



Datex-Ohmeda Output Protocols

- Ohmeda Com 1.0 Serial Protocol
- 7800 Serial Protocol
- INOvent Line-Printer Output
- Modulus CD Computer Output

Version 1.5

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1.0 Purpose

The purpose of this document is to describe and examples for the following Datex-Ohmeda Output Protocols:

- Ohmeda Com 1.0 Protocol
- 7800 Serial Protocol
- INOvent Line-Printer Output
- Modulus CD Computer Output

2.0 Ohmeda Com 1.0 Serial Protocol (7900 & 7100 ventilators)

The following section describes the Ohmeda Com 1.0 Protocol. This protocol is the **recommended** protocol to communicate with the Datex-Ohmeda 7900 and 7100 ventilators.

2.1 Electrical Interface

RS-232C signal standards.

(7900 - Non Aestiva) 9 pin female D connector - Data Communications Equipment configuration (DCE)

- pin 2 - receive data
- pin 3 - transmit data
- pin 5 - signal ground

(Aestiva - 7900 & 7100) 15 pin female D connector - Data Communications Equipment configuration (DCE)

- pin 6 - receive data
- pin 13 - transmit data
- pin 5 - signal ground

Baud Rate: 19.2K
Byte format: Start bit + 7 data bits + parity bit + stop bit
Parity: ODD

2.2 Software Interface

Datex-Ohmeda Com 1.0 Waveform Communications Protocol.

2.2.1 Summary of Input Commands and Output Data

When the device is first turned ON, the default transmission mode is set to "Slave Mode", the Checksum Mode is "Enabled" and Waveforms are disabled.

Command Headers:

<ESC>VTD	Disable Checksum Mode
<ESC>VTE	Enable Checksum Mode (this is the default mode)
<ESC>VTS	Slave Mode (this is the default mode - will reset auto mode)
<ESC>VTX	Auto Mode (see description of Measured Data and Status Data Responses)
<ESC>VT\$	Send Setup Data
<ESC>VT?	Send All Data (will send one Status and Measured Data Response - not valid in Auto Mode)
<ESC>VTW...	Enable Waveform Data (default is no waveforms enabled)

Response Headers:

:VTD...	Measured Data Response
:VTM...	Setup Data Response
:VTN	NACK (negative acknowledge)
:VTQ...	Status Data Response
:VTW...	Waveform Data Response
:VTR	Alarm Silence Switch Press Response
:VTY	ACK (positive acknowledge)

2.2.2 Device Commands Sent By External Device

2.2.2.1 Data Transmit Mode Select Commands

<ESC>VTXc<CR>	Auto Mode
<ESC>VTSc<CR>	Slave Mode

2.2.2.2 Data Request Command

<ESC>VT?c<CR>	Send All Data (Valid in Slave Mode only)
<ESC>VT\$c<CR>	Send Setup Data

2.2.2.3 Checksum Control Commands

<ESC>VTEc<CR>	Enable Checksum Mode
<ESC>VTDc<CR>	Disable Checksum Mode

2.2.2.4 Enable Waveform Data Mode

<ESC>VTWabc<CR>	Send Waveform Data
Bits	Description
a & b	any one of the following (note1 : order determines order of data in response packet) (note2 : b valid only if a != 0)
	0 turn waveform data OFF (this is the ASCII character zero)
	P include Pressure Data
	F include Flow Data
	V include Volume Data
c	Checksum

2.2.3 Device Responses Sent Back

2.2.3.1 ACK Response

:VTYc<CR>	Positive Acknowledge Response
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2.2.3.2 NAK Response

:VTNc<CR>	Negative Acknowledge Response
-----------	-------------------------------

2.2.3.3 Alarm Silence Switch Pressed Response

:VTRc<CR>	Alarm Silence Switch Press Response (if no alarms are on or all displayed alarms are silenced)
-----------	--

2.2.3.4 Measured Data Response

In auto mode, the Measured Data Response will be transmitted at the end of a breath or 10 seconds from the last transmission, whichever occurs first.

:VTDaaaabbbbddddeeeffggghhhiiijc<CR>		Measured Data Response Each entry is zero filled and right justified--ie. aaaa = 0095. "?" means bad data due to any technical problem(s). "-" means data not available due to system state.
Bits	Measured Data Name	Units and/or description
aaaa	measured tidal volume	mL, ?, -
bbbb	measured minute volume	L*100, ?, -
ddd	measured respiratory rate	/min, ?, -
eee	measured oxygen level	% O ₂ , ?, -
fff	measured max positive pressure	cm H ₂ O, ?
ggg	measured inspiratory plateau pressure	cm H ₂ O, ?, -
hhh	measured mean pressure	cm H ₂ O, ?, -
iii	minimum pressure	cm H ₂ O, ?, -
j	measured data status	0100000x (bit 0=1=new breath data; bit 0=0=10 second data)
c	checksum	

2.2.3.5 Status Data Response

In auto mode, the Status Data Response will be transmitted every 1 second (if a change occurs in the status data) or a minimum of once every 10 seconds. Note that the status byte bit is set=1 for an active condition and 0 for an inactive condition.

:VTQaaaabbbddddeeffggghiiijjkkkllmmnnnoooqrrrrrrrrrrc<CR>		Status Data Response Each entry is zero filled and right justified--ie. aaaa = 0	
Bits	Status Data Name	Units and/or description	
aaaa	set tidal volume	mL	
bbb	set respiratory rate	/min	
dddd	set I:E ratio	1:eee.e	
ee	inspiratory pause	% Pause	
ff	set PEEP	cm H ₂ O	
ggg	set peak pressure limit	cm H ₂ O	
hh	set inspired pressure	cm H ₂ O	
ii	set sustained pressure alarm limit	cm H ₂ O	
jjj	high minute volume alarm limit	L*10	
kkk	low minute volume alarm limit	L*10	
lll	high Vte limit	ml/10	
mmm	low Vte limit	ml/10	
nnn	high oxygen alarm limit	% O ₂	
ooo	low oxygen alarm limit	% O ₂	
q	ventilation mode	v	volume mode
		p	pressure mode
		b	backup volume mode
		-	bag mode
rrrrrrrrrr	status bytes	See "2.2.3.5.1 Status Bytes Bitmaps".	
c	checksum		

2.2.3.5.1 Status Bytes Bitmaps

The status bytes are a string of 12 bytes, starting from left (byte 1) to the right (byte 12). Each byte has eight bits of data from D7 (MSB) to D0 (LSB).

Note that the bit is set=1 for an active condition (true) and 0 for an inactive condition (false).

byte 1	
bit	Alarm/Status
D0	High O ₂
D1	Low O ₂
D2	1
D3	1
D4	1
D5	Check O ₂ Sensor
D6	O ₂ Calibration Error

byte 2	
bit	Alarm/Status
D0	High Paw
D1	Low Paw
D2	Sustained Paw (shutdown)
D3	Sustained Paw
D4	Sub-Atmospheric Paw
D5	Pressure Mode Available
D6	1

byte 3	
bit	Alarm/Status
D0	Pinspired Not Achieved
D1	PEEP Not Achieved
D2	No Pressure Mode/PEEP
D3	Manifold Pressure Sensor Failure
D4	Inspiratory Overshoot
D5	Inspiration Stopped
D6	High Pressure Limit Reached (min sys)

byte 4	
bit	Alarm/Status
D0	Low VE
D1	High VE
D2	Low Vte
D3	High Vte
D4	Vt Not Achieved
D5	Volume Apnea
D6	Volume Apnea > 2 min

byte 5	
bit	Alarm/Status
D0	No Inspiratory Flow Sensor
D1	No Expiratory Flow Sensor
D2	Inspiratory Reverse Flow
D3	Expiratory Reverse Flow
D4	Check Flow Sensors
D5	Insp Vt/Vte Mismatch
D6	Vdel Mismatch

byte 6	
bit	Alarm/Status
D0	Bellows Empty
D1	Flow Valve Failure
D2	Gas Inlet Valve Failure
D3	12 Hour Test
D4	Bootup Gas Inlet Valve Failure
D5	No O ₂ Pressure
D6	No Fresh Gas Flow

byte 7	
bit	Alarm/Status
D0	+V analog Failure
D1	-V analog Failure
D2	+15V SIB Out-of-Range
D3	+15V Manifold Out-of-Range
D4	Display Voltage Out-of-Range
D5	Vaux_ref Out-of-Range
D6	Vext_ref Out-of-Range

byte 8	
bit	Alarm/Status
D0	A/D Converter Failure
D1	CPU Failure
D2	Memory (EEPROM) Failure
D3	Memory (flash) Failure
D4	Memory (RAM) Failure
D5	Memory (video) Failure
D6	Bootup Memory Failure

byte 9	
bit	Alarm/Status
D0	Software Watchdog Failure
D1	Hardware Watchdog Failure
D2	Internal Clock Too Fast
D3	Internal Clock Too Slow
D4	CPU Internal Error
D5	Memory (redundant storage) Fail
D6	Flow Sensor Cal Data Corrupt

byte 10	
bit	Alarm/Status
D0	On Battery
D1	No Battery
D2	Low Battery Charge
D3	Low Battery
D4	Low Battery (shutdown)
D5	Battery Voltage Out Of Range
D6	Battery Current Out Of Range

byte 11	
bit	Alarm/Status
D0	Circuit Auxiliary
D1	Auxiliary Breathing Circuit
D2	"no confirmation of changed setting"
D3	Control Settings Input Has Failed
D4	Heliox Mode is ON
D5	Backup Volume Mode
D6	Mechanical Ventilation On

byte 12	
bit	Alarm/Status
D0	Volume Monitor Active
D1	Apnea Detect ON
D2	Apnea Alarm Silenced
D3	Low VE Limit Set
D4	Alarms Silenced
D5	1
D6	Service Calibrations Due

2.2.3.6 Setup Data Response

Only returned when a request for setup data is received.

:VTMaaaabdddeffghc<CR>		Setup Data Response
Bits	Setup Data Name	Units and/or description
aaaa	software revision number	0001-9999 = 0.01-99.99
b	language	0-9 & A-F (see Note: Language)
dd	display contrast setting	1-64
e	alarm volume setting	1-5
ff	altitude setting	-4 to 36, in 100's of meters
g	drive gas	0 = oxygen, A = air
h	model number	0=7800, 1=7810, 5=7850, 6=7900, 7=Centiva, 8=7100
c	checksum	
Note: Language	0=English, 1=Spanish, 2=German, 3=Kanji, 4=Dutch, 5=Swedish, 6=French, 7=Italian, 8=Danish, 9=Polish, A=Chinese, B=Czech, C=Hungarian, D=Russian, E=Portuguese, F=Other	

2.2.3.7 Waveform Data Response

If Waveform Data Mode is enabled, a Waveform Data Response will be transmitted every 240 mS. Up to 2 blocks of fifteen (15) data samples taken every 16 mS will be sent with each message. Each data value is a 3-digit, zero filled, right justified ASCII Hex representation of a 12bit binary value.

:VTW[aaabbb...nnnooo][aaabbb...nnnooo]c<CR>		Waveform Data Response
For each waveform signal selected (maximum of two signals)		
Bits	Waveform Data Name	Units and/or description
aaa	1st 16ms waveform sample	0 -> "000", 512 -> "200", 4095 -> "FFF"
bbb	2nd 16ms waveform sample	0 -> "000", 512 -> "200", 4095 -> "FFF"
...
nnn	14th 16ms waveform sample	0 -> "000", 512 -> "200", 4095 -> "FFF"
ooo	15th 16ms waveform sample	0 -> "000", 512 -> "200", 4095 -> "FFF"

Waveform Data shall be scaled as follows:

Pressure		
range:	-20 to 120 cm H ₂ O	
Raw Data	Scaled Value	Transmitted
-20	0	"000"
0	512	"200"
120	3584	"E00"

Flow		
Range:	-100 to 100 L/M	
Raw Data	Scaled Value	Transmitted
-100	512	"200"
0	2048	"800"
100	3584	"E00"

Volume		
range:	0 to 2 L	
Raw Data	Scaled Value	Transmitted
0	512	"200"
2	3584	"E00"

2.2.4 Example

The Ohmeda Com 1.0 serial protocol *default* is "Slave Mode" with "Checksum Enabled". So data **will not** automatically be sent out the serial port.

If an external device wants to stay in "Slave Mode" it must send the <ESC>VT?c<CR> packet ("Send All Data") to receive one Status Data and one Measured Data packet. The external device will then need to request sending all the data on a periodic basis. This method is not recommended because the external device has the potential to request sending all the data faster than the Datex-Ohmeda device is capable of.

So, the preferred method is to use "Auto Mode" by sending the <ESC>VTXc<CR> packet. This will allow the Datex-Ohmeda device to send the measured data and status data whenever changes occur, or every 10 seconds when changes do not occur. Using this method **will not** put a strain on the Datex-Ohmeda device and again is the preferred method to use.

Listed below is an example to get a Datex-Ohmeda device into auto mode with no checksum and pressure waveform enabled. Using this method the "c" [checksum] can be any character (except <CR>) for all commands sent after the <ESC>VTDw<CR> command (in this example <SP> is used).

- <ESC>VTDw<CR> - Disable checksum ("w" or 0x77 is the checksum value for this command)
- <ESC>VTX<SP><CR> - Set into Auto mode (<SP> used for checksum since checksum disabled)
- <ESC>VTWPO<SP><CR> - Request pressure waveform data

----- End of Section 2.0 - Ohmeda Com 1.0 Protocol -----

3.0 7800 Serial Protocol (for use with 7800 ventilators ONLY)

The following section describes the 7800 Serial Protocol. This protocol is the **recommended** protocol to communicate with the Datex-Ohmeda 7800 ventilators.

3.1 Electrical Interface

RS-232C signal standards.

Connector: 25 pin female D type connector - Data Terminal Equipment Configuration (DTE)

pin 2 - transmit data

pin 3 - receive data

pin 7 - signal ground

Baud Rate: 1200

Byte format: Start bit (logic 0) + 7 data bits + parity bit + stop bit (logic 1)

Parity: ODD

3.2 Software Interface

7800 Serial Protocol.

3.2.1 Summary of 7800 Serial Protocol

When the ventilator is first turned ON, the default transmission mode is set to "Auto Mode," the data format mode is set to "Printer Mode," and the checksum mode is "disabled."

Command Headers:

<ESC>VTD	Disable Checksum Mode (this is the default mode)
<ESC>VTE	Enable Checksum Mode
<ESC>VTS	Slave Mode
<ESC>VTX	Auto Mode (this is the default mode)
<ESC>VT?	Send All Data (will send one Status and Measured Data Response - not valid in Auto Mode)
<ESC>VTP	Printer Mode (this is the default mode)
<ESC>VTQ	Compressed Mode

Response Headers:

:VTD...	Measured Data Response
:VTN	NACK (negative acknowledge)
:VTQ...	Status Data Response
:VTR	Alarm Silence Switch Press Response
:VTY	ACK (positive acknowledge)

3.2.2 Device Commands Sent By External Device

3.2.2.1 Data Transmit Mode Select Commands

<ESC>VTXc<CR>	Auto Mode (Causes the ventilator to output data at each breath or every 10 seconds)
<ESC>VTSc<CR>	Slave Mode (Causes the ventilator to output data when requested by device using a "Send All Data" command)

3.2.2.2 Data Request Command

<ESC>VT?c<CR>	Send All Data (Valid in Slave Mode only - data is sent in compressed format)
---------------	--

3.2.2.3 Checksum Control Commands

<ESC>VTEc<CR>	Enable Checksum Mode
<ESC>VTDc<CR>	Disable Checksum Mode (Checksum byte ignored in this command, but cannot be <CR>)

3.2.2.4 Data Format Mode Select Commands

<ESC>VTPc<CR>	Printer Mode (Outputs data in a printer format, an 80 byte frame)
<ESC>VTQc<CR>	Compressed Mode (outputs data in a compressed measured-and-status data format, 30 and 37 bytes respectively)

3.2.3 Device Responses Sent Back

3.2.3.1 ACK Response

:VTYc<CR>	Positive Acknowledge Response
-----------	-------------------------------

3.2.3.2 NAK Response

:VTNc<CR>	Negative Acknowledge Response
-----------	-------------------------------

3.2.3.3 Alarm Silence Switch Pressed Response

:VTRc<CR>	Alarm Silence Switch Press Response (if no alarms are active or if all alarms are silenced)
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3.2.3.4 Format for Data in Compressed Mode

3.2.3.4.1 Measured Data Response

In auto mode, the Measured Data Response will be transmitted at the end of a breath or 10 seconds from the last transmission, whichever occurs first.

:VTDaaaabbbbddddeeeffggghhhic<CR>		Measured Data Response Each entry is zero filled and right justified--ie. aaaa = 0095. "?" means bad data due to any technical problem(s). "-" means data not available due to system state.
Bits	Measured Data Name	Units and/or description
aaaa	measured tidal volume	mL, ?, -
bbbb	measured minute volume	L*100, ?, -
ddd	measured respiratory rate	B/min, ?, -
eee	measured oxygen level	% O ₂ , ?, -
fff	measured max positive pressure	cm H ₂ O, ?
ggg	measured inspiratory plateau pressure	cm H ₂ O, ?, -
hhh	measured minimum pressure	cm H ₂ O, ?, -
i	measured data status	01xx0000 (bit4=0=normal breath; bit4=1=sigh breath; bit5=0=10 second data; bit5=1=new breath data)
c	checksum	

3.2.3.4.2 Status Data Response

In auto mode, the Status Data Response will be transmitted every 1 second (if a change occurs in the status data) or a minimum of once every 10 seconds. Note that the status byte bit is set=1 for an active condition and 0 for an inactive condition.

:VT0aaaabbbddddeeeeffghhijjqqqqqqc<CR>		Status Data Response Each entry is zero filled and right justified--ie. aaaa = 0095.
Bits	Status Data Name	Units and/or description
aaaa	set tidal volume	mL
bbb	set respiratory rate	B/min
ddd	set inspiratory flow	L/min
eeee	set I:E ratio	1:eee.e (not rounded)
fff	set peak pressure limit	cm H ₂ O
gg	set sustained pressure alarm limit	cm H ₂ O
hh	low minute volume alarm limit	L*10
ii	low oxygen alarm limit	% O ₂
jj	high oxygen alarm limit	% O ₂
qqqqqq	status bytes	See "3.2.3.4.2.1 Status Bytes Bitmaps" listed below.
c	checksum	

3.2.3.4.2.1 Status Bytes Bitmaps

The status bytes are a string of 6 bytes, starting from left (byte 1) to the right (byte 6). Each byte has eight bits of data from D7 (MSB) to D0 (LSB).

Note that the bit is set=1 for an active condition (true) and 0 for an inactive condition (false).

byte 1	
bit	Alarm/Status
D0	High O ₂
D1	Low O ₂
D2	Apnea
D3	Low patient VE
D4	High Pressure
D5	Low Pressure
D6	1

byte 2	
bit	Alarm/Status
D0	Sustained Pressure
D1	Sub-Atmospheric Pressure
D2	AC Fail (primary supply voltage low)
D3	Low Battery
D4	O ₂ Limit Set Error
D5	Vent Setting Range Error
D6	1

byte 3	
bit	Alarm/Status
D0	O ₂ Sensor Failure
D1	Volume Sensor Failure
D2	Maximum Pressure > 60 cm H ₂ O
D3	Reverse Flow
D4	Low Gas Supply Pressure
D5	Apnea Alarm Off
D6	1

byte 4	
bit	Alarm/Status
D0	A/D Conversion Failure (VENT FAIL 0)
D1	CPU Failure (VENT FAIL 1)
D2	ROM Checksum Failure (VENT FAIL 2)
D3	RAM Read/Write Failure (VENT FAIL 3)
D4	Gas Supply > 30 psig (VENT FAIL 4)
D5	Power Loss (VENT FAIL 5)
D6	1

byte 5	
bit	Alarm/Status
D0	Flow Output Incorrect or continuously ON (VENT FAIL 6)
D1	Exh. valve not ON/OFF in insp/exp (DRIVE CKT.OPEN)
D2	Gas Supply Control Solenoid Not ON (VENT FAIL 8)
D3	D/A write/read failure (VENT FAIL 9)
D4	Pressure Transducer Board Failure (VENT FAIL 10)
D5	7.5v Supply Out-of-range (VENT FAIL 11)
D6	1

byte 6	
bit	Alarm/Status
D0	Flow Table Values 0,FF or Non-increasing (VENT FAIL 12)
D1	Inspiratory pause on
D2	Volume Monitor Standby
D3	Ventilation Switch ON
D4	Volume Sensor Cartridge Coasting (end of breath not detected)
D5	Alarms Are Silenced
D6	1

3.2.3.4.3 Example of How To Enter Compressed Data Mode

The 7800 serial protocol will *default* into "Printer Mode" in "Auto Mode," and the checksum mode is "disabled."

Since the default mode is "Printer Mode", the command to enter into compressed mode must be sent. Listed below is an example to get a Datex-Ohmeda device into the Compressed Data mode with Checksum mode disabled and also in Auto mode (using this method the 'c'[checksum] should be a space (' ') because we are disabling the checksum mode).

- <ESC>VTDC<CR> - Disable checksum
- <ESC>VTQc<CR> - Turn On Compressed Data Mode
- <ESC>VTXc<CR> - Set into Auto mode

3.2.3.5.2 Parameter Settings

Listed below is a table that describes the Parameter Settings that appear in the last 11 columns of the printer format.

Heading	Format	Description	Units
SET	none	text describing that this is the settings	none
VT	dddd	set tidal volume	mL
RR	ddd	set respiratory rate	B/min
IF	ddd	set inspiratory flow	L/min
I:E	1:ddd.d	set inspiratory time: expiratory time ratio	
PL	ddd	set inspiratory pressure limit	cm H ₂ O
LVE	d.d	set low minute volume alarm limit	L
LO	dd	set low oxygen alarm limit	% O ₂
HO	dd	set high oxygen alarm limit	% O ₂
MV	d	mechanical ventilation status	1 if On, 0 if Off
IP	d	inspiratory pause status	1 if On, 0 if Off

3.2.3.5.3 Example of Data in Printer Mode

This is an example of the printer mode data.

```

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.
.
569 11.34 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
569 11.36 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
565 11.37 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
569 11.35 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0

MEAS  VT   VE  RR  O2  MAX  PT  MIN  SET  VT  RR  IF   I: E  PL  LVE  LO  HO  MV  IP
      565 11.38 20 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      563 11.40 20 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
S     855 11.77 19 21 27 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      569 11.34 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      569 11.35 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      569 11.36 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      565 11.37 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0
      569 11.32 18 21 21 --- 3      650 20 50 1: 2.8 58 0.0 18 0 1 0

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----- End of section 3.0 7800 Serial Protocol -----

4.0 INOvent Line-Printer Format Output

The following section describes the Datex-Ohmeda INOvent line-printer format output.

4.1 Electrical Interface

RS-232C signal standards.

Connector: 9 pin female DSUB connector

pin 2 - receive data

pin 3 - transmit data

pin 5 - signal ground (isolated)

Baud Rate: 9600

Byte format: Start bit + 8 data bits + stop bit

Parity: NONE

4.2 Description of Line-Printer Output

The INOvent delivery system outputs lines of data periodically. The lines are terminated by a carriage return/line feed. This format is suitable for logging to a serial printer or to a terminal or PC program such as Procomm or Windows Terminal. The first heading line is sent about 20 seconds after the system is powered up. Additional lines of data are sent once each minute. The data is not averaged, it represents the instantaneous values at the time the line is output.

4.2.1 Format of Line-Printer Output

The first column is the time in hours and minutes since the system was powered up.

The second, third and fourth columns are the monitored gas concentrations, as shown on the display panel. Each of these three values may be followed by a single character 'H', 'L', or '?'. Respectively, these characters indicate a High Alarm Limit violation, a Low Alarm Limit violation, or invalid data (such as when calibrating).

The fifth column is the Set NO value. It may be followed by a 'C' or 'P' character which means, respectively, that a Sensor Calibration is underway, or that the system is in Pause Flow mode.

If there are any active delivery alarms, the most recent one will be shown in the sixth column as the character '!' followed by a code number.

If there are any active component self-test delivery alarms, the most recent one will be shown in the sixth or seventh column as the character '*' followed by a code number. The code numbers indicate which delivery alarm is active. The code numbers do not indicate monitoring alarms.

4.2.1.1 Alarm Codes and Self-Test Fault Codes

4.2.1.1.1 Delivery Alarm Codes

List of delivery alarm codes. This are the codes that will appear in the alarm column of the Line-Printer Output (sixth column) prefixed with '!'.

(!) Delivery Alarm Codes	
Code	Alarm
2	Over-delivery
3	High NO Flow
6	Delivered NO greater than Set NO
7	Increased NO Flow
9	Delivered NO less than Set NO
10	Decreased NO Flow

4.2.1.1.2 Delivery Self-Test Fault Codes

List of self-test fault codes. This are the codes that will appear in the alarm column of the Line-Printer Output (sixth or seventh column) prefixed with '*'.

(*) Delivery Self-Test Fault Codes			
Code	Self-Test Fault	Code	Self-Test Fault
0	Five-volt Power Supply	25	Stack Overflow
1	Injector Module Power	26	System RAM
3	+15 v Power	27	Processor Exception
4	-15 v Power	28	Real-time Clock
6	Running on Battery	29	NOCB/NOMB Communications
7	Low Battery Charge	30	CPU Self-test
8	Low Battery Voltage	39	A/D Converter
10	Dead Battery	40	D/A Converter
12	Shutoff Valve Current	41	Independent Reference Voltage
13	Shutoff Valve Leak	45	A/D Inoperable
14	Secondary Audio Buzzer	47	Injector Module EEPROM
15	Battery is Discharging	48	Injector Module Signal
16	SIM40 Software Watchdog	51	NOFC EEPROM
17	External Hardware Watchdog	52	NOFC Signal
18	Battery Current Too Low	53	NOFC High-flow Valve
19	Battery Current Too High	54	NOFC Low-flow Valve
20	Battery Voltage Too High	55	NOFC Delivery Leak
21	Program Flash ROM CRC	56	NOFC Powerup Leak Check
22	System EEPROM		

4.2.1.2 Example of Line-Printer Output

Listed below is an example of the line-printer output.

hh:mm	O2	NO2	NO	Set NO	(Alarm)	
0:01	2L	0.0	0.7	0.0		
0:02	2L	0.0	0.0	7.2		
0:03	0?	0.0?	0.0?	7.2C		
0:04	0?	0.0?	0.0?	7.2C	!7	
0:05	0?	0.0?	0.0?	7.2C	!7	
0:06	0?	0.0?	0.0?	7.2C	!7	*48
0:07	22	0.1	7.5	7.2		
0:08	21	0.0	7.5	7.2		
0:09	20L	-0.1	4.8	3.8		
0:10	21	-0.1	4.2	3.8		
0:11	21	0.0	4.1	3.8P	*48	
0:12	21	0.0	3.9	3.8P	*48	
0:13	22	0.1	4.0	3.8		
0:14	22	0.1	4.0	3.8		

----- End of section 4.0 INOvent Line-Printer Format Output -----

5.0 Modulus CD Computer Output

5.1 General

When Computer is selected on the Manual Setup page, data shall be sent to the Computer device by the CD every 20 seconds. Data shall be sent via the Serial interface port on the CD. The port shall be configured to use a Baud Rate of 1200, 7 data bits, odd parity, and 1 stop bit.

All data sent shall be ASCII text. The Computer data stream shall consist of header information followed by data. All data shall be contained in 7 character wide fields in one of five formats as listed below. When data for a particular parameter is not available, format 4 shall be used (dashed data).

5.2 NIBP Readings

NIBP readings shall be sent undashed to the Computer, on the 20 second update, **only** after the completion of a successful blood pressure determination. NIBP readings shall be sent dashed to the Computer if **no** successful blood pressure determination has completed within the 20 second update period.

5.3 Header Description

The header sent shall be formatted as follows:

CDw.vv-wwff.ff-fffh:mm:ss^^		Header Data
Bits	Status Data Name	Units and/or description
vv.vv-ww	Software version number	example: 03.31-AAB
ff.ff-fff	Computer format version	example: 04.00-AAC
hh:mm:ss	Current Time (hour:minute:second)	example: 10:43:21
^^	Two spaces	Two spaces

Note : For the 4.00 software release the following Computer format versions shall apply:

BASE 03.30-AAA
CV 04.00-AAC

5.4 Data Format Definitions

The following format definitions are used in the data descriptions that follow for the Base and CV data streams.

Format	Description
#1	Integer left justified in 7 character field, no leading zeros, with spaces filling out field to the right.
#2	"nn.d^^^" for fractional numbers, where nn is right justified to the decimal point with spaces filling out to the left, d is left justified to the decimal point with spaces filling out to the right, and ^^^ is three spaces.
#3	"nn.dt^^" Same as format #2 with "t" indicating agent via the following conventions: i = ISO e = ENF h = HAL s = SEV d = DES
#4	"----^^^" for all values where no data is available. ^^^ is three spaces.
#5	"nn.ddl" Same as format #2 with "l" indicating the ECG lead label via the following conventions: a = I b = II c = III d = MCL1 e = MCL6 f = AVL g = AVF h = AVR i = V1 j = V2 k = V3 l = V4 m = V5 n = V6

5.5 Units

The following units shall be used for data sent to the Computer, regardless of the units used for display on the CD. Where necessary, the CD shall convert data to the required units.

Parameter	Units
Blood Pressures	mmHg
CO ₂	mmHg
O ₂	%
N ₂ O	%
Agent	%
SpO ₂	%
Vt	mL
Ve	liters/min
PR	bpm
HR	bpm
Pmax	cm H ₂ O
Pmin	cm H ₂ O
RR	B/min
TEMP1	degrees C
TEMP2	degrees C
ST1	mm
ST2	mm

5.6 Base System Data

Data for a Base system shall use the following formats ("^" is a space):

Parameter	Format #	Min. Value	Zero Value	Max. Value	Notes
SYS (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
DIA (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
MAP (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
PR	1	0^^^^^^	0^^^^^^	300^^^^	
Agt-I	3	^0.0t^^	^0.0t^^	99.9t^^	*1
Agt-E	3	^0.0t^^	^0.0t^^	99.9t^^	*1
SpO ₂	1	0^^^^^^	0^^^^^^	999^^^^	*2
O ₂ -I	1	0^^^^^^	0^^^^^^	999^^^^	*3
Pmax	1	0^^^^^^	0^^^^^^	999^^^^	*4
Pmin	1	-99^^^^	0^^^^^^	999^^^^	*5
CO ₂ -I	1	0^^^^^^	0^^^^^^	99^^^^	
CO ₂ -E	1	0^^^^^^	0^^^^^^	99^^^^	
Ve	2	^0.0^^^	^0.0^^^	99.9^^^	
Vt	1	0^^^^^^	0^^^^^^	9999^^^	
RR	1	0^^^^^^	0^^^^^^	99^^^^	
N ₂ O	1	0^^^^^^	0^^^^^^	999^^^^	*6

Notes:

- *1 Gas monitor limits range of Agt data to 0.0 to 30.0 %.
- *2 Oximeter limits range of SpO₂ data to 0 to 100 %.
- *3 Ventilator limits range of O₂ data to 0 to 110 %.
- *4 Ventilator limits range of Pmax data to 0 to 127 cmH₂O.
- *5 Ventilator limits range of Pmin data to -20 to 127 cmH₂O.
- *6 Gas monitor limits range of N₂O to 0 to 100 %.

5.6.1 Example of Base System data output

This is an example of the Base system data output.

CD04.00-AAC03.30-AAA11:30:40	----	----	----	61	1.5i	1.5i	63	24	15	3	32	34	3.8	378	10	29
CD04.00-AAC03.30-AAA11:31:00	----	----	----	61	1.5i	1.5i	63	23	15	3	32	33	3.8	378	10	29
CD04.00-AAC03.30-AAA11:31:20	----	----	----	61	1.5i	1.5i	63	22	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:31:40	----	----	----	61	1.5i	1.5i	66	22	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:32:00	----	----	----	60	1.5i	1.5i	98	12	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:32:20	117	79	91	61	1.5i	1.5i	98	12	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:32:40	120	80	95	61	1.5i	1.4i	98	12	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:33:00	120	78	95	60	1.5i	1.4i	98	39	15	3	32	32	3.8	378	10	29
CD04.00-AAC03.30-AAA11:33:20	117	79	93	60	1.5i	1.4i	98	39	15	3	32	32	3.8	378	10	28
CD04.00-AAC03.30-AAA11:33:40	117	79	95	60	1.5i	1.4i	98	39	15	3	32	32	3.8	378	10	28
CD04.00-AAC03.30-AAA11:34:00	116	78	95	61	1.4i	1.4i	98	39	15	3	32	32	3.8	378	10	28
CD04.00-AAC03.30-AAA11:34:20	----	----	----	60	1.4i	1.4i	98	39	15	3	32	32	3.8	376	10	28
CD04.00-AAC03.30-AAA11:34:40	120	80	94	61	1.4i	1.4i	98	39	15	3	32	32	3.8	378	10	28
CD04.00-AAC03.30-AAA11:35:00	----	----	----	60	1.4i	1.4i	98	39	15	3	32	32	3.8	378	10	28
CD04.00-AAC03.30-AAA11:35:20	117	80	94	60	1.4i	1.4i	98	177	15	3	32	32	3.8	375	10	28
CD04.00-AAC03.30-AAA11:35:40	116	79	94	61	1.4i	1.4i	98	172	15	3	33	35	3.8	378	10	28
CD04.00-AAC03.30-AAA11:36:00	117	78	95	60	----	----	98	171	15	3	35	35	3.8	378	10	27
CD04.00-AAC03.30-AAA11:36:20	117	79	95	61	8.4h	8.2h	98	169	15	3	35	35	3.8	378	10	27
CD04.00-AAC03.30-AAA11:36:40	120	79	94	60	10.6h	9.3h	98	169	15	3	35	41	3.8	375	10	32
CD04.00-AAC03.30-AAA11:37:00	117	77	94	60	12.8h	12.8h	98	167	15	3	8	47	3.8	378	10	32
CD04.00-AAC03.30-AAA11:37:20	116	81	95	60	11.3h	9.1h	98	176	15	3	34	42	3.8	378	10	31
CD04.00-AAC03.30-AAA11:37:40	117	78	93	60	9.7h	9.6h	98	88	15	3	37	39	3.8	378	10	31

5.7 CV System Data

Data for a CV system shall use the following formats ("^" is a space):

Parameter	Format	Min. Value	Zero Value	Max. Value	Notes
SYS (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
DIA (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
MAP (NIBP)	1	-50^^^^	0^^^^^^	300^^^^	
PR	1	0^^^^^^	0^^^^^^	300^^^^	
Agt-I	3	^0.0t^^	^0.0t^^	99.9t^^	*1
Agt-E	3	^0.0t^^	^0.0t^^	99.9t^^	*1
SpO ₂	1	0^^^^^^	0^^^^^^	999^^^^	*2
O ₂ -I	1	0^^^^^^	0^^^^^^	999^^^^	*3
Pmax	1	0^^^^^^	0^^^^^^	999^^^^	*4
Pmin	1	-99^^^^	0^^^^^^	999^^^^	*5
CO ₂ -I	1	0^^^^^^	0^^^^^^	99^^^^	
CO ₂ -E	1	0^^^^^^	0^^^^^^	99^^^^	
Ve	2	^0.0^^^	^0.0^^^	99.9^^^	
Vt	1	0^^^^^^	0^^^^^^	9999^^^	
RR	1	0^^^^^^	0^^^^^^	99^^^^	
N ₂ O	1	0^^^^^^	0^^^^^^	999^^^^	*6
HR	1	0^^^^^^	0^^^^^^	300^^^^	
ART1 SYS	1	-50^^^^	0^^^^^^	300^^^^	
ART1 DIA	1	-50^^^^	0^^^^^^	300^^^^	
ART1 Mean	1	-50^^^^	0^^^^^^	300^^^^	
ART2 SYS	1	-50^^^^	0^^^^^^	300^^^^	
ART2 DIA	1	-50^^^^	0^^^^^^	300^^^^	
ART2 Mean	1	-50^^^^	0^^^^^^	300^^^^	
PAP SYS	1	-50^^^^	0^^^^^^	300^^^^	
PAP DIA	1	-50^^^^	0^^^^^^	300^^^^	
PAP Mean	1	-50^^^^	0^^^^^^	300^^^^	
CVP Mean	1	-50^^^^	0^^^^^^	300^^^^	
RAP Mean	1	-50^^^^	0^^^^^^	300^^^^	
LAP Mean	1	-50^^^^	0^^^^^^	300^^^^	
ICP Mean	1	-50^^^^	0^^^^^^	300^^^^	
PRS SYS	1	-50^^^^	0^^^^^^	300^^^^	
PRS DIA	1	-50^^^^	0^^^^^^	300^^^^	
PRS Mean	1	-50^^^^	0^^^^^^	300^^^^	

Printed copies are for reference only.
Verify that this version is current before using.

Parameter	Format	Min. Value	Zero Value	Max. Value	Notes
TEMP1	2	^0.0^^^	^0.0^^^	50.0^^^	
TEMP2	2	^0.0^^^	^0.0^^^	50.0^^^	
ST1	5	-9.99 ^	^0.00 ^	^9.99 ^	
ST2	5	-9.99 ^	^0.00 ^	^9.99 ^	

Notes:

- *1 Gas monitor limits range of Agt data to 0.0 to 30.0 %.
- *2 Oximeter limits range of SpO₂ data to 0 to 100 %.
- *3 Ventilator limits range of O₂ data to 0 to 110 %.
- *4 Ventilator limits range of Pmax data to 0 to 127 cmH₂O.
- *5 Ventilator limits range of Pmin data to -20 to 127 cmH₂O.
- *6 Gas monitor limits range of N₂O to 0 to 100 %.

5.7.1 Example of CV data output

This is an example of the CV data output.

0004.00-AAC04.00-AAC12:21:00	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	305	12	34	60	----	----	----	----	----	----	----	----	----	0	79	-10	-9	-9	-9	36.1	46.1	-2.16c	5.84h
0004.00-AAC04.00-AAC12:21:20	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	306	12	34	60	----	----	----	----	----	----	----	----	----	0	79	-10	-9	-9	-9	36.1	46.1	-2.08c	5.84h
0004.00-AAC04.00-AAC12:21:40	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	34	60	----	----	----	----	----	----	----	----	283	79	-10	-9	-9	-9	36.1	46.1	-2.08c	5.84h	
0004.00-AAC04.00-AAC12:22:00	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	34	60	----	----	----	----	----	----	----	----	291	79	-10	-9	-9	-9	36.1	46.1	-2.08c	5.84h	
0004.00-AAC04.00-AAC12:22:20	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	34	60	----	----	----	----	----	----	----	----	292	80	-10	-9	-9	-9	36.1	46.1	-2.16c	5.84h	
0004.00-AAC04.00-AAC12:22:40	115	78	91	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	33	60	----	----	----	----	----	----	----	----	293	80	-10	-9	-9	-9	36.1	46.1	----	f ---- g	
0004.00-AAC04.00-AAC12:23:00	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	33	----	----	----	----	----	----	----	----	----	291	79	-10	-9	-9	-9	36.1	46.1	----	f ---- g	
0004.00-AAC04.00-AAC12:23:20	----	----	----	62	1.1s	1.1s	91	25	11	2	37	37	3.7	308	12	33	60	----	----	----	----	----	----	----	----	291	79	-10	-9	-9	-9	36.1	46.1	----	f ---- g	
0004.00-AAC04.00-AAC12:23:40	----	----	----	62	1.1s	1.1s	91	25	11	2	36	37	3.7	308	12	33	60	291	291	292	----	----	----	----	----	292	80	-10	-9	-9	-9	36.1	46.1	-1.44f	-4.48g	
0004.00-AAC04.00-AAC12:24:00	----	----	----	62	1.1s	1.1s	91	25	11	2	36	37	3.7	308	12	33	60	289	289	289	79	78	79	-10	-10	-10	-9	79	-10	-9	-9	-9	36.1	46.1	-1.44f	-4.48g
0004.00-AAC04.00-AAC12:24:20	----	----	----	62	1.1s	1.0s	91	25	11	2	36	36	3.7	308	12	33	60	291	290	290	80	79	79	-8	-10	-8	-9	----	----	----	----	----	36.1	46.1	-1.36f	-4.48g
0004.00-AAC04.00-AAC12:24:40	----	----	----	62	1.1s	1.1s	91	25	11	2	36	36	3.7	308	12	33	57	288	286	288	79	76	79	-10	-10	-10	-5	----	----	----	----	----	36.1	46.1	-1.36f	-4.56g
0004.00-AAC04.00-AAC12:25:00	----	----	----	62	1.1s	1.0s	91	25	11	2	36	36	3.7	308	12	32	57	289	288	288	80	78	78	-10	-10	-10	1	----	----	----	----	----	36.1	46.1	----	----
0004.00-AAC04.00-AAC12:25:20	----	----	----	62	1.0s	1.0s	91	25	11	2	36	36	3.7	308	12	32	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
0004.00-AAC04.00-AAC12:25:40	----	----	----	62	1.0s	1.0s	91	25	11	2	36	36	3.7	308	12	32	57	77	27	77	289	281	287	----	----	----	----	----	----	----	----	----	36.6	46.6	----	b ---- c
0004.00-AAC04.00-AAC12:26:00	----	----	----	62	1.0s	1.0s	91	25	11	2	36	36	3.7	308	12	32	----	80	79	79	292	292	292	-10	-10	-10	1	----	----	----	----	----	36.1	46.1	----	b ---- c
0004.00-AAC04.00-AAC12:26:20	----	----	----	62	1.0s	1.0s	91	25	11	2	36	36	3.7	306	12	32	----	80	79	79	292	292	292	-10	-10	-10	1	----	----	----	----	----	36.1	46.1	----	----
0004.00-AAC04.00-AAC12:26:40	----	----	----	62	1.0s	1.0s	91	25	11	2	35	36	3.7	308	12	32	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
0004.00-AAC04.00-AAC12:27:00	----	----	----	62	----	----	91	25	11	2	35	36	3.7	305	12	32	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

----- End of section 5.0 Modulus CD Computer Output -----