DATREND
Systems Inc.

vPad-XSC™

Automation Interface
for Phase 3 Defibrillator Analyzer

User Manual

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Systems Inc.

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● Use at least four inches of tightly packed, industrial-approved, shock-absorbent material all around the instrument.

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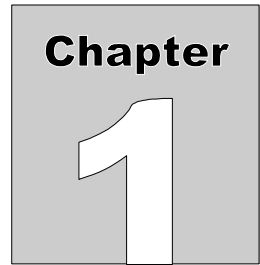
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vPad-XSC for Phase 3 USER MANUAL

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1   Overview

vPad-XSC™ for *Phase 3* (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 and transcutaneous pacemakers using the *Phase 3* analyzer.

In addition to automated control of *Phase 3* operation, the vPad-XSC provides:

- automatic assessment of measurement results based on user-defined limits

- test reports in summary or detailed format

- flexibility of workspace with the optional wireless Bluetooth module

This manual provides guidance for users integrating vPad-Check™ and vPad-XSC™ for *Phase 3* 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
- DB9 null modem cable (P/N 3140-400) for connection to *Phase 3*
- User Manual (P/N 6100-089)

1.2 Optional Accessories

- Bluetooth wireless module (P/N 7050-028)

For a complete list of available accessories, visit www.datrend.com or contact Datrend Customer Service (see Chapter 4 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 a *Phase 3* 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    "Phase 3" | P | 5
```

initializes a data connection between the Interface and *Phase 3* using the keyword "**xopen**". Other statements are responsible for configuring and initiating tests through *Phase 3*.

Checklists can be written on the Android tablet, or on a personal computer (PC), using a text editor. Once a new Checklist has been written, it can be imported to vPad-Check through a USB flash drive or directly from the PC. 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: .

Chapter

2
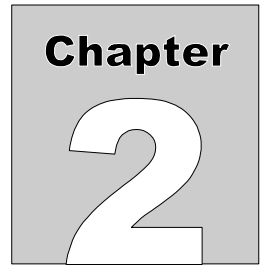
2 Connection and Setup

Verify DIP switches on the Interface unit are set appropriately for your application: for a wired setup, all three DIP switches are set to the **OFF** position; for a wireless setup all DIP switches are **ON**.

For a wired setup, connect the DB9 serial port of the Interface to the DB9 serial port of *Phase 3* using the null modem serial cable (P/N 3140-400) provided with the Interface. For a wireless setup, connect the Bluetooth module (P/N 7050-028) to the DB9 serial port of *Phase 3*.

Power up *Phase 3* and select REMOTE mode from the main menu. For a wireless system, *Phase 3* will apply power to the Bluetooth module and the module will then be initialized.

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.

vPad-XSC for Phase 3 USER MANUAL

Chapter

3

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. A sample Checklists to control *Phase 3* through the Interface are provided with the vPad-Check installation.

A Checklist that controls *Phase 3* may consist of at least three types of instructions: initialization, configuration, and test.

3.1   Initialization

Before attempting to send commands to *Phase 3*, a Checklist must first initialize the connection. For example, the vPL statement

```
xopen      "Phase 3" | P | 5
```

causes the Interface to attempt handshaking with *Phase 3*. The character "P" in uppercase is an identifier which represents the vPad-XSC™ for *Phase 3*; the "P" is mandatory and enables vPad-Check to address commands to the *Phase 3* 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. "Phase 3" 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 *Phase 3*. Configuration statements can set limits for automatic pass/fail assessment, as well as to change *Phase 3* settings for defibrillator and pacemaker tests. In a Checklist, pass/fail limits and *Phase 3* 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 *Phase 3* 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 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 <u>disabled</u>.

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**
pacer pulse energy	7	**target**	0 to **999** %	**percent** only
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
pacer noise immunity	10	**min**	0 to **32000** µV	–
		max	0 to **32000** µV	–
		range	0 to **32000** µV	0 to **32000** µV

lim	<limit_ID>,	<limit_type>,	<param_1>,	<param_2>
TEST LIMIT	ALLOWABLE VALUES in **bold**			
pacer sensitivity	**11**	**min**	**0** to **32000** µV	–
		max	**0** to **32000** µV	–
		range	**0** to **32000** µV	**0** to **32000** µV

3.2.1.1 Example 1: Setting a Defibrillator Energy Limit

To illustrate how the "lim" command is used, the 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 % (`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: Setting Pacemaker Sensitivity Limit

Before executing a pacer sensitivity test, a Checklist can set pass/fail limits through following vPL statement:

```
xctrl  "Setting sensitivity limit: 25 to 45uV" | lim11,range,25,45
```

For this statement,

11	immediately following the "`lim`" command specifies the limit is for pacer sensitivity;
`range`	sets limit type as a min/max range as opposed to a minimum or maximum only;
25	is the minimum value (25 microvolts), and
45	is the maximum value (45 microvolts).

No target is needed for range limits. Measurement results are automatically assessed as long as limit is not set to "none".

3.2.1.5 Example 5: 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.

<div align="center">

TABLE 2: Default Limit Settings

</div>

TEST LIMIT	ID	DEFAULT VALUES		
		LIMIT TYPE	**PARAMETER 1**	**PARAMETER 2**
defib energy	1	`target`	$\pm\,15\,\%$	`percent`
defib charge time	2	`max`	**15** s	-
defib sync delay	3	`range`	**20** ms min	**65** ms max
pacer pulse current	4	`target`	$\pm\,10\,\%$	`percent`
pacer pulse rate	5	`target`	$\pm\,2$ PPM	`units`
pacer pulse width	6	`none`	-	-
pacer pulse energy	7	`none`	-	-
pacer paced refractory period	8	`none`	-	-
pacer sensed refractory period	9	`none`	-	-
pacer noise immunity	10	`min`	**6000** μV	-
pacer sensitivity	11	`max`	**2000** μV	-

3.2.3 ECG Simulation

Phase 3 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< code >< scale >< mode >
```

where:

< *info* > is a description of the waveform, which is briefly displayed to the user
< *code* > is the ECG waveform identifier,
< *scale* > is the simulation amplitude scale, and
< *mode* > is the mode of reaction to a defibrillator discharge.

For a full list of wave codes, scales, and modes, refer to **Chapter 5 - Remote Control**, "ECG Configuration Command" in the **Phase 3 Operating Manual**, supplied with the *Phase 3* defibrillator and pacemaker analyzer.

3.2.3.1 Example 6: Configuring ECG Simulation

The following vPL statement configures *Phase 3*'s ECG simulator:

```
xctrl  "Setting ECG to Fine VFIB" | ECGDK21
```

For this statement,

ECG	is the *Phase 3* remote command for ECG simulation,
DK	is the wave code for Fine Ventricular Fibrillation,
2	sets simulation amplitude to x2 scale, and
1	indicates that the simulator should return to normal sinus rhythm after a defibrillator discharge.

This type of statement would typically precede a statement that tests defibrillator energy or other aspect of defibrillator performance.

A carriage return character (<CR> or "\r") as specified in the **Phase 3 Operating Manual** is not necessary in a vPL statement as the Interface handles such formatting automatically.

3.2.4 Pacemaker Test Load

Most pacemaker manufacturers specify the load resistance at which their device should be tested. *Phase 3* has a variable load bank for a wide range of pacemaker test requirements. vPL statements that configure pacer loads are of the form

```
xctrl  "< info >" | PLD< code >
```

where:

    < *info* > is a description of the selected load, which is briefly displayed to the user; and
    < *code* > is the unique identifier for a particular pacer load.

For a full list of pacer load codes, refer to **Chapter 5 - Remote Control**, "Pacer Load Select Command" in **Phase 3 Operating Manual**.

3.2.4.1 Example 7: Configuring Pacemaker Test Load

The following vPL statement configures *Phase 3*'s pacer test load:

```
xctrl  "Setting pacer load to 600 ohms" | PLDL
```

For this statement,

PLD   is the *Phase 3* remote command for pacer load select, and
L   is the pacer load code for 600 ohms.

This type of statement would typically precede statements that test pacemaker performance.

The carriage return (<CR> and "\r") specified in **Phase 3 Operating Manual** is not necessary in a vPL statement as the Interface handles such formatting automatically.

3.3   Defibrillator Tests

Once a Checklist has initialized communication with the Interface, configured *Phase 3* 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 *Phase 3*, followed by remote test statements.

While executing a test, the Interface acts as an intermediary that relays commands to *Phase 3* 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 >,< targ1 >,< targ2 >,...
```

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 *Phase 3*, and
< *targ1* >
< *targ2* > ... are optional targets associated with automatic pass/fail assessment of the measurement results, separated by commas (", ").

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

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 >,< targ >

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

Note the comma ("**,**") separating the required parameters from 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 2J and discharge defib now!" | DELS,2

For this statement,

    DEL   commands *Phase 3* to prepare for a low-range discharge,
    S   instructs the Interface to prepare a short report, and
    2   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 2 J ±15 %. For the case of a "PASS", the Test Report will contain an entry similar to the following:

```
_____

  Task:    Set energy to 2J and discharge defib now!
  Data:    Defibrillator Energy Test:
               Energy Limits:      2 J +/-  15 %
               Energy:   1.9 J
  Result: PASS
_____
```

Short reports contain only the essential measurements from the analyzed discharge. If more details are needed, a statement specifying the long format report can be used, for example:

```
xtest  "Set energy to 2J and discharge defib now!" | DELL,2
```

For the same measurement data as shown above for the short format, the long format would appear in the Test Record as:

```
_____

 Task:    Set energy to 2J and discharge defib now!
 Data:    Defibrillator Energy Test:
          Energy Limits:     2 J +/-    15 %
          Total Energy:     1.9 J   Wave:  BIPHASIC
          Phase Delay:    0.44 ms  Tilt:   75.3 %
                          PHASE-1   PHASE-2
          Phase Energy (J):   1.5       0.4
          Peak Voltage (V):   190        93
          Peak Current (A):  3.80      1.86
          Avg. Voltage (V):   136        66
          Avg. Current (A):  2.72      1.32
          Pulse Width (ms):  4.13      4.13
 Result: PASS
_____
```

The above example result is for a biphasic defibrillator waveform. Pulsed biphasic waveform reports are similar, though they include phase frequency (Hz) and duty cycle (%) measurements instead of phase delay and tilt.

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* >

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, and
< *targ* > is an <u>optional</u> 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 target of 100 joules through a vPL statement similar to the following:

```
xtest  "Charge when Phase3 'beeps', then discharge" | DCHS,100
```

For this statement,

DCH commands *Phase 3* to initiate a charge time test;
S is a placeholder which may be either "S" or "L"; and
100 is the optional target energy (J).

Assuming that defib energy and charge time limits are set to defaults, the Interface automatically assigns a "PASS" result if the energy measured is 100 J ±15 % and charge time is less than 15 s. For the case of a "PASS", the Test Report will contain an entry similar to the following:

```
_____

  Task:    Charge when Phase 3 'beeps', then discharge.
  Data:    Defibrillator Charge Time Test:
            Energy Limits:    100 J +/-  15 %
            Energy:  99.0 J
            Maximum Charge Time:    15 s
                        Result:   8.7 s
  Result: PASS
_____
```

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 >< ref >< fmt >,< 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),
< *ref* >   can be "**Q**" for Q-wave sync reference or "**R**" for R-wave,
< *fmt* >   can be either "**S**" or "**L**", as there is only one test result format, and
< *targ* >   is an <u>optional</u> 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 70 joules through a vPL statement similar to the following:

```
xtest  "Set defib to sync mode and discharge now!" | DSHQS,70
```

For this statement,

DSH   commands *Phase 3* to prepare for a high-range, sync'ed discharge;
Q   means delay is timed from the Q-wave;
S   is a placeholder which may be either "S" or "L"; and
70   is the optional target energy (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 70 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:
           Energy Limits:     70 J +/-  15 %
           Energy: 70.2 J
           Delay Limit: Min    20 ms  Max    65 ms
                Result:   +46 ms
  Result: PASS
```
_____

3.4 Pacemaker Tests

Once a Checklist has initialized communication with the Interface, configured *Phase 3* 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 *Phase 3*, 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 >" | PP< meth >< delay >,< targ >,...
```

where:

> < *instr* > is an instruction to be displayed to the user while the pacer pulse test is in progress,
> PP   is the command for measuring pacer pulses,
> < *meth* >   is the method for measuring the pulse current, which can be "**A**" for average current,
> "**L**" for leading edge, "**T**" for trailing edge, or "**P**" for peak value,
> < *delay* > is the number of measurements to discard before capturing a final result, which can be
> "**N**" for none or a number from **0 to 99**, and
> < *targ* >, ... is a series of <u>optional</u> targets for automatic pass/fail assessment, listed in the
> following order:
>> pulse current   (in milliamps)
>> pulse rate   (in pulse per minute)
>> pulse width   (in milliseconds)
>> pulse energy   (in microjoules (default), or explicitly specified with a "mJ"
>>   or "uJ" suffix)

The method of measuring the pulse current < *meth* > depends on the waveform of the pacer pulse being measured, while the < *delay* > parameter allows users to specify a number of pulse measurements to skip before a final measurement is recorded, thereby giving the pacer time to stabilize its output before a pass/fail test is applied.

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.

Pulse energy targets are assumed to be in microjoules by default, though users may choose to specify the unit of measure as either "uJ" or "mJ". Therefore, "1000", "1000uJ" and "1mJ" are equivalent energy target values.

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" | PPLN,30,70
```

For this statement,

PP	commands *Phase 3* to begin analyzing pacer pulses,
L	specifies the leading edge as the method of measuring peak current,
N	means the Interface will report on the first pacer pulse detected,
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 20 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
            Energy:    ---      +/-   ---      3906 uJ
 Result: PASS
_____
```

A placeholder "- - -" appears in the test data whenever a target is not specified or a limit is not enabled. If the "xtest" statement is modified to

```
xtest  "Wait! Then verify pacer pulse test result" | PPLN,30,70,18,4000
```

the same measurement data would then appear in the Test Report as:

```
_____

 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:    18 ms  +/-   ---       18.27 ms
            Energy:  4000 uJ  +/-   ---        3906 uJ
 Result: PASS
_____
```

If pulse width limit and pulse energy limit had been enabled with these vPL statements:

```
xctrl    "Setting pulse width tol to +/-2ms" | lim6,target,2,units
xctrl    "Setting pulse energy tol to +/-10%" | lim7,target,10,percent
```

before executing the pacer pulse test, then the same measurement data would appear in the Test Report as:

_____

```
 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:    18 ms  +/-   2 ms      18.27 ms
             Energy:  4000 uJ  +/-  10 %        3906 uJ
 Result: PASS
```
_____

In the above example where all targets are specified and all limits are enabled, then each one of the four measured values must be within limits for a "PASS" result.

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.

Phase 3 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:  70.1 PPM
                                Min      Max     Result
         Paced Refr.  (ms):     200      500       340
         Sensed Refr. (ms):     ---      300       126
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.

3.4.3 Pacemaker Noise Immunity Test

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

xtest   **"<** *instr* **>" | PN<** *freq* **><** *fmt* **>**

where:

    < *instr* **>** is an instruction to be displayed to the user while the immunity test is in progress,
    PN   is the command to measure noise immunity,
    < *freq* **>** is the noise frequency, which can be "**A**" for 60 Hz or "**B**" for 50 Hz, and
    < *fmt* **>**   can be either "**S**" or "**L**", as there is only one test result format.

Since the only limit types allowed for pacer noise immunity limit are "min", "max", and "range", no target is needed in the "xtest" statement. Results are automatically assessed as long as the limit is enabled.

3.4.3.1 Example 13: Measuring Pacemaker Noise Immunity

A Checklist may start a pacer noise immunity test through a vPL statement similar to the following:

xtest   **"Wait! Then verify noise test result" | PNAS**

For this statement,

    PN   commands *Phase 3* to immediately begin simulating ECG noise,
    A   sets the test noise to 60 Hz, and
    S   is a placeholder, which may also be "L"

Assuming that the pacer noise immunity limit has been set to default, the Interface automatically assigns a "PASS" result if measured noise immunity is greater than 6000 µV. In the case of a "PASS", the Test Report would contain an entry similar to the following:

```
_____

 Task:   Wait! Then verify noise test result
 Data:   Pacer Noise Immunity Test:
           Noise Freq.:    60 Hz
           Immunity:  Min  6000 uV  Max    --- uV
             Result:    9000 uV
 Result: PASS
_____
```

A placeholder "- - -" appears in the test data whenever a limit is not applicable, such as the maximum noise immunity when the limit is set to "min", or the limit is not enabled.

3.4.4 Pacemaker Sensitivity Test

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

xtest   "< *instr* **>" | PSN<** *fmt* **>**

where:

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

Since the only limit types allowed for pacer sensitivity limit are "**min**", "**max**", and "**range**", no target is needed in the "**xtest**" statement. Results are automatically assessed as long as the limit is enabled.

3.4.4.1 Example 14: Measuring Pacemaker Sensitivity

A Checklist may start a pacer sensitivity test through a vPL statement similar to the following:

**xtest   "Wait! Then verify sensitivity result" | PSNS**

For the this statement,

PSN   commands *Phase 3* to immediately begin generating pacer triggers, and
S   is a placeholder, which may also be "**L**"

Assuming that the pacer sensitivity limit is set to default, the Interface automatically assigns a "PASS" result if measured sensitivity is less than 2000 μV. In the case of a "PASS", the Test Report would contain an entry similar to the following:

_____

```
Task:   Wait! Then verify sensitivity test result
Data:   Pacer Sensitivity Test:
            Pacer Pulse Rate:  70.1 PPM
            Sensitivity:  Min   --- uV  Max  2000 uV
                Result:    1100 uV
Result: PASS
```
_____

A placeholder "- - -" appears in the test data whenever a limit is not applicable, such as the minimum sensitivity when limit is set to "**max**", or the limit is not enabled.

Chapter

4
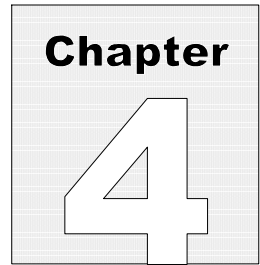
4 Calibration and Maintenance

Calibration of vPad-XSC for *Phase 3* 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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