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FLUKE Biomedical
Impulse 6000D/7000DP Communications Interface

Version 2.4 4/28/2016

INTRODUCTION

The Impulse 6000D and Impulse 7000DP can be controlled remotely through its Computer Port: a USB Interface port that looks like a COM port to a personal computer (PC).

You can control the Impulse by sending commands to it and receiving responses, including test data, through the COM port.

OPERATING SYSTEM REQUIREMENT

Fluke supports connecting the Impulse to a PC running Windows XP, Vista, or a later version.

VIRTUAL COM PORT

The Impulse USB port is built from an integrated circuit (IC) device that is commonly used inside adapter cables that convert USB to RS232. When this device is connected to a PC it looks like a COM port to the PC. When Windows enumerates the device it assigns a COM port number to it. It is called a virtual COM port (VCP).

The IC is an FT232R from the FTDI company. It is compatible with the USB Version 2.0 Full Speed specification.

The USB port may reside inside the Impulse, but the PC acts like it now has an additional COM port and that COM port is connected to an RS232 serially controlled instrument.

Once your Impulse is connected and the COM port is enumerated, you can control it by sending remote commands to the COM port and receiving responses.

COMPUTER CABLE CONNECTION

The Impulse Computer Port is a USB Device Port (peripheral) with a Type B square connector. It connects to a PC USB Controller Port that has a Type A rectangular connector.

Connect the Impulse to your PC with a standard USB Type A to Type B cable such as the one supplied with the Impulse.

WINDOWS SOFTWARE DRIVER

Versions of Windows XP, Vista, and later, include a software driver for FTDI USB Serial Converters, including the FT232R. The USB ID numbers are: VID 0403 and PID 6001.

When you connect the Impulse to your PC for the first time, Windows should recognize and register your Impulse as a USB Serial Converter and USB Serial Port (COMx).

DEVICE MANAGER

Run Device Manager to check the status of the Impulse COM port. When viewing by Type, your Impulse shows up in two places:

- Universal Serial Bus controllers / USB Serial Converter.
- Ports (COM & LPT) / USB Serial Port (COMx).

If you view by Connection, the Impulse will be under one of the USB Root Hubs as:

- USB Serial Converter / USB Serial Port (COMx).

Note: If Device Manager only lists the USB Serial Converter but not the COM port it could be that the Virtual COM Port driver is not enabled. Open USB Serial Converter Properties and go to Advanced. Check the Load VCP box if it is not already checked and press OK. Then the COM port should show up.

Note: You can changed the COM port number assigned by Windows in Device Manager. Open the Properties for the USB Serial Port (COMx), go to Port Settings and press Advanced. Select the desired COM Port Number from the drop down list box and press OK. To get the device list to show the new COM port number perform a Scan for hardware changes.

Note: If Device Manager says that a COM port number is in use, it may be from another USB device that is no longer being used. You can click through the error message and force it to the number you want.

Note: If you unplug your Impulse, you can still see it in Device Manager by selecting View / Show hidden devices. It will be shown grayed out.

ADVANCED USERS

Advanced users can get more information about the FT232R from the FTDI web site: www.ftdichip.com. You can get new software drivers, application notes, and USB utilities. You can learn how to view your USB connections and load and/or delete all FTDI drivers from your PC. You can get drivers for other operating systems. You can even use their D2XX direct interface API to include in your own custom interface programs if you don't want to use a COM port.

COM PORT SETTINGS

Settings for the COM port should be made by the program that opens and uses the COM port such as:

- Terminal emulation program (HyperTerminal, Tera Term or other)
- Your custom Impulse controller program
- Fluke Ansur Test Automation System program

The settings in Device Manager are usually irrelevant because they are overridden by the controlling program.

The COM port should be set to:

- 115,200 baud
- No parity
- 8 data bits
- 1 stop bit
- Hardware handshaking should be turned on.

COMMAND PROTOCOL

Commands may be sent in upper or lower case.

Commands must be terminated by a Carriage Return (CR) (0x0D) and/or a Line Feed (LF) (0x0A).

Some commands require one or more parameters to be sent with them. Where a command needs parameters, the command is followed by an equal sign and the parameters. Multiple parameters are separated by commas.

Space (SP) (0x20) characters are ignored. The Backspace (BS) (0x08) character removes the previously transmitted character from the command. The Escape (ESC) (0x1B) character erases all previously transmitted characters.

COMMAND RESPONSES

After receiving a command, the Impulse will not store or respond to additional received characters until it has executed the command and responded to it.

The Impulse always responds to a command after it has executed it, by returning a response, terminated by a Carriage Return (0x0D) and a Line Feed (0x0A).

The standard command response is "*", unless other data is to be returned. "*" indicates that the command was understood and executed.

A few commands remain active after returning an initial response, as described below.

Incorrect commands return the following error codes:

Code	Description
!	Command empty, no characters
!00	No commands allowed now
!01	Unknown command
!02	Illegal command, not allowed in current mode
!03	Illegal parameter
!04	Receive error
!05	General failure
!06	Option not installed, such as Pacer command sent to Impulse 6000D
!20	Defib data not available
!21	Gas gauge bad read
!24	Data corrupted

LOCAL CONTROL

The Impulse powers up initially under local control by user keys. Then, the only legal command is `REMOTE` that brings Impulse to remote control.

REMOTE CONTROL

In remote control, Impulse accepts commands and executes them. Some commands set Impulse into special modes. Some commands are only legal in certain modes. The modes are listed in the table:

Mode Mnemonic	Description
`MAIN`	Main remote mode
`DEFIB`	Measure defib pulses
`PAPULSE`	Measure pacer pulse parameters
`PASENSE`	Test pacer sensitivity
`PAREFRACT`	Measure pacer refractory periods
`ECG`	Simulate ECG waves.
`ECGPACED`	Simulate ECG interactively with pacer.
`ECGPERF`	Simulate ECG waves for performance testing.
`ECGNOISE`	Simulate noise on ECG.

The `LOCAL` command brings Impulse back to local control.

PACER COMMANDS (IMPULSE 7000DP ONLY)

Commands for pacer functions only work with the Impulse 7000DP. The Impulse 6000D will respond to them with the `!06` error code.

COMMAND SPECIFICATIONS

Note: Unless specified otherwise, commands return *****.

GENERAL COMMANDS

REMOTE

Modes: Local control.
Description: Goes to remote control **MAIN** mode.

LOCAL

Modes: All.
Description: Exits remote control and returns to local control.

IDENT

Modes: All.
Description: Asks for the identification with option and software version number.
Returns: The identification: TBD.

SN

Mode: All.
Description: Retrieves serial number.
Returns: Serial number.

VER

Modes: All.
Description: Asks for the software version number.
Returns: The software version: 3 digits with decimal point, format `n.nn`.

MODE=MODE

Modes: **MAIN**.
MODE: The mode to go to: The mnemonic of the mode.
Description: Go to the designated mode.

QMODE

Modes: All.
Description: Queries the mode.
Returns: The current mode mnemonic.

QSET

Modes: All.
Description: Queries the current settings.
Returns: Current settings, separated by commas; settings depend on mode as applicable: first the mode mnemonic, then settings:

DEFIB,LD=load,WV=wave,CV=wave conversion,EA=ECG amplitude
PAPULSE,BR=brand,IN=input,LD=load
PASENSE,BR=brand,IN=input,LD=load,SH=shape,WD=width,PL=polarity,
EA=ECG amplitude
PAREFRACT,BR=brand,IN=input,LD=load
ECG,WV=wave,EA=ECG amplitude
ECGPACED,WV=wave,TH=threshold,EA=ECG amplitude
ECGPERF,SH=shape,FQ=frequency,EA=ECG amplitude [regular performance wave]
ECGPERF,SH=shape,WD=width,RT=rate,EA=ECG amplitude [for R wave pulse]

ECGNOISE,NF=noise frequency,EW=ECG wave on/off,NA=noise amplitude

EXIT

Modes: All.
Description: Turns off measurement and ECG. Exits the current mode and goes to **MAIN** mode.

GLOBAL SETUP COMMANDS

DEFLOAD=LOAD

Model: Impulse 7000DP only
Special: This is a special command only to be used when the Impulse 7000DP is connected to an Impulse 7010 Defibrillator Selectable Load Accessory. It tells the 7000DP how to compute the defib pulse parameters.
After disconnecting the 7010, be sure to set the load back to 50 ohms or cycle power. The 7000DP powers up to 50 ohms.
Mode: All.
LOAD: The defib load in ohms: 3 digits: **025** to 2**00** by **025**.
Description: Sets the load to be used for defib tests when connected to the Impulse 7010 Defibrillator Selectable Load Accessory.

PAINPUT=INPUT

Model: Impulse 7000DP only
Mode: All modes
INPUT: The pacer input: **DEFIB** or **PACER**.
Description: Sets the input to be used for pacer tests.

PALOAD=LOAD

Model: Impulse 7000DP only
Mode: All.
LOAD: The pacer load in ohms: 4 digits: **0050** to **1500** by **0050**.
Description: Sets the load to be used for pacer tests. Connects that load to the pacer jacks.

PABRAND=BRAND

Model: Impulse 7000DP only
Modes: All.
BRAND: The pacer brand: **NONE**, **PHYSIO**, **PHILIPS**, **ZOLL**, **CARDIAC**, **MRL**, **SCHILLER**, or **MDE**. (Also **MEDTRONIC** for legacy, same algorithm as **PHYSIO**).
Description: Sets the pacer brand algorithm to be used for pacer tests.

ECGAMPL=AMPLITUDE

Modes: All modes except **PASENSE** and **ECGNOISE**.
AMPLITUDE: The amplitude in mV: 3 digits with decimal point: **0.05** to **5.00**.
Description: Sets the ECG wave amplitude for all ECG waves except for Pacer Sensitivity and ECG Noise waves.

ECGREF=LEAD

Modes: All.
LEAD: The ECG reference lead II or I.
Description: Sets the ECG reference lead.

DEFIB MODE COMMANDS

DCONVERT=WAVE

Mode: **DEFIB**.
WAVE: The defib post-shock conversion wave:

CONVERT	Convert to normal sinus 60 bpm.
NOCONVERT	No change to wave.
ASYSTOLE	Change to asystole wave.
SYNCCONVERT	Convert to normal sinus 60 bpm only if sync time within range of -120 to +380 ms, otherwise change to asystole.

Description: Sets the defib post-shock conversion wave.

DAFIB=GRAN

Mode: **DEFIB**.
GRAN: The afib granularity: **COARSE** or **FINE**.
Description: Runs the afib wave.

DVFIB=GRAN

Mode: **DEFIB**.
GRAN: The vfib granularity: **COARSE** or **FINE**.
Description: Runs the vfib wave.

DVFIB2=GRAN

Mode: **DEFIB**.
GRAN: The vfib granularity: **COARSE** or **FINE**.
Description: Runs the vfib2 wave. Vfib2 is a faster version of vfib.

DMONOVTACH=RATE

Mode: **DEFIB**.
RATE: The mono vtach rate in BPM: 3 digits: **120** to **300**.
Description: Runs the mono vtach wave at the specified rate.

DPOLYVTACH=CODE

Mode: **DEFIB**.
CODE: The poly vtach code: 1 digit: **1** to **5**.
Description: Runs the poly vtach wave of the specified code.

DNSR=RATE

Mode: **DEFIB**.
RATE: The normal sinus rate in BPM: 3 digits: **150** to **300**.
Description: Runs the normal sinus wave at the specified rate.

DASYSTOLE

Mode: **DEFIB**.
Description: Runs the asystole wave.

DREADY

Mode: **DEFIB**.
Description: Ready the measurement system to wait for and measure a defib pulse.
Returns: ***(CrLf)**. Then waits for the defib pulse.
After detecting and processing the defib pulse:
Returns the defib data in numeric fields separated by commas:

Type of pulse:
- **1** for Monophasic
- **2** for Bi-Phasic
- **3** for Pulsed Bi-Phasic

For type 1 pulse, the remaining fields are:

Energy (J): **XXX.X**
Peak Voltage (V): **XXXX**
Peak Current (A): **XXX.X**
Pulse Width 50% (ms): **XX.X**
Pulse Width 10% (ms): **XX.X**
Sync Time (ms): **±XXX**
ECG Wave now running:
- **N** for no change.
- **C** for converted to NSR at 60 bpm.
- **A** for Asystole.

Charge Time (s): **XXX.X**

Example: **1,123.4,2000,040.2,08.3,12.4,+120,N,012.3**

For type 2 pulse, the remaining fields are:

Energy (J): **XXX.X**
Phase 1 Peak Voltage (V): **XXXX**
Phase 1 Average Voltage (V): **XXXX**
Phase 1 Peak Current (A): **XXX.X**
Phase 1 Average Current (A): **XXX.X**
Phase 1 Pulse Width (ms): **XX.X**
Phase 2 Peak Voltage (V): **XXXX**
Phase 2 Average Voltage (V): **XXXX**
Phase 2 Peak Current (A): **XXX.X**
Phase 2 Average Current (A): **XXX.X**
Phase 2 Pulse Width (ms): **XX.X**
Inter-Phase Delay (ms): **XX.X**
Tilt (%): **XX**
Sync Time (ms): **±XXX**
ECG Wave now running:
- **N** for no change.
- **C** for converted to NSR at 60 bpm.
- **A** for Asystole.

Charge Time (s): **XXX.X**

Example: **2,123.4,2000,1453,040.2,033.1,10.3,**
1256,0967,032.2,018.1,09.2,
02.3,12,+120,N,012.3

For type 3 pulses, the remaining fields are:

Energy (J): **XXX.X**
Phase 1 Peak Voltage (V): **XXXX**
Phase 1 Average Voltage (V): **XXXX**
Phase 1 Peak Current (A): **XXX.X**
Phase 1 Average Current (A): **XXX.X**
Phase 1 Pulse Width (ms): **XX.X**

Phase 2 Peak Voltage (V): **XXXX**
Phase 2 Average Voltage (V): **XXXX**
Phase 2 Peak Current (A): **XXX.X**
Phase 2 Average Current (A): **XXX.X**
Phase 2 Pulse Width (ms): **XX.X**
Inter-Phase Delay (ms): **XX.X**
Tilt (%): **XX**
Frequency (Hz): **XXXX**
Duty Cycle (%): **XX**
Sync Time (ms): **±XXX**
ECG Wave now running:
N for no change.
C for converted to NSR at 60 bpm.
A for Asystole.
Charge Time (s): **XXX.X**

Example: **3,123.4,2000,1453,040.2,033.1,10.3,**
1256,0967,032.2,018.1,09.2,
02.3,12,4023,41,+120,N,012.3

Exit: If no defib pulse comes, will quit after receiving **ESC** character, then sends **CrLf** and quits.

DWAVEDATA

Mode: **DEFIB**.
Description: Requests the defib pulse data from the last measured defib pulse.
Returns: The defib pulse data: 2,500 signed current readings, in Amps, 20 µs apart, formatted: **±XXX.X**, separated by commas. With a CRLF after every 10 readings.
Example: **+001.2,+002.3,-043.2,+100.0, ...**
ErrorMessage: Returns **!20** if no defib pulse data available.

PACER PULSE COMMANDS

PAREADY

Model: Impulse 7000DP only
Modes: **PAPULSE**.
Description: Ready the measurement system to wait for and measure pacer pulses continuously.
Returns: *****. Then waits for pacer pulses. After processing each pacer pulse, returns the pacer data in numeric fields separated by commas:
Rate (PPM): **XXX.X**
Pulse Width (ms): **XXX.XX**
Energy (uJ): **XXXXXXX**
Amplitude (mA): **+XXX.XX**
Example: **120.4,021.63,0146343,+118.62**
It takes 2 pulses to calculate a rate. For the 1st pulse, the rate will be returned as **000.0**.
Continues sending pacer data for every pacer pulse detected.
Note: For version 2.02 and after, amplitude is always positive. We continue to use the '+' sign for legacy interface code.

Exit: Will quit after receiving **ESC** character, then sends **CrLf** and quits.

PACER SENSITIVITY COMMANDS

PASRWAVE=WAVE,WIDTH,POLARITY

Model: Impulse 7000DP only
Modes **PASENSE**.
WAVE: The wave shape: 3 characters: **FLT** for flat (off), **SQR** for square, **TRI** for triangle, **SIN** for sine.
WIDTH: The width in ms: 3 digits: **001** to **300**.
POLARITY: The polarity: **0** for positive, **1** for negative.
Description: Runs the specified pacer sensitivity test pulse.

PASAMPL=AMPLITUDE

Model: Impulse 7000DP only
Mode: **PASENSE**.
AMPLITUDE: The amplitude in mV: 3 digits with decimal point: **0.05** to **5.00**.
Description: Sets the pacer sensitivity wave amplitude.

PASAUTO

Model: Impulse 7000DP only
Mode: **PASENSE**.
Description: Runs the sensitivity test automatically. This test takes several seconds depending on the rate. The test interacts with pacer pulses to determine the sensitivity threshold amplitude for the sensitivity wave that is running.
Returns: ***(CrLf)**. Then waits for pacer pulses and returns intermediate and final test data for amplitude. Returns data:

R=XXX	Pacing rate measured from the initial 3 pulses, only once.
A~X.XX	Intermediated amplitude, every pacer pulse.
A=X.XX	Final amplitude, only once.

Exit: This test will exit before completion if it receives any alphabetic character. Then it returns *****.

PACER REFRACTORY COMMANDS

PARAUTO

Model: Impulse 7000DP only
Mode: **PAREFRACT**.
Description: Runs the refractory period test automatically. This test takes several seconds depending on the pacing rate. The test interacts with pacer pulses to determine the Pulse Refractory Period (PRP), then the Sense Refractory Period (SRP).
Returns: ***(CrLf)**. Then waits for pacer pulses and returns intermediate and final test data for pacing rate, PRP and SRP. Returns data after every pacer pulse:

R=XXX	Pacing rate, only once, after 2 pulses.
P~XXX	Intermediate PRP, every pacer pulse after rate.
P=XXX	Final PRP, only once.
S~XXX	Intermediate SRP, every pacer pulse after final PRP.
S=XXX	Final SRP, only once.

Exit: This test will exit before completion if it receives any alphabetic character. Then it returns *****.

ECG NOISE COMMANDS

NOISE=FREQUENCY,ECG

Modes: ECGNOISE.
FREQUENCY: The noise frequency in Hz: **50** or **60**.
ECG: Flag to turn ECG NSR60 wave on or off, added to the noise: **T** (on) or **F** (off).
Description: Runs the specified noise wave.

NOISEAMPL=AMPLITUDE

Modes: ECGNOISE.
AMPLITUDE: The noise amplitude in mV: 3 digits with decimal point: **00.0** to **10.0**.
Description: Sets the noise amplitude.

ECG COMMANDS

ATRPACE=WIDTH,AMPLITUDE

Mode: **ECG**.
WIDTH: The width in ms: 2 digits with decimal: **0.1**, **0.2**, **0.5**, **1.0**, or **2.0**.
AMPLITUDE: The amplitude in mV: 3 digits with sign: **±000** to **±700** (for zero, **0000** also valid).
Description: Sets the width and amplitude for the simulated TV atrial pacer pulse.

VENTPACE=WIDTH,AMPLITUDE

Mode: **ECG**.
WIDTH: The width in ms: 2 digits with decimal: **0.1**, **0.2**, **0.5**, **1.0**, or **2.0**.
AMPLITUDE: The amplitude in mV: 3 digits with sign: **±000** to **±700** (for zero, **0000** also valid).
Description: Sets the width and amplitude for the simulated TV ventricular pacer pulse.

NSR=RATE

Mode: **ECG**.
RATE: The normal sinus rate in BPM: 3 digits: **030** to **360**.
Description: Runs the normal sinus wave at the specified rate.

AFIB=GRAN

Mode: **ECG**.
GRAN: The afib granularity: **COARSE** or **FINE**.
Description: Runs the afib wave.

VFIB=GRAN

Mode: **ECG**.
GRAN: The vfib granularity: **COARSE** or **FINE**.
Description: Runs the vfib wave.

VFIB2=GRAN

Mode: **ECG**.
GRAN: The vfib granularity: **COARSE** or **FINE**.
Description: Runs the vfib2 wave. Vfib2 is a faster version of vfib.

MONOVTACH=RATE

Mode: **ECG**.
RATE: The vtach rate in BPM: 3 digits: **120** to **300**.
Description: Runs the vtach wave at the specified rate.

POLYVTACH=CODE

Mode: **ECG**.
CODE: The poly vtach code: 1 digits: **1** to **5**.
Description: Runs the poly vtach wave of the specified code.

SPVWAVE=WAVE

Mode: **ECG.**
WAVE: The supraventricular wave to run:

AFL	Atrial Flutter
SNA	Sinus Arrhythmia
MBT	Missed Beat
ATC	ATach
PAT	Paroxysmal ATach
NOD	Nodal Rhythm
SVT	Supra VTach

Description: Runs the supraventricular ECG wave.

PREWAVE=WAVE

Mode: **ECG**.
WAVE: The premature wave to run:

PAC	Atrial PAC
PNC	Nodal PNC
PVC1	PVC1 Left Vent
PVC1E	PVC1 LV Early
PVC1R	PVC1 LV R on T
PVC2	PVC2 Right Vent
PVC2E	PVC2 RV Early
PVC2R	PVC2 RV R on T
MF	Multifocal PVCs

Description: Runs the premature ECG wave.

VNTWAVE=WAVE

Mode: **ECG**.
WAVE: The ventricular wave to run:

PVC6M	PVCs 6/min
PVC12M	PVCs 12/min
PVC24M	PVCs 24/min
FMF	Freq Multifocal
TRIG	Trigeminy
BIG	Bigeminy
PAIR	Pair PVCs
RUN5	Run 5 PVCs
RUN11	Run 11 PVCs
ASYS	Asystole

Description: Runs the ventricular ECG wave.

CNDWAVE=WAVE

Mode: **ECG**.

WAVE: The conduction wave to run:

1DB	1º Block
2DB1	2º Block Type I
2DB2	2º Block Type II
3DB	3º Block
RBBB	RBBB
LBBB	LBBB

Description: Runs the conduction ECG wave.

TVPWAVE=WAVE

Mode: **ECG**.

WAVE: The TV paced wave to run:

ATR	Atrial 80 BPM
ASY	Async 75 BPM
DFS	Demand Freq Sinus
DOS	Demand Occ Sinus
AVS	AV Sequential
NCP	Non-Capture
NFN	Non-Function

Description: Runs the TV paced ECG wave.

ECG PACED COMMANDS

EPATHRESH=THRESHOLD

Model: Impulse 7000DP only

Mode: **ECGPACED**.

THRESHOLD: Pacer response threshold mA: 3 digits: 000 to 250 (000 turns off threshold check and allows all pacer pulses to trigger).

Description: Sets the threshold of pacer amplitude to trigger pacer response wave for pacer interactive ecg waves.

EPAWAVE=WAVE

Model: Impulse 7000DP only

Mode: **ECGPACED**.

WAVE: The ECG paced wave to run:

ASY	Asynchronous
NCP	Non-Capture
NFN	Non-Function

Description: Runs the wave.

EPADEMAND=RATE

Model: Impulse 7000DP only

Mode: **ECGPACED**.

RATE: The normal sinus rate in BPM for the Demand wave in this mode: 3 digits: 030 to 360.

Description: Runs the Demand wave at the rate.

ECG PERFORMANCE COMMANDS

EPFWAVE=WAVE,FREQUENCY

Modes **ECGPERF**.

WAVE: The wave shape: 3 characters: **FLT** for flat (off), **SQR** for square, **TRI** for triangle, **SIN** for sine.

FREQUENCY: The frequency in Hz: 3 digits with no decimal point **001** to **200**; or 4 digits with decimal point **0.050** to **9.999**.

Description: Runs the specified performance wave.

EPFRWAVE=WAVE,WIDTH,RATE

Modes **ECGPERF**.

WAVE: The wave shape: 3 characters: **FLT** for flat (off), **SQR** for square, **TRI** for triangle, **SIN** for sine.

WIDTH: The width in ms: 3 digits: **001** to **300**.

RATE: The rate in BPM: 3 digits: **030** to **300**.

Description: Runs the specified performance pulse.