DATREND Systems Inc.

vPad-XSC™

Automation Interface for Impulse 4000 Defibrillator Analyzer

User Manual

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DATREND Systems Inc.

To order this manual, use Part Number 6100-024

Revision	Revision History Description	Date
A	Initial Release	2019-Jan-24

Unpacking and Inspection

Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the freight carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

Claims

Our routine method of shipment is via common carrier. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim.

If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact your local sales representative or DSI immediately.

Standard Terms and Conditions

Refunds & Credits

Please note only serialized products (products labelled with a distinct serial number) and accessories are eligible for partial refund and/or credit. Non-serialized parts and accessory items (cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. In order to receive a partial refund/credit, the product must not have been damaged, and must be returned complete (meaning all manuals, cables, accessories, etc.) within 90 days of original purchase and in “as new” and resalable condition. The *Return Procedure* must be followed.

Return Procedure

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from Datrend Customer Service. All items being returned must be sent *prepaid* (freight, duty, brokerage, and taxes) to our factory location.

Restocking Charges

Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15%. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20%. Additional charges for damage and/or missing parts and accessories will be applied to all returns. Products which are not in “as new” and resalable condition, are not eligible for credit return and will be returned to the customer at their expense.

Certification

This instrument was thoroughly tested and inspected and found to meet DSI’s manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Research Council of Canada (NRC) and/or the National Institute of Standards and Technology (NIST). Devices for which there are no NRC/NIST calibration standards are measured against in-house performance standards using accepted test procedures.

Warranty and Product Support

Datrend Systems Inc. ("DSI") warrants this instrument to be free from defects in materials and workmanship under normal use and service for 90 days from the date of original purchase. During the warranty period DSI will, at our option, either repair or replace defects in materials and workmanship at no charge; provided the product is returned (shipping, duty, brokerage and taxes prepaid) to DSI. Any and all transportation charges incurred are the responsibility of the purchaser and are not included within this warranty. This warranty extends only to the original purchaser and does not cover damage from abuse, neglect, accident or misuse or as the result of service or modification by other than DSI. IN NO EVENT SHALL DATREND SYSTEMS INC. BE LIABLE FOR CONSEQUENTIAL DAMAGES.

No warranty shall apply when damage is caused by any of the following:
- Power failure, surges, or spikes,
- Damage in transit or when moving the instrument,
- Improper power supply such as low voltage, incorrect voltage, defective wiring or inadequate fuses,
- Accident, alteration, abuse or misuse of the instrument,
- Fire, water damage, theft, war, riot, hostility, acts of God, such as hurricanes, floods, etc.

Only serialized products (those items bearing a distinct DSI serial number tag) are covered under this warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and non-serialized modules are not covered under this warranty.

This warranty gives you specific legal rights and you may have other rights, which vary from province to province, state to state, or country to country. This warranty is limited to repairing the instrument to DSI's specifications.

When you return an instrument to DSI for service, repair or calibration, we recommend shipment using the original shipping foam and container. If the original packing materials are not available, we recommend the following guide for repackaging:
- Use a double-walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use non-abrasive material around all projecting parts.
- Use at least four inches of tightly packed, industrial-approved, shock-absorbent material all around the instrument.

DSI will not be responsible for lost shipments or instruments received in damaged condition due to improper packaging or handling. All warranty claim shipments must be made on a prepaid basis (freight, duty, brokerage, and taxes). No returns will be accepted without a Return Materials Authorization ("RMA") number. Please contact Datrend (refer to Chapter 5 of this manual) to obtain an RMA number and receive help with shipping/customs documentation.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than Datrend Systems, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Datrend Systems for service and calibration, especially during the original warranty period. In all cases, breaking the tamper-resistant Quality Seal should be avoided at all cost, as this seal is the key to your original instrument warranty. In the event that the seal must be broken to gain internal access to the instrument (e.g., in the case of a customer-installed firmware upgrade), you must first contact Datrend Systems at 1-800-667-6557. You will be required to provide us with the serial number for your instrument as well as a valid reason for breaking the Quality Seal. You should break this seal only after you have received factory authorization. Do not break the Quality Seal before you have contacted us! Following these steps will help ensure that you will retain the original warranty on your instrument without interruption.

WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Datrend Systems will not be responsible for any injuries sustained due to unauthorized equipment modifications.

DSI DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR APPLICATION.

THIS PRODUCT CONTAINS NO USER-SERVICEABLE COMPONENTS. UNAUTHORIZED REMOVAL OF THE INSTRUMENT COVER SHALL VOID THIS AND ALL OTHER EXPRESSED OR IMPLIED WARRANTIES.

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1 Overview

vPad-XSC™ for **Impulse 4000** (referred to as "*the Interface*" in this manual) is an intelligent hardware interface which supports vPad electrical safety analyzers having the vPad-Check™ software application (App) installed. The Interface allows vPad-Check to conduct automated maintenance and inspection sequences on defibrillators using the **Impulse 4000** analyzer.

In addition to automated control of **Impulse 4000** operation, the vPad-XSC provides automatic assessment of measurement results based on user-defined limits

This manual provides guidance for users integrating vPad-Check™ and vPad-XSC™ for **Impulse 4000** into new and existing maintenance processes.

1.1 Standard Accessories

- XSC Interface unit (P/N 7400-109 or 7400-110)
- RJ-12 cable (P/N 3140-069) for connection to XBUS of vPad safety analyzer
- User Manual (P/N 6100-024)

1.2 Optional Accessories

- DB9F to DB25F null modem cable (P/N 3140-442) for connection to **Impulse 4000** (Assman AK124-3-R)

For a complete list of available accessories, visit www.datrend.com or contact Datrend Customer Service (see Chapter 5 for contact details)

1.3 Checklists and vPL

In vPad-Check, equipment maintenance and inspection procedures are called ***Checklists***. A Checklist can contain a sequence of prompts for the operator as well as machine instructions to configure the vPad safety analyzer and to conduct other tests through a remote instrument. In this case, the remote instrument is an **Impulse 4000** defibrillator and transcutaneous pacemaker analyzer.

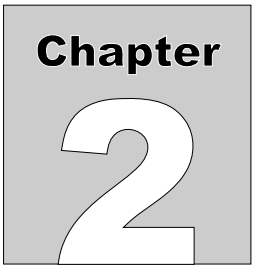
In a Checklist, prompts and machine instructions are written as statements in ***vPad Programming Language*** (vPL). A statement generally consists of a specific keyword followed by one or more parameters. For example, the statement

```
xopen   "Impulse 4000 XSC" | D | 5
```

initializes a data connection between the Interface and **Impulse 4000** using the keyword "**xopen**". Other statements are responsible for configuring and initiating tests through **Impulse 4000** .

Checklists can be written on the Android tablet, or on a personal computer (PC), using a text editor, or using the Datrend vPad-IDE. Once a new Checklist has been written, it can be imported to vPad-Check through a USB flash drive, via Bluetooth or a cloud service (Dropbox, Google Drive or OneDrive). Further information on Checklists and vPL, including a full list of vPL keywords, is provided in the **vPad-Check Operating Manual** which can be opened with the Datrend Docs app: 

.



2 Connection and Setup

Verify DIP switches on the Interface unit are set appropriately for your application: for a wired setup, DIP switch 3 (BTENA) is set to the ***OFF*** position, and the remaining two are set to ***ON***.

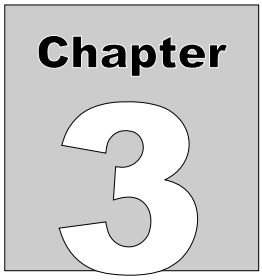
For a wired setup, connect the DB9 serial port of the Interface to the DB9 serial port of **Impulse 4000** using the null modem serial cable (P/N 3140-400) provided with the Interface.

Connect the XBUS port on the Interface to the XBUS port on the vPad safety analyzer using the RJ12 cable (P/N 3140-069) provided with the Interface. Note that the two XBUS ports on the Interface are interchangeable. This enables several vPad-XSC interfaces of different types to be chained in series if necessary.

Once connected to the vPad safety analyzer, the "Power" indicator on the Interface should light up to show that it is now ready for operation.

Power up **Impulse 4000** .

The system is now ready for operation.



3 Checklist Programming

A Checklist contains operator prompts and machine instructions for conducting an automated maintenance and inspection sequence. To create or edit a Checklist (with a *.vpl* extension), you may use any text editor that works with plain text (*.txt*) files, or use the Datrend API program vPad-IDE. Sample Checklists to control **Impulse 4000** through the Interface are provided with the vPad-Check installation.

A Checklist that controls **Impulse 4000** may consist of at least three types of instructions: initialization, configuration, and test.

3.1 Initialization

Before attempting to send commands to **Impulse 4000**, a Checklist must first initialize the connection. For example, the vPL statement

```
xopen"Impulse 4000 XSC" | D | 5
```

causes the Interface to attempt handshaking with **Impulse 4000**. The character **"D"** in uppercase is an identifier which represents the vPad-XSC™ for **Impulse 4000**; the **"D"** is mandatory and enables vPad-Check to address commands to the **Impulse 4000** Interface specifically. The value **"5"** sets a delay time in seconds, after which the data connection is checked before proceeding with subsequent Checklist steps; this value can be reduced to **"2"** if a wired connection is in use. **Impulse 4000 XSC** is simply a description of the device under control by the Interface and this may be modified to a different description, if desired. For a complete explanation of the **"xopen"** statement, refer to the **vPad-Check Operating Manual**.

When vPad-Check encounters this statement, it will interrogate the Interface and notify the operator whether initialization was successful. If handshaking succeeds, the "Online" indicator will light up on the Interface unit. If not, the operator should verify connections and power, then retry the initialization.

3.2 Configuration

As an optional function, the Interface has the ability to automatically assign a pass/fail result for measurement data obtained from **Impulse 4000**. Configuration statements can set limits for automatic pass/fail assessment, as well as to change **Impulse 4000** settings for defibrillator and pacemaker tests. In a Checklist, pass/fail limits and **Impulse 4000** settings are configured with **"xctrl"** statements. For more information on the **"xctrl"** statement, refer to the **vPad-Check Operating Manual**.

3.2.1 Setting Limits and Tolerances

The Interface supports the following **Impulse 4000** test functions:

- defibrillator energy
- defibrillator charge time
- defibrillator sync delay (cardioversion)

- pacer pulse
- pacer refractory period
- pacer noise immunity
- pacer sensitivity

When automatically assigning a pass or fail, each test utilizes one or more pass/fail limits which are stored in the Interface's memory. Limits are initialized to default values when power is applied to the Interface, but may be modified through the **"lim"** command. Modified limit settings do not persist once the Interface is disconnected from the vPad safety analyzer, or the safety analyzer is powered off. Limits are set as required during Checklist runtime.

Limit configuration statements in vPL are of the form

xctrl"< ***info*** >**"** | **lim**< ***id*** >,< ***type*** >,< ***p1*** >,< ***p2*** >

where:

< info >	is a description of the limit setting, which is briefly displayed to the user
< id >	is an ID number (1, 2, 3...) representing the limit to be set,
< type >	is the type of limit, such as a target with % tolerance or a min, max or range,
< p1 >	is the first pass/fail threshold, the effect of which depends on limit type, and
< p2 >	is a second pass/fail threshold which, again, depends on limit type.

Table 1 lists the permitted values for the **"lim"** command. Additionally, any limit type can be set to "**none**", which disables automatic assessment for the affected test types. If the Interface receives a limit configuration command with a disallowed limit type, that particular limit will be disabled.

Note that the units of measurement are assumed when specifying a limit value.

TABLE 1: Allowed Values for Limit Configuration

lim	**<***limit_ID***>,**	**<***limit_type***>,**	**<***param_1***>,**	**<***param_2***>**
TEST LIMIT	ALLOWABLE VALUES in **bold**			
defib energy	**1**	**target**	**0** to **999** %/J	**percent** or **units**
		range	**0** to **999** J	**0** to **999** J
defib charge time	**2**	**max**	**0** to **32000** s	-
defib sync delay	**3**	**min**	**0** to **32000** ms	-
		max	**0** to **32000** ms	-
		range	**0** to **32000** ms	**0** to **32000** ms
pacer pulse current	**4**	**target**	**0** to **999** %/mA	**percent** or **units**
		range	**0** to **999** mA	**0** to **999** mA
pacer pulse rate	**5**	**target**	**0** to **999** %/PPM	**percent** or **units**
pacer pulse width	**6**	**target**	**0** to **999** %/ms	**percent** or **units**
N/A	**7**			
pacer paced refractory period	**8**	**min**	**0** to **32000** ms	-
		max	**0** to **32000** ms	-
		range	**0** to **32000** ms	**0** to **32000** ms
pacer sensed refractory period	**9**	**min**	**0** to **32000** ms	-
		max	**0** to **32000** ms	-
		range	**0** to **32000** ms	**0** to **32000** ms

3.2.1.1 Example 1: Setting a Defibrillator Energy Limit

To illustrate how the "**lim**" command is used, consider following statement:

```
xctrl  "Setting defib energy tol. to 10%" | lim1,target,10,percent
```

For this statement,

1	immediately following the "**lim**" command specifies the limit is for defib energy;
target	specifies the limit type as a target with tolerance, as opposed to a min/max range;
10	is the tolerance value (±10); and
percent	sets the tolerance type as a percentage, as opposed to a number of joules (**units**).

Note that this defib energy limit will be shared for all three defibrillator tests (defibrillator energy, charge time, and sync delay). The "target" value referred to above is not included with the limit, but is specified in the vPL statement that executes the energy measurement itself.

3.2.1.2 Example 2: Setting Defibrillator Charge Time Limit

In this next example, the vPL statement sets the defib charge time limit to a maximum of 12 seconds:

```
xctrl  "Setting charge time limit to max. 12 sec" | lim2,max,12
```

For this statement,

2	immediately following the **"lim"** command specifies the limit is for charge time;
max	specifies limit type as maximum, the only allowable type for charge time,
12	is the maximum value (12 seconds)

In this case, the "**lim**" command does not include a ***<param_2>*** since it is not required.

Limits persist until modified by a ***"xctrl"*** statement. There is no need to set a defib energy limit for a charge time test if it has previously been set for a debrillator energy test.

3.2.1.3 Example 3: Setting Pacemaker Pulse Current Limit

The following vPL statement sets pacer pulse current limit to a target with tolerance in mA:

```
xctrl  "Setting pulse current tol. to +/-3mA" | lim4,target,3,units
```

For this statement,

4	immediately following the "**lim**" command specifies the limit is for pacer current;
target	specifies the limit type as a target with tolerance, as opposed to a min/max range;
3	is the tolerance value (±3); and
units	sets the tolerance type as a number of milliamps as opposed to **% (percent)**.

The "target" value referred to above is not included with the limit, but is specified in the vPL statement that executes the pacer pulse test itself.

3.2.1.4 Example 4: Disabling a Limit

Sometimes automatic assessment may not be desirable, in which case a vPL statement similar to the following can be used to disable a particular limit. For example:

```
xctrl "Disabling pulse width limit" | lim6,none
```

For this statement,

6	immediately following the **"lim"** command specifies the limit is for pacer pulse width;
none	sets the limit to **"none"**, disabling automatic pass/fail. Other parameters of the command are omitted because they are not necessary.

Once a limit has been disabled, a target specified in a **"xtest"** statement will appear in the Test Record, but the corresponding measurement value will not be passed or failed automatically.

3.2.2 Resetting Limits to Defaults

The following vPL statement resets all limit settings to defaults:

```
xctrl  "< info >" | rslm
```

where:

< info > is a descriptive message which is briefly displayed to the user.

Table 2 lists the limit default values, which are assigned at power-on of the Interface, or in response to the **"rslm"** command as above.

TABLE 2: Default Limit Settings

TEST LIMIT	ID	DEFAULT VALUES		
		LIMIT TYPE	PARAMETER 1	PARAMETER 2
defib energy	1	target	± 15 %	percent
defib charge time	2	max	15 s	-
defib sync delay	3	range	20 ms min	65 ms max
pacer pulse current	4	target	± 10 %	percent
pacer pulse rate	5	target	± 2 PPM	units
pacer pulse width	6	none	-	-
N/A	7	none	-	-
pacer paced refractory period	8	none	-	-
pacer sensed refractory period	9	none	-	-

3.2.3 ECG Simulation

Impulse 4000 simulates ECG signals while conducting defibrillator and pacemaker tests. A Checklist may select an ECG waveform through the Interface. This is typically done prior to performing a defib or pacer test. ECG configuration statements are of the form

```
xctrl  "< info >" | ECG,< lead >,< wave >
```

where:

< info > is a description of the waveform, which is briefly displayed to the user
< lead > is the ECG lead configuration,
< wave > is the ECG waveform identifier.

3.2.3.1 Example 1: Configuring ECG Simulation

The following vPL statement configures **Impulse 4000**'s ECG simulator:

```
xctrl  "Setting ECG to NSB120" | ECG, II, NSB120
```

For this statement,

ECG is the **Impulse 4000** remote command for ECG simulation,
II lead configuration, either I or II
NSB120 is the waveform designation

This type of statement would typically precede a statement that tests defibrillator energy or other aspect of defibrillator performance. Note that only certain waveforms should be used with Defibrillator tests **(*)** or Cardioversion tests **(**).**

ECG waveform designations:

ZERO	**zero output, ECG off**		**NSB30**	**Normal sinus rhythm @30BPM**
SQU	**2-Hz square wave**		**NSB60 ****	**Normal sinus rhythm @60BPM**
PUL	**4-second pulse**		**NSB80 ****	**Normal sinus rhythm @80BPM**
SIN0.O5	**0.05-Hz sine wave**		**NSB120 ****	**Normal sinus rhythm @120BPM**
SIN0.5	**0.5-Hz sine wave**		**NSB160**	**Normal sinus rhythm @160BPM**
SIN1	**1-Hz sine wave**		**NSB200**	**Normal sinus rhythm @200BPM**
SIN10	**10-Hz sine wave**		**NSB240**	**Normal sinus rhythm @240BPM**

SIN25	**25-Hz sine wave**		**NSB300**	**Normal sinus rhythm @300BPM**
SIN30	**30-Hz sine wave**		**TRG**	**Trigeminy**
SIN40	**40-Hz sine wave**		**RUN5**	**Run of 5 PVC's**
SIN50	**50-Hz sine wave**		**RUN11**	**Run of 11 PVC's**
SIN60	**60-Hz sine wave**		**VNT**	**Ventricular rhythm 120BPM**
SIN100	**100-Hz sine wave**		**VTC130 ***	**Ventricular tachycardia 130BPM**
SIN125	**125-Hz sine wave**		**VTC175 ***	**Ventricular tachycardia 175BPM**
SIN150	**150-Hz sine wave**		**VTC180 ***	**Ventricular tachycardia 180BPM**
SQ1K	**1-kHz square wave**		**VTC185 ***	**Ventricular tachycardia 185BPM**
TRI	**2-Hz sine wave**		**VTC220 ***	**Ventricular tachycardia 220BPM**
AF1 **	**Atrial fibrillation 1, coarse**		**VFB1 ***	**Ventricular fibrillation 1, coarse**
AF2 **	**Atrial fibrillation 2, fine**		**VFB2 ***	**Ventricular fibrillation 2, coarse**
AFL	**Atrial flutter**		**ASY1**	**Asystole 1, some movement**
SINA	**Sinus arrhythmia**		**ASY2**	**Asystole 2, flat**
1DB	**1st degree AV block**		**ASN**	**Asynchronous, continuous, transvenous paced**
2DB1	**2nd degree AV block, Type 1, Wenckebach**		**DM1**	**Demand 1, mostly paced, transvenous paced**
2DB2	**2nd degree AV block, Type 2**		**DM2**	**Demand 2, mostly paced, transvenous paced**
3DB	**3rd degree AV block**		**AVS**	**Atrioventricular sequential, transvenous paced**
PVC1	**PVC type 1**		**NCA**	**Noncapture, transvenous paced**
PVC2	**PVC type 2**		**NFU**	**Nonfunctional, transvenous paced**
MF	**Multifocal PVC's**		**TQASYS**	**Asystole, transcutaneous paced**
PAIR	**Pair or couplet of PVC's**		**TQBRAD**	**Bradycardia, transcutaneous paced**
BIG	**Bigeminy**		**TQDEM**	**Demand, transcutaneous paced**
			TQNC	**Noncapture, transcutaneous paced**

*** allowable DEFIBWAVE settings** **** allowable CARDIOWAVE settings**

3.3 Defibrillator Tests

Once a Checklist has initialized communication with the Interface, configured **Impulse 4000** test settings and, optionally, prepared limits for automatic pass/fail assessment, vPad is ready to execute a range of defibrillator tests. A typical Checklist will include prompts instructing the operator how to set up the defibrillator and **Impulse 4000** , followed by remote test statements.

While executing a test, the Interface acts as an intermediary that relays commands to **Impulse 4000** and reformats the numerical results into a form suitable for vPad-Check and the Test Record.

vPL statements which trigger a remote test begin with the **"xtest"** keyword, in the form

```
xtest  "< instr >" | < cmd >,< par1 >,< par2 >,...
```

where:

< instr >	is an instruction that is displayed to the user while the test is in progress,
< cmd >	is a command representing the test to be executed by **Impulse 4000**, and
< par1 > **< par2 >**	... are optional parameters associated with automatic pass/fail assessment of the measurement results, separated by commas (“, ”).

The number of parameters specified in the **"xtest"** statement depends on the test to be executed. Automatic pass/fail assessment is disabled if a required parameter has not been specified in the statement. In this case, a "---" will appear in the Test Record report.

For a detailed description of the vPL **"xtest"** statement, refer to **vPad-Check Operating Manual**.

3.3.1 Defibrillator Energy Test

To perform a defibrillator energy test, use a vPL statement of the form

xtest "< instr >" | DE< range >< fmt >,< wave >,<target>

where:

<instr> is an instruction to be displayed to the user while the energy test is in progress,
DE is the command to measure defib energy,
<range> can be "**L**" for low range (up to 50 joules) or "**H**" for high (up to 600 joules),
<fmt> can be "**S**" for short report format or "**L**" for long format, and
<wave> is the optional designation of the waveform to be output , and
<target> is an optional energy target (in joules) for automatic pass/fail assessment

Note the comma ("**,**") separating the required parameters from the waveform designator and the optional target energy.

3.3.1.1 Example 8: Measuring Defibrillator Energy

A Checklist may start a defibrillator energy test with a target of 2 joules through a vPL statement similar to the following:

```
xtest   "Set Energy to 10J, and\nDISCHARGE defib!\n\nVerify energy is 8.5
to 11.5J" | DELL,VFB1,10
```

For this statement,

DEL commands **Impulse 4000** to prepare for a low-range discharge,
L instructs the Interface to prepare a long report, and
VFB1 instructs the Interface to set the ECG wave to **VFB1** , and
10 is the optional target energy (J)

Assuming the defib energy limit is set to its default value, the Interface automatically assigns a "PASS" result if the energy measured is 10 J ±15 %. For the case of a "PASS", the Test Report will contain an entry similar to the following:

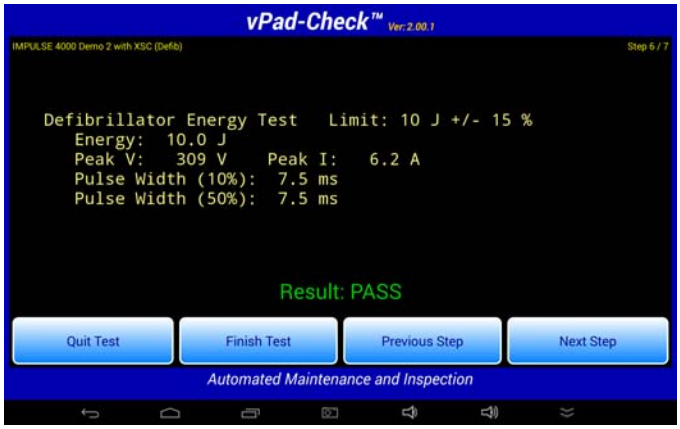
If a parameter is not specified, its position in the statement must be present but left blank. For instance, if no waveform is to be defined, the above statement would be changed to:

```
xtest   "Set Energy to 10J, etc." | DELL,,10
```

For the test shown above the long format has been specified (**DELL**) and would appear in the Test Record as:

```
Task:   Set energy to 10J, etc.
Data:   Defibrillator Energy Test   Limit: 10 J +/-  15 %
        Energy:    10.0 J
        Peak V:    309 V     Peak I: 6.2 A
        Pulse Width (10%):   7.5 ms
        Pulse Width (50%):   7.5 ms
Result: PASS
```

The results would display on the tablet as:



If less information is needed, the short form report can be used by using **DELS** instead of **DELL**.

```
Task:   Set energy to 10J and DISCHARGE defib!
        Verify energy is 8.5 to 11.5J
Data:   Defibrillator Energy Test:  Limit:10 J +/-  15 %
        Energy:   10.9 J
Result: PASS
```

3.3.2 Defibrillator Charge Time Test

To perform a defibrillator charge time test, use a vPL statement of the form

xtest "< *instr* >" | DCH< *fmt* >,< *targ* >,<wave>

where:

< instr > is an instruction to be displayed to the user while the charge time test is in progress,
DCH is the command to measure defib charge time,
< fmt > can be either "**S**" or "**L**", as there is only one test result format,
< wave > is ECG waveform designator, selected from the ECG table with ****** indicators, and
< targ > is an optional energy target (in joules) for automatic pass/fail assessment

Note the comma ("**,**") separating the required parameters from the optional target energy.

3.3.2.1 Example 9: Measuring Defibrillator Charge Time

A Checklist may start a defibrillator charge time test with a standard target energy equal to the maximum energy that the defibrillator can supply using a vPL statement similar to the following:

```
xtest  "Charge when Impulse 4000 shows MAXESTART, then discharge.\n\n
        Verify charge time is less than 10 seconds" | DCHS,AFB1,360
```

For this statement,

DCH commands **Impulse 4000** to initiate a charge time test;
S is a placeholder which may be either "S" or "L" (does not affect report)

Assuming that defib energy and charge time limits are set to defaults, the Interface automatically assigns a "PASS" result if the charge time is less than 10 s. For the case of a "PASS", the Test Report will contain an entry similar to the following:

If a parameter is not specified, its position in the statement must be present but left blank. For instance, if no waveform is to be defined, the above statement would be changed to:

```
xtest   "Charge when Impulse 4000 shows MAXESTART, etc." | DEHS,,360
```

This will result in a typical test report result:

```
Task:      Charge when Impulse 4000 shows MAXESTART, etc.
Data:      Defibrillator Charge Time
Test:      Energy Limit: 360 J +/-  15 %
           Energy:   363.9 J
           Maximum Charge Time:   10 s
                Result:   21.0 s
Result:    FAIL
```

3.3.3 Defibrillator Sync Delay (Cardioversion) Test

To perform a defibrillator sync delay test, use a vPL statement of the form

`xtest "< instr >" | DS< range >,< wave >,< targ >`

where:

< instr > is an instruction to be displayed to the user while the sync test is in progress,
DS is the command to measure defib sync delay,
< range > can be "**L**" for low range (up to 50 joules) or "**H**" for high (up to 600 joules),
< wave > is ECG waveform designator, selected from the ECG table with ***** indicators, and

< targ > is an optional energy target (in joules) for automatic pass/fail assessment.

Note the comma ("**,**") separating the required parameters from the optional target energy.

3.3.3.1 Example 10: Measuring Defibrillator Sync Delay

A Checklist may start a defibrillator sync delay test with a target of 20 joules through a vPL statement similar to the following:

```
xtest "Set defib to sync mode and discharge now!" | DSH,AF2,20
| 5
```

For this statement,

DSH commands ***Phase 3*** to prepare for a high-range, sync'ed discharge;
AF2 is the waveform designator from the ECG table; and
20 is the optional energy target (J).

Assuming that defib energy and sync delay limits are set to defaults, the Interface automatically assigns a “PASS” result if the energy measured is 20 J ±15 % and sync delay is between 20 ms and 65 ms. For the case of a "PASS", the Test Report will contain an entry similar to the following:

```
Task:      Set defib to sync mode and discharge now!
Data:      Defibrillator Sync Delay Test
Test:      Energy Limit: 20 J +/-  15 %
           Energy:   20.2 J
           Delay Limit: Min 20 ms  Max 64 ms
                Result:   32.2 ms
Result:    PASS
```

3.4 Pacemaker Tests

Once a Checklist has initialized communication with the Interface, configured test settings and, optionally, prepared limits for automatic pass/fail assessment, vPad is ready to execute a range of pacemaker tests. A typical Checklist will include prompts instructing the operator how to set up the pacer and **Impulse 4000**, followed by remote test statements.

3.4.1 Pacemaker Pulse Test

To perform a pacer pulse test, use a vPL statement of the form

xtest "< *instr* >" | PPPN,< *targ*1 >,<*targ2*>

where:

< *instr* > is an instruction to be displayed to the user while the pacer pulse test is in progress,
PPPN is the command for measuring pacer pulses,
< *targ1* > is the optional target for automatic pass/fail assessment, for pulse current (in ma)
< *targ2* > is the optional target for automatic pass/fail assessment, for pulse rate (in PPM [pulse per minute])

Note the comma ("**,**") separating the required parameters from the optional target values. In order to enable automatic assessment, the statement must specify both the pulse current and the pulse rate target. Pulse width and pulse energy measurements are assessed if targets are included, and ignored if they are not.

3.4.1.1 Example 11: Measuring Pacemaker Pulse

A Checklist may start a pacemaker pulse test through a vPL statement similar to the following:

```
xtest"Wait! Then verify pacer pulse test result" | PPPN,30,70
```

For this statement,

PPPN commands ***Phase 3*** to begin analyzing pacer pulses,
30 is the optional target pulse current (mA), and
70 is the optional target pulse rate (PPM).

Assuming that pacer pulse current and rate limits are set to defaults, the Interface automatically assigns a "PASS" result if the measured current is 30 mA ±10 % and pulse rate is 70 PPM ±2 PPM. For the case of a "PASS", the Test Report will contain an entry similar to the following:

```
Task:   Wait! Then verify pacer pulse test result
Data:   Pacemaker Pulse Test:
                    Acceptable Limits       Results
           Current:    30 mA  +/-  10 %      29.8 mA
              Rate:    70 PPM +/-   2 PPM    70.1 PPM
             Width:   --- ms  +/-   ---      18.27 ms
Result: PASS
```

A placeholder "- - -" appears in the test data whenever a target is not specified or a limit is not enabled.

3.4.2 Pacemaker Refractory Period Test

To perform a pacemaker refractory test, use a vPL statement of the form

```
xtest"< instr >" | PRF< fmt >
```

where:

< instr > is an instruction to be displayed to the user while the refractory test is in progress,
PRF is the command to measure pacer refractory period, and
< fmt > can be either "**S**" or "**L**", as there is only one test result format.

Impulse 4000 measures two pulse characteristics for this test: the paced refractory period (PRP) and the sensed refractory period (SRP). Since the only limit types allowed for both measurements are "`min`", "`max`", and "`range`", no target is needed in the "`xtest`" statement. Results are automatically passed or failed after pacer PRP and SRP limits have been enabled.

3.4.2.1 Example 12: Measuring Pacemaker Refractory Period

A Checklist may start a pacemaker refractory test with automatic pass/fail through vPL statements similar to the following:

```
xctrl   "Setting PRP limit: 200 to 500ms" | lim8,range,200,500
```

```
xctrl   "Setting SRP limit: max 300ms" | lim9,max,300

xtest   "Wait! Then verify refractory test result" | PRFS
```

For the above "`xtest`" statement,

PRF commands ***Phase 3*** to immediately begin testing the pacer refractory period, and
S is a placeholder, which may also be "`L`"

Since the PRP limit and SRP limit are enabled prior to running the test, the Interface automatically assigns a "PASS" result if the PRP is between 200 ms and 500 ms, and SRP is less than 300 ms. For the case of a "PASS", the Test Report will contain an entry similar to the following:

```
Task:   Wait! Then verify pacer refractory test result
Data:   Pacer Refractory Test:
           Pacer Rate: 141 PPM
                                    Min     Max   Result
           Paced Refr.  (ms):       200     500     202
           Sensed Refr. (ms):       ---     500     155
Result: PASS
```

A placeholder "- - -" appears in the test data whenever a limit is not applicable, for example, a minimum SRP when the limit is set to "max", or when the limit has not been enabled.

3.5 Direct Commands

The interface box provides the flexibility to the VPL programmer to use the 'normal' **Impulse 4000** remote control commands directly by putting a special token **'#'** in front of a **Impulse** command, for example, **#LOC**.

Example:

```
xctrl  "Go to LOCAL mode" | #LOC
```

There is, however, some limitations to the use of the direct commands. Basically, only control commands without any return data can be used this way. The interface box waits for a '*' confirmation from the **Impulse** after sending the commands, then sends an acknowledgement to the vPad-check Procedure, and finishes the command execution.

For a detailed description of the vPL Procedure language, refer to **vPad-Check Operating Manual**.

4 Appendix A - VPL Procedures

The following are examples of VPL Procedures using the **454 XSC** interface

Example 1:

```
// Demo checklist using a Impulse 4000 with XSC interface for defib
// energy and other measurements. Energies tested are 5, 10, 50, 100,
// 200 and maximum energy (charge time test).
// Cardioversion/sync is also tested.
// Note, the // indicates that this line is commented out and will not be processed
// as part of the test

// Display Checklist title
prompt  "Demo of Impulse 4000 Defib\nRemote Control via XSC" | bold

// Setup instructions
//prompt  "Impulse 4000 setup"

// Initialize connection with XSC
xopen   "Impulse 4000 XSC" | D | 5


// Disable automatic assessment for defib energy
// Pass/fail is by manual entry, based on displayed acceptance ranges
// (15% tolerance)
//xctrl   "Disabling automatic PASS/FAIL..." | lim1,none,
//
//
//// Enable automatic assessment for defib energy (15% tolerance)
xctrl   "Setting Energy tolerance to 15% of target..." | lim1,target,15,percent | 5
//
//// Repeat for 10J energy
prompt  "DEFIB ENERGY TEST\n\n"\+
        "1. Set defib energy to 10 JOULES.\n\n"\+
        "2. Charge up the defib.\n\n"\+
        "3. Wait two seconds.\n\n"\+
        "4. Press 'Next Step' button after defib has charged." | medium
xtest   "DISCHARGE defib!\n\nVerify energy is 8.5 to 11.5J" | DELL,VFB1,10

//// Repeat for 50J energy (high range test)
//prompt  "DEFIB ENERGY TEST\n\n"\+
//        "1. Set defib energy to 50 JOULES.\n\n"\+
//        "2. Charge up the defib.\n\n"\+
//        "3. Wait two seconds.\n\n"\+
```

```
//        "4. Press 'Next Step' button after defib has charged." | medium
//xtest   "DISCHARGE defib!\n\nVerify energy is 43 to 58J" | DEHL,VFB1,50 | 5
//
//// Repeat for 100J energy (high range test)
//prompt  "DEFIB ENERGY TEST\n\n"\+
//        "1. Set defib energy to 100 JOULES.\n\n"\+
//        "2. Charge up the defib.\n\n"\+
//        "3. Wait two seconds.\n\n"\+
//        "4. Press 'Next Step' button after defib has charged." | medium
//xtest   "DISCHARGE defib!\n\nVerify energy is 85 to 115J" | DEHL,VFB1,100 | 2
//
//// Repeat for 200J energy (high range test)
//prompt  "DEFIB ENERGY TEST\n\n"\+
//        "1. Set defib energy to 200 JOULES.\n\n"\+
//        "2. Charge up the defib.\n\n"\+
//        "3. Wait two seconds.\n\n"\+
//        "4. Press 'Next Step' button after defib has charged." | medium
//xtest   "DISCHARGE defib!\n\nVerify energy is 170 to 230J" | DEHL,VFB1,200 | 2
//
//// Change automatic charge time limit to 10 seconds
//// Pass/fail is by manual entry because energy setting is not specified
xctrl   "Setting Charge Time limit to 10 sec maximum..." | lim2,max,10 | 5
//
// Charge time test at max energy (high range test)
prompt  "CHARGE TIME TEST\n\n"\+
        "1. Set defib energy to operate from battery.\n\n"\+
        "2. Set defib energy to MAXIMUM.\n\n"\+
        "3. DO NOT CHARGE until Impulse 4000 shows 'MAXESTART'.\n\n"\+
        "4. Discharge IMMEDIATELY AFTER defib reaches set energy.\n\n"\+
        "5. Press 'Next Step' button when ready to proceed..." | medium
xtest   "Charge when Impulse 4000 shows MAXESTART, then discharge.\n\n"\+
        "Verify charge time is less than 10 seconds" | DCHS,VFB1,300

// Set Phase 3 ECG simulator to Coarse AFIB
//xctrl   "Setting ECG to Coarse AFIB..." | ECGDA10 | -2
//
// Enable automatic assessment for sync delay (20 - 64 milliseconds)
xctrl   "Setting sync delay range to 20 - 64 msec..." | lim3,range,20,64 | 2

// Cardioversion test (high range test; sync to Q-wave)
prompt  "CARDIOVERSION TEST\n\n"\+
        "1. Set defib energy to 20 JOULES.\n\n"\+
        "2. Enable defib SYNC mode.\n\n"\+
        "3. Charge up the defib.\n\n"\+
        "4. Wait two seconds.\n\n"\+
        "5. Press 'Next Step' button after defib has charged." | medium
xtest   "DISCHARGE defib!\n\nVerify delay is 20 to 64 msec" | DSL,AF2,20 | 5

xctrl   "Go to LOCAL mode" | #LOC

prompt  "End of Impulse 4000 demo"
//power   off

// End of script
```

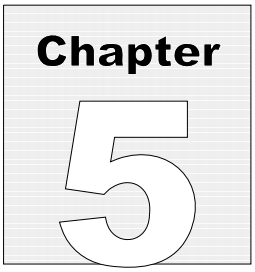
Example 2:

```
// Demo checklist using a Impulse 4000 XSC interface for
// transcutaneous pacer pulse and other measurements.
//

// Display Checklist title
color   #F8F880
prompt  "Demo of Impulse 4000 Pacer Test\nRemote Control via XSC" | bold

// Setup instructions
// prompt  "Setup Impulse 4000"

// Initialize connection with XSC and Phase 3
xopen   "Setting up Impulse 4000 XSC" | D | 5

// Prepare limits for automatic assessment
xctrl   "Setting ECG to NSB120" | ECG,II,NSB120 |

xctrl   "Setting ECG to NSB240" | ECG,II,NSB240 |

xctrl   "Setting ECG to NSB60" | ECG,II,NSB60 |

// xctrl   "Setting ECG to Garbage" | ECG,I,Garbage | 2
// above produces an error


prompt  "End of Impulse 4000 pacer demo"

xctrl   "Go to LOCAL mode" | #LOC

// End of script
```

Example 3:

```
// Demo checklist using a Impulse 4000 XSC interface for
// transcutaneous pacer pulse and other measurements.
//

// Display Checklist title

prompt  "Demo of Impulse 4000 Pacer Test\nRemote Control via XSC" | bold

// Setup instructions
prompt  "Setup Impulse 4000, press 'Next Step'"

// Initialize connection with XSC and Impulse
xopen   "Impulse 4000 XSC" | D | 5

// Prepare limits for automatic assessment
xctrl   "Setting output tolerance to 10% of target..." | lim4,target,10,percent | 2
xctrl    "Setting rate tolerance to within 2 PPM..." | "lim5,target,2,units" | 2
xctrl    "Setting width tolerance to within 3 ms..." | "lim6,target,3,units" | 2
```

```
// Prompt user to prepare pacer for the test
prompt  "PACER PULSE TEST\n\n"\+
        "1. Set pacer unit to READY.\n\n"\+
        "2. Set rate to 70 PPM, output to 30 mA.\n\n"\+
        "3. Set mode to FIXED.\n\n"\+
        "4. Start pacing, then press 'Next Step'." | medium

// Get IP4k to perform pacer pulse test
xtest  "WAIT!\n\nVerify current is 27 to 33 mA\n"\+
        "at 68 to 70 PPM" | PPPN,30,70,20

// Repeat for 120 mA, 140 PPM output
// First 2 results are discarded
//prompt  "PACER PULSE TEST\n\n"\+
//        "1. Set rate to 140 PPM, output to 120 mA.\n\n"\+
//        "2. Start pacing, then press 'Next Step'." | medium
//        xtest     "WAIT!\n\nVerify current is 108 to 132 mA\n"\+
//        "at 138 to 142 PPM" | PPP2,120,140 | 2
//
// Enable automatic assessment for refractory test
xctrl   "Setting paced refractory limit to 200 - 500 ms..." | lim8,range,200,500 | 2
xctrl   "Setting sensed refractory limit to 500 ms maximum..." | lim9,max,500 | 2
//
// Prompt user to prepare pacer for refractory test
prompt  "PACER REFRACTORY TEST\n\n"\+
        "1. Connect pacer ECG leads to Impulse 4000.\n\n"\+
        "2. Set rate to 140 PPM, output to 30 mA.\n\n"\+
        "3. Set mode to DEMAND.\n\n"\+
        "4. Start pacing, then press 'Next Step'." | medium
xtest  "WAIT!\n\nVerify results are within displayed limits" | PRFS

xctrl   "Go to LOCAL mode" | #LOC

prompt  "End of Impulse 4000 pacer demo"

// End of script
```



5 Calibration and Maintenance

Calibration of vPad-XSC for **Impulse 4000** is not required.

For service assistance, contact Datrend for a Return Materials Authorization (RMA) number and the location of the nearest Service Facility.

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