



## Instrumentation for High-Power Ultrasonic Applications

Rev. T-I-A18

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Innerspec Technologies offers high-power ultrasonic equipment using patented technology. The **Innerspec PowerBox** line is a one-stop instrumentation solution with the most advanced hardware and software, while our **temate® TB Amplifiers** and software packages are designed to give researchers both state-of-the-art tools and flexibility to conduct experiments and design their own applications.

### 1. Innerspec PowerBox Instrumentation


The **Innerspec PowerBox** line is a collection of portable, high-power and high-speed instruments designed for the most energy-demanding and high-speed non-destructive testing. The **Innerspec PowerBox H, 1, 2 and 8** incorporate intelligent processors with integrated digitizers and broadband pulsers/receivers to perform a variety of flaw inspection, thickness, and material property measurements in factory or field environments. Spike and tone-burst pulses at frequencies from 50 kHz to 7MHz can be generated to excite a full range of ultrasonic wave modes, including guided waves, in pulse-echo and pitch-catch arrangements.

The **Innerspec PowerBox H** is the first hand-held, battery operated instrument capable of generating up to 1200V or 8kW of peak power at speeds of up to 100Hz. For pulse-echo operation, a built-in transmitter/receiver switch permits connecting directly to the instrument with no additional hardware. A built-in thermocouple port permits taking temperature readings to correct Time-Of-Flight measurements, and a one-axis encoder input can be used for integration with an automated or manual scanner. The instrument can be used with sensors from Innerspec Technologies or other manufacturers. A setting of 600Vpp (approx. 3kW) is also available to maximize battery life if the application does not require full power. Embedded **temate®** software permits the user to modify the triggering and receiving patterns, use advanced filters to enhance signal-to-noise and present the information on A, B, C and Line Scan formats. Screen captures, device settings and data can be downloaded to a PC using additional software provided with the instrument.

The **Innerspec PowerBox 1, 2 and 8** are designed for portability without sacrificing power or speed. These systems generate up to 2000Vpp or 20kW of peak power per channel at speeds of up to 2000Hz. Control is performed through an external PC over a PCMCIA or Ethernet connection. A built-in encoder, and 12 programmable Inputs/Outputs facilitate integration with a scanner and other external equipment. **temate®** software is supplied for PC data logging, imaging and analysis. The **Innerspec PowerBox 1** also includes a built-in magnet-pulser that provides the ability to use electromagnetic probes used for scanning ferromagnetic materials without adhering to the surface, and generating unique wave modes.



## 1.1. Innerspec PowerBox H Technical Specifications

<p>The <b>Innerspec PowerBox H</b> is designed for ultrasonic applications that require very high voltages and/or long bursts of energy such as non-contact techniques (EMAT, Air-Coupled) and inspection of highly-attenuating materials. The instrument is capable of generating up to 1200V or 8kW of peak power at speeds of up to 300Hz.</p>	 <p><b>Innerspec PowerBox H</b></p>
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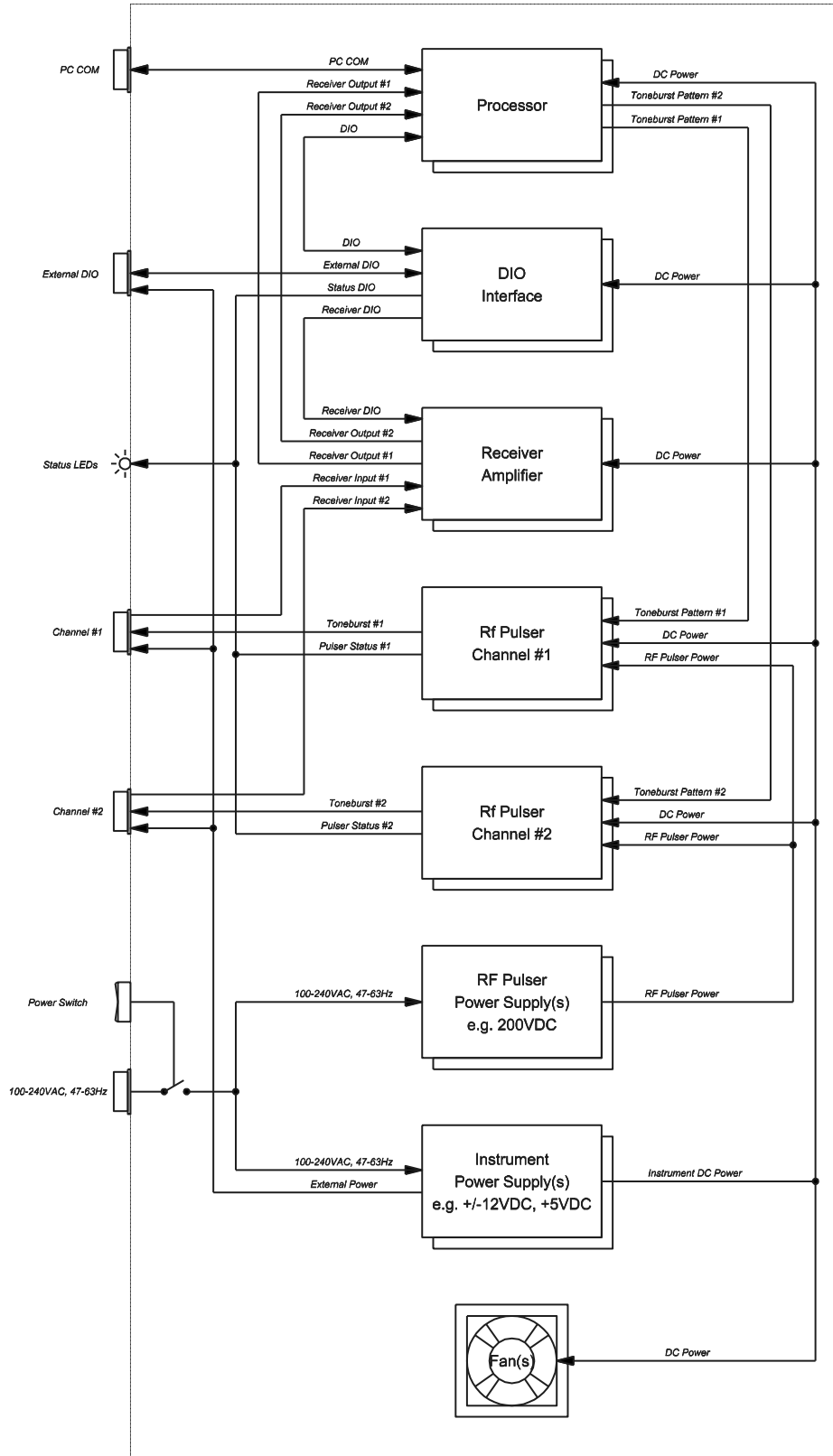
<b>Part Number</b>	245A0183
<b>Ultrasonic Channels</b>	1
<b>Bandwidth</b>	100kHz to 6MHz
<b>Pulse Repetition Rate</b>	Up to 300 Hz
<b>RF Pulser</b>	Spike, Toneburst Waveforms 8 kW Power Output 1200Vpp @ 25App into 50 Ohms 0.1% Maximum Duty
<b>Receiver</b>	<b>Pulse-Echo Mode</b> 1 k $\Omega$ Input Impedance 30 dB to 70 dB Gain <0.05 dB Gain Resolution <b>Pitch-Catch Mode</b> 50 $\Omega$ Input Impedance -20 dB to 60 dB Gain <0.1 dB Gain Resolution
<b>P/R Modes</b>	Pulse-Echo, Pitch-Catch
<b>A/D Converters</b>	12-bit, 100MHz
<b>Filtering</b>	FIR Digital Filters
<b>Rectification</b>	Full-wave, +/- half-wave, and RF mode
<b>Evaluation Gates</b>	Interface plus 2 Gates Amplitude and Time Measurements
<b>Encoder Interface</b>	A/B Quadrature
<b>PC Communication</b>	USB MiniAB Drag-n-drop
<b>Software</b>	<b>temate</b> <sup>®</sup> with A, B, C and Line Scans plus PC Interface Software
<b>Connectors</b>	Lemo EGG.0B.302.CLL Lemo EGG.2B.319.CLL
<b>Operating Temperature</b>	0°C (32°F) to 40°C (105°F)
<b>AC Power Input</b>	100-240VAC, 50-60Hz
<b>Other I/O</b>	Magnet Pulser Trigger Thermocouple Input (Type K 0° C-1024° C) General Purpose I/O (5V TTL) Encoder/Signal Cond. Power VGA output Ethernet 10/100 SD Card
<b>Dimensions</b>	8"W x 9"H x 4"T 203mm x 229mm x 100mm
<b>Weight</b>	2.71Kgs (6lbs)
<b>Battery Life</b>	4-8 Hours

## 1.2. Innerspec PowerBox 1, 2 &amp; 8 Technical Specifications

	Innerspec PowerBox 1	Innerspec PowerBox 2	Innerspec PowerBox 8
<b>Part Number</b>	245A0118	245A0299	245A0144
<b>Ultrasonic Channels</b>	1	2	8
<b>Bandwidth</b>	50kHz to 6MHz	150 kHz to 7 MHz @ 8KW 50kHz- 7MHz @ 4KW	100kHz to 6MHz
<b>Pulse Repetition Frequency</b>	Up to 2kHz	Up to 2kHz	Up to 2kHz
<b>RF Pulser</b>	Spike, Toneburst Waveforms 8 kW Power Output 1200Vpp @ 25App into 50 Ohms 1% Maximum Duty	Spike, Toneburst Waveforms 8 kW Power Output per Channel 1200Vpp @ 25App into 50 Ohms 1% Max. Duty per Channel	Spike, Toneburst Waveforms 2.5 kW to 20 kW Power Output per Channel 200Vpp to 2000Vpp @ 40App into 50 Ohms 1% Max. Duty per Channel
<b>Magnet Pulser</b>	45A Peak Current 9 kW Peak Power 1% Maximum Duty	NA	NA
<b>Receivers</b>	50 $\Omega$ Input Impedance -20 dB to 60 dB Gain 0.3 dB Gain Resolution 8 Low Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz) 8 High Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz)	50 $\Omega$ Input Impedance -20 dB to 60 dB Gain 0.3 dB Gain Resolution 8 Low Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz) 8 High Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz)	50 $\Omega$ Input Impedance -20 dB to 60 dB Gain 0.3 dB Gain Resolution 8 Low Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz) 8 High Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz)
<b>P/R Modes</b>	Pulse-Echo, Pitch-Catch	Pulse-Echo, Pitch-Catch	Pulse-Echo, Pitch-Catch
<b>A/D Converters</b>	14-bit, 100MHz	14-bit, 100MHz	14-bit, 100MHz
<b>Filtering</b>	IIR/FIR Digital Filters	IIR/FIR Digital Filters	IIR/FIR Digital Filters
<b>Rectification</b>	Full-wave, +/- half-wave, and RF mode	Full-wave, +/- half-wave, and RF mode	Full-wave, +/- half-wave, and RF mode
<b>Evaluation Gates</b>	4 Gates per Channel Amplitude and Time Measurements	4 Gates per Channel Amplitude and Time Measurements	4 Gates per Channel Amplitude and Time Measurements
<b>Encoder Interface</b>	A/B Quadrature or Clock/Direction	A/B Quadrature or Clock/Direction	A/B Quadrature or Clock/Direction
<b>Alarms &amp; Auxiliary I/O</b>	12 User Programmable TTL I/O	12 User Programmable TTL I/O	12 User Programmable TTL I/O
<b>PC Communication</b>	PCMCIA Interface Records to any MS Windows Device	Ethernet Interface Records to any MS Windows Device	Ethernet Interface Records to any MS Windows Device
<b>PC Software</b>	<b>temate</b> <sup>®</sup> Imaging and Analysis Software	<b>temate</b> <sup>®</sup> Imaging and Analysis Software	Imaging and Analysis Software
<b>Operating Temperature</b>	32°F (0°C) to 105°F (40°C)	32°F (0°C) to 105°F (40°C)	32°F (0°C) to 105°F (40°C)
<b>Electrical Power Input</b>	100-240VAC, 47-63Hz	100-240VAC, 47-63Hz	100-240VAC, 47-63Hz
<b>Dimensions</b>	12.750" x 13.250" x 9.250"	12.750" x 13.250" x 9.250"	12" x 18" x 9.250"
	324mm x 336mm x 235mm	324mm x 336mm x 235mm	305mm x 457mm x 235mm

### 1.3. Innerspec PowerBox Hardware Schematic

(Example for Innerspec PowerBox 2)



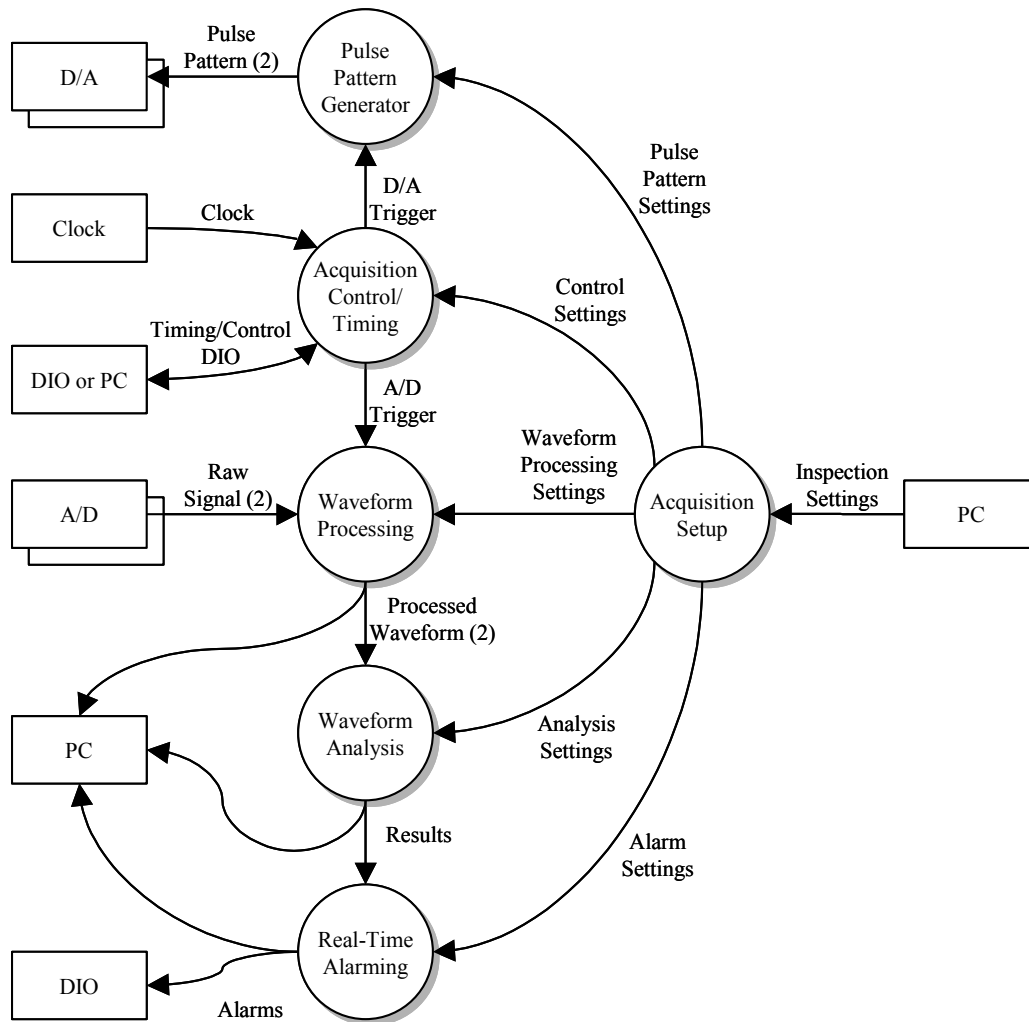
#### 1.4. Innerspec PowerBox Software Specifications

Innerspec Technologies offers a complete suite designed for the unique requirements of EMAT testing. Innerspec Technologies **temate**<sup>®</sup> Software is designed specifically for EMAT testing. It controls the **Innerspec PowerBox 1, 2 and 8**, and provides a complete suite of analysis and presentation features to perform the most complex inspections and measurements in automated and manual environments. The following is a list of features included with **temate**<sup>®</sup> Software:

- MS Windows XP Interface
- A-Scan
- Transmitter and Receiver Timing Capabilities for RF and Magnet Pulser
- Real-Time Waveform Export
- IIR/FIR Band-Pass Filter Controls
- Built-In Advanced Software Filters and Data Analysis Algorithms
- Waveform Analysis Module with Gated Peak Detection, Time-Of-Flight Measurements, B, C Scans and Strip Charts and Real-Time Alarming to PC and DIO
- Built-In Communication Tools
- (I/O, RS-232, TCPIP, Ethernet, X-Y Encoder)
- External Trigger for Automatic Operation

1.5. Software Context Diagram:

- Acquisition Setup module receives and manages inspection setup parameters from either internal memory or via PC link
- Acquisition Control/Timing module controls DIO settings and triggers pulsing and digitization upon DIO, PC control, or internal clock based on settings (counter/divide to interpret DIO encoder input)
- Pulse Pattern Generator module, upon trigger, outputs a pre-defined pulse pattern via D/A
- Waveform Acquisition module, upon trigger, receives ultrasonic signal via A/D, applies IIR/FIR digital filters to waveforms and real-time algorithms, and sends to PC and based on settings

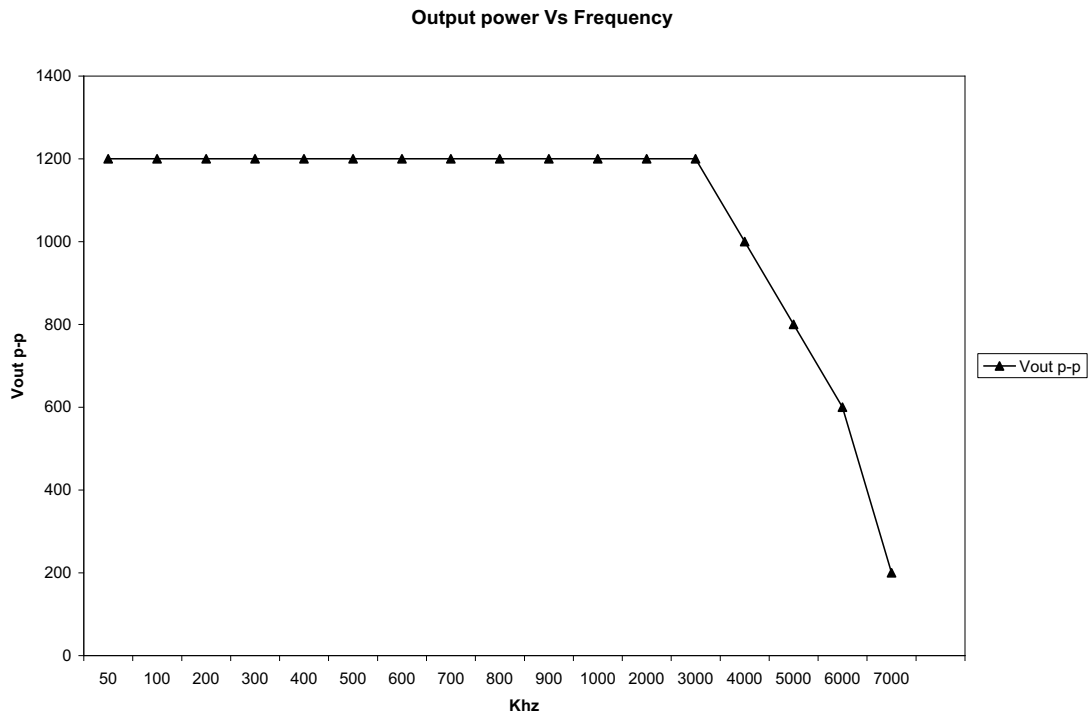




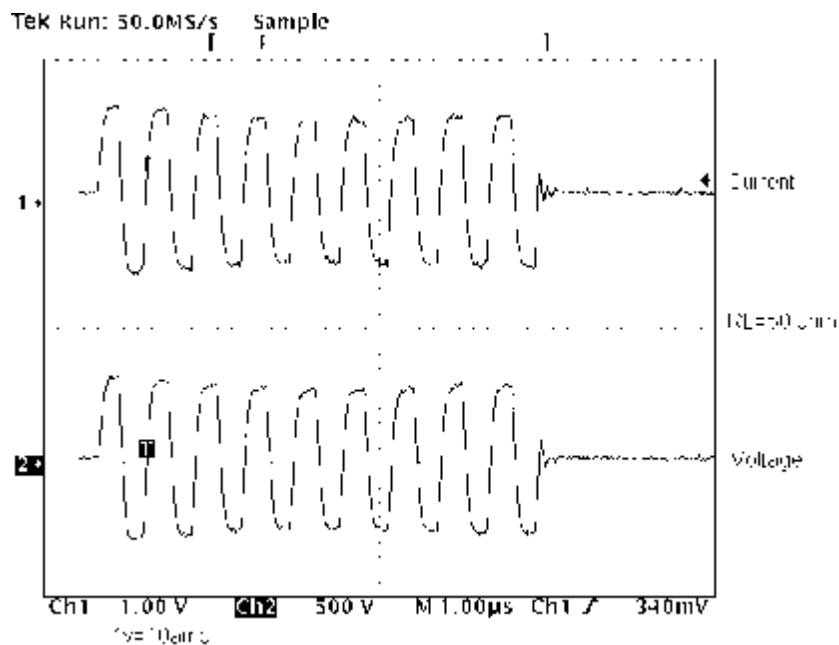
### 1.6. RF Pulser Performance

The **temate® PowerBox** and the **temate® TB Amplifiers** include high-power RF pulsers for ultrasonic EMAT non-destructive testing. The typical curves are from 50Khz to 7mhz into a 50 ohm load. Custom versions for higher frequencies can be developed upon request. Contact Innerspec Technologies for details.

#### 1.6.1. 8KW RF Pulser

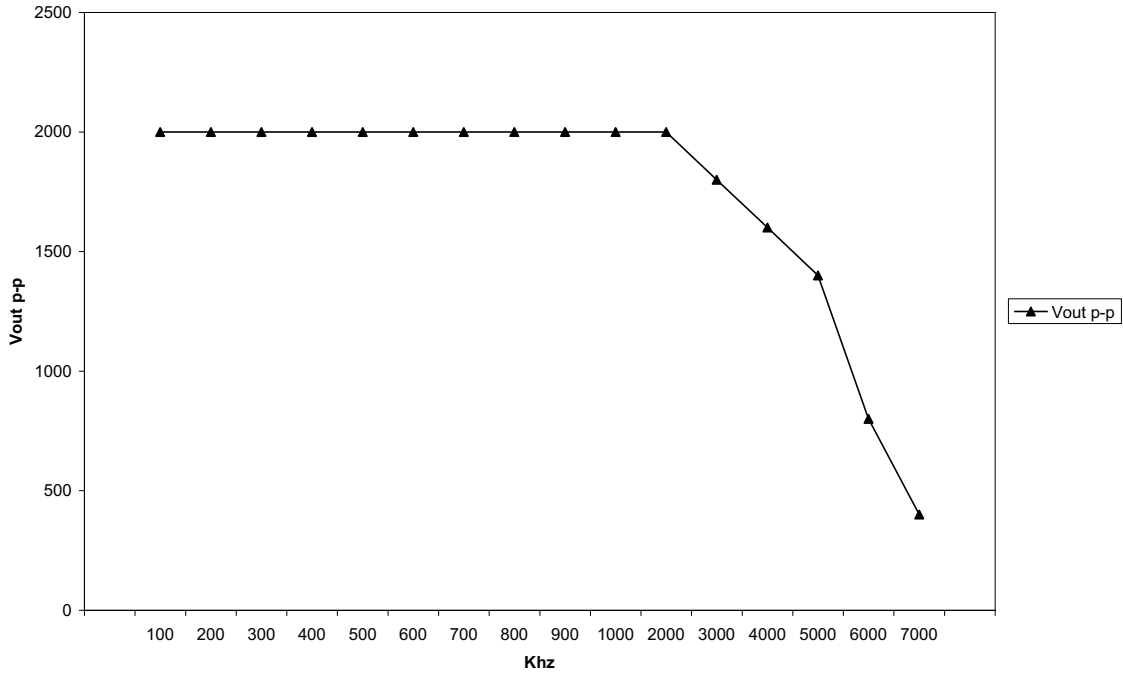


Typical output currents and voltages 8Kw RF pulser at 1.5Mhz

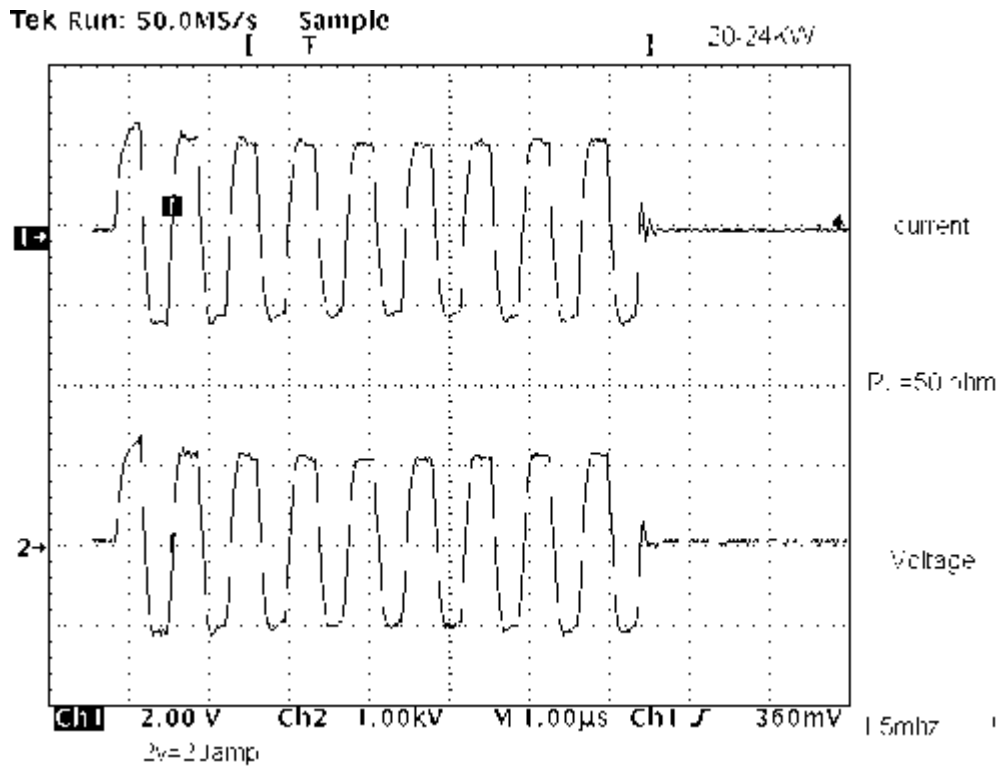


1.6.2. 20Kw RF Pulser

Output power Vs Frequency



Typical output currents and voltages 20Kw RF pulser at 1.5Mhz.



## 2. temate® HP Pulser

The **temate®** HP Pulser is a 2U Rackmount instrument that combines a digitally controlled tone burst pattern generator with our 2-channel high-power programmable tone burst amplifier.



**temate®** HP Pulser

	2 Channel Low Frequency	2 Channel High Frequency
<b>Part Number</b>	245A0234	245A0179
<b>Digital Controller Features</b>	<ul style="list-style-type: none"> <li>• LCD Display with Keypad to Select Frequency, Number of Cycles, Delays and Other Configuration Settings</li> <li>• Memory to Save, Recall Configuration Settings</li> <li>• Internal or External Trigger Mode</li> <li>• External 5VDC Trigger Input with Configurable Divider (e.g. Encoder Trigger)</li> <li>• External Trigger Output for Electromagnet Pulser Control</li> <li>• Synchronized 5VDC Output</li> </ul>	
<b>Frequency range*</b>	50kHz to 5 MHz	1MHz to 20 MHz
<b>Output Power Peak</b>	2 Channels x 2.5kW-20kW @50 Ohms	
<b>Max. Duty cycle</b>	1% per Channel	
<b>Maximum PRF</b>	2000 Hz	
<b>Output Power Average</b>	200W per Channel (Maximum Power)	
<b>Voltage peak to peak</b>	400V-2000V	
<b>High Power Signal Out</b>	2 BNC	
<b>Monitor (O-Scope) connector</b>	2 BNC	
<b>Indicators</b>	Power on, Voltage out, Fuse and Thermal indicator	
<b>Temperature</b>	32°F (0°C) to 105°F (40°C)	
<b>Humidity</b>	95% non condensing Humidity	
<b>Protection</b>	Thermal, fuse (including open circuit operation)	
<b>Electric Power Input</b>	90/253 VAC 50/60 Hertz	
<b>Dimensions</b>	6.875" L x 12.875" W x 3.5" H (2U Standard Rack-Mount)	
	429mm L x 327mm W x 89mm H (2U Standard Rack-Mount)	
<b>Weight</b>	15 lbs (7 kg)	

\* Standard Frequency Configurations. Other options available upon requests.

### 3. temate® PXI Pulser/Receiver Card

The **temate® PXI Pulser/Receiver** is a high-power ultrasonic instrument designed to be installed on a standard PXI or CompactPCI chassis. The instrument provides 8kW (1200Vpp toneburst) of power, ideal for researchers & integrators, interested in a compact, high-power ultrasonic instrument to drive EMAT and piezoelectric transducers (standard or air-coupled).

The pulser can be operated directly from the PXI computer using dedicated software that permits modifying all pulsing parameters, or use the factory-provided drivers to set the equipment from a separate application. The received signal can be viewed on the same computer, an external oscilloscope, streamed to another application. Data streaming can include TOF and Peak-Amplitude for three independent gates or the complete waveform of the signal, all at full PRF rates. Driver application examples are provided in both C++ and Labview. The unit permits operation in Pitch-Catch or Pulse-Echo modes using a built-in Transmit/Receive switch.




**temate® PXI  
Pulser/Receiver Card**

	<b>temate® PXI Pulser/Receiver</b>
<b>Part Number</b>	245A0235
<b>Digital Controller Features</b>	<ul style="list-style-type: none"> <li>• Software Application based on our <b>temate®</b> software technology to select and manage settings (Frequency, Number of Cycles, Delays and Other Configuration)</li> <li>• Internal or External Trigger Mode</li> <li>• External 5VDC Trigger Input with Configurable Divider (e.g. Encoder Trigger)</li> <li>• External Trigger Output for Electromagnet Pulser Control</li> <li>• Synchronized 5VDC Output</li> <li>• Drivers provided to allow parameter modification, A-Scan and C-Scan data streaming</li> <li>• User SDK with driver example code in both C++ and Labview</li> </ul>
<b>Frequency range*</b>	0.100MHz to 6 MHz
<b>Output Power Peak</b>	1 Channels x 0.17kW-8kW @50 Ohms
<b>Max. Duty cycle</b>	0.25% per Channel
<b>Maximum PRF</b>	2000 Hz
<b>Output Power Average</b>	20W per Channel (Maximum Power)
<b>Voltage peak to peak</b>	150V-1200V
<b>High Power Signal Out</b>	1 BNC
<b>Receiver</b>	50 Ω Input Impedance -10 dB to 70 dB Gain 0.3 dB Gain Resolution Additional 30dB Pre-Amplifier 8 Low Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz) 8 High Pass RF Filters; (Off, .1, .2, .5, 1, 2, 5, 10 MHz)
<b>Monitor (O-Scope) connector</b>	1 BNC
<b>Indicators</b>	Power on, Voltage out, Thermal and External Trigger indicator
<b>Temperature</b>	32°F (0°C) to 105°F (40°C)
<b>Humidity</b>	95% non-condensing Humidity
<b>Protection</b>	Thermal, fuse (including open & short circuit operation)
<b>Electric Power Input</b>	Provided by the PXI/cPCI chassis
<b>Dimensions</b>	4 Slot PXI/cPCI
<b>Weight</b>	2.0 lbs (0.8 kg)

\* Standard Frequency Configurations. Other options available upon request.

## 4. temate® TB Amplifiers

<p>The <b>temate® TB Amplifiers</b> take low-voltage signals and convert them into high-power pulse trains for the most power-demanding applications.</p> <p>Our <b>temate® TB Amplifiers</b> come standard in 1, 2 and 4 channels and are designed to be used in standard rack-mount configurations to facilitate integration.</p> <p>Please review section 1.6. in this document for performance charts and additional information.</p>	
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	1 Channel HB Toneburst	2 Channel HB Toneburst	4 Channel HB Toneburst
<b>Part Number</b>	245A0331	245A0317	245A0318
<b>Output Power Peak</b>	6KW	6KW per channel	6KW per channel
<b>Max. Duty cycle</b>	1% all (.01 duty)		
<b>Maximum PRF</b>	(Hertz x Duty) / (Cycles x Groups of cycles) =PRR Note: 5.5mhz , .01 duty, 10 cycles , 1 group = 5500 PRR		
<b>Output Power Average</b>	60W	60W per channel	60W per channel
<b>Voltage peak to peak</b>	1100 V	1100 V per channel	1100 V per channel
<b>Input signal</b>	Two 5v TTL signals with 20nano-seconds between pulses per TB card		
<b>Signal In</b>	TTL		
<b>Monitor Signal Out</b>	Vout, 10v =550v		
<b>Voltage out settings</b>	Vout p-p : 0, 46, 141, 237, 334, 430, 526, 622, 718, 814, 910, 1006, 1100. (+/- 2V)		
<b>Negative Power off switch (mode)</b>	Rotary		
<b>Frequency range</b>	20khz to 5.5mhz		
<b>Airflow requirement</b>	40 cfm		
<b>Indicators</b>	Each channel: Vout, Fuse, Over temp, Over-load and Vout p-p meter for all channels		
<b>Temperature</b>	25-50 C°		
<b>Humidity</b>	95% non-condensing		
<b>Protection</b>	Short circuit (resettable), Over-temp, Fuse.		
<b>Electric Power Input</b>	95-253 vac @ 4amps max	95-253 vac @ 6.3 amps max	95-253 vac @ 12 amps max
<b>Dimensions</b>	17"W x15.375"D x 1.325 "H with 19" Rack mount panel		
<b>Weight</b>	8.5lbs.	9 lbs.	12.5 lbs.

## 5. temate® Magnet Pulsers



Magnet Pulsers permit rapid pulsing of electro-magnetic probes used for EMAT applications. These short-duration magnetic fields have some advantages over those generated with permanent magnets. Namely:

- Permit scanning of ferrous parts without adhering to the part
- Increase signal-to-noise ratio in some applications
- Permit generation of strong tangential fields



	temate® PowerBox MP	Rack-Mount MP	Rack-Mount MPHP
<b>Part Number</b>	245A0105	245A0178	245A0156
<b>Output Power Peak</b>	12kW into 550µH – 2mH		15kW into 550µH – 2mH
<b>Peak Current Intermittent</b>	150A, 1ms Max, Current and Thermally Limited		
<b>Peak Current Repetitive 100A</b>	0.5 Hours On, 10 Minutes Off		0.5 Hours On, 15 Minutes Off
<b>Peak Current Repetitive 75A</b>	Continuous		
<b>Duty Cycle 100Hz</b>	Time On: 2.35ms Max, Time Off: 1.35ms Min		
<b>Input Signal</b>	TTL up to 400Hz		
<b>Input Voltage</b>	150VDC @ 4App, 0.6kW	300VDC @ 5App, 1.5kW	300VDC @ 10App, 3kW
<b>RMS Current</b>	54A Max		
<b>Current Shape</b>	$v(t) = L di(t)/ dt$ for charge $I = E/R(1 - e^{-rt/L})$ discharge		
<b>Monitor (O-Scope) connector</b>	None	25 amp = 1 volt	
<b>Airflow requirement</b>	60 cfm		
<b>Indicators</b>	Power on, Volts in, Amps in, Ground Fault	Power on, Over current, IGBT Sat, Over Temp, Ground Fault	
<b>Temperature</b>	32°F (0°C) to 105°F (40°C)		
<b>Humidity</b>	95% non condensing Humidity		
<b>Protection</b>	Thermal, fuse (including open circuit operation)		
<b>Electric Power Input</b>	100/240 VAC 50/60 Hertz		
<b>Dimensions</b>	12.750" x 13.250" x 9.250"	19" x 3.5" x 13" (2U)	
	324mm x 336mm x 235mm	485mm x 330mm x 89mm (2U)	
<b>Weight</b>	17 lbs (8 kg)	15 lbs (8 kg)	

## 7. Innerspec DataHub – Portable and Integrated

<p>Innerspec DataHub Devices are web-based servers for supervisory control and data acquisition (SCADA), customized for Innerspec’s portable and integrated systems.</p> <p>These devices permit remote control of the equipment using a Local Area Network (LAN) connection, and are ideal for storing and presenting consolidated data from one or multiple systems. Custom software with unique reports and analysis tools is already available for some applications, and others can be built upon request. A developer’s license is also available for our portable PowerBox instruments.</p>	 <p><b>Innerspec DataHub-PB</b></p>  <p><b>Innerspec DataHub-INT</b></p>
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	Innerspec DataHub-PB	Innerspec DataHub-INT
<b>Part Number</b>	800A0238	800A0237
<b>Software Applications</b>	See Sensors & Accessories Catalog	Contact A Sales Representative
<b>Form Factor</b>	Portable Device	Rack-Rount
<b>Storage Capabilities</b>	Small (Solid State – SSM)	Large (RAID)
<b>Remote Operation</b>	Yes	
<b>Inspection Results Access</b>	Yes	
<b>Non-Proprietary Export</b>	Yes	
<b>Developer Licensing</b>	No	Yes
<b>Additional Licenses</b>	No	Yes
<b>Unlimited Software Upgrades</b>	Yes	No
<b>Special Device Support Rate</b>	Yes	No
<b>Guaranteed Replacement Program</b>	Yes	No
<b>Discount on Future Upgrades</b>	Yes	No
<b>Temperature</b>	32°F (0°C) to 105°F (40°C)	
<b>Humidity</b>	95% non condensing Humidity	
<b>Dimensions</b>	6.875" L x 12.875" W x 1.640" H (1U Standard Rackmount)	1.97" x 1.97"
	429mm L x 327mm W x 44mm H (1U Standard Rack-Mount)	50mm x 50mm
<b>Weight</b>	17 lbs.	0.75 lbs.

**8. Laptop PC**

To avoid potential hardware incompatibilities, Innerspec Technologies recommends purchasing **temate**<sup>®</sup> Software pre-installed on the Laptop PC. The table below shows a list of laptops currently offered by Innerspec Technologies and accessories to connect to **Innerspec PowerBox 1 & 2**.

Part Number	Model
260A7712	Basic Laptop Computer with <b>temate</b> <sup>®</sup> Software
260A7713	Hardened Laptop (ToughBook or equivalent) with <b>temate</b> <sup>®</sup> Software
260A7714	High Performance Laptop for <b>temate</b> <sup>®</sup> PowerBox 8 with <b>temate</b> <sup>®</sup> Software
232V0393	Spare PCMCIA Cable (necessary for PowerBox 1 and 2)
260V7704	PCMCIA Port Card (necessary for PowerBox 1 and 2)
260V7709	PCI Express Card (necessary for PowerBox 1 and 2)



## 9. Limited Warranty

**Innerspec Technologies** warrants these products to be free of defects in Material and Workmanship for a period of one year from date of purchase by end user. **Innerspec Technologies** will, at its choice, replace or repair parts found defective and return equipment or parts to the purchaser.

The above stated warranty does not apply to products which have failed due to misuse, alteration, unauthorized repair or modification. The purchaser is responsible for transportation costs of the equipment to and from the factory for warranty replacement or repair. The above warranty does not include incidental or consequential damage