Xpod®

Models 3011LP, 3012LP, 3017LP, 3018LP

Specification and Technical Information

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7602-000-15

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Specifications

Displayed Oxygen Saturation Range (SpO_2)	0 to 100%	
Displayed Pulse Rate Range	18 to 321 beats per minute (BPM)	
Measurement Wavelengths and Output Power*	Red: 660 nanometers @ 0.8 mW max. avg. Infrared: 910 nanometers @ 1.2 mW max. avg. (using Nonin PureLight® sensor)	
SpO_2 Accuracy (A_{rms})**	70 to 100%	
No Motion	**Adults/Pediatrics*** **	**Neonates**
REUSABLE:		
8000AX Series:	± 2 digits	N/A
800XJ Series:	± 3 digits	N/A
8000SX Series:	± 2 digits	N/A
8000R:	± 3 digits	N/A
8000Q2:	± 3 digits	N/A
DISPOSABLE:		
6000 Series:	± 2 digits	± 3 digits
7000 Series:	± 2 digits	± 3 digits
6500 Series:	± 2 digits	N/A
Motion		
REUSABLE:		
8000AX Series:	± 2 digits	N/A
800XJ Series:	± 3 digits	N/A
8000SX Series:	± 3 digits	N/A
Low Perfusion**	± 2 digits	± 3 digits
Pulse Rate Accuracy	**Adults/Pediatrics*** **	**Neonates**
No Motion (18 – 300 BPM)		
REUSABLE:		
8000AX Series:	± 3 digits	N/A
800XJ Series:	± 3 digits	N/A
8000SX Series:	± 3 digits	N/A
8000R:	± 3 digits	N/A
8000Q2:	± 3 digits	N/A
DISPOSABLE:		
6000 Series:	± 3 digits	± 3 digits
7000 Series:	± 3 digits	± 3 digits
6500 Series:	± 2 digits	N/A
Motion (40 – 240 BPM)		
REUSABLE:		
8000AX Series:	± 5 digits	N/A
800XJ Series:	± 5 digits	N/A
8000SX Series:	± 5 digits	N/A
Low Perfusion (40 – 240 BPM) **	± 3 digits	± 3 digits

* This information is especially useful for clinicians performing photodynamic therapy.
** ±1 A_{rms} represents approximately 68% of measurements.
*** Includes infant patients.
**** Does not apply to those sensors listed as N/A under the neonate column, 8000R and 8000Q2.

Notes:
Group:
inger Clip Sensors: 8000AA-1, 8000AA-3, 8000AP-1, 8000AP-3
x Sensors: 8000J-1, 8000J-3, 8008J, 8001J
oft Sensors: 8000SS, 8000SM, 8000SL,
8000Q2, 8000R
e Group:
n® III (7000 Series) Sensors: 7000A, 7000P, 7000I, 7000N
ries Sensors: 6000CA, 6000CP, 6000CI, 6000CN
Durafoam Disposable Sensors: 6500MA, 6500SA

Temperature	
Operating:	-5 to +50 °C for Xpod, 0 to +40 °C for sensor
Storage/Transportation:	-40 to +70 °C
Humidity	
Operating:	10% to 95% non-condensing
Storage/Transportation:	10% to 95% non-condensing
Patient Isolation	Type BF (See Appendix A for a diagram)
Leakage Current	Not Applicable
Dimensions	
Cable Length:	1 meter ±10% or per customer request (2 meter maximum)
Housing:	No larger than 1.1 cubic inches in volume +10%
Weight	No more than 75 grams

Power Draw (typical)*

Typical 35mW or less with 3.3V input (non-USB configuration)
90 mW +/-20 mW for USB configurations

Power Draw by Voltage Input:

Input Voltage	Power* mW
1.0	50
1.2	46
1.4	41
1.6	39
1.8	37
2.0	36
2.2	36
2.4	35
2.6	34
2.8	34
3.0	33
3.2	33
3.3	34

Input Voltage	Power* mW
3.4	34
3.6	35
3.8	36
4.0	37
4.2	39
4.4	40
4.6	41
4.8	43
5.0	45
5.2	46
5.4	47
5.5	47

Inrush Current**

To accept a wide range of voltage inputs, the Xpod voltage regulation is produced through two stages;, a switching boost and then a linear voltage regulator. Because the current may exceed 400mA for short period when power is applied, integrators should characterize the inrush current with the intended host power supply.

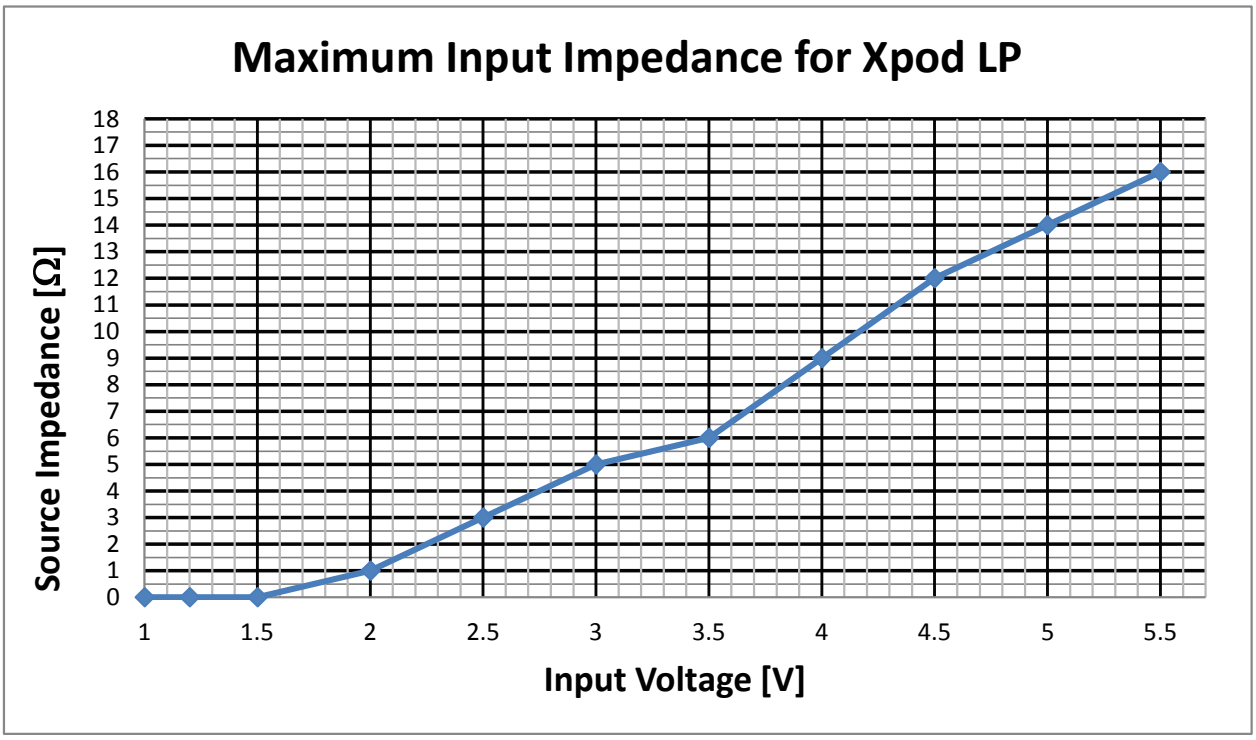
Voltage Input	1.0 to 5.5 VDC, w/100 mV max. ripple

* Excludes USB configurations and Range Modified (RM) Xpod LP version.

** Applies to standard Xpod LP configurations only.

Voltage Input Characterization of Input Impedance*

The trend line on the reference graph below shows the allowable maximum source impedance that will enable communication output**. Below the trending line shows the acceptable range devices.

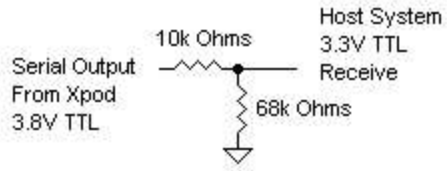


Maximum Input Impedance for Xpod LP (typical)*:

$V_{in\ Min}$ [V]	Z_{Max} [Ω]
1.0	0.01
1.2	0.01
1.5	0.01
2.0	1
2.5	3
3.0	5
3.5	6
4.0	9
4.5	12
5.0	14
5.5	16

* Applies to standard Xpod LP configurations only.

** A left on the shelf completely discharged device may not initially power up at 1 V input voltage.

Data I/O Signals	0 to +3.7 VDC +/-5% When connecting serial data directly to an MCU operating from 3.3V or when 3.3V is required, simply down convert 3.7V to 3.3V per suggested diagram: 
Patient Isolation	Meets IEC 60601-1 Dielectric withstand Degree of protection: Type BF-Applied Part See Appendix A for an isolation diagram
Leakage Current	Not applicable
Dimensions (approximate)	53 mm (2.1 in.) x 20 mm (0.8 in.) x 15 mm (0.6 in.)
Weight	No greater than 75 g (2.7 oz.) including cable and Hirose connector
Fluid Spill Resistance	IP33
Ruggedness	IEC 60068-2-27
Shock:	Sinusoidal – IEC 60068-2-6
Ruggedness (Vibration)	Random – IEC 60068-2-64
Sensors	Designed to use Nonin-branded PureLight® sensors only (see Accessories)
Shielding	An RF shield is included (placed over the analog components)
Regulatory Status/Information	Contact Nonin regulatory@nonin.com
ROHS	2011/65/EU
Biocompatability	ISO 10993-01
Warranty	1 year from the date of purchase

This product complies with all applicable clauses of the following standards:
IEC 60601-1
IEC 60601-1-11
ISO 80601-2-61

Configurations

Nonin offers three standard configurations with USB connectivity, one standard with a Mini-12 connector, and one standard without a connector. In addition, a non-standard configuration, called Range Modified Xpod LP, is available for operation with legacy products.

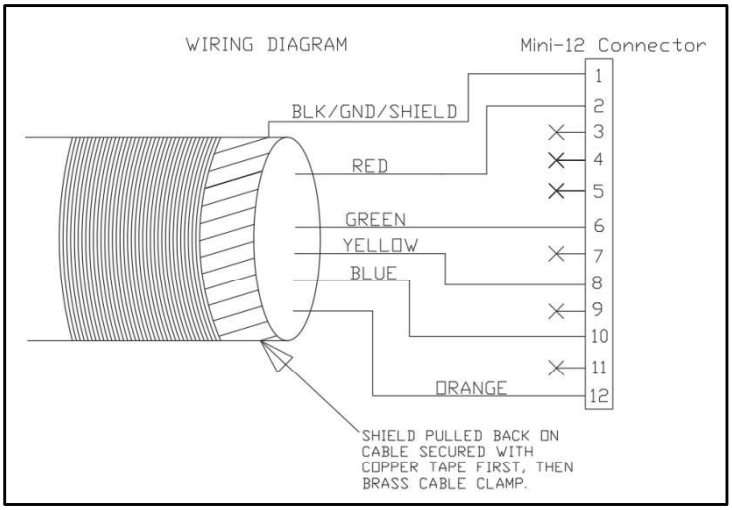
Standard Configurations:

Model	Nonin P/N	Data Format Default	Termination	Data Format Selectable Y/N
3012LP	6703-002	DF2	No connector	Yes
3012LP	6703-004	DF2	Mini-12 connector	Yes
3012LP	6703-001	DF2	USB	No
3017LP	8898-001	DF7	USB	No
3018LP	8899-001	DF8	USB	No

Mini-12 Configuration

The Mini-12 connector is a compact and reliable connector for medical products. This configuration allows your system to select the data format, either by a software command or resistor. When choosing this connector, you must determine the proper mechanical fit and level of compression required for your application.

The manufacturer of the Mini-12 connector is Hirose. The Hirose sensor connector part number is LX40-12. The Hirose receptacle connector part number is LX60-12S.



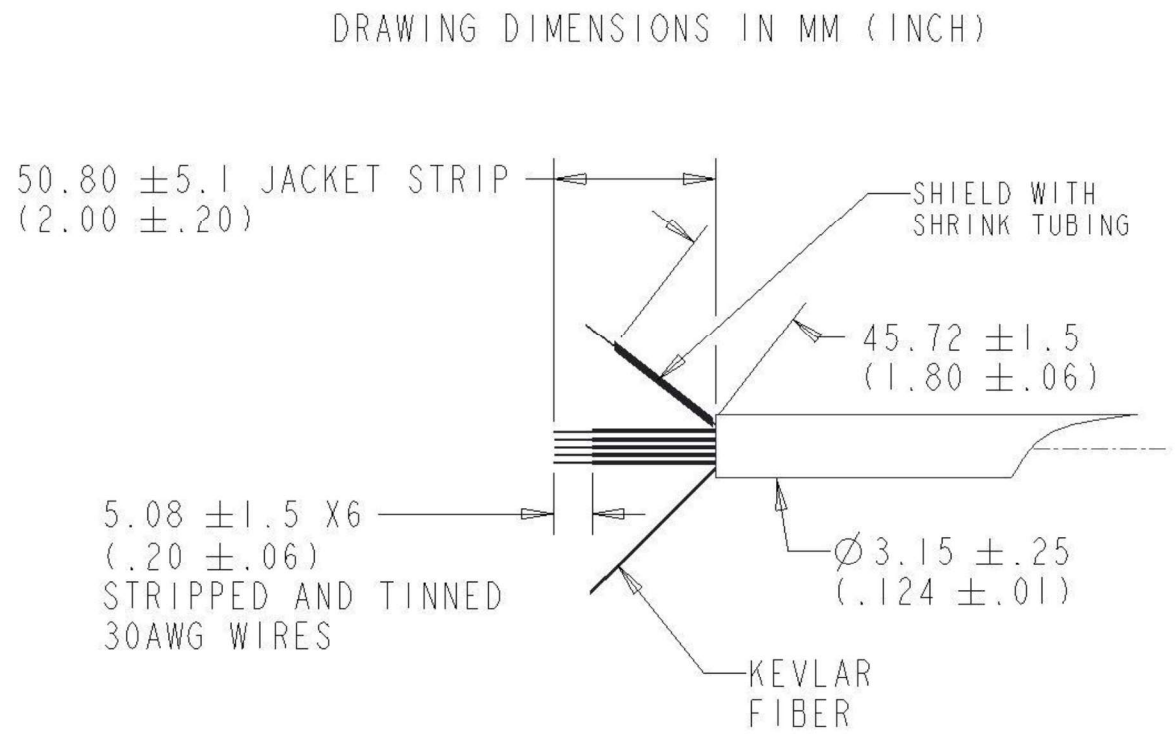
USB Connector Configurations

The Xpod LP USB configuration features a proprietary USB circuit that is compliant to the USB 2.0 standards. The Nonin USB design reduces the risk of overloading the USB power source — making the Xpod USB configuration robust for many applications. The USB configurations feature data formats that cannot change via a software command or resistor.

Unterminated – No Connector

If a standard connector offering does not meet your product needs, the unterminated Xpod LP is available. This configuration allows you to select the data format either by a software command or resistor. The unterminated Xpod LP allows you to assemble the Xpod LP with a specific connector of your choosing. Nonin recommends assembling the Xpod LP with connectors capable of withstanding a 9.07 kg (20 lbs.) connector to cable pull strength test, and that have a minimum 0.68 kg (1.5 lbs) retention force.

As part of the Nonin OEM advantage, Nonin can assemble the Xpod LP with your specific connector. Contact Nonin OEM sales for a quote and volume commitments.



Cable jacket material is polyurethane.

Inputs/Outputs: Host Cable Conductors

Inputs

Red Wire = Power Input (1.0 to 5.5 VDC)

For all possible power input conditions, make sure your power source can supply enough power to properly start and operate the Xpod. See Inrush Power specification on page 2.

Black Wire = Circuit Ground/Cable Shield

Yellow Wire = Option 1 – Select data format using resistor in host device per the Data Format Selection.

Option 2 – Select data format using software command per the Data Format Selection.

Outputs

Green Wire = Serial Output:

9600 Baud, 8 data bits, One Start bit (Start bit =0), One Stop bit (Stop bit = 1), No Parity.

Output Level: TTL (0 to 3.8 VDC)

Host Input Impedence must be greater or equal to 4kΩ.

Blue Wire = PPG Output: Digital Pulse Indicator

See Technical Note T-0604 for more information.

Orange Wire = NC (reserved for future use)

Note: Xpod is not isolated from input voltage,

Data Format Selection

Select Data Format by Hardware Resistor (Excludes USB Versions)

Placing a resistor between Serial Input (yellow wire) and ground at the host connector end of cable can be used to select the data format. The table below lists the resistor values used per Data Format.

Output Format	Data Rate	Resistor Value (Ohms)
Data Format 1*	3 Bytes/once per second	Less than or equal to 626
Data Format 2	5 Bytes/75 times per second	8.2K ±5%
Data Format 7	5 Bytes/75 times per second	4.3K ±5%
Data Format 8	4 Bytes/once per second	22K ±5%

*Data format 1 is retained for legacy purposes. If once per second data is desired, please use Data Format 8.

If the resistance is equal or greater to 297K and the software select option is not used, the default data format will be selected.

Select Data Format by Software Select (Excludes USB Versions)

If the host system does not use a resistor to select the data format, the host can select the Xpod data format by transmitting a 3-byte serial command within 1 second from power on of the Xpod. To select the data format, the host must send the Xpod the command as described below:

Byte1: $53 (ASCII value for letter capital “S”…for “Soft Select”)

Byte2: The Data Format (Hex value 01 for DF1, 02 for DF2, 07 for DF7, 08 for DF8)

Byte3: Checksum (Hex value) = Byte1 + Byte2

The Xpod must receive the user command within 1 second after power is applied to the Xpod. Commands after the first second from power on will not be processed.

Data format select by serial configuration from host to XPOD:

9600 Baud, 8 data bits, One Start bit (Start bit =0), One Stop bit (Stop bit = 1), No Parity.

Key points when using the software select feature:

1. The data format selected by the software command will be lost when power to the Xpod is removed.
2. When using the software select feature, make sure the host device sends the command within one second after applying power to the Xpod.
3. If the host receives the wrong data format, remove power from the Xpod. Then apply power and send the desired software command within one second.

Patient Algorithm - SmartPoint™

Data formats 2, 7, and 8 provide a SmartPoint indicator. The SmartPoint Algorithm qualifies the data for recording purposes and eliminates the guesswork of determining when the patient measurement is qualified for recording purposes. When the SmartPoint Algorithm indicates the reading is high quality, the SPA bit will be set in data formats 2, 7, and 8.

Note: The SmartPoint Algorithm (SPA) bit is valid with Oximeter Firmware Revision (SREV) 16 and greater. Do not use SPA indicator with Oximeter Firmware Revision less than 16.

Serial Data Format #1

This data format provides continuous data transmission of a 3 byte data packet sent once per second. The data packet includes real-time data including: SpO_2 and Pulse Rate formatted for display, and status of the measurement.

Packet Description

Three bytes of data are transmitted 1 once per second.

Byte 1 - Status							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
1	SNSD	OOT	LPRF	MPRF	ARTF	PR8	PR7
***Note**: Bit 7 is always set							
Byte 2 - Pulse Rate							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	PR6	PR5	PR4	PR3	PR2	PR1	PR0
***Note**: Bit 7 is always clear							
Byte 3 - SpO_2							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	SP6	SP5	SP4	SP3	SP2	SP1	SP0
***Note:** Bit 7 is always clear							

The following are all active high:

SNSD:	Sensor Disconnect	Sensor is not connected to oximeter or sensor is inoperable.
OOT:	Out Of Track	An absence of consecutive good pulse signals.
LPRF:	Low Perfusion	Amplitude representation of low/no signal quality.
MPRF:	Marginal Perfusion	Amplitude representation of low/marginal signal quality.
ARTF:	Artifact	Indicated artifact condition on each pulse.
PR8 –PR0:	Pulse Rate	Standard 4-beat average values without display holds.
SP6 – SP0:	SpO_2	Standard 4-beat average values without display holds.

These SpO_2 and PR values are formatted for recording purposes and are updated every 1/3 of second. When the sensor is removed from the site, these values will be formatted with the missing data value. The following output options are available in standard mode:

PR: 4-beat Pulse Rate Average

SpO_2: 4-beat SpO_2 Average

When SpO_2 and PR values cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127. The missing data could be result of these conditions:

1. Sensor is positioned improperly.
2. Sensor was removed prior to a reading.

3. Signal at the sensor site is not discernable. Warm the site or choose a different site.

Serial Data Format #2

This data format provides continuous data transmission of a 5 byte data packet sent 75 times per second. The data packet includes real-time data including: 8-bit waveform value, six different output options for the SpO_2 value, four different averaging options for the Pulse Rate values, and options formatted for both recording and display purposes, as well as status information for the measurement.

Packet Description

A frame consists of 5 bytes; a packet consists of 25 frames. Three packets (75 frames) are transmitted each second.

Packet Description					
Frame	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**
1	01	STATUS	PLETH	PR MSB	CHK
2	01	STATUS	PLETH	PR LSB	CHK
3	01	STATUS	PLETH	SpO_2	CHK
4	01	STATUS	PLETH	SREV	CHK
5	01	STATUS	PLETH	reserved	CHK
6	01	STATUS	PLETH	reserved	CHK
7	01	STATUS	PLETH	reserved	CHK
8	01	STATUS	PLETH	STAT2	CHK
9	01	STATUS	PLETH	SpO_2-D	CHK
10	01	STATUS	PLETH	SpO_2 Fast	CHK
11	01	STATUS	PLETH	SpO_2 B-B	CHK
12	01	STATUS	PLETH	reserved	CHK
13	01	STATUS	PLETH	reserved	CHK
14	01	STATUS	PLETH	E-PR MSB	CHK
15	01	STATUS	PLETH	E-PR LSB	CHK
16	01	STATUS	PLETH	E-SpO_2	CHK
17	01	STATUS	PLETH	E-SpO_2-D	CHK
18	01	STATUS	PLETH	reserved	CHK
19	01	STATUS	PLETH	reserved	CHK
20	01	STATUS	PLETH	PR-D MSB	CHK
21	01	STATUS	PLETH	PR-D LSB	CHK
22	01	STATUS	PLETH	E-PR-D MSB	CHK
23	01	STATUS	PLETH	E-PR-D LSB	CHK
24	01	STATUS	PLETH	reserved	CHK
25	01	STATUS	PLETH	reserved	CHK

Notes:
Byte 1 - Always 01
Byte 2 - Always 128 or greater
Byte 3 - Can be any number between 0 and 255
Byte 4 - Always 127 or less
Byte 5 - Can be any number between 0 and 255; is the sum of bytes 1-4 (modulo 256)
Reserved bytes are undefined

Byte 1 – START BYTE:

Always set to a 01 value.

Byte 2 – STATUS BYTE

This byte provides status information at a rate of 1/75 of a second.

Range: 128 to 255

Byte 2 – Status							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
1	SNSD	ARTF	OOT	SNSF	YPRF		SYNC
					RPRF	GPRF	
*__Note__: Bit 7 is always set.							

The following are all active high:

SNSD:	Sensor Disconnect	Sensor is not connected to oximeter or sensor is inoperable.
ARTF:	Artifact – short term	Indicates artifact condition of each pulse (occurs only during pulse).
OOT:	Out Of Track	An absence of consecutive good pulse signals.
SNSA:	Sensor Alarm	Device is providing unusable data for analysis (set when the finger is removed or sensor is disconnected).
RPRF:	*Red Perfusion	Amplitude representation of low/poor signal quality (occurs only during pulse).
YPRF:	*Yellow Perfusion	Amplitude representation of low/marginal signal quality (occurs only during pulse).
GPRF:	*Green Perfusion	Amplitude representation of high signal quality (occurs only during pulse).
SYNC:	Frame Sync	1 in Frame 1 (0 in Frames 2 through 25).

* The oximeter reports each pulse by setting/clearing the RPRF and GPRF bits for a period of 12 frames (160 ms). The table below describes the condition and state of the pulse perfusion bits.

Condition	**RPRF Bit 2 of Status Byte**	**GPRF Bit 1 of Status Byte**
Green – high pulse signal	0	1
Yellow – low/marginal pulse signal	1	1
Red – low/no pulse signal	1	0

Byte 3 – PLETH BYTE

This byte consists of an 8 bit plethysmographic waveform (pulse waveform). The pulse oximeter infra-red signal is filtered and then compressed into an 8 bit value. The compression provides good detail for low to medium pulse signals. For an uncompressed waveform with better resolution, refer to Data Format 7.

Range: 0 to 255

Byte 4 – FLOAT BYTE

This byte is used for SpO_2, Pulse Rate, and information that can be processed at a rate of 1/3 of a second.

Range: 00 to 127

SREV: Oximeter Firmware Revision Level

STAT2: Status Byte 2 (occurs 1 of 25) - description given below

Byte 4 – STAT 2							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	R	SPA	R	R	R	R	R
***Note**: Bit 7 is always clear.							

The following are all active high:

SPA: High Quality SmartPoint Measurement

R: Reserved (range - 0 or 1), for future use

Note: The SmartPoint Algorithm (SPA) bit is valid with Oximeter Firmware Revision (SREV) 16 and greater. Do not use SPA indicator with Oximeter Firmware Revision less than 16. Firmware revision is available in data format 2 transmitted SREV value.

Standard Mode - Formatted for Recording Purposes:

These values are formatted for recording purposes and are updated every 1/3 of second. When the finger is removed from the device these values will be formatted with the missing data value. The following output options are available in standard mode:

PR: 4-beat Pulse Rate Average

E-PR: 8-beat Pulse Rate Extended Average

SpO_2: 4-beat SpO_2 Average

E-SpO_2: 8-beat SpO_2 Extended Average

SpO_2 Fast: 4-beat Average optimized for fast responding

SpO_2 B-B: Beat to Beat value – No Average

When SpO_2 and PR cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127.

Display Mode - Formatted for Display Purposes:

These values are formatted for display purposes and are updated every 1.5 seconds. When the sensor is removed from the site, the last SpO_2 and Pulse Rate reading will be reported for 10 seconds before changing to the missing data value. During this 10 second period the sensor alarm bit (SNSA) is set, indicating that the sensor has been removed. This feature is useful for spot-check measurements. The following output options are available in Display Mode:

PR-D:	4-beat Pulse Rate Average
E-PR-D:	8-beat Pulse Rate Extended Average
SpO_2-D:	4-beat SpO_2 Average
E-SpO_2-D:	8-beat SpO_2 Extended Average

When SpO_2 and PR cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127. The missing data could be result of these conditions:

1. Sensor is positioned improperly.
2. Sensor was removed prior to a reading.

Signal at the sensor site is not discernable. Warm the site or choose a different site.

PR Format:

	7	6	5	4	3	2	1	0
PR MSB	0	R	R	R	R	R	PR8	PR7

	7	6	5	4	3	2	1	0
PR LSB	0	PR6	PR5	PR4	PR3	PR2	PR1	PR0

SpO_2 Format:

	7	6	5	4	3	2	1	0
SpO_2	0	SP6	SP5	SP4	SP3	SP2	SP1	SP0

R = Reserved (range 0 or 1)

Byte 5 – CHK

This byte is used for the checksum of bytes 1 through 4.

Range: 00 to 255

CHK: Checksum = (Byte 1 + Byte 2 + Byte 3 + Byte 4) modulo 256

Serial Data Format #7

This data format provides the same information as Data Format 2, except that the waveform value provides the full resolution of 16 bits instead of 8 bits. This data format must be selected by hardware resistor select or software select.

Packet Description

A frame consists of 5 bytes; a packet consists of 25 frames. Three packets (75 frames) are transmitted each second.

Packet Description					
Frame	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**
1	STATUS	PLETH MSB	PLETH LSB	PR MSB	CHK
2	STATUS	PLETH MSB	PLETH LSB	PR LSB	CHK
3	STATUS	PLETH MSB	PLETH LSB	SpO_2	CHK
4	STATUS	PLETH MSB	PLETH LSB	SREV	CHK
5	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
6	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
7	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
8	STATUS	PLETH MSB	PLETH LSB	STAT2	CHK
9	STATUS	PLETH MSB	PLETH LSB	SpO_2-D	CHK
10	STATUS	PLETH MSB	PLETH LSB	SpO_2 Fast	CHK
11	STATUS	PLETH MSB	PLETH LSB	SpO_2 B-B	CHK
12	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
13	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
14	STATUS	PLETH MSB	PLETH LSB	E-PR MSB	CHK
15	STATUS	PLETH MSB	PLETH LSB	E-PR LSB	CHK
16	STATUS	PLETH MSB	PLETH LSB	E-SpO_2	CHK
17	STATUS	PLETH MSB	PLETH LSB	E-SpO_2-D	CHK
18	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
19	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
20	STATUS	PLETH MSB	PLETH LSB	PR-D MSB	CHK
21	STATUS	PLETH MSB	PLETH LSB	PR-D LSB	CHK
22	STATUS	PLETH MSB	PLETH LSB	E-PR-D MSB	CHK
23	STATUS	PLETH MSB	PLETH LSB	E-PR-D LSB	CHK
24	STATUS	PLETH MSB	PLETH LSB	reserved	CHK
25	STATUS	PLETH MSB	PLETH LSB	reserved	CHK

Notes:

Byte 1 - Always 128 or greater
Byte 2 - Can be any number between 0 and 255
Byte 3 - Can be any number between 0 and 255
Byte 4 - Always 127 or less
Byte 5 - Can be any number between 0 and 255; is the sum of bytes 1-4 (modulo 256)
Reserved bytes are undefined

Byte 1 – STATUS BYTE

This byte provides status information at a rate of 1/75 of a second.

Range: 128 to 255

Byte 1 – Status							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
1	SNSD	ARTF	OOT	SNSF	YPRF		SYNC
					RPRF	GPRF	
***Note**: Bit 7 is always set.							

The following are all active high:

SNSD:	Sensor Disconnect	Sensor is not connected to oximeter or sensor is inoperable.
ARTF:	Artifact	Indicates artifact condition of each pulse (occurs only during pulse).
OOT:	Out Of Track	An absence of consecutive good pulse signals.
SNSA:	Sensor Alarm	Device is providing unusable data for analysis (set when the finger is removed or sensor is disconnected).
RPRF:	*Red Perfusion	Amplitude representation of low/no pulse signal (occurs only during pulse).
YPRF:	*Yellow Perfusion	Amplitude representation of low/marginal signal quality (occurs only during pulse).
GPRF:	*Green Perfusion	Amplitude representation of high signal quality (occurs only during pulse).
SYNC:	Frame Sync	= 1 in Frame 1 (=0 in frames 2 through 25).

* The oximeter reports each pulse by setting/clearing the RPRF and GPRF bits for a period of 12 frames (160 ms). The table below describes the condition and state of the pulse perfusion bits.

Condition	**RPRF Bit 2 of Status Byte**	**GPRF Bit 1 of Status Byte**
Green – high pulse signal	0	1
Yellow – low/marginal pulse signal	1	1
Red – low/no pulse signal	1	0

Byte 2 & 3 – PLETH BYTE

These two bytes consist of a 16 bit plethysmographic waveform (pulse waveform).

Range: 0 to 65535 (MSB:LSB)

Byte 2 = MSB Pulse Waveform

Byte 3 = LSB Pulse Waveform

Pulse waveform value = (Byte 2 decimal value * 256) + Byte 3 decimal value

Byte 4 – FLOAT BYTE

This byte is used for SpO_2, Pulse Rate, and information that can be processed at a rate of 1/3 of a second.

Range: 00 to 127

SREV: Oximeter Firmware Revision Level

STAT2: Status Byte 2 (occurs 1 of 25) - description given below

Byte 4 – STAT 2							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	R	SPA	R	R	R	R	R
*__Note__: Bit 7 is always clear.							

The following are all active high:

SPA: High quality SmartPoint Measurement

R: Reserved (range - 0 or 1), for future use

Note: The SmartPoint Algorithm (SPA) bit is valid with Oximeter Firmware Revision (SREV) 16 and greater. Do not use SPA indicator with Oximeter Firmware Revision less than 16. Firmware revision is available in data format 7 transmitted SREV value.

Standard Mode - Formatted for Recording Purposes:

These values are formatted for recording purposes and are updated every 1/3 of second. When the sensor is removed from the site, these values will be formatted with the missing data value. The following output options are available in standard mode:

PR: 4-beat Pulse Rate Average

E-PR: 8-beat Pulse Rate Extended Average

SpO_2: 4-beat SpO_2 Average

E- SpO_2: 8-beat SpO_2 Extended Average

SpO_2 Fast: 4-beat Average optimized for fast responding

SpO_2 B-B: Beat to Beat value – No Average

When SpO_2 and PR cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127. The missing data could be result of these conditions:

1. Sensor is positioned improperly.
2. Sensor was removed prior to a reading.
3. Signal at the sensor site is not discernable. Warm the site or choose a different site.

Display Mode - Formatted for Display Purposes:

These values are formatted for display purposes and are updated every 1.5 seconds. When the sensor is removed from the site, the last SpO_2 and Pulse Rate reading will be reported for 10 seconds before changing to the missing data value. During this 10 second period the sensor alarm bit (SNSA) is set, indicating that the sensor has been removed. This feature is useful for spot-check measurements. The following output options are available in Display Mode:

PR-D:	4-beat Pulse Rate Average
E-PR-D:	8-beat Pulse Rate Extended Average
SpO_2-D:	4-beat SpO_2 Average
E- SpO_2-D:	8-beat SpO_2 Extended Average

When SpO_2 and PR cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127.

PR Format:

	7	6	5	4	3	2	1	0
PR MSB	0	R	R	R	R	R	PR8	PR7

	7	6	5	4	3	2	1	0
PR LSB	0	PR6	PR5	PR4	PR3	PR2	PR1	PR0

SpO_2 Format:

	7	6	5	4	3	2	1	0
SpO_2	0	SP6	SP5	SP4	SP3	SP2	SP1	SP0

R: Reserved (range- 0 or 1)

Byte 5 – CHK

This byte is used for the checksum of bytes 1 through 4.

Range: 00 to 255

CHK: Checksum = (Byte 1 + Byte 2 + Byte 3 + Byte 4) modulo 256

Serial Data Format #8

This data format provides continuous data transmission of a 4 byte data packet sent once per second. The data packet includes real-time data including: SpO_2 and Pulse Rate formatted for display and status of the measurement. This data format must be selected by the hardware resistor select or software select feature.

Packet Description

Three bytes of data are transmitted once per second.

Byte 1 - Status							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
1	SNSD	OOT	LPRF	MPRF	ARTF	PR8	PR7
*__Note__: Bit 7 is always set							

Byte 2 - Pulse Rate (PR-D)							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	PR6	PR5	PR4	PR3	PR2	PR1	PR0
*__Note__: Bit 7 is always clear							

Byte 3 - SpO_2-D							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	SP6	SP5	SP4	SP3	SP2	SP1	SP0
*__Note__: Bit 7 is always clear							

Byte 4 – Status2							
BIT7	**BIT6**	**BIT5**	**BIT4**	**BIT3**	**BIT2**	**BIT1**	**BIT0**
0	R	SPA	R	SNSA	R	R	R
*__Note__: Bit 7 is always clear							

Note: The SmartPoint Algorithm (SPA) bit is valid with Oximeter Firmware Revision (SREV) 16 and greater. Do not use SPA indicator with Oximeter Firmware Revision less than 16. Because the firmware revision is not available in DF8 data packet, use the Model 3018LP S/N to determine when SPA bit is valid. The SmartPoint SPA bit is valid in Model 3018LP S/N 502109021 and greater.

The following are all active high:

SNSD:	Sensor Disconnect	Sensor is not connected to oximeter or sensor is inoperable.
ARTF:	Artifact	Indicated artifact condition on each pulse.
OOT:	Out Of Track	An absence of consecutive good pulse signals.
LPRF:	Low Perfusion	Amplitude representation of low/no signal quality.
MPRF:	Marginal Perfusion	Amplitude representation of low/marginal signal quality.
SNSA:	Sensor Alarm	Device is providing unusable data for analysis or sensor is
SPA:	SmartPoint Algorithm	High quality SmartPoint measurement.
PR8 – PR0:	Pulse Rate (PR-D)	4-beat Pulse Rate average formatted for display.
SP6 – SP0:	SpO_2 (SpO_2-D)	4-beat SpO_2 average formatted for display.
R	Reserved	Reserved for future use.

The SpO_2 and Pulse Rate values are formatted for display purposes and are updated every 1.5 seconds. When the sensor is removed from the site, the last SpO_2 and Pulse Rate reading will be reported for 10 seconds before changing to the missing data value. During this 10 second period the sensor alarm bit (SNSA) is set, indicating that the sensor has been removed. This feature is useful for spot-check measurements. The following output options are available in Display Mode:

PR-D: 4-beat Pulse Rate Average
SpO_2-D: 4-beat SpO_2 Average

When SpO_2 and PR cannot be computed, the system will send a missing data indicator. For missing data, the PR equals 511 and the SpO_2 equals 127. The missing data could be result of these conditions:

1. Sensor is positioned improperly.
2. Sensor was removed prior to a reading.
3. Signal at the sensor site is not discernable. Warm the site or choose a different site.

Indications for Use

The Xpod is intended to provide medical device manufacturers with a small, low-power oximeter that can be easily attached to a host device externally. The Xpod measures functional oxygen saturation of arterial hemoglobin (%SpO_2) and pulse rate (BPM) for adult, pediatric, infant and neonatal patients. When integrated with a medical device manufacturer's host system, the Xpod may be used in any environment where pulse oximetry measurements are made.

Warnings

- Do not use this device in an MR environment.
- Explosive Hazard: Do not use this device in an explosive atmosphere or in the presence of flammable anesthetics or gases.
- This module does not meet defibrillation-proof requirement per IEC 60601-1.
- Use only with Nonin-branded PureLight® pulse oximeter sensors. These sensors are manufactured to meet the accuracy specifications for Nonin pulse oximeters. Using other manufacturers' sensors can result in inaccurate pulse oximeter performance.
- Loss of monitoring can result if any objects hinder the pulse measurement. Ensure that no blood flow restrictors (e.g., blood pressure cuff) hinder pulse measurements.
- As with all medical equipment, carefully route cables and connections to reduce the possibility of entanglement or strangulation.
- Operation of this module below the minimum amplitude of 0.3% modulation may cause inaccurate results.
- The use of accessories, sensors, and cables other than those specified by Nonin may result in increased emission and/or decreased immunity of this device.
- Do not use a damaged sensor.

⚠ Cautions

- The accuracy of the SpO_2 measurement may be affected if the total sensor cable length (including extension cables) is greater than 3 meters (9.8 feet).
- Follow local, state, or national governing ordinances and recycling instructions regarding disposal or recycling of the device and device components.
- In compliance with the European Directive on Waste Electrical and Electronic Equipment (WEEE), do not dispose of this product as unsorted municipal waste. This device contains WEEE materials; please contact your distributor regarding take-back or recycling of the device.
- This pulse oximeter module is designed to determine the percentage of arterial oxygen saturation of functional hemoglobin. Factors that may degrade pulse oximeter performance or affect the accuracy of the measurement include the following:
  - excessive ambient light
  - excessive motion
  - electrosurgical interference
  - blood flow restrictors (arterial catheters, blood pressure cuffs, infusion lines, etc.)
  - moisture in the sensor
  - improperly applied sensor
  - incorrect sensor type
  - poor pulse quality
  - venous pulsations
  - anemia or low hemoglobin concentrations
  - cardiogreen or other intravascular dyes
  - carboxyhemoglobin
  - methemoglobin
  - dysfunctional hemoglobin
  - artificial nails or fingernail polish
  - a sensor not at heart level

⚠ Cautions

• This device has motion tolerant software that minimizes the likelihood of motion artifact being misinterpreted as good pulse quality. In some circumstances, however, this device may still interpret motion as good pulse quality. This covers all available outputs (i.e. SpO_2, PR, PLETH, PPG).
• Inspect the sensor application site at least every 6 to 8 hours to ensure correct sensor alignment and skin integrity. Patient sensitivity may vary due to medical status or skin condition. Discontinue use of adhesive tape strips if the patient exhibits an allergic reaction to the adhesive material.
• This equipment complies with IEC 60601-1-2 for electromagnetic compatibility for medical electrical equipment and/or systems. This standard is designed to provide reasonable protection against harmful interference in a typical medical installation. However, because of the proliferation of radio-frequency transmitting equipment and other sources of electrical noise in healthcare and other environments, it is possible that high levels of such interference due to close proximity or strength of a source might disrupt the performance of this device. Medical electrical equipment needs special precautions regarding EMC, and all equipment must be installed and put into service according to the EMC information specified in this manual.
• Portable and mobile RF communications equipment may affect medical electrical equipment.
• Oximeter readings may be affected by the use of an electrosurgical unit (ESU)
• The oximeter sensor may not work on cold extremities due to reduced circulation. Warm or rub the finger to increase circulation, or reposition the sensor.
• A functional tester cannot be used to assess the accuracy of a pulse oximeter or sensor.

For more information about required safety and regulatory requirements for pulse oximeters, refer to ISO 80601-2-61, and IEC 60601-1. Additional safety information can be found in the labeling provided with each Nonin sensor.

Accessories

The following Nonin accessories may be used with the Xpod module. See the respective sensor instructions for detailed information regarding specified sensor use (patient population, body/tissue, and application).

Model Number	Description
8000AA-1	Adult Articulated Internal Spring Finger Clip, 1 m (3 ft) cable
8000AA-3	Adult Articulated Internal Spring Finger Clip, 3 m (9.8 ft) cable
8000AP-1	Pediatric External Spring Finger Clip, 1 m (3 ft) cable
8000AP-3	Pediatric External Spring Finger Clip, 3 m (9.8 ft) cable
8000J-1	Adult Flex, 1 m (3 ft) cable
8000J-3	Adult Flex, 3 m (9.8 ft) cable
8001J	Neonatal Flex, 1 m (3 ft) cable
8008J	Infant Flex, 1 m (3 ft) cable
8000Q2	Ear Clip, 1 m (3 ft) cable
8000R	Reflectance, 1 m (3 ft) cable
8000SS	Sensor, Reusable, Soft, Small, 1 m (3 ft) cable
8000SS-3	Sensor, Reusable, Soft, Small, 3m (9.8ft) cable
8000SM	Sensor, Reusable, Soft, Medium, 1 m (3 ft) cable
8000SM-3	Sensor, Reusable, Soft, Medium, 3 m (9.8 ft) cable
8000SL	Sensor, Reusable, Soft, Large, 1 m (3 ft) cable
8000SL-3	Sensor, Reusable, Soft, Large, 1 m (3 ft) cable7000A Flexi-Form® III Adult, 1 m (3 ft) cable, 24-pack
7000P	Flexi-Form III Pediatric, 1 m (3 ft) cable, 24-pack
7000I	Flexi-Form III Infant, 1 m (3 ft) cable, 24-pack
7000N	Flexi-Form III Neonate, 1 m (3 ft) cable, 24-pack
6000CA	Sensor, Disposable, Adult, 45 cm (17.5 in) cable
6000CP	Sensor, Disposable, Pediatric, 45 cm (17.5 in) cable
6000CI	Sensor, Disposable, Infant, 90 cm (35.5 in) cable
6000CN	Sensor, Disposable, Neonate, 90 cm (35.5 in) cable
6500SA	Sensor, Durafoam Disposable, Standard, 1 m (3 ft) cable
6500MA	Sensor, Durafoam Disposable, Small, 1 m (3 ft) cable
UNI-RA-0	7.5” 90-degree Patient Cable
UNI EXT-X	Patient Extension Cable (select 1, 3, 6, or 9 meters)

Equipment Response Time

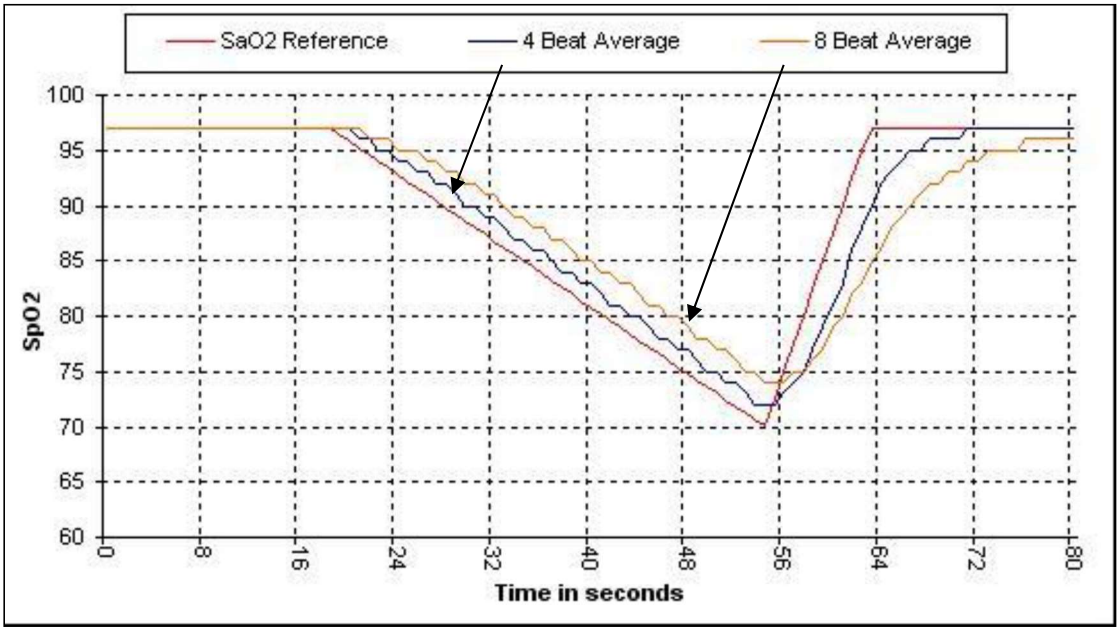
SpO_2 Values	Average	Latency
Standard/Fast Averaged SpO_2	4 beat average	2 beats
Extended Averaged SpO_2	8 beat average	2 beats

Pulse Rate Values	Average	Latency
Standard/Fast Averaged Pulse Rate	4 beat average	2 beats
Extended Averaged Pulse Rate	8 beat average	2 beats

Example – SpO2 Exponential Averaging

SpO_2 decreases 0.75% per second (7.5% over 10 seconds)

Pulse Rate – 75 BPM



Specific to this example:

- The response of the 4-beat average is 1.5 seconds.
- The response of the 8-beat average is 3 seconds.

Testing Summary

SpO_2 accuracy, motion and low perfusion testing was conducted by Nonin Medical, Incorporated as described below.

SpO_2 Accuracy Testing

SpO_2 accuracy testing is conducted during induced hypoxia studies on healthy, non-smoking, light-to-dark-skinned subjects during motion and no-motion conditions in an independent research laboratory. The measured arterial hemoglobin saturation value (SpO_2) of the sensors is compared to arterial hemoglobin oxygen (SaO_2) value, determined from blood samples with a laboratory co-oximeter. The accuracy of the sensors in comparison to the co-oximeter samples measured over the SpO_2 range of 70 – 100%. Accuracy data is calculated using the root-mean-squared (A_{rms} value) for all subjects, per ISO 80601-2-61 formerly ISO 9919 , Standard Specification for Pulse Oximeters for Accuracy.

Pulse Rate Motion Testing

This test measures pulse rate accuracy with motion artifact simulation introduced by a pulse oximeter tester. This test determines whether the oximeter meets the criteria of ISO 80601-2-61, formerly ISO 9919, for pulse rate during simulated movement, tremor, and spike motions.

Low Perfusion Testing

This test uses an SpO_2 Simulator to provide a simulated pulse rate, with adjustable amplitude settings at various SpO_2 levels. The module must maintain accuracy in accordance with ISO 80601-2-61, formerly ISO 9919, pulse rate and SpO_2 at the lowest obtainable pulse amplitude (0.3% modulation).

Manufacturer's Declaration for Xpod

Table 1: Electromagnetic Emissions

Emissions Test	Compliance	Electromagnetic Environment—Guidance
This module is intended for use in the electromagnetic environment specified below. The customer and/or user of this device should ensure that it is used in such an environment.		
RF Emissions CISPR 11	Group 1	This module uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions CISPR 11	Class B	This module is suitable for use in all establishments, including domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC 61000-3-2	N/A	
Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3	N/A	

Table 2: Electromagnetic Immunity

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment—Guidance
This module is intended for use in the electromagnetic environment specified below. The customer and/or user of this device should ensure that it is used in such an environment.			
Electrostatic Discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical Fast Transient/Burst IEC 61000-4-4	N/A	N/A	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	N/A	N/A	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions, and voltage variations on power supply input lines IEC 61000-4-11	N/A	N/A	Mains power quality should be that of a typical commercial or hospital environment. If the user of the module requires continued operation during power mains interruptions, it is recommended that the device be powered from an uninterruptible power supply or battery pack.
Power Frequency (50/60 Hz) Magnetic Field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Note: U_T is the AC mains voltage before application of the test level.			

Table 3: Guidance and Manufacturer's Declaration—Electromagnetic Immunity

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment—Guidance
This module is intended for use in the electromagnetic environment specified below. The customer and/or user of this module should ensure that it is used in such an environment.			
Portable and mobile RF communications equipment should be used no closer to any part of the module, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.			
			Recommended Separation Distance
Conducted RF IEC 61000-4-6	6 Vrms 150 kHz to 80 MHz ISM and AR Frequency Bands	6 Vrms	$d = 0.58\sqrt{P}$
Radiated RF IEC 61000-4-3	10 V/m 80 MHz to 800 MHz	10 V/m	$d = 0.35\sqrt{P}$
	10 V/m 800 MHz to 2.7 GHz	10 V/m	$d = 0.70\sqrt{P}$
	Up to 28 V/m Proximity fields from RF wireless communications equipment[c]	Up to 28 V/m	$d = 0.3$ Where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and *d* is the minimum separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than the compliance level in each frequency range.[b] Interference may occur in the vicinity of equipment marked with the following symbol: 
Notes: • At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. • These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.			

a) Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the device is used exceeds the applicable RF compliance level above, the device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the module.

b) Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.

c) Per Table 9 of IEC 60601-1-2:2014

Table 4: Recommended Separation Distances

This table details the recommended separation distances between portable and mobile RF communications equipment and this device.

This device is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. Users of this device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communication equipment (transmitters) and the device as recommended below, according to maximum output power of the communications equipment.

Rated Maximum Output Power of Transmitter W	**Separation Distance According to Frequency of Transmitter**		
	150 kHz to 80 MHz $d = 0.58\sqrt{P}$	80 MHz to 800 MHz $d = 0.35\sqrt{P}$	800 MHz to 2.7 GHz $d = 0.70\sqrt{P}$
0.01	0.06	0.04	0.07
0.1	0.18	0.11	0.22
1	0.58	0.35	0.70
10	1.8	1.11	2.21
100	5.8	3.50	7.00

For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTES:

1. At 80 MHz and 800 MHz, the higher frequency range applies.
2. These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects, and people.

Range Modified (RM) XPOD 3012LP

The following section is applies to the Range Modified (RM) XPOD 3012LP configuration. This configuration, in comparison to the standard Xpod 3012LP, has a reduced voltage input range (minimum voltage input of 2.8V instead of 1.0V). This configuration allows the Range Modified 3012LP to operate with legacy systems that limit the inrush current to the first generation Xpod.

Power Draw (typical)

Typical: 35mW or less with 3.3V input

Power Draw by Voltage Input:

Input Voltage	Power mW
2.8	34
3	33
3.2	33
3.3	34
3.4	34
3.6	35
3.8	36
4	37
4.2	39
4.4	40
4.6	41
4.8	43
5	45
5.2	46
5.4	47
5.5	47

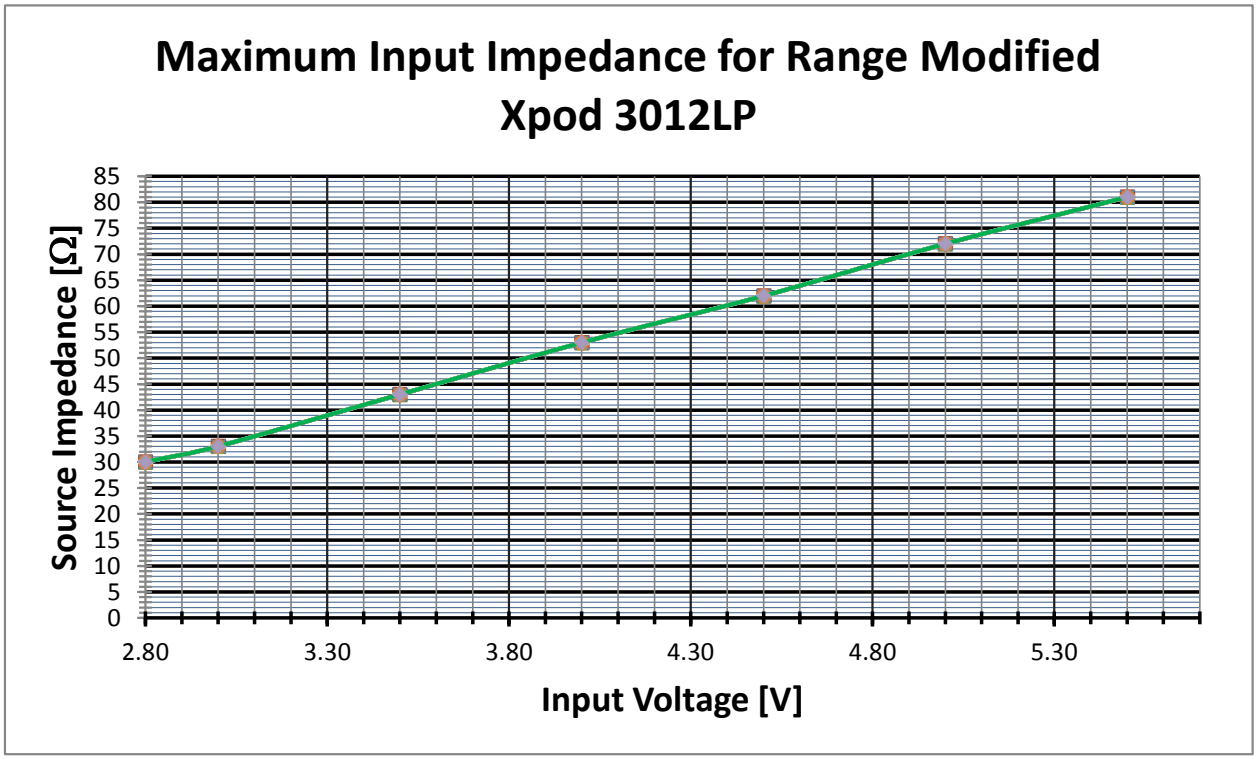
Voltage Input

2.8 to 5.5 VDC, w/100 mV max. ripple

Range Modified (RM) XPOD 3012LP

Voltage Input Characterization vs Input Impedance for Range Modified Xpod 3012LP

The trend line on the reference graph below shows the allowable maximum source impedance that will enable the Range Modified XPOD 3012LP communication output within 2 seconds. Below the trending line shows the acceptable range devices.



Maximum Input Impedance for Range Modified Xpod LP (typical):

$V_{in\ Min}$ [V]	Z_{Max} [Ω]
2.8	30
3.0	33
3.5	43
4.0	53
4.5	62
5.0	72
5.5	81

Range Modified (RM) XPOD Model 3012LP Inputs/Outputs: Host Cable Conductors

Inputs

Red Wire = Power Input (2.8 to 5.5 VDC)

Black Wire = Circuit Ground/Cable Shield

Outputs

Green Wire = Serial Output:

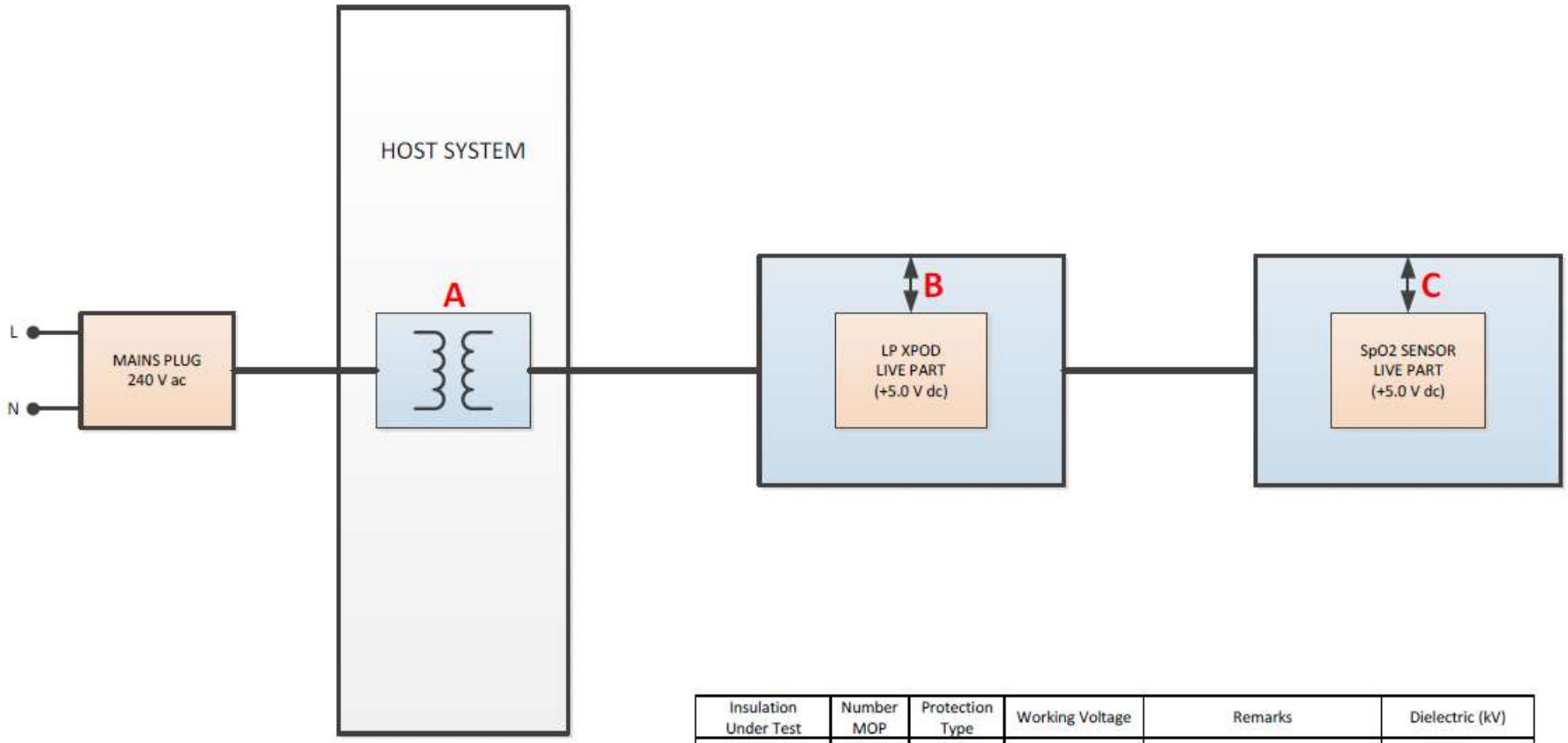
9600 Baud, 8 data bits, One Start bit (Start bit =0), One Stop bit (Stop bit = 1), No Parity.

Output Level: TTL (0 to 3.8 VDC)

Host Input Impedance must be greater or equal to 4kΩ.

Note: Xpod is not isolated from input voltage.

Appendix A – XPOD LP Isolation Diagram



Insulation Under Test	Number MOP	Protection Type	Working Voltage	Remarks	Dielectric (kV)
A	2	MOPP	240 Vac	Provided by Host System	Host
	2	MOPP	*x* Vdc		Host
B	1	MOPP	240 Vac	Provided Through Insulation	1.5
	2	MOPP	5 Vdc		1.0 (Secondary)
C	1	MOPP	240 Vac	Provided Through Insulation	1.5
	2	MOPP	5 Vdc		1.0 (Secondary)