height summary, with a 128 bin histogram, might look similar to the following:

```
Cnt=31482,Max=1109,Pos=12.4,Bin=  69,DeltaT=49,Time=4.673388750,455ff000b2468fe
```

where:

- Cnt is the number of accumulated counts since last Counts or ZeroCounts command
- Max is the Pulse maximum height (peak height) in ADC bits. Full scale analog measurements are 2048 bits.
- Pos is the location in ADC Sample # after the pulse detection threshold (DiscLow or LowerDisc) is crossed
- Bin is the MCA Bin # corresponding to the value *Max*. This can be calculated as Floor(Max/(2048/nBins) where nBins is the number of MCA bins.
- DeltaT is the number of DTRes intervals since the last pulse
- Time is the number of elapsed seconds since activating PeakMode (setting PeakMode=1)

PulseWave *R/W* *Pulse waveform output mode.*

If a *PulseWave* command is issued, the peak-height information (as displayed in the PeakMode command) is followed with data representing the pulse shape. The analog pulses are bi-polar and the pulse-shape data are integers ranging from -2047 to +2047, with a value of 0 representing the quiescent state of the amplifier output.

The full command syntax is *PulseWave=N,F*
where
N= # of waveform points to print.
F= Output format

Examples:

```
PulseWave=32,0
Max=1413,Pos=10.62,Bin=  88,Cnt=9474190,Time=1071.020001125,DeltaT=19999,5850109f982bb2d
598
750
903
1031
1135
1221
1290
1340
1376
1401
1411
1413
1404
1387
1363
1332
1296
1253
1210
1161
1107
1052
994
936
877
815
755
694
631
568
508
447
```

```
Pulsewave=32,1
Max=1415,Pos=10.63,Bin=88, Cnt=9792270,Time=7432.640001125, DeltaT=19999,587014538cb702d
599,750,907,1032,1135,1223,1291,1341,1378,1401,1413,1415,1405,1389,1364,1333,1297,1255,12
09,1160,1107,1052,994,935,877,815,755,695,631,569,507,446
```

```
Pulsewave=32,2
Max=1414,Pos=10.63,Bin=  88,Cnt=9796863,Time=7524.500001125,DeltaT=19999,586014613ce552d
   0    598  751  904 1032 1135 1221 1290 1341 1377 1402 1413 1413 1406 1388 1363 1334
  16   1297 1256 1210 1160 1106 1053  994  936  876  815  755  693  631  570  507  446
```

LEDMode *R/W* *LED Activaton Mode*

LEDMode= 1, the red LED on the back of the NPM3100E will momentarily flash whenever a pulse is detected.
LEDMode= 0, the LED flash is suppressed.

Entering *LEDMode* without an argument will display the current LEDMode value.

Example:
```
LEDMode=0
0
LEDMode
0
```

Counts *R* *Display and Zero the Neutron Pulse Counter*

Displays the number of pulses counted and Elapsed Time since the last *"Counts"* command was issued or since the last *"ZeroCounts"* command was issued. The neutron counts value is set to zero following the display of the current value.

Example:
```
Counts
143,79
```
⇨ 143 counts were tabulated over a 79 second interval. The counts and timer are zeroed after the command.

Query *R* *Display the Neutron Counter Without Zeroing*

Displays the number of pulses counted since the last "*Counts"* command was issued or since the last "*ZeroCounts*" command was issued. The *"Query"* command does not zero the neutron counts value.

Example:
```
Query
1956,257
```
⇨ 1956 counts have been tabulated over a 257 second interval. The counts and timer are <u>not</u> zeroed.

Cps *R* *Display the Neutron Counts Per Sec*

Displays the current Counts per Second calculation, (calculated every second)

Example:
```
Cps
223
```

ZeroCounts *C* *Zero the neutron pulse counter*

Zeroes the neutron counts and elapsed time timer value in the NPM's internal digital counter. Returns 0 when complete.

Example:
```
ZeroCounts
0
```

TTLOutMode *R/W* *Configures the Feedthrough State of TTL Input*

TTLOutMode may have a value of 0 or 1.
TTLOutMode=0 will disable the feedthrough of TTL Input pulses to the TTL Output.
TTLOutMode=1 will enabled the feedthrough all TTL Input pulses straight to the TTL Output. i.e. 5 *usec* wide TTL input pulses will be directly fed through as 5 *usec* wide output pulses.

Example:
```
TTLOutMode=1
1
TTLOutMode
1
```

TTLOutWidth *R/W* *TTLOutput Width for Neutron Generated Pulses*

TTLOutWidth sets the TTLOutput pulse width in nanoseconds for Neutron generated pulses.
TTLOutWidth may have values of 0, 25, 50, 100, 200, 500, 1000, 2000, 5000, and 10000 nanosecsonds.

TTLOutWidth=0 will disable the TTLOutput for Neutron generated pulses.
TTLOutWidth=25 will result in the production of 25 *nsec* wide TTLOutput pulses for each Neutron generated pulse.

Examples:
```
TTLOutWidth=2000
2000
TTLOutWidth
2000
```
2 *usec* wide TTLOut pulses will be produced for each Neutron generated pulse detected

TTLCounter *R/W* *Turns On and Off the counting of TTLInput pulses*

TTLCounter=0 turns OFF (diables) the counting of TTLInput pulses.
TTLCounter=1 turns ON (enables) the counting of TTLInput pulses.

Example:
```
TTLCounter
2000
```

TTLCounts *R/W* *Display and Zero the TTLInput Pulse Counter.*

Example:
```
TTLCounts
4989,1245
```
⇨ 4989 TTLInput pulses counted during a 1245 second interval.

TTLQuery *R/W* *Display but do Not Zero the TTLInput Pulse Counter*

Example:
```
TTLQuery
3190,4560
```
⇨ 3190 TTLInput pulses counted during a 4560 second interval.

ZeroTTLCounts *R/W* *Zeroes the TTLInput Pulse Counter.*

Immediately zeroes the TTLInput pulse counter. Returns a value of 0 when complete.

Example:
```
ZeroTTLCounts
0
```

PulseSim *R/W* *Pulse Simulation Period.*

The NPM3100 allows for internally generated pulses to be fed into the Analog signal chain. This can be used to verify the operation of the electronics and the counting system.
The user may enter *PulseSim=N* where N is the period between pulses in microseconds.

Note: The Analog input

Allowed values of N (microsec) are:
0=OFF, 50000, 20000, 10000, 5000, 2000, 1000, 500,200,100

Corresponding,respectively, to pulse rates of:
0Hz, 20Hz, 50Hz, 100Hz, 200Hz, 500Hz, 1000Hz, 2000Hz, 5000Hz, 10000Hz

The *PulseSim* function typically generates pulses approximately 80% of Full Scale when the NPM Gain is set to 3.0.

Example:
```
PulseSim=20000
PulseSim Period =  20000 us
```

This will result in simulated pulses internally generated at a rate of 50Hz.

7.3 Multichannel Analyzer (MCA) Commands and Parameters

Command Quick Reference Table

Name	Type	Operation
Hgm	R	Report the histogram according to HgmMode
MaxHgm	R	Report histogram maximum information
ZeroHgm	C	Zero the histogram
HgmMode	R/W	Histogram output format (1,2,3)
Nbins	R/W	Number of Bins used in the integrated Multi-Channel Analyzer histograms

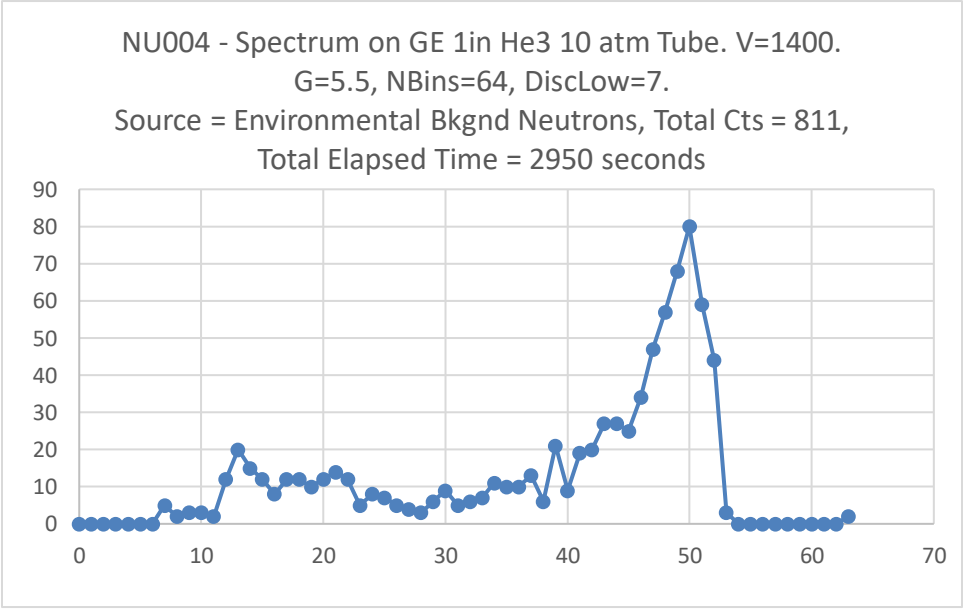
Table 9: Multichannel Analyzer Commands

Hgm *R* *Displays the MCA histogram*

Displays the currently accumulated pulse height spectrum or histogram according to the format specified by the *HgmMode* parameter.

Example:
With Nbins=64
Hgm

```
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,5
8,2
9,3
10,3
11,2
12,12
13,20
.
.
.
.
43,27
44,27
45,25
46,34
47,47
48,57
49,68
50,80
51,59
52,44
53,3
54,0
```



```
55,0
56,0
57,0
58,0
59,0
60,0
61,0
62,0
63,2
Total=811,2950
```

MaxHgm *R* *Display histogram maximum value information*

Reports postion of histogram maximum, maximum value, and total histogram counts. Can be useful as a quick monitor of Detector and electronic performance and status.

Example:
MaxHgm
50,80,811

Displays the position of histogram maximum in Bin numbers, maximum value of the histogram (in number of counts), and the total number of counts in the histogram.

ZeroHgm *C* *Clears the NPM pulse height histogram*

Zeroes or Clears the neutron pulse module histogram recorded by the integrated Multichannel Analyzer. Returns 0 when zeroing is completed.

HgmMode *R/W* *Reported Histogram format mode*

The *HgmMode* parameter specifies the format in which the histogram is displayed following an *Hgm* command.

HgmMode= 1 , the histogram consists of a single column with *Nbins* number of rows. Each row contains the number of pulse counts that have been placed in the corresponding bin number.

HgmMode= 2 , the histogram is displayed in a similar manner to *HgmMode=1* except that a prefixed column is added which specifies the bin number for each histogram value.

HgmMode= 3 , the histogram is displayed in a similar manner to *HgmMode=1* except that the histogram values are scaled such that the histogram peak has a value of 255. This is useful for normalized graphical representations of the histogram. Since the Pulse Height spectrum is a property of the Tube and the operating parameters, the shape of the curve should be independent of the total tounts accumulated (ignoring Poisson statistical fluctuations).

In all cases, the histogram is followed by the total number of counts represented in the histogram and the total number of seconds that have elapsed, since the histogram was last zeroed with the *ZeroHgm* command. Entering *HgmMode* without an argument will display the current *HgmMode* value.

Example:
```
HgmMode=2
2
```

Nbins *R/W* *Number of MCA Histogram Bins*

Specifies the number of bins, or resolution, of the pulse-height histogram recorded by the integrated Multichannel Analyzer (MCA). Allowed values for *Nbins* are: 64, 128, 256, 512, and 1024. Any other value will be rejected. Entering "*Nbins*" with no argument displays the current value.

Example:
```
Nbins= 128
128
Nbins
128
```

7.4 Delta-Time Histogram (Differential Arrival Time Spectrum) Commands

Command Quick Reference Table

Name	Type	Operation
DTRes	R/W	Delta-Time resolution (microsec)
DTHgm	R	Report Delta-T Histogram
ZeroDTHgm	C	Zero the Delta-T Histogram

Table 10: Differential Arrival Time Spectrum Commands

DTRes *R/W.* *Delta-Time Resolution (μsec)*

Example:
```
DTRes=1000
1000
DTRes
1000
```

The current resolution in microsec for the Delta-T Pulse Arrival Time spectrum. Each bin in the histogram represents a *DTRes* width of time and indicates the number of pairs of pulses which have arrived in that DeltaT interval. Pulse pairs with Delta-T Pulse Arrival times greater than 1000**DTRes* will be tabulated in the highest bin, i.e. Bin 999.

Entering "*DTRes*" with no argument displays the current value.

Allowed values of *DTRes* are 1, 10, 100, 1000, and 10000 *usec*.

DTHgm *R.* *Report the Delta-T Histogram*

Reports the DeltaT Histogram.
The DeltaT Histogram is 1000 bins in size, and is reported as columns of (N**DTRes*), followed by the number of pulses in that DT interval, i.e. Bin 8 will contain the number of pairs of pulses which arrived in the DeltaT time interval spanning (8**DTRes*) and (9**DTRes*).
Pulses with differential Pulse Arrival times greater than 1000**DTRes* will be tabulated in the highest bin, i.e. Bin 999.

ZeroDTHgm *C* *Clears the Delta-T Histogram*

Zeroes or Clears the DeltaT Arrival Time spectrum internally recorded.

7.5 Sensor Commands

Command Quick Reference Table

Name	Type	Operation
Temperature	R	Temperature and Relative Humidity
Humidity	R	Temperature and Relative Humidity

Table 11: Sensor Commands

Temperature *R* *Report Temperature and Relative Humidity*

Report Temperature and Relative Humidity, Comma Separated, i.e.
T, RH

Example:
```
temperature
 28.7,35.5
```

The temperature is 28.7 C and the Relative Humidity is 35.5%

Humidity *R* *Report Temperature and Relative Humidity*

Report Temperature and Relative Humidity, Comma Separated, i.e.
T, RH

Example:
```
humidity
 28.7,35.5
```

The temperature is 28.7 C and the Relative Humidity is 35.5%

7.6 Data Logging Commands

Command Quick Reference Table

Name	Type	Operation
PrintDAT	R/W	Print Data Record to Terminal each Recordperiod
LogDAT	R/W	Save Data Record to SD Card each Recordperiod
RecordPeriod	R/W	Data Sampling period, in seconds: >= 3 seconds
NewFilePeriod	R/W	NewFile creation period: Day, Month, Year
Time	R/W	Report or Set Time and Date
LogMode	R	Report Current Data Logging settings
ShowFilenames	R	Report Active DAT and HGM Filenames
PrintHGM	R/W	Print HGM to terminal each Recordperiod
LogHGM	R/W	Save HGM to SD card according to RecordsPerHGM and Recordperiod parameters
RecordsPerHGM	R/W	Number of Records between Sampled and Zeroed HGMs
LogTemp	R/W	Log Temperature in each Data Record
LogHum	R/W	Log Humidity each Data Record
LogTTLCounts	R/W	Log TTLInput Counts

Table 12: Data Logging Commands

PrintDAT *R/W Print data each RecordPeriod (0 or 1)*

Turns OFF/ON printing of data to the output each RecordPeriod
0 = OFF; 1= ON.

Example:
```
PrintDAT=1
1
```

LogDAT *R/W Save data to SD cards each RecordPeriod (0 or 1)*

Turns OFF/ON the saving of text formatted data to the SD cards each RecordPeriod 0 = OFF, 1= ON.

Example:
```
LogDAT=1
1
```

RecordPeriod *R/W Data recording interval in seconds*

Specifies the number of seconds between the sampling of data records. Minimum allowed value is 3 seconds.

Example:
```
RecordPeriod= 60
60
```

NewFilePeriod *R/W Interval for New File Creation*

Specifies the period of time between which new files will automatically be created. Allowable periods are the words: Day, Month, and Year.

Example:
```
NewFilePeriod = Day
Day
```

Time *R/W Date and Time (i.e. 2012/05/08 14:35:22)*

Date and Time in YYYY/MM/DD HH:MM:SS format.

Example:
```
Time=2012/07/09 15:24:00
2012/07/09,15:24:00
```

Waiting 20 seconds and then querying:
```
Time
2012/07/09,15:24:20
```

LogMode *R Reports the current Logger parameters*

Reports the current Datalogger parameters.

Example:
```
logmode
PrintDAT      = 0
LogDAT        = 1
RecordPeriod  = 60
NewFilePeriod = Day
PrintHGM      = 0
LogHGM        = 1
```

```
RecordsPerHGM = 60
LogTemp       = 1
LogHum         = 1
```

ShowFilenames *R* *Report active DAT and HGM filenames*

Report the currently active DAT and HGM filenames.

Example:
LogDAT=1
LogHGM=0

```
showfilenames
DAT FileName = /DAT/IP173_1301180000.DAT
HGM FileName : Not Saving Histogram
```

PrintHGM *R/W* *Print histogram data periodically (0 or 1)*

Turns OFF/ON the periodic reporting of the Multichannel Analyzer Histogram data to the terminal. 0 = OFF, 1= ON.

When *PrintHGM=1* histograms will be sampled and reported to the terminal every (*RecordPeriod* * *RecordsPerHGM*) seconds.

Example:

```
PrintHGM=0
0
```

LogHGM *R/W* *Save histograms to SD cards periodically*

Turns OFF/ON the periodic recording of the Multichannel Analyzer Histogram data to the SD cards. 0= OFF, 1= ON.

When *LogHGM=1* histograms will be sampled and recorded to the SD cards every (*RecordPeriod* * *RecordsPerHGM*) seconds.

Example:

```
LogHGM=1
1
```

RecordsPerHGM *R/W* *Number of data recording intervals between sampled histograms*

The *RecordsPerHGM* parameter specifies the number of records that must occur for each histogram. *RecordsPerHGM* can have a minimum value of 1 record per histogram. Entering *RecordsPerHGM* without an argument will display the current RecordsPerHGM value.

Example:

```
RecordsPerHGM = 60
60
```

Note: If RecordPeriod = 60 and RecordsPerHGM=60, then Histograms would be sampled every 60 minutes, or once per hour.

LogTemp *R/W* *Include Temperature in Data Records*

Turns OFF/ON the inclusion of Temperature in the data sampled each RecordPeriod. 0 = OFF, 1 = ON. Requires Sensors option.

Example:

```
LogTemp=1
1
```

LogHum *R/W* *Include Humidity in Data Records*

Turns OFF/ON the inclusion of Relative Hunidity % in the data sampled each RecordPeriod. OFF = 0, ON = 1. Requires Sensors option.

Example:

```
LogHum=1
1
```

LogTTLCounts *R/W* *Include Exernal TTL Input Counts in Data Records*

Turns OFF/ON the inclusion of External TTL Input Counts in the data sampled each RecordPeriod. OFF = 0, ON = 1. Requires Sensors option.

Example:

```
LogTTLCounts=1
1
```

7.7 File system Commands and Parameters

7.7.1.1 File system Overview

The NPM collection of commands for handling and working with files has been implemented to match closely the analogous Microsoft DOS operating system commands. There are one or two Secure Digital memory cards, one internal (0:/) and, in some models, one removable external (1:/) and both memory cards are formatted with the FAT32 file system. There are three specific directories located in the root of the SD card(s), the DAT, HGM and LST directories.

Upon startup, the NPM3 creates these directories if they don't already exist. It also conditionally creates new files based on the unit's name and the date and time.

As in DOS, one can change to a file's directory in order to access the file or one can enter the file's entire path in order to access the file from any other directory. For instruction purposes, this manual assumes that the file of interest is located in the current working directory.

Command Quick Reference Table

Name	Type	Operation
Dir	R	Report files in directory
GetCwd	R	Reports the current working directory
DiskInfo	R	Report bytes free and size of SD cards
FileInfo A.B	R	Report File Information
Type A.B	R	Print to the output the File A.B
Cd A	C	Change directory to A
0: or 1:	C	Set current disk to 0: or 1: (NPM3100 series has only 0: internal card)
Copy A.B X.Y	C	Copy file
Rename A.B X.Y	C	Rename file
Attrib ?? A.B	C	Set or change attributes of a file.
Del A.B	C	Delete a file.
MkDir A	C	Make a new file directory
Format	C	Format the 0: internal SD card. Caution!

Table 13: Filesystem Commands

Dir *R* *List of files in the active file directory*

Entering '*Dir*' without an argument will display the contents of the current working directory. Entering "*Dir*" with a pathname will display the contents of the directory specified by the path.

GetCWD *R* *Report the current working directory*

Retrieve the current working directory location.

DiskInfo *R* *Report SD card bytes free and SD card Size in bytes*

FileInfo *R* *Report file information (as output in 'Dir' command)*

Reports file information for a single file as reported by the 'Dir' command.

Example:

```
fileinfo ip173_1205210000.dat
----A 2013/01/20 11:13     38669 ip173_1205210000.dat
```

Type *R* *List the contents of a file*

List the contents of a file.
Entering "*type*" without an argument will list the entire contents of a file.
One may also list a specified portion of the file, either a the beginning (Head) of the file or at its end (Tail). The number of blocks (512 bytes each) to be listed is specified with an integer.

Example 1:

To retrieve the entire contents of a file:

```
Type File1.xyz
```

To retrieve the first 1024 bytes of a file:

```
Type File1.xyz Head 2
```

To retrieve the last 4096 bytes of a file:

```
 Type File1.xyz Tail 8
```

Cd *C* *Change the active directory*

This command will behave like the PC based DOS 'cd' command.
Entering '*cd*' without an argument will behave as the '*getcwd*' comand and will return current working directory location.

Entering '*cd*' followed by a directory name or a path to a directory on the active drive will change the current active working directory to the specified location

Example:
```
cd 0:/HGM
0:/HGM
```

Entering 'cd' followed by a directory name or a path to a directory on a different drive will change the default active directory on the different drive. i.e., if the active directory is 0:/HGM and the user enters '*cd 1:\HGM*' the active working directory will remain 0:/DAT, but when the user subsequently enters '*1:*' the active working directory will become *1:\HGM*.

Example:
```
getcwd
0:/DAT
cd 1:/HGM
0:/DAT
1:
1:/HGM  External SD Card
cd
1:/HGM
```

0: or **1:** *C* *Select internal (0:) or External (1:) SD Cards*

'0:' will make the active SD card the internal SDcard.
'1: ' will make the active SD card the external SDcard.

Copy *C* *Copy a file*

Copy a file to another filename and/or location.

Example 1:
Copying a file from the current working directory to the SD card DAT directory.
```
Copy  File1.xyz  0:/DAT/File1.bak
```

Rename *C* *Rename a file*

Changes the name of a file.

Example:
Rename File1.xyz Name1.abc

Attrib *C* *Set attributes of a file*

The 'Attrib' command can be used to change the Read-only and Archive attributes of a file.

Example1:
`Attrib +R File1.xyz` (Make the file be Read-Only)

Example2:
`Attrib -R File1.xyz` (Remove the Read-Only flag)

Example3:
`Attrib +A File1.xyz` (Set the Archive flag)

Example4:
`Attrib -A File1.xyz` (Remove the Archive flag)

Del *C* *Delete a file or files*

The 'Del' command can be used to delete a file from the current or other directory.

Example:
Del 1:/HGM/File1.xyz

Wildcard deletes are also allowed.

For example, all files ending with .xyz can be deleted from a directory with:

```
Del *.xyz
```

All of the files in a directory can be deleted with:

```
Del *.* or Del *.
```

Example:

```
Del 1:/HGM/*.hgm
```

Mkdir *C* *Create a new directory*

Creates a daughter directory.

Example:

```
mkdir temp
OK
```

Format *C* *Format the Internal SD card (use with Caution)*

Allows complete erasure and formatting of the internal SDcard. This command should be used with care because all data on the card will be lost.

Example of Internal SD card format:

```
0:
0:/DAT  Internal SD Card
format
You are requesting to Format, 0: Internal SD Card
If you are sure you want to do this enter: Y.
Otherwise just hit return.
Y
Please wait....

Done formatting, 0: Internal SD Card
0:
0:/  Internal SD Card
getcwd
0:/
```

7.8 Listmode Commands and Parameters

Command Quick Reference Table

Name	Type	Operation
ListMode	R/W	Turns Off/On (0/1) ListMode data logging
ListMax	R/W	Number of ListMode records (pulses) to log
ListStatus	R	Current ListMode data record number.
ListView	C	Convert binary ListMode data file to Text or Hex rep
ListStream	R/W	Real-Time Streaming of ListMode events to TCPIP port… No Logging. 0->Off, 1-Text, 2-Hex Rep, 3-Binary
ResetTime	C	Resets ListMode timestamp timer.

Table 14: Listmode Commands

ListMode *R/W* *Turns Off/On (0 / 1) List Mode Logging of Data. Data is saved in binary format, 8 bytes per data record.*
0 -> Will stop ListMode datalogging.
1 -> Will activate ListMode datalogging (acquisition of ListMax records)
Example:
ListMode=1

ListMax *R/W* *Read or Write the number of Records to beacquired during ListMode datalogging (i.e. when ListMode=1)*
Example:
ListMax = 100000
ListMode=1

ListStatus *R* *Return current record number*

ListView *R* *Convert binary ListMode data file and send out on TCPIP Port. If a terminal program is being used, this will display converted data on the terminal.*
Options:
Start - The starting record number
End - The ending record number
Hex - Output data in Hexadecimal Format.

ListStream *R/W* *Stream real-time ListMode records to the TCPIP Port. If a terminal is being used, this will result in real-time display on the Terminal*
0 -> Stops ListMode streaming.
1 -> Streaming in Text format.
2 -> Streaming in Hexadecimal character format.
3 -> Streaming in Binary format. Best if a PC acquisition program is directly acquiring data.

Example 1:

Incoming periodic detector pulses with Peak Pulse Height of 47 and cadence of 500 usec (0.0005 seconds) are streamed in Text format

```
ListStream = 1
Output:
48,0.112600000
48,0.112800000
48,0.112999900
48,0.113200000
48,0.113400000
48,0.113599900
…
…
```

Example 2:

Incoming periodic detector pulses with Peak Pulse Height of 47 and cadence of 500 usec (0.0005 seconds) are streamed in Hex format.

```
ListStream = 2
Output:
305f6000066ef90
305f6000066f75f
306f6000066ff30
306f60000670700
305f60000670ecf
305f600006716a0
```

Where

`305` -> (hex chars 13-15) is Decimal 773, is the Peak Amplitude on a scale of 0-> 1024

`f6` -> (hex chars 11-12) is Decimal 246, the Device identifier number

hex chars 1-10 is a 40 bit number corresponding to the Timestamps in increments of 100 nsec (0.1 usec)

7.9 Network Parameters

The commands in this section apply to NPM3100E devices which provide an Ethernet interface.

Command Quick Reference Table

Name	Type	Operation
IPAddress	R/W	Device IP Address. Be careful when changing this value. Record the newly set IP Addr. Will become active after device reboot or power cycle
NetMask	R/W	Subnet mask, i.e. 255.255.255.0
GatewayAddress	R/W	Gateway Address

Table 15: Network Commands

IPAddress *R/W Active IP Address of the device*

Allows the NPM3100E user to set the IP Address.
Use with caution and record the new IP address!

Note: A new IP Address will only become active after the new IP Address has been set and accepted by the device. A device reboot will then be required to begin using the new IP Address.

Example: Set IP Address of device to 192.168.15.20

ipaddress=192.168.15.20

You are sure you want to change the IP Address to: 192.168.15.20 ?
If yes, record the new IP Address and enter 'YES'
YES
New IP Address will take effect after Reboot
192.168.15.20

Netmask *R/W Subnet mask, i.e., 255.255.255.0*

Allows the user to change the Subnet mask.

GatewayAddress *R/W Gateway Address.*

Allows the user to change the Gateway Address on the device. This will be ignored as the device does not autonomously send data or connect to the Internet.

8 The Value of the Pulse Height Spectrum

The NPM3100 series integrated MCA internally records pulse height spectrums for a detector. This can be used to quickly and reliably configure the detector without a neutron source, using only environmental or 'background' neutrons. The pulse height spectrum is also a valuable diagnostic monitoring tool, allowing the user to verify that the detector system is operating properly.

Helium-3 (He3 or ^{3}He, both notations are used in this document) , Boron Trifluoride (BF3 or BF_3, both notations are used in this document), and Boron-lined proportional gas tubes are often used in to detect thermal neutrons. These detectors have well characterized pulse height spectra (histograms) that depend upon the detector geometry, gas composition, pressure and other factors. As one of these spectra is developed, in some cases sharp features can be identified quickly. For example, a He3 detector has a salient peak in its spectrum. Once this feature is identified, the NPM's high voltage, gain and discriminator settings can be configured to optimize the system, make full use of its dynamic range and set the lower discriminator to maximize neutron counts.

Use of the pulse height spectrum in configuring an NPM and proportional detector is superior (faster and more accurate) compared to the so-called 'high voltage plateau' technique. The plateau method attempts to roughly infer the shape of pulse height spectrum in order to optimize the high voltage, gain and discriminator settings. This method can be time consuming, especially in the case of low neutron count rates. Having the pulse height spectrum available makes the plateau method unnecessary.

The NPM3100's MCA enables "real-time" monitoring of the proper function of the neutron detector system since a detector's pulse height spectrum is a good gauge of its health. If a detector's spectrum changes over time, its shape may provide information about the failure mode. For example, the spectrum may indicate whether the problem is with the detector or the electronics, or whether environmental factors such as humidity are involved. In some cases, a failing detector can be retuned so that it can continue to operate and provide good data.

The following sections present classic pulse height spectra for He3, BF3, and Boron-lined gas proportional detectors. For comparison, a brief discussion of the High Voltage Plateau Method is included.

The user of Quaesta Instruments Neutron Pulse Modules may find references such as Glenn F. Knoll's book **Radiation Detection and Measurement** useful in understanding neutron detector pulse height spectra and detector operation in general.

8.1 Helium-3 Detector Spectra

A typical pulse height spectrum for a He3 tube acquired in the laboratory is shown in **Figure 43** **Figure 43**. Different gas pressures and tube designs will alter the appearance somewhat but the basic features will remain.

The location of the Peak relative to the Lower Edge of the so called "Wall Effect Continuum" is a property of the gas used in the detector. For $^{3}\mathrm{He}$ gas an alpha particle and a triton are produced when a neutron reacts with a $^{3}\mathrm{He}$ nucleus, i.e.

$^{3}_{2}\mathrm{He} + ^{1}_{0}\mathrm{n} \rightarrow ^{3}_{1}\mathrm{He} + ^{1}_{1}\mathrm{p}$, Q-value= $0.764\mathrm{Mev}$. In this case the ratio:

$$\frac{E_{^3H}}{E_{^3H} + E_p} = \frac{0.191\mathrm{Mev}}{0.191\mathrm{Mev} + 0.573\mathrm{Mev}} = 0.25$$

This ratio can also be found from the histogram (for $^{3}\mathrm{He}$ gas detectors) as

$$\frac{Bin\#of\ Lower\ Edge of\ Continuum}{Bin\#of\ Peak\ Location}$$ = 24/97 ~ 0.25 ; see **Figure 43**

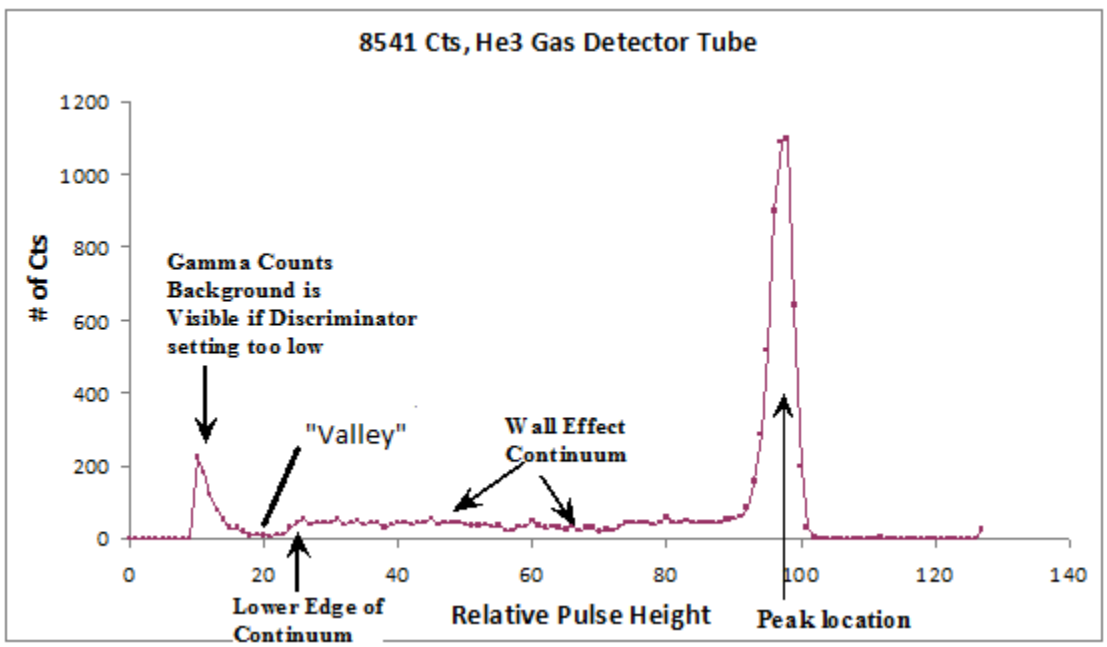


Figure 43: Typical He3 Histogram (Pulse Ht Spectrum)

A counting "valley" is located to the left of the wall effect continuum and separates the neutron generated pulses from lower amplitude pulses created through gamma ray background and electronic noise.

To count all measured neutrons with maximum insensitivity to changes in operating voltage, electronic gain, and tube performance, set the lower discriminator in the counting valley region. To ensure immunity from gamma ray counts, set the lower discriminator further to the right in the wall effect region.

The pulse height spectrum helps a user consistently, reliably, and repeatedly set the voltage, gain, and lower and upper discriminators to achieve his goals.

8.2 BF3 (Boron-10 enriched) Detector Spectra

For BF_3 (B-10 enriched) gas detectors, the spectrum has the general characteristics shown in **Figure 44Figure 44** and is well characterized in the literature. Different gas pressures and tube designs will alter the spectral shape somewhat. The dual peaks in this pulse height spectrum are a result of the branching of the reaction between the excited state and ground state of the ^{7}Li product nucleus.

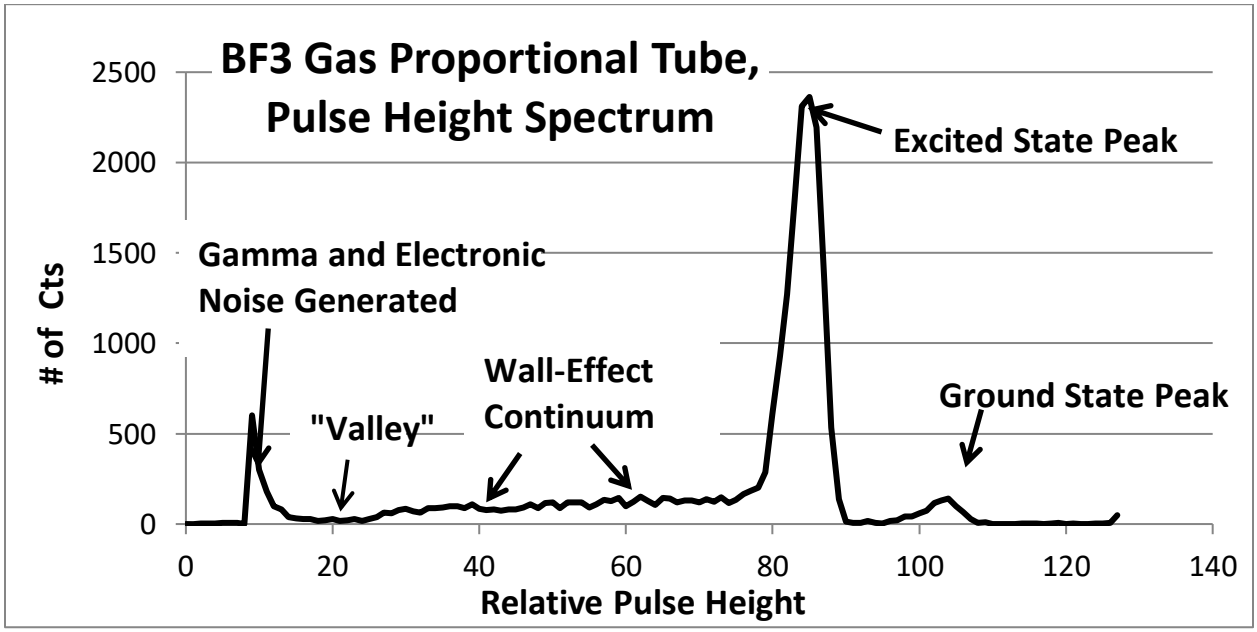


Figure 44: Typical BF3 Histogram (Pulse Height Spectrum)

A counting valley is located to the left of the wall effect continuum and separates the neutron generated pulses from lower amplitude pulses created through gamma ray background and electronic noise.

8.3 Boron-10 Lined Tube Spectrums

Boron-10 lined tubes introduce boron as a solid coating on the interior walls of a proportional counter tube. The interactions with incoming neutrons occur in the wall of the tube. The nuclear reactants are a Lithium-7 nucleus and an alpha particle.

Due to momentum conservation, reaction products are oppositely directed, and one goes into the fill-gas and produces an ionization signal while the other is directed into the tube wall and does not produce any signal. This behavior leads to a pulse height spectrum without a central peak and without a counting valley. The result is a spectrum with the characteristic shape shown in **Figure 45Figure 45**.

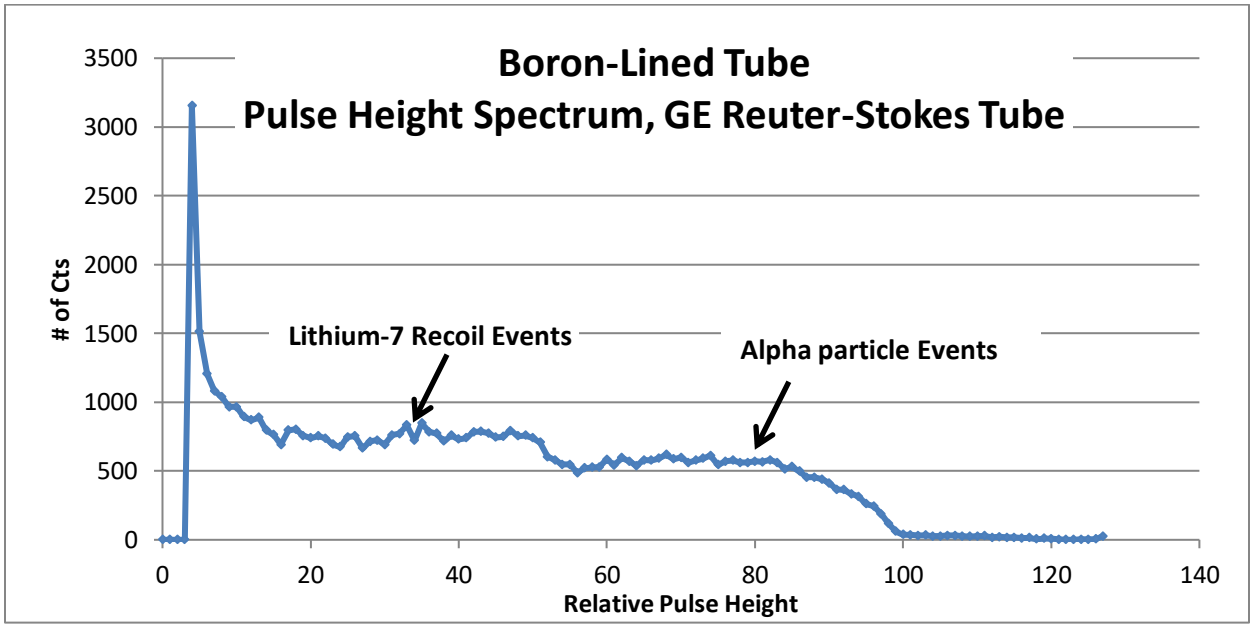


Figure 45: Typical Boron-10 lined Tube Histogram (Pulse Height Spectrum)

Configuring Boron-10 lined tubes with the use of NPM3100 series pulse height spectra ensures consistency across multiple detectors. High voltage, gain, upper and lower discriminator settings can easily be selected in a consistent way with respect to the detectors' spectra.

Although Boron-10 lined gas proportional tubes lack a counting valley they can be used to produce stable and reliable neutron measurements over time if they are set up and monitored properly.

8.4 Using Histograms to Tune the NPM Operating Parameters

Lower Discriminator: A Lower Discriminator setting acts as a low threshold for neutron pulse counting and pulse height recording. If pulse heights are lower than the Lower Discriminator level, then they are not counted or recorded by the NPM. The Lower Discriminator level is selected in terms of histogram bin number. For a typical 128 bin He3 histogram, if the central peak is located at bin 100, then the counting valley will be located approximately in the low 20's bin number range. See section 8.1 for more information.
If the Lower Discriminator is set to the left of the counting valley, then gamma rays and electronic noise canl begin to contaminate the neutron counts. Neutron count sensitivity is maximized by setting the lower discriminator in the counting valley, but immunity to noise can be enhanced (if the user desires) by setting the discriminator to the right of the counting valley in the shelf region of the spectrum.

Gain: By increasing the amplifier gain, one increases the measured pulse heights which has the effect of sliding the peak to the right in the spectrum. Changing the gain expands and compresses the histogram along the horizontal axis. Increasing the gain will amplify the neutron pulse heights but will also amplify the gamma ray signal and electronic noise.

High Voltage: Increasing/decreasing the high voltage applied to the tube will also amplify/reduce the pulse heights. Increasing the pulse heights via the high voltage, rather than changing the electronic gain, has the benefit of amplifying the detector generated pulse heights while not amplifying the electronic noise. However, neutron detector tube manufacturers generally provide a recommended operating voltage at which the detector has been designed for optimal performance. In addition, increased operating voltage can lead to a greater incidence of spurious counts due to high voltage breakdown or reduced tube lifetime for some tubes. If the tube operation is sensitive to higher humidity, then increased operating voltages can sometimes increase such sensitivity.

Upper Discriminator: The Upper Discriminator allows one to filter out pulse heights which are higher than a chosen value. The NPM3100 series devices count pulse heights greater than the Lower Discriminator bin number and lower than or equal to the Upper Discriminator bin number.

Histogram Bins are numbered from 0 to nBins-1. A 128 bin histogram will have bins numbered from 0 to 127. Setting the Upper Discriminator setting to 127 or higher results in effectively no Upper Discriminator at all; i.e. all pulse heights greater than the Lower Discriminator setting will be counted, including Full Scale pulses. Spurious

counts in the form of high voltage breakdown events are often Full Scale (high pulse amplitude events).

Note:
For Quaesta Instruments NPM devices, the Upper Discriminator setting does not affect the recorded histogram but does affect the counted pulse tally. That is, pulses with pulse heights greater than the Upper Discriminator setting will still show up in the recorded pulse height spectrum histogram but will NOT be included with the total neutron count. This arrangement allows the user to monitor the number of high amplitude pulses in the spectrum while **not** counting these pulses as neutron events.

8.5 High Voltage Counting Plateau Generation

Note:

Use of the integrated MCA in Quaesta Instruments Neutron Pulse Modules allows one to set up their neutron detectors in Minutes without generating a traditional High Voltage Plateau Curve. The information below is provided as a reference.

If an MCA is not available for a Neutron Pulse Module, then a pulse height spectrum cannot be produced. However, some information about the underlying spectrum is necessary to properly configure the Neutron Pulse Monitoring electronics and detector. An alternate approach to using the spectrum directly is to infer the underlying spectrum using the "High Voltage Counting Plateau" Method. The Total counts reported by a Neutron Pulse Module is the integral of the pulse height spectrum between the upper and lower discriminators. The High Voltage counting plateau method involves recording the Total counts while sweeping the High Voltage and keeping the Gain, Lower Discriminator and Upper Discriminators constant.

Note that while all Quaesta Instruments Neutron Pulse Modules have an Upper Discriminator, many industry utilized Neutron Pulse Monitoring devices do not have an Upper Discriminator. The use of the Upper Discriminator allows one to filter high amplitude pulses such as may be generated from spurious counts or High Voltage breakdown in the Detector or the Detector insulator. If one wishes to generate High Voltage plateau curves similar to those produced when

Traditional High Voltage Plateau curves are generated by sweeping the High Voltage and recording counts (while keeping the Electronic Gain and Lower Discriminator fixed) A typical Total Counts vs High Voltage curve produced will look something like that shown in **Figure 46**.

The curve is generated by adjusting the high voltage and measuring the neutron count rate at that voltage, and then changing the high voltage and repeating. The Counting Plateau region is that region where the Count rate changes the least with changing voltage. To produce a well-defined or sharper plateau curve, a number of data points must be generated.
Note: If the neutron count rate is low, which is likely the case unless the user has a neutron source, then data must be taken for a longer time period at each high voltage setting to achieve good signal to noise as dictated by Poisson statistics. The sharper the plateau curve, the better one can infer the shape of the underlying pulse height spectrum. Therefore, a useful plateau curve requires many data points with good signal to noise, and without a neutron source, acquiring such data can be time consuming.

Proper selection of NPM parameters will result in operation in the 'counting plateau region' of the Total Counts vs Voltage curve. In such a configuration the NPM and detector system is maximally insensitive to changes in gain, high voltage, and even the discriminator level. If done properly, the lower discriminator will have been set at or near the counting valley of the pulse height spectra seen in **Figure 43** and **Figure 44**.

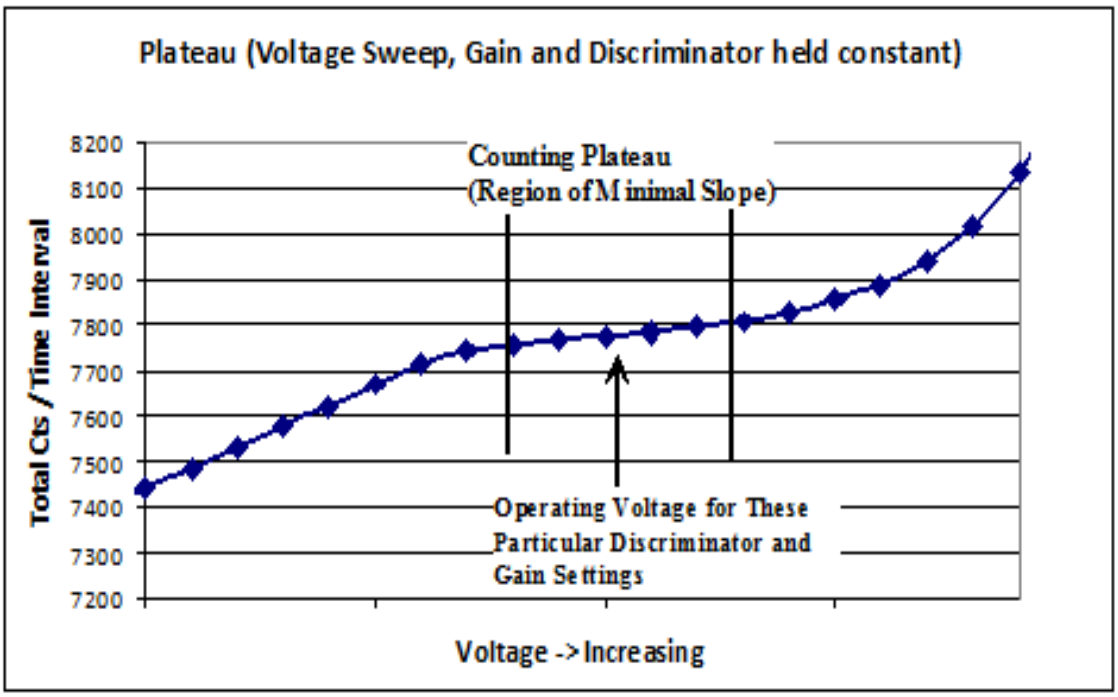


Figure 46: Traditional Counts vs High Voltage Plateau curve for He3 and BF3 tubes

Note:

Use of the integrated MCA in Quaesta Instruments Neutron Pulse Modules allows one to set up their neutron detectors in Minutes without generating a traditional High Voltage Plateau Curve. Generating a traditional neutron counting plateau can be quite time consuming. Neutron sources are often needed to accomplish the task in a timely fashion.

Furthermore, Boron-10 lined proportional gas tube pulse height spectrums do not have a counting valley and, therefore, will not have a high voltage plateau at all.

It is obvious that use of the Pulse Heigh Spectrum generated by an MCA, such as that in Quaesta Instruments NPM devices, allows the user to much more quickly and reliably set up a Neutron detector system such that its High Voltage, Gain, Lower and Upper Discriminators are configured to operate in a Counting Plateau regime. The user is in complete control of the device configuration.

Another beneift of the integrated MCA is monitoring of the detector systems is also enabled, allowing the user to verify that the Detector system is properly counting.

8.6 Detector Configuration Examples

This section contains recommended procedures for configuring an NPM3100 device with He3 or BF3 detectors. The procedures are meant to make good use of the dynamic spectrum of the NPM to maximize neutron counts; and to optimize stable operation over time. They involve setting the lower discriminator in the spectrum's counting valley. The user may modify these procedures as needed for his particular application. For example, if immunity to noise is a priority, the lower discriminator can be set above (to the right of) the counting valley, further from low level noise and unwanted gamma ray signal.

8.6.1 Procedure for Configuring Helium-3 Detectors

1. Set the number of Histogram Bins to 128. (Factory default).
2. Set the high voltage near the Tube manufacturer's recommended operating voltage.
3. Set the gain so that the location of the central peak is at approximately Bin 100.
4. Set the lower discriminator in the 20 – 23 bin range. The low edge of the shelf continuum should be at approximately bin 24-25. If the gamma background and other low amplitude noise are well behaved then this will place the lower discriminator in the counting valley. (See **8.1 *Helium-3 Detector Spectr*).**

5. For greater immunity to noise and gamma ray pile up signal, set the lower discriminator to the right of the counting valley. (See **8.1 *Helium-3 Detector Spectr*).**
6. Set the upper discriminator value as desired to filter high pulse amplitude events as desired. Remember that histogram bin numbers range from 0 to (nBins -1). If the upper discriminator is set to the maximum histogram value, bin 127 in this case, then this effectively deactivates the upper discriminator entirely. Full scale events that saturate the device's analog-to-digital converter (ADC) will all be counted as valid neutron events, though they would likely not be neutrons if the central peak is set near bin 100. Setting the upper discriminator bin to something less than 127, i.e. **UpperDisc=126** removes from the neutron counter all events with a pulse height of bin 127 or higher. This filters out all events that saturate the ADC which are generally not caused by neutrons.

8.6.2 Procedure for Configuring Boron Trifluoride Detectors

1. Set the number of histogram bins to 128. (Factory default).
2. Set the operating high voltage near the Tube manufacturer's recommended operating voltage.
3. Set the gain so that the location of the central peak is located at or near bin 85 in the spectrum.
4. Set the lower discriminator level to the 27-30 bin range (the low edge of the continuum should be somewhere near bin 30). If the gamma background and other low amplitude noise are well behaved then one can set the discriminator in the counting valley. See section **8.2 *BF3 (Boron-10 enriched) Detector Spectr***.
5. For greater immunity to noise and gamma ray pile up signal, set the lower discriminator to the right of the counting valley. See section **8.2 *BF3 (Boron-10 enriched) Detector Spectr*.**
7. Set the upper discriminator value as desired to filter high pulse amplitude events. Remember that histogram bin numbers range from 0 to (nBins -1).). If the upper discriminator is set to the maximum histogram value, bin 127 in this case, then this effectively deactivates the upper discriminator entirely. Full scale events that saturate the device's analog-to-digital converter (ADC) will all be counted as valid neutron events, though they would likely not be neutrons if the central peak is set near bin 100. Setting the upper discriminator bin to something less than 127, i.e. **UpperDisc=126** removes from the neutron counter all events with a pulse height of bin 127 or higher. This filters out all events that saturate the ADC which are generally not caused by neutrons.

6.

8.6.3 Counting Plateau Generation with the NPM3100

Though configuring an NPM and detector using the pulse height spectrum is highly recommended, the NPM3100 may be used to generate a high voltage or gain swept counting plateau. The NPM has features which aid in this process. The user can easily set the high voltage, gain and discriminator levels and vary any or all of these using the device Command Set. An integral digital counter in the NPM will count neutron pulses within a user specified time window which should be selected based upon the neutron count rate and desired signal to noise of the data points taken. A plateau can be generated by hand using a terminal interface and plotting data in an external program such as Excel. See Section **8.5 High Voltage Counting Plateau Generation** for a discussion.

Another possible approach is to use an external software application to automatically produce a counting plateau using the NPM3100 device. In this method, the software application would call the device Command Set and generate a plateau in much the same way a user does by hand, but the process would be automated.

Appendix A NPM3100 Command Quick Reference Tables

A quick reference list of available commands and parameters are included in the tables below. Commands are sent in text format via the communications interface. Commands should be terminated with a Carriage Return and Linefeed character sequence (i.e. CR+LF). Terminal emulators such as Tera Term Pro or Windows Hyperterminal can be configured to communicate with NPM3100 devices. Since the USB interface on the NPM3100U device can present itself as a Virtual COM Port to a computer and thereby emulate an RS232 device, the user may communicate via a user created RS232 interface application.

A GUI application provided by Quaesta Instruments can also be utilized to communicate with NPM3100 devices. Both the command prompt based Command Set and the GUI application make use of the basic NPM3100 firmware commands identified in the quick reference tables below. Detailed command descriptions are can be found in section **7 Device Command Set.**

Commands are not case-sensitive (i.e. they are case-insensitive).

The device Command Set has three general types of commands:

C – Control Commands
R – Read Commands
R/W -- Read/Write Parameter Commands

Read/Write parameters can be queried or read by simply typing the name (i.e., ‘Gain’) and can be written or set by using an equal sign after the parameter (i.e. ‘Gain=3.8’).

The quick reference tables below are organized below by command functionality and subsystem.

A.1 Miscellaneous Device Commands and Parameters

Name	Type	Operation
Name	R/W	Name of the NPM device
Menu	R	Report all available commands
Help	R	Report all available commands
Info	R	Report device identification and parameters
Sdev	R	Noise Standard Deviation
Uptime	R	Seconds since device startup
Reboot	C	Reset the system

Table 16: Miscellaneous Device Commands

A.2 NPM Neuchrometer Commands and Parameters

Name	Type	Operation
Voltage	R/W	High Voltage Supply value in Volts (250 to MaxVoltage)
MaxVoltage	R/W	Maximum allowed High Voltage (0 to HV range maximum, Model version specific, ie NPM3100E-2.5kV)
Gain	R/W	Amplifier Gain (1.0 to 20.0)
DiscLow or LowerDisc	R/W	Lower Discriminator (Neutron Pulse Threshold)
DiscHigh or UpperDisc	R/W	Upper Discriminator
DeadTime	R/W	Pulse detection dead-time or "lockout" time (μsec)
PeakMode	R/W	Pulse peak display mode - not typically used (0 or 1)
PulseWave	R/W	Display waveform of the next received pulse
LEDMode	R/W	LED activation mode (0 or1)
Counts	R	Report and zero the total neutron pulse counts
Query	R	Report the total neutron pulse counts without zeroing
Cps	R	Report the counts per second
ZeroCounts	C	Zero the neutron pulse counter
TTLOutMode	R/W	Configures the TTLOut Feedthrough of TTLInput
TTLOutWidth	R/W	TTLOutput pulse width for Neutron Generated Pulses
TTLCounter	R/W	Disables and Enables the external TTLInput counter (0 or 1)
TTLCounts	R	Display and Zero the TTLInput counter and elapsed time
TTLQuery	R	Display and Not Zero the TTLInput counter and elapsed time
ZeroTTLCounts	C	Zeroes the TTLInput counter and elapsed time
PulseSim	R/W	Pulse Simulation Period in *usec*

Table 17: NPM Subsystem Commands and Parameters

A.3 Multichannel Analyzer (MCA) Commands and Parameters

Requires device with MCA (-MCA) option.

Name	Type	Operation
Hgm	R	Report the histogram according to HgmMode
MaxHgm	R	Report histogram maximum information
ZeroHgm	C	Zero the histogram
HgmMode	R/W	Histogram output format (1,2,3)
Nbins	R/W	Number of Bins used in the integrated Multi-Channel Analyzer histograms

Table 18. Multichannel Analyzer (MCA) Commands and Parameters

A.4 Delta-Time (Differential Arrival Time) Spectrum Commands and Parameters

Requires device with Delta-T Histogram option.

Name	Type	Operation
DTRes	R/W	Delta-Time resolution (microsec)
DTHgm	R	Report Delta-T Histogram
ZeroDTHgm	C	Zero the Delta-T Histogram

Table 19. Delta-Time (Differential Arrival Time) Spectrum Commands and Params

A.5 Sensors Commands

Requires device with Delta-T Histogram option.

Name	Type	Operation
Temperature	R	Temperature and Relative Humidity
Humidity	R	Temperature and Relative Humidity

Table 20. Sensors Commands

A.6 Data Logging Commands and Parameters

Requires device with Datalogging (-DL) option.

Name	Type	Operation
PrintDAT	R/W	Print Data Record to Terminal each Recordperiod
LogDAT	R/W	Save Data Record to SD Card each Recordperiod
RecordPeriod	R/W	Data Sampling period, in seconds: >= 3 seconds
NewFilePeriod	R/W	NewFile creation period: Day, Month, Year
Time	R/W	Report or Set Time and Date
LogMode	R	Report Current Data Logging settings
ShowFilenames	R	Report Active DAT and HGM Filenames
PrintHGM	R/W	Print HGM to terminal each Recordperiod
LogHGM	R/W	Save HGM to SD card according to RecordsPerHGM and Recordperiod parameters
RecordsPerHGM	R/W	Number of Records between Sampled and Zeroed HGMs
LogTemp	R/W	Log Temperature in each Data Record
LogHum	R/W	Log Humidity each Data Record
LogTTLCounts	R/W	Log TTLInput Counts

Table 21. Datalogging Commands and Parameters

A.7 File System Commands and Parameters

Requires device with Datalogging (-DL) option.

Name	Type	Operation
Dir	R	Report files in directory
GetCwd	R	Reports the current working directory
DiskInfo	R	Report bytes free and size of SD cards
FileInfo A.B	R	Report File Information
Type A.B	R	Print to the output the File A.B
Cd A	C	Change directory to A
0: or 1:	C	Set current disk to 0: or 1: (NPM3100 series has only 0: internal card)
Copy A.B X.Y	C	Copy file
Rename A.B X.Y	C	Rename file
Attrib ?? A.B	C	Set or change attributes of a file.
Del A.B	C	Delete a file.
MkDir A	C	Make a new file directory
Format	C	Format the 0: internal SD card. Caution!

Table 22. File System Commands and Parameters

A.8 ListMode Commands and Parameters

Requires device with ListMode (-LM) option.

Name	Type	Operation
ListMode	R/W	Turns Off/On (0/1) ListMode data logging
ListMax	R/W	Number of ListMode records (pulses) to log
ListStatus	R	Current ListMode data record number
ListView	C	Convert binary ListMode data file to Text or Hex rep
ListStream	R/W	Real-Time Streaming of ListMode events… No Logging. 0->Off, 1-Text, 2-Hex Rep, 3-Binary
ResetTime	C	Resets ListMode timestamp timer.

Table 23. ListMode Commands and Parameters

A.9 NPM3100E Network (Ethernet) Parameters

Command Quick Reference Table

Name	Type	Operation
IPAddress	R/W	Device IP Address. Be careful when changing this value. Record the newly set IP Addr. Will become active after device reboot or power cycle
NetMask	R/W	Subnet mask, i.e. 255.255.255.0
GatewayAddress	R/W	Gateway Address

Table 24. NPM3100E Network (Ethernet) Parameters

Appendix B NPM3100U Communication via COM Port

The NPM3100U USB interface will present itself in Windows as a Virtual COM port, i.e., USB Serial Port. See Ctrl Panel -> Device Manager, as in **Figure 47**. The 'Ports' section will list the NPM3100U interface as a USB Serial Port. Older Windows versions (Windows XP) may need to download and install FTDI drivers from the FTDI website (http://www.ftdichip.com/Drivers/VCP.htm).
After the Virtual COM port (COM 12 in **Figure 47**) is assigned by Windows, PC applications can communicate to the NPM3100U device a standard RS232 interface device.

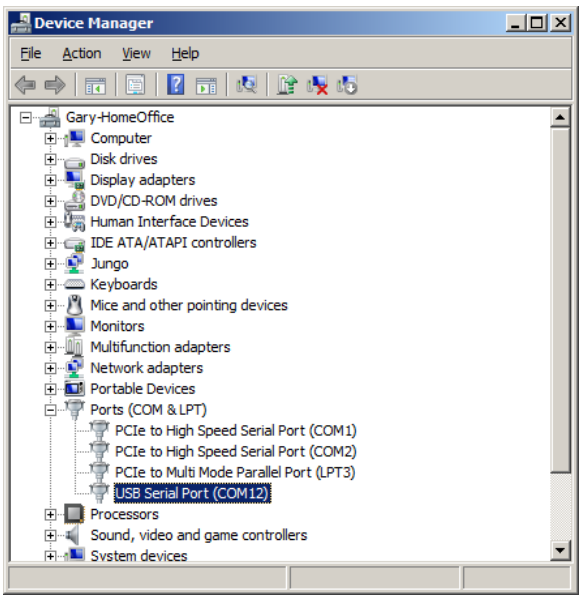


Figure 47. Device Manager Virtual COM Ports

NPM3100U COM Port Settings:

Baud Rate:	115200
Data Bits:	8
Parity:	NO Parity
Stop Bit:	1
Flow Control:	None

Note: When configuring a Terminal Program, make sure commands transmitted to the NPM3100 devices are terminated by a CR + LF (Carriage Return + Linefeed Sequence).

B.1 Connection to NPM3100U via TeraTerm Pro

TERMINAL Configuration

Teraterm Pro is a very good freely available Terminal interface program which can be used to Interface directly to the NPM3100U device. Other terminal interface programs which provide for RS232 connectivity can also be used, such as Windows Hyperterminal or PuTTY. Settings similar to those described for TeraTerm Pro should be used.

The latest version of Teraterm Pro can be downloaded from:
http://ttssh2.sourceforge.jp/index.html.en

After installed, the TeraTerm Pro window will appear as in **Figure 48**

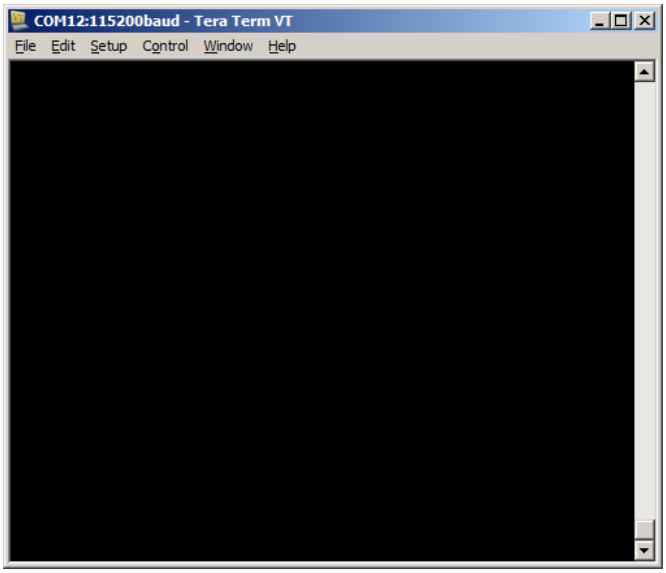


Figure 48. Teraterm Default Window

Open a new connection (File->New Connection), as in **Figure 49** and select the USB Virtual COM port corresponding to the attached NPM3100U device.

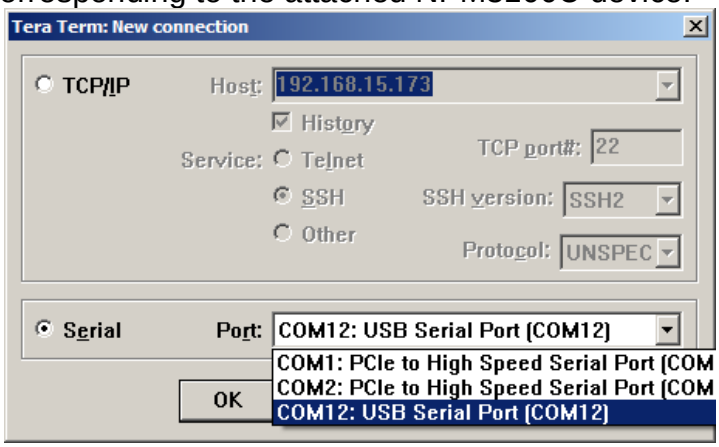


Figure 49. TeraTerm New Connection Window

Configure the Terminal through the menu Setup-> Terminal. See **Figure 50**. The New-line configuration Transmit option must be set to CR+LF. Other suggested configuration options are shown in **Figure 50** as well.

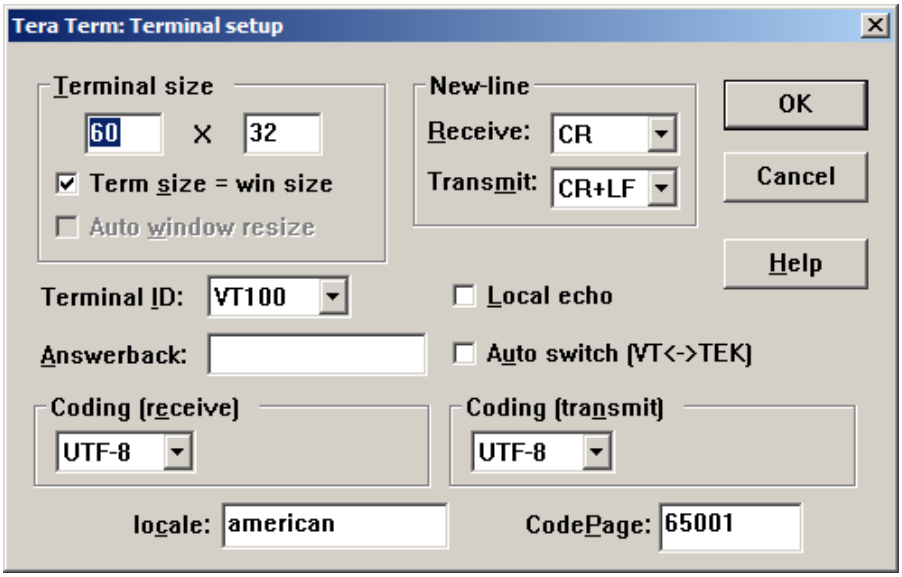


Figure 50. TeraTerm Terminal Setup Window

Configure Teraterm's Serial Port settings through the menu Setup -> Serial Port. See **Figure 51Figure 51.**
Serial Port Settings are: 115200 baud, 8 Data bits, No Parity, 1 Stop Bit, and No Flow Control.

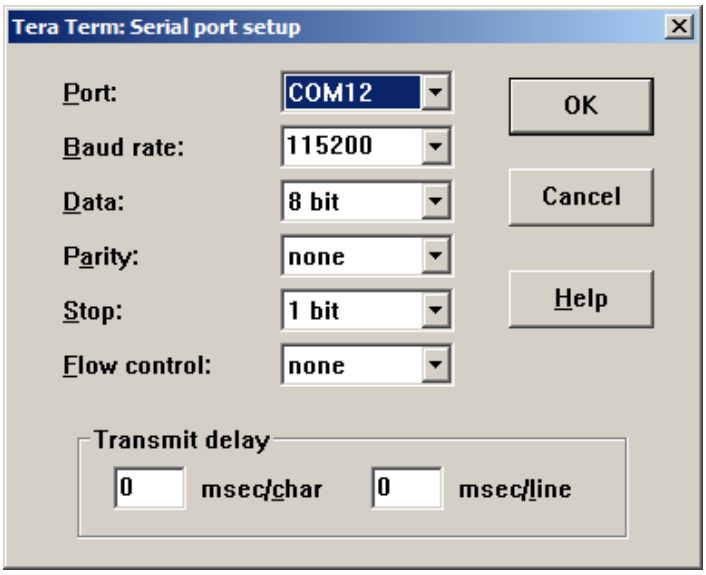


Figure 51. TeraTerm Serial Port Setup

B.2 Connection to NPM3100U via Hyperterminal

Tera Term Pro is recommended as a terminal interface program for use with NPM3100 series products. However, Windows Hyperterminal or other COM port terminal capable applications will allow communication with NPMs as well. This section describes connecting to an **NPM3100U** device using Hyperterminal.

Windows Hyperterminal is available as a free utility on Windows XP machines and for a small nominal cost for Windows 7 and later Windows operating platforms. See **Figure 52**.

Windows Hyperterminal can also be purchased for use on Windows 7 machines.

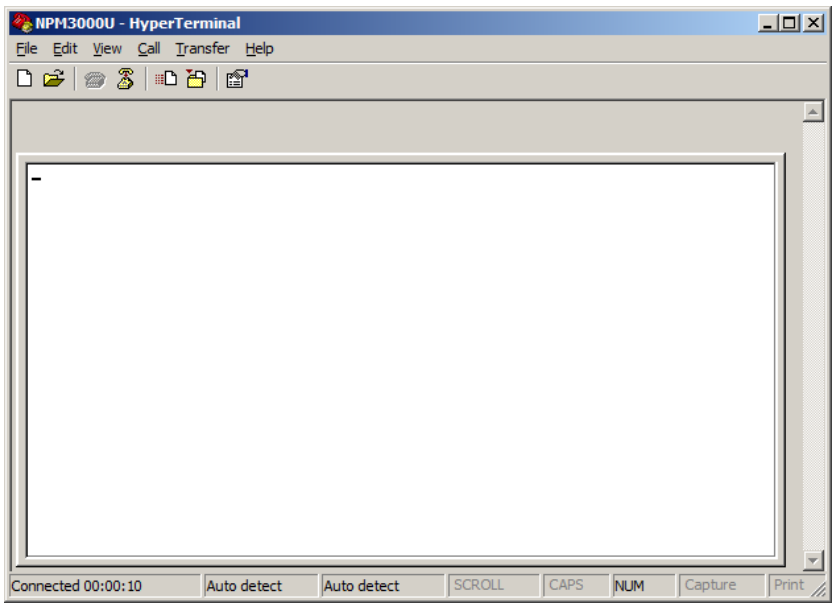


Figure 52: Windows Hyperterminal Main Window

Figure 53 shows Hyperterminal's New Connection Window available from the Hyperterminal File=>New Connection menu selection.

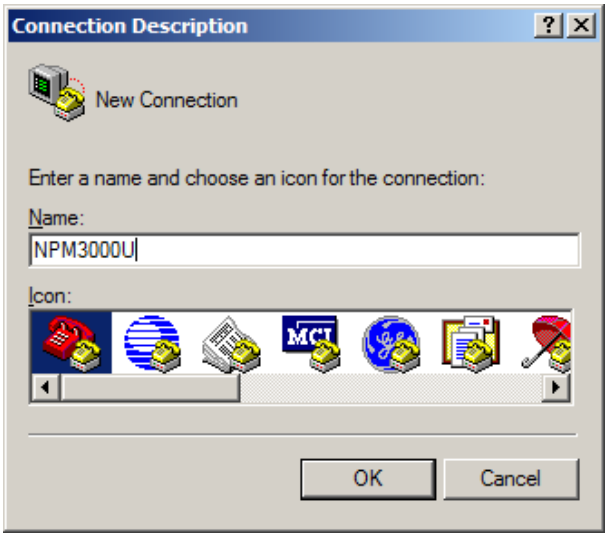


Figure 53: Windows Hyperterminal New Connection

Figure 54 shows the Window displayed after the OK command button in **Figure 53** is clicked. Select the Virtual COM port assigned to the NPM device (see).

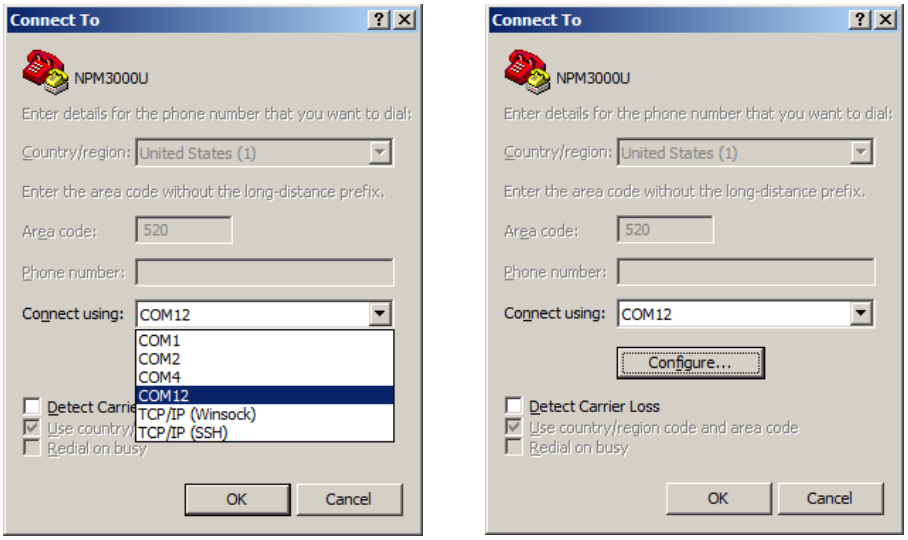


Figure 54: Hyperterminal COM Port Selection

Select the “Configure” command button and the COM Port Settings selection window shown in **Figure 55**. Select 115200 Baud, 8 Data Bits, No Parity, 1 Stop Bit and No Flow Control.

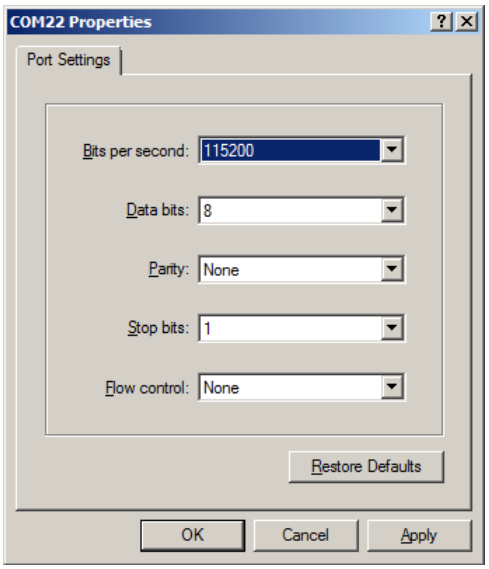


Figure 55: Hyperterminal COM Port Settings

From the Hyperterminal Main Window, select File=> Properties to open a window of the form shown in **Figure 56**

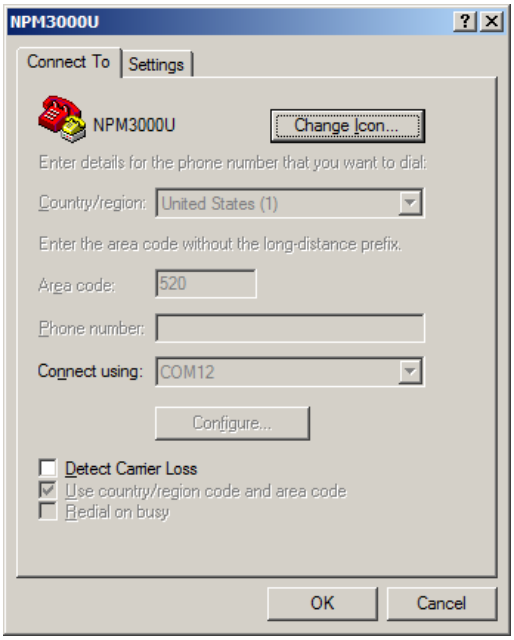


Figure 56: Windows Hyperterminal Connection Properties.

Figure 57 shows options available via the Settings Tab of **Figure 56**. Select VT100 and a Backscroll buffer size of 500 lines (the maximum allowed).

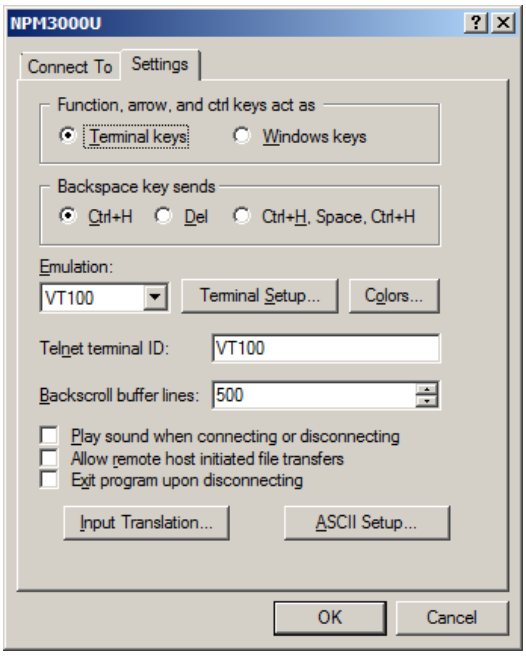


Figure 57: Hyperterminal Terminal Settings

Next, select the "ASCII Setup" button and a form as in **Figure 58** will appear. Select the "Send line ends with line feeds" checkbox. This is necessary as all commands sent to the NPM3100 device must terminate with a Carriage Return + Line Feed character sequence (these are Hex characters 0x0D and 0x0A).

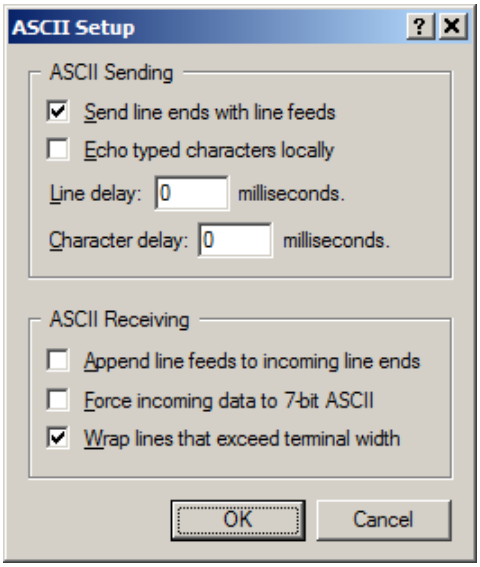


Figure 58: Windows Hyperterminal CR + Line Feed Setup.

Lastly, the user may desire to change the font size of the text shown in the terminal window as the default Windows Hyperterminal font size is quite large.

From the main Hyperterminal window select View->Font and a form as shown in **Figure 59** will open. The user can select his Font and Font Size preference, but those shown in **Figure 59** are a suggestion.

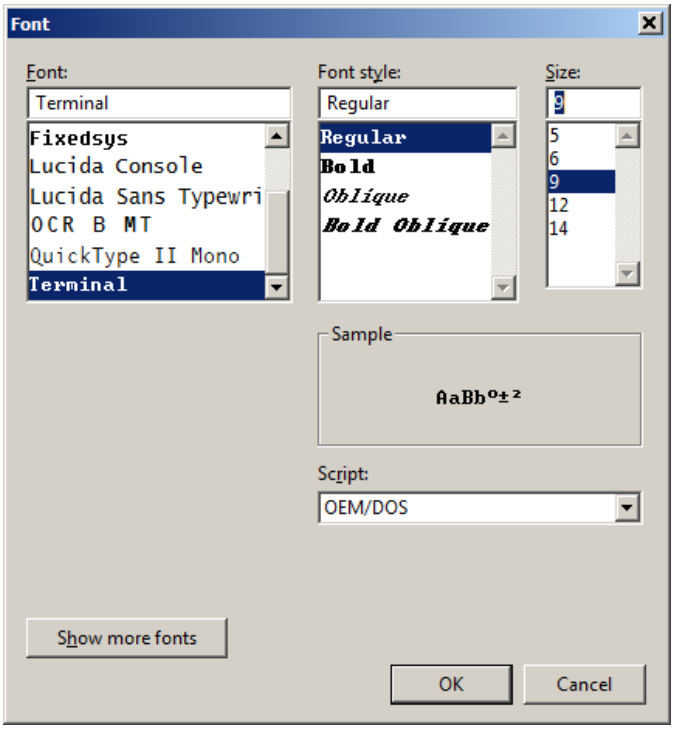


Figure 59: Windows Hyperterminal Font Setup.

Appendix C Firmware Upload Procedures

Quaesta recommends that new firmware be uploaded only if one or more of the following conditions is met:

1. A Firmware upgrade is desired for new functionality or if a relevant bug has been addressed and fixed in a firmware update.
2. The NPM3100 device firmware is corrupted. This should be a very rare occurrence as the microcontroller and firmware used in the NPM3100 device has been designed to operate many years without failure.

There are several firmware upload procedure options available to the NPM3100 user.

Each one of these firmware upload procedures relies upon the presence of a small bootloader firmware program resident in the NPM3100 device. The bootloader is the first microcontroller code which runs upon system reset. A reset occurs when power is cycled, a brown-out reset occurs, the watchdog timer expires, or a user issues the reboot command.

New Firmware can be uploaded easily if existing device firmware is intact and the NPM3100 device is functional. One of two firmware upload procedures can be used:

1. Use of the External SD card (if present) on the device. This requires local access to the device's external SD card and the ability to cycle the NPM power. This procedure can also be used if the main firmware code is corrupted. (Note: *NPM3100 series devices do not have external SD cards*).

2. Via Tera Term Pro, a Windows based terminal emulation program. The Xmodem file transfer is utilized. The sequence of steps is time critical, and therefore the user is encouraged to practice in the laboratory first before using this procedure on a field unit. Use of Tera Term Pro may also require the cycling of the power on the NPM electronics. This procedure can be used if the main firmware code is corrupted, but power cycling of the NPM electronics portion of the NPM3100 device will be required to gain access to the bootloader program.

Note: If the NPM3100 device firmware is corrupted, then new firmware can still be uploaded as long as the NPM3100 device bootloader program is still resident and functioning.

C.1 Firmware Upload using the Quaesta Instruments GUI

This Manual Section is in Progress.

C.2 Firmware Upload Using the External SD card.

****External SD Card is Not present in all devices.**

FW upgrade of Quaesta NPM device can be accomplished via the External SD card if the unit contains an external SD card and physical access to the device is available.

The following procedure should be followed:

1. Obtain an appropriate NPM firmware upgrade file from Quaesta Instruments for the model of device being upgraded. This file wil have a ".bin" or "*.crp" extension. i.e., filename will have form of "NPMXXX.bin" or "NPMXXX.crp"
2. Remove the External microSD card and copy the obtained bin file to the top level directory of the microSD card, renaming the file if necessary to "NPMXXX.bin" or as "NPMXXX.crp" as appropriate.
   Important: The filename on the microSD card must have the filename "NPMXXX.crp".
3. Power cycle the NPM device and the device bootloader will search for the NPMXXX.bin or NPMXXX.crp file as appropriate. If found, the new firmware will be uploaded. Once successful, the unit will begin running the new firmware.

The user may find it useful to monitor the FW upload process by connecting to the device first with a terminal emulation program such as Tera Term Pro or Windows Hyperterminal.

Upon power cycle terminal output from the unit will pause while the SD cards are power cycled. During FW upload from an NPMXXXX.bin or NPMXXXX.crp file, a series of dots will be printed as the bootloader loads blocks of data from the SD card firmware file. When new firmware is successfully loaded the firmware will run, displaying the informational header and list of parameter values as shown in the example output on the next page.

Note: It is recommended that the user remove, rename, or delete the NPM3XXX.bin or NPM3XXX.crp file from the External microSD card after successful firmware upgrade. If the NPM3XXX.bin file is left on the external microSD card, the NPM3XXX bootloader will attempt to reload the new firmware each time the unit is power cycled or rebooted. This will likely not cause any problems, but if a power glitch or other anomaly occurs during a firmware upload from the external microSD card, the loaded Firmware may be corrupted. In such

a case the unit may need to be power cycled again for the firmware to be read from the SD card and loaded properly.

Example:

Retrieve an appropriate FW binary file by contacting Quaesta Instruments LLC support. Copy the firmware file to the NPM3XXX device external SD card, making sure it is named NPM3XXX.bin or NPM3XXX.crp as appropriate for the NPM model.
For example:

```
dir
1:/ External SD Card
----A 2013/01/21 22:15    106236 NPM3100U.crp
   1 File(s),    106236 bytes total,    0 Dir(s)
1:/ External SD Card
```

Upon power cycle or reboot the NPM3XXX bootloader will search for the NPM3XXX file on the external SD card, and if present, begin loading the new firmware into its main Firmware program space.

```
reboot
.......................................................................
.......................................................................
.................................................

Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version   1.0.8
BootLoader Version 2
Model              NPM3100
Model Version      USB
Serial Number      0123456789ABCDEF
Time Constant      3us
Name               Name
Identifier         255

***NEUCHROMETER PARAMETERS***
Voltage Set        950
Voltage Measured   0.0
MaxVoltage         2500
Gain               3.0
DiscLow            10
DiscHigh           127
DeadTime           30
PeakMode           0
LEDMode            1
TTLOutMode         1
TTLOutWidth        100
TTLCounter         1
PulseSim(uS)       OFF
nBins              128
HgmMode            2
DtResolution       1000

***LOGGER PARAMETERS***
```

```
RecordPeriod(Sec)  60
NewFilePeriod      Day
RecordsPerHGM      60
PrintDAT           0
PrintHGM           0
LogDAT             1
LogHGM             1
LogTemp            1
LogHum             1
LogTTL             1
ListSectors        1
Current Time       2015/08/31 11:41:49
File Created: /DAT/Name_1508311141.DAT
File Created: /HGM/Name_1508311141.HGM
```

C.3 Firmware Upload Using Tera Term's Xmodem File Transfer

The presence of a working bootloader is necessary in order to upload new firmware to the NPM3100 device.

The recommended method of firmware uploading to the NPM3100 devices is via the GUI application firmware upgrade tool provided in the Quaesta Instruments GUI NPM3100 GUI interface application.

For completeness, uploading new firmware to the NPM3100 devices via Tera Term Pro is presented. In this case the Xmodem file transfer option available in Tera Term may also be used to upload Firmware via the Xmodem file transfer protocol.

When a working bootloader is present on the NPM3100 series device, at device power on or reboot a series of 6 or more question marks spaced 1 second apart will be transmitted to the terminal output, beginning a few seconds after power on or reboot. During the period of question mark display, the bootloader is operating and waiting for a FW upgrade process to be initiated, described below. If the upgrade process is not initiated after a set number of question marks, then the NPM 3100 device will load and run its resident program.

A summary of steps for uploading new Firmware is listed here for reference. See below for more detailed instructions.

Step 1. Either power cycle the unit or type 'reboot' in the terminal (no quotes).
Step 2. Enter <CTRL-Q> at the question marks. Wait for directions.
Step 3. Select XMODEM file transfer and select the file (**make sure to select the CRC radio button in the file dialog**)
Step 4. If FW uploads properly a progress box will indicate 100% complete and the new firmware will run displaying the current NPM3100 operating parameters.

Note that if the new firmware does not load the user may have to power cycle the device and repeat the firmware upgrade attempt. If main code firmware is not present on the NPM3100 device or the firmware main code is corrupted or incompletely loaded, then the unit will display a series of question marks (??????????) and may appear to "hang", becoming unresponsive. The unit will need to be power cycled if this occurs. After power cycle the series of question marks should begin again, allowing for another opportunity for firmware upload.

```
After Power Cycling or Device Reboot->
??????????
Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version   1.X.X
BootLoader Version 2
Model              NPM3100
Model Version      USB
Serial Number      0123456789ABCDEF
```

```
Time Constant       3us
Name                Name
Identifier          255

***NEUCHROMETER PARAMETERS***
Voltage Set         950
Voltage Measured    0.0
MaxVoltage          2500
Gain                3.0
DiscLow             10
DiscHigh            127
DeadTime            30
PeakMode            0
LEDMode             1
TTLOutMode          1
TTLOutWidth         100
TTLCounter          1
PulseSim(uS)        OFF
nBins               128
HgmMode             2
DtResolution        1000

***LOGGER PARAMETERS***
RecordPeriod(Sec)   60
NewFilePeriod       Day
RecordsPerHGM       60
PrintDAT            0
PrintHGM            0
LogDAT              0
LogHGM              0
LogTemp             1
LogHum              1
LogTTL              1
ListSectors         1
Current Time        2015/09/14 11:41:49
```

If the user types a “CTRL Q” when the question marks are displayed the NPM3100 device will prepare for a firmware upgrade via the Xmodem CRC protocol. The user should see a message from the device indicating that the existing application will be erased. Select Y if you wish to proceed.

```
reboot
??              ->User enters <CTRL-Q) here
Existing application will be erased.
Do you really want to continue? (Y or N)
Y               ->Make sure to enter Capital Y
Erasing Sector 1
Erasing Sector 2
Erasing Sector 3
Erasing Sector 4
Erasing Sector 5
Erasing Sector 6
Erasing Sector 7
Transfer file using XMODEM-CRC
CCCCCC          ->Do not Type any Characters at the C
                ->User selects File as in Figure 60: Tera Term XMODEM Firmware Upgrade File Selection
```

When C’s begin, do not type any characters, and with the computer mouse, Select File->Transfer->XMODEM->Send…
A File Selection Box of the form shown in **Figure 60** will appear.

Make sure the **CRC** radio button is selected at the bottom of the window. Navigate to the folder which contains the desired NPMXXXX firmware *.crp file and select the file. Select the **Open** command button and the firmware will be uploaded. A progress box of the form shown in **Figure 61** will be displayed.

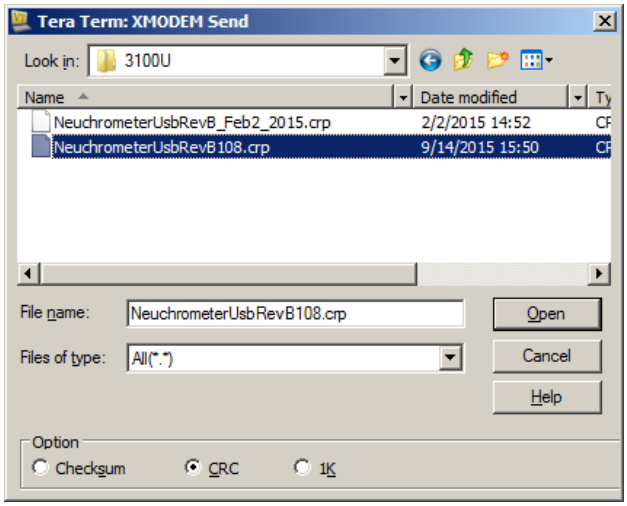


Figure 60: Tera Term XMODEM Firmware Upgrade File Selection

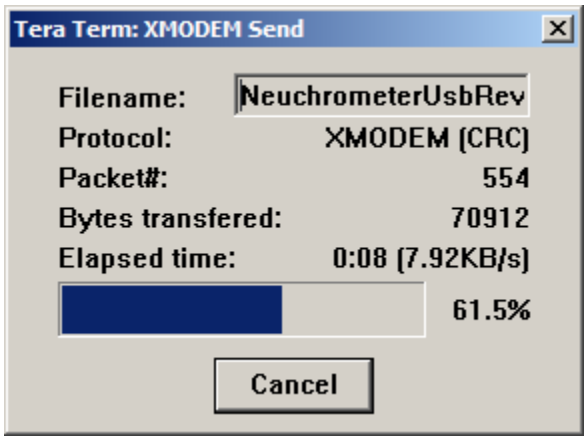


Figure 61: Tera Term XMODEM Firmware Upgrade Progress

```
CCCCCC
```
(User selects File as in* Figure 60*. Then* Figure 61 *will appear).

➔ ***Firmware is Loaded and Application Starts.***

```
Quaesta Instruments, LLC
www.QuaestaInstruments.com
Firmware Version    1.0.8
BootLoader Version 2
Model               NPM3100
Model Version       USB
Serial Number       0123456789ABCDEF
```

->Should show the FWVers selected in Figure 60.

```
Time Constant       3us
Name                Name
Identifier          255

***NEUCHROMETER PARAMETERS***
Voltage Set         950
Voltage Measured    0.0
MaxVoltage          2500
Gain                3.0
DiscLow             10
DiscHigh            127
DeadTime            30
PeakMode            0
LEDMode             1
TTLOutMode          1
TTLOutWidth         100
TTLCounter          1
PulseSim(uS)        OFF
nBins               128
HgmMode             2
DtResolution        1000

***LOGGER PARAMETERS***
RecordPeriod(Sec)   60
NewFilePeriod       Day
RecordsPerHGM       60
PrintDAT            0
PrintHGM            0
LogDAT              1
LogHGM              1
LogTemp             1
LogHum              1
LogTTL              1
ListSectors         1
Current Time        2015/09/14 16:20:49
File Created: /DAT/Name_1509141620.DAT
File Created: /HGM/Name_1509141620.HGM
```

The FW upgrade should not disturb the Operating parameters that were in place prior to the FW upgrade.

.

Appendix D Menu Command

D.1 NPM3100U Menu Command Output

The NPM3100U device has integrated TTLInput and TTLOutput functionality.
The Multi-Channel Analyzer (MCA), Delta-Time Histogram, Sensors, Datalogger, Filesystem, and ListMode Commands will only be available if the corresponding options are selected for the devices when ordered.

```
menu

*** List of available Commands (Not Case Sensitive)***

*** Cntrl-R to repeat previous command***

*** - C -  Control commands***
*** - R -  Read commands   ***
*** -R/W-  Read/Write parameters. Enter the parameter name to see the current value
***
***        To change the value enter the parameter name followed by the new value
***
***        Separate the parameter name from the new value with an Equal, Space, Comma, or
Colon***

***Miscellaneous Commands***

Name            -R/W- Identifier: e.g. 'Name=Detector #1', maximum 16 characters
Menu            - R - List of all commands
Help            - R - List of all commands
Info            - R - Identification and Parameters
Sdev            - R - Noise Std Dev: e.g. 'SDEV=100' is 4096 sample Sdev, averaged 100 times)
BaudRate        -R/W- BaudRate: BaudRate=921600,921600,460800,230400,115200; back to 115200 at
bootup
UpTime          - R - Seconds since Startup
Reboot          - C - System reset

***Neuchrometer Commands***

Voltage         -R/W- High Voltage: e.g. 'Voltage=1000', maximum is MaxVoltage
MaxVoltage      -R/W- Maximum Allowable Voltage: e.g. 'MaxVoltage=1500', maximum is 2000
Gain            -R/W- Gain: e.g. 'Gain=5.3', from 1 to 20
LowerDisc       -R/W- Lower Discriminator: e.g. 'LowerDisc=25', maximum is nBins-1
UpperDisc       -R/W- Upper Discriminator: e.g. 'UpperDisc=127', maximum is nBins-1
DeadTime        -R/W- DeadTime: e.g. 'DeadTime=100', in microseconds from 25 to 10000
PeakMode        -R/W- Peak Mode: e.g. 'PeakMode=1' -> peak info
PulseWave       - R - Pulse Waveform: e.g. 'PulseWave=64,2'-> first 64 wave points, format 2
LEDMode         -R/W- LED Mode: 1 for ON, 0 for OFF
Counts          - R - Report and Zero the Counts and the Timer
Query           - R - Report the Counts Without Zeroing
Cps             - R - Report the Counts per second
ZeroCounts      - C - Zero the Count value
TTLOutMode      -R/W- TTL Out Mode: .e.g. ,TTLOutMode=1, allows TTLInput to feedthrough to
TTLoutput
TTLOutWidth     -R/W- TTL Out Width (nanosecs):
                      TTLOutWidth=0,25,50,100,200,500,1000,2000,5000,10000
TTLCounter      -R/W- Eanble/Disable the TTL Counter
TTLCounts       - R - Report and Zero the TTL Counts and the Timer
TTLQuery        - R - Report the TTL Counts Without Zeroing
ZeroTTLCounts   - C - Zero the TTL Count value
PulseSim        -R/W- PulseSim Period(uS), 0=OFF,50000,20000,10000,5000,2000,1000,500,200,100,50

***Multi-Channel-Analyzer Commands***

Hgm             - R - Report Histogram, format according to HgmMode
MaxHgm          - R - Report position of histogram max, max cts value, and total histogram counts
```

```
ZeroHgm         - C - Zero the Histogram
HgmMode         -R/W- Histogram Mode: e.g. 'HgmMode=1', mode is 1,2, or 3
nBins           -R/W- Number of Histogram Bins: e.g. 'NBINS=256', 64,128,256,512,1024,2048

***Delta-Time-Histogram Commands***

DTRes           -R/W- Delta-Time resolution (microseconds): (e.g. 'DTRes=100',
                       1,10,100,1000,10000
DTHgm           - R - Report Delta-Time Histogram (fixed at 1000 bins)
ZeroDTHgm       - C - Zero the Delta-Time Histogram

***Sensor Commands***

Temperature     - R - Temperature(Celsius) and Humidity(%Relative)(Optional)
Humidity        - R - Temperature(Celsius) and Humidity(%Relative)(Optional)
In Progress.

***Data Logger Commands***

PrintDAT        -R/W- Print Data Records:  1 for Yes, 0 for No
LogDAT          -R/W- Save  Data Records:  1 for Yes, 0 for No
RecordPeriod    -R/W- Record Period in seconds{ >= 3 }: e.g. 'RecordPeriod= 3600'
NewFilePeriod   -R/W- NewFile Period: e.g. 'NewFilePeriod= Day', Day,Month,Year
Time            -R/W- Time and date: e.g. 'Time= 15/02/06 16:34:00'
LogMode         - R - Report current LogMode settings
ShowFileNames   - R - Report current File Names
PrintHGM        -R/W- Print Histograms:    1 for Yes, 0 for No
LogHGM          -R/W- Save  Histograms:    1 for Yes, 0 for No
RecordsPerHGM   -R/W- Number of records per Histogram: e.g. 'RecordsPerHisto= 100'
LogTemp         -R/W- Include Temperature: 1 for Yes, 0 for No
LogHum          -R/W- Include Humidity:    1 for Yes, 0 for No
LogTTLCounts    -R/W- Include TTL Counts: 1 for Yes, 0 for No

***File System Commands***

Dir             - R - Report files in directory
GetCwd          - R - Report current working directory
DiskInfo        - R - Report bytes free and size of SD cards
FileInfo A.B    - R - Report file information: e.g. 'FileInfo Qwerty.dat'
Type A.B        - R - Display a file (see manual for Switches): e.g. 'Type XYZ_1501191456.DAT'
Cd A            - C - Change to a different directory : e.g. 'Cd HGM' or 'Cd..' or 'Cd /'
0: or 1:        - C - Change to the Internal drive '0:', or to the External drive '1:'
Copy A.B X.Y    - C - Copy a file: e.g. 'Copy 1105191456.DAT 1:/BackupData.TXT'
Rename A.B X.Y  - C - Rename or move a file: e.g. 'Rename 1105191456.DAT
1:/ARC/DAT/BackupData.TXT'
Attrib ?? A.B   - C - Change Attributes of a file: e.g. 'Attrib +R-A 1105191456.DAT'
Del A.B         - C - Delete a file: e.g. 'Del 1105191456.DAT' or 'Del *.DAT'
MkDir A         - C - Make a new directory: e.g. 'MkDir Locker'
Format          - C - Format the internal SD card. Use with Caution!


***List Mode Commands***

ListStream      -R/W- ListStream=? : 0->Off; 1,2,3->Real-Time Streaming Text,Hex,Binary
                       respectively
ResetTime       - C - Reset the TimeStamp timer to zero
ListMode        -R/W- ListMode=? : 1->Record; 0->Off;
ListMax         -R/W- Maximum number of List records to store:  e.g. 'ListMax=100000'
ListStatus      - R - Report current List record number
ListView        - R - View ListMode Data (see manual): e.g. 'ListView XYZ_1501191456.LST End=100
Hex'
```

D.1 NPM3100E Menu Command Output

The Multi-Channel Analyzer (MCA), Delta-Time Histogram, Sensors, Datalogger, Filesystem, and ListMode Commands will only be available if the corresponding options are selected for the devices when ordered.

```
menu

*** List of available Commands (Not Case Sensitive)***

*** Cntrl-R to repeat previous command***

*** - C -  Control commands***
*** - R -  Read commands   ***
*** -R/W-  Read/Write parameters. Enter the parameter name to see the current value
***
***        To change the value enter the parameter name followed by the new value
***
***        Separate the parameter name from the new value with an Equal, Space, Comma, or
Colon***

***Miscellaneous Commands***

Name            -R/W- Identifier: e.g. 'Name=Detector #1', maximum 16 characters
Menu            - R - List of all commands
Help            - R - List of all commands
Info            - R - Identification and Parameters
Sdev            - R - Noise Standard Deviation: e.g. 'SDEV=10000' is 10000 sample Sdev)
UpTime          - R - Seconds since Startup
ClockSource     -R/W- 0: Low power internal; 1: High accuracy internal; 2: External master
Reboot          - C - System reset

***Neuchrometer Commands***

Voltage         -R/W- High Voltage: e.g. 'Voltage=1000', maximum is MaxVoltage
MaxVoltage      -R/W- Maximum Allowable Voltage: e.g. 'MaxVoltage=1500', maximum is 2000
Gain            -R/W- Gain: e.g. 'Gain=5.3', from 1 to 20
LowerDisc       -R/W- Lower Discriminator: e.g. 'LowerDisc=25', maximum is nBins-1
UpperDisc       -R/W- Upper Discriminator: e.g. 'UpperDisc=127', maximum is nBins-1
DeadTime        -R/W- DeadTime: e.g. 'DeadTime=1000', in microseconds from 25 to 65000
PeakMode        -R/W- Peak Mode: e.g. 'PeakMode=1' -> peak info
PulseWave       - R - Pulse Waveform: e.g. 'PulseWave=64,2'-> first 64 wave points, format 2
LEDMode         -R/W- LED Mode: 1 for ON, 0 for OFF, LEDMode is always ON when Ethernet is ON
Counts          - R - Report and Zero the Counts and the Timer
Query           - R - Report the Counts Without Zeroing
Cps             - R - Report the Counts per second
ZeroCounts      - C - Zero the Count value
PulseSim        -R/W- PulseSim Period(uS), 0=OFF,50000,20000,10000,5000,2000,1000,500,200,100,50

***Multi-Channel-Analyzer Commands***

Hgm             - R - Report Histogram, format according to HgmMode
MaxHgm          - R - Report position of histogram maximum, maximum value, and total histogram
counts
ZeroHgm         - C - Zero the Histogram
HgmMode         -R/W- Histogram Mode: e.g. 'HgmMode=1', mode is 1,2, or 3
nBins           -R/W- Number of Histogram Bins: e.g. 'NBINS=256', 64,128,256,512,1024,2048

***Delta-Time-Histogram Commands***
```

```
DTRes           -R/W- Delta-Time resolution (microseconds): (e.g. 'DTRes=100',
                       1,10,100,1000,10000
DTHgm           - R - Report Delta-Time Histogram (fixed at 1000 bins)
ZeroDTHgm       - C - Zero the Delta-Time Histogram

***Data Logger Commands***

PrintDAT        -R/W- Print Data Records:  1 for Yes, 0 for No
LogDAT          -R/W- Save  Data Records:  1 for Yes, 0 for No
RecordPeriod    -R/W- Record Period in seconds{ >= 3 }: e.g. 'RecordPeriod= 3600'
NewFilePeriod   -R/W- NewFile Period: e.g. 'NewFilePeriod= Day', Day,Month,Year
Time            -R/W- Time and date: e.g. 'Time= 15/02/06 16:34:00'
LogMode         - R - Report current LogMode settings
ShowFileNames   - R - Report current File Names
PrintHGM        -R/W- Print Histograms:    1 for Yes, 0 for No
LogHGM          -R/W- Save  Histograms:    1 for Yes, 0 for No
RecordsPerHGM   -R/W- Number of records per Histogram: e.g. 'RecordsPerHisto= 100'

***File System Commands***

Dir             - R - Report files in directory
GetCwd          - R - Report current working directory
DiskInfo        - R - Report bytes free and size of SD cards
FileInfo A.B    - R - Report file information: e.g. 'FileInfo Qwerty.dat'
Type A.B        - R - Display a file (see manual for Switches): e.g. 'Type XYZ_1501191456.DAT'
Cd A            - C - Change to a different directory : e.g. 'Cd HGM' or 'Cd..' or 'Cd /'
Copy A.B X.Y    - C - Copy a file: e.g. 'Copy 1105191456.DAT 1:/BackupData.TXT'
Rename A.B X.Y  - C - Rename or move a file: e.g. 'Rename 1105191456.DAT
1:/ARC/DAT/BackupData.TXT'
Attrib ?? A.B   - C - Change Attributes of a file: e.g. 'Attrib +R-A 1105191456.DAT'
Del A.B         - C - Delete a file: e.g. 'Del 1105191456.DAT' or 'Del *.DAT'
MkDir A         - C - Make a new directory: e.g. 'MkDir Locker'
Format          - C - Format the internal SD card. Use with Caution!


***List Mode Commands***

ListStream      -R/W- ListStream=? : 0->Off; 1,2,3->Real-Time Streaming Text,Hex,Binary
                      respectively
ResetTime       - C - Reset the TimeStamp timer to zero
ListMode        -R/W- ListMode=? : 1->Record; 0->Off;
ListMax         -R/W- Maximum number of List records to store:  e.g. 'ListMax=100000'
ListStatus      - R - Report current List record number
ListView        - R - View ListMode Data (see manual): e.g. 'ListView XYZ_1501191456.LST End=100
Hex'
***Network Commands***

IpAddress       -R/W- IpAddress: e.g. 'IpAddress=192.168.15.40'
SubNetMask      -R/W- SubNetMask:   e.g. 'SubNetMask=255.255.255.0'
GatewayAddress  -R/W- GatewayAddress: e.g. 'GatewayAddress=192.168.15.1'
TcpPort         -R/W- TCP/IP Port#: e.g. 'TcpPort=12400'
```