



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 Innerspec PowerBox H 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>Innerspec PowerBox H</p>
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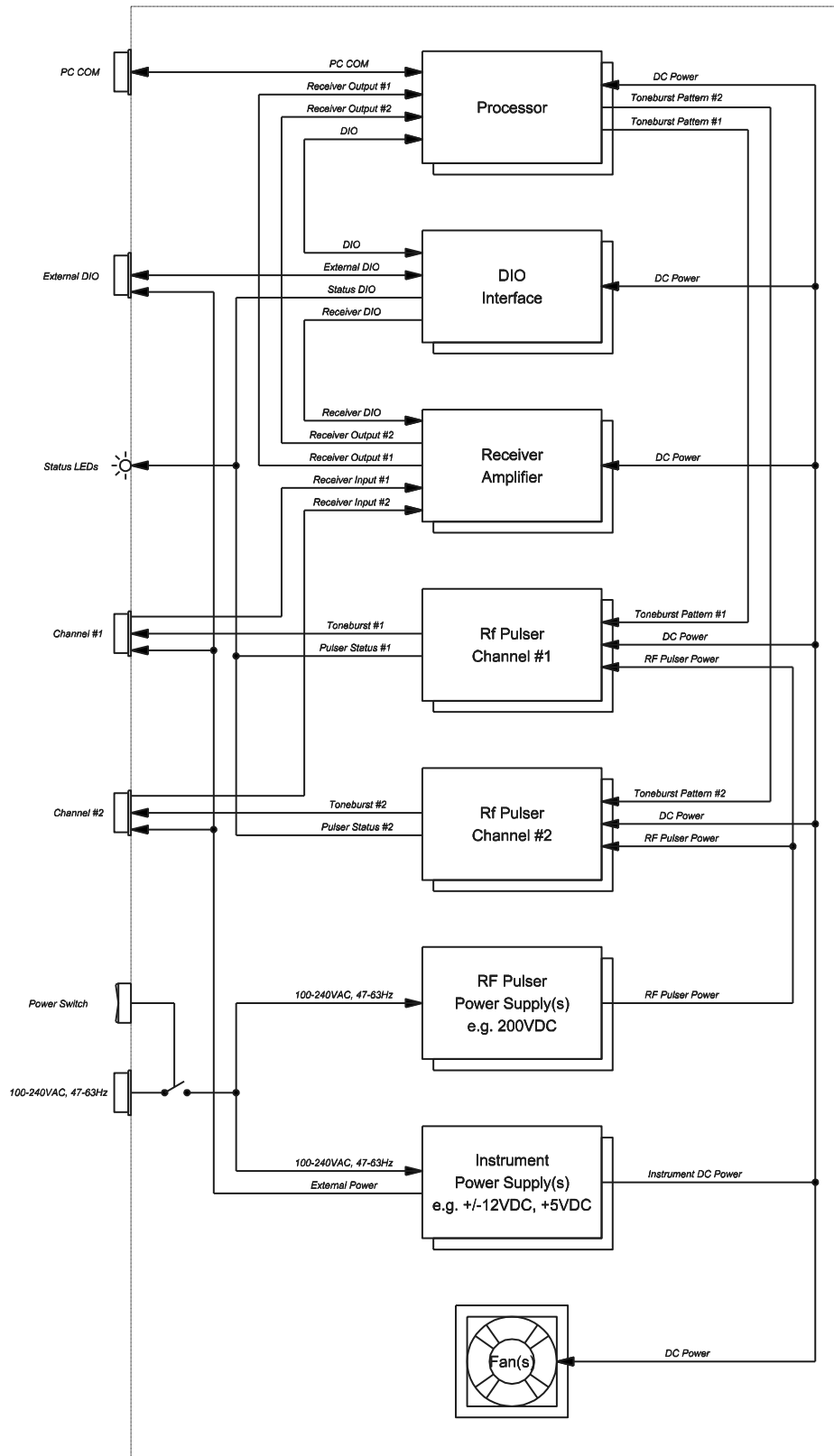
Part Number	245A0183
Ultrasonic Channels	1
Bandwidth	100kHz to 6MHz
Pulse Repetition Rate	Up to 300 Hz
RF Pulser	Spike, Toneburst Waveforms 8 kW Power Output 1200Vpp @ 25App into 50 Ohms 0.1% Maximum Duty
Receiver	Pulse-Echo Mode 1 k Ω Input Impedance 30 dB to 70 dB Gain <0.05 dB Gain Resolution Pitch-Catch Mode 50 Ω Input Impedance -20 dB to 60 dB Gain <0.1 dB Gain Resolution
P/R Modes	Pulse-Echo, Pitch-Catch
A/D Converters	12-bit, 100MHz
Filtering	FIR Digital Filters
Rectification	Full-wave, +/- half-wave, and RF mode
Evaluation Gates	Interface plus 2 Gates Amplitude and Time Measurements
Encoder Interface	A/B Quadrature
PC Communication	USB MiniAB Drag-n-drop
Software	temate [®] with A, B, C and Line Scans plus PC Interface Software
Connectors	Lemo EGG.0B.302.CLL Lemo EGG.2B.319.CLL
Operating Temperature	0°C (32°F) to 40°C (105°F)
AC Power Input	100-240VAC, 50-60Hz
Other I/O	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
Dimensions	8"W x 9"H x 4"T 203mm x 229mm x 100mm
Weight	2.71Kgs (6lbs)
Battery Life	4-8 Hours

1.2. Innerspec PowerBox 1, 2 & 8 Technical Specifications

	Innerspec PowerBox 1	Innerspec PowerBox 2	Innerspec PowerBox 8
Part Number	245A0118	245A0299	245A0144
Ultrasonic Channels	1	2	8
Bandwidth	50kHz to 6MHz	150 kHz to 7 MHz @ 8KW 50kHz- 7MHz @ 4KW	100kHz to 6MHz
Pulse Repetition Frequency	Up to 2kHz	Up to 2kHz	Up to 2kHz
RF Pulser	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
Magnet Pulser	45A Peak Current 9 kW Peak Power 1% Maximum Duty	NA	NA
Receivers	50 Ω 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 Ω 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 Ω 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)
P/R Modes	Pulse-Echo, Pitch-Catch	Pulse-Echo, Pitch-Catch	Pulse-Echo, Pitch-Catch
A/D Converters	14-bit, 100MHz	14-bit, 100MHz	14-bit, 100MHz
Filtering	IIR/FIR Digital Filters	IIR/FIR Digital Filters	IIR/FIR Digital Filters
Rectification	Full-wave, +/- half-wave, and RF mode	Full-wave, +/- half-wave, and RF mode	Full-wave, +/- half-wave, and RF mode
Evaluation Gates	4 Gates per Channel Amplitude and Time Measurements	4 Gates per Channel Amplitude and Time Measurements	4 Gates per Channel Amplitude and Time Measurements
Encoder Interface	A/B Quadrature or Clock/Direction	A/B Quadrature or Clock/Direction	A/B Quadrature or Clock/Direction
Alarms & Auxiliary I/O	12 User Programmable TTL I/O	12 User Programmable TTL I/O	12 User Programmable TTL I/O
PC Communication	PCMCIA Interface Records to any MS Windows Device	Ethernet Interface Records to any MS Windows Device	Ethernet Interface Records to any MS Windows Device
PC Software	temate [®] Imaging and Analysis Software	temate [®] Imaging and Analysis Software	Imaging and Analysis Software
Operating Temperature	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)
Electrical Power Input	100-240VAC, 47-63Hz	100-240VAC, 47-63Hz	100-240VAC, 47-63Hz
Dimensions	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)



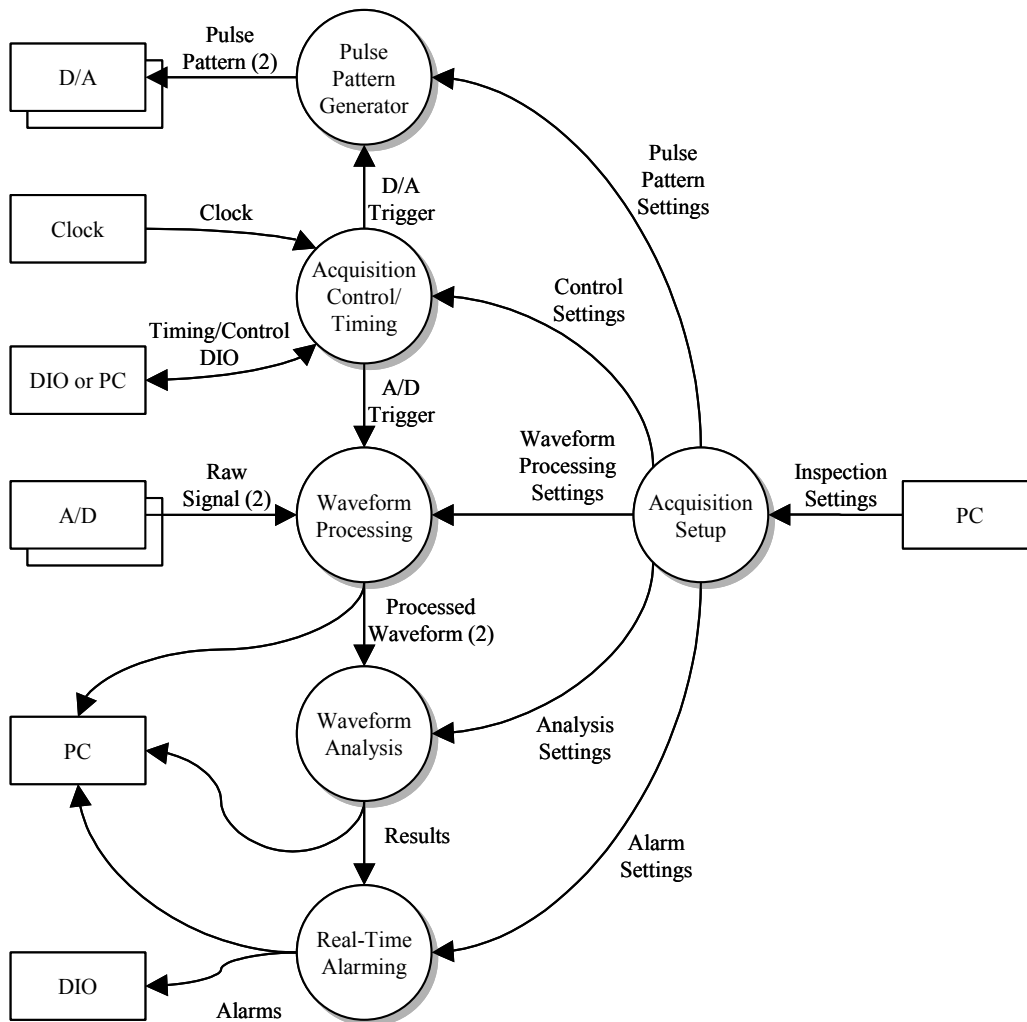
1.4. Innerspec PowerBox Software Specifications

Innerspec Technologies offers a complete suite designed for the unique requirements of EMAT testing. Innerspec Technologies **temate**[®] 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**[®] 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, TCP/IP, Ethernet, X-Y Encoder)
- External Trigger for Automatic Operation

1.5. Software Context Diagram:

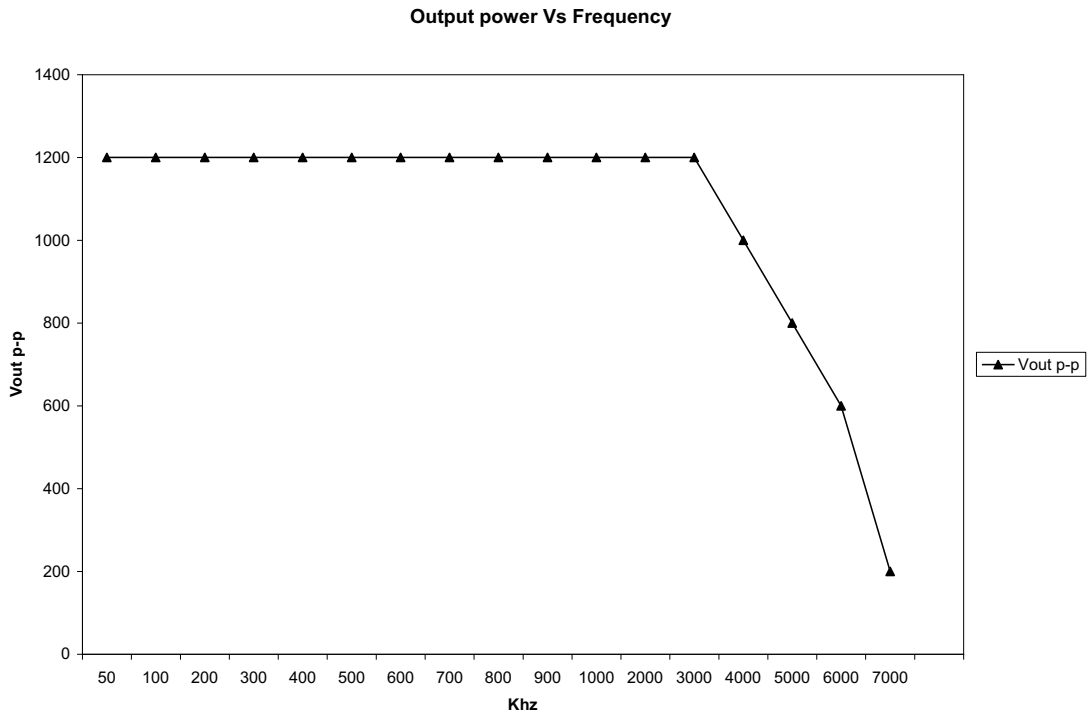
- Acquisition Setup module receives and manages inspection setup parameters from either internal memory or via PC link
- Acquisition Control/Timing module controls DIO settings and triggers pulsing and digitization upon DIO, PC control, or internal clock based on settings (counter/divide to interpret 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



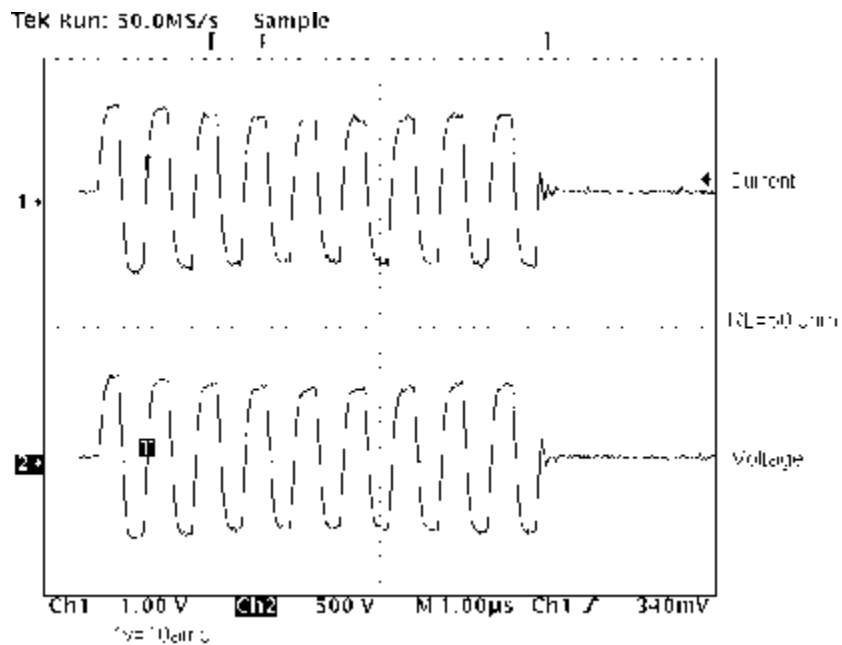
1.6. RF Pulser Performance

The **temate® PowerBox** and the **temate® TB Amplifiers** include high-power RF pulsers for ultrasonic EMAT non-destructive testing. The typical power 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

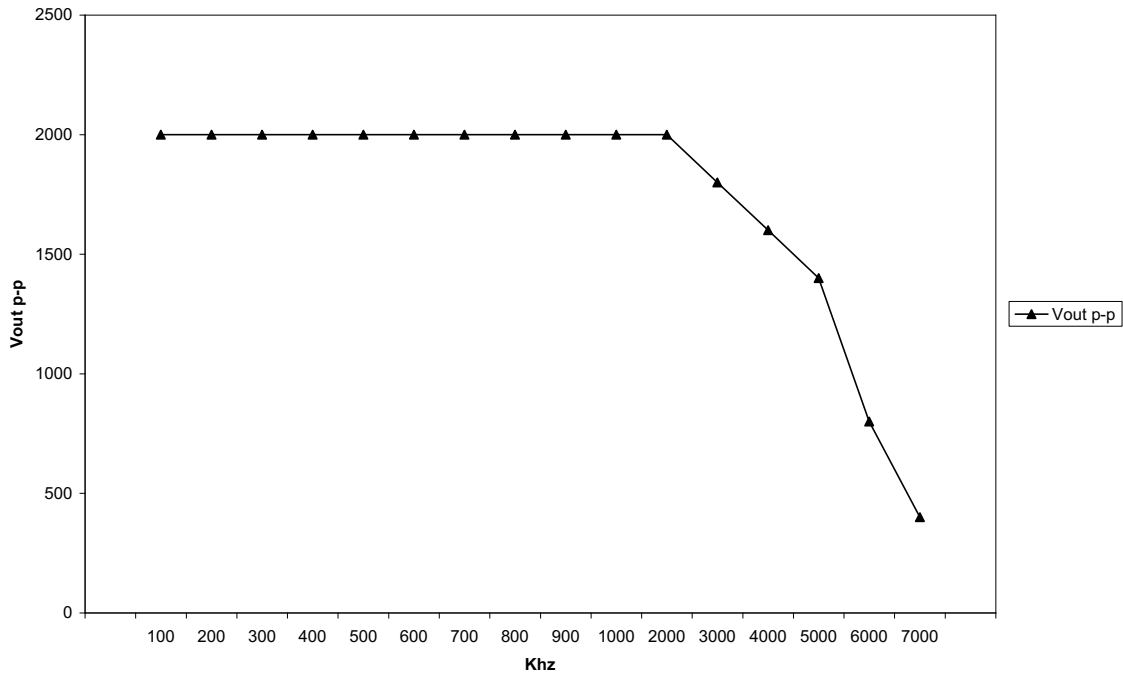


Typical output currents and voltages 8Kw RF pulser at 1.5Mhz

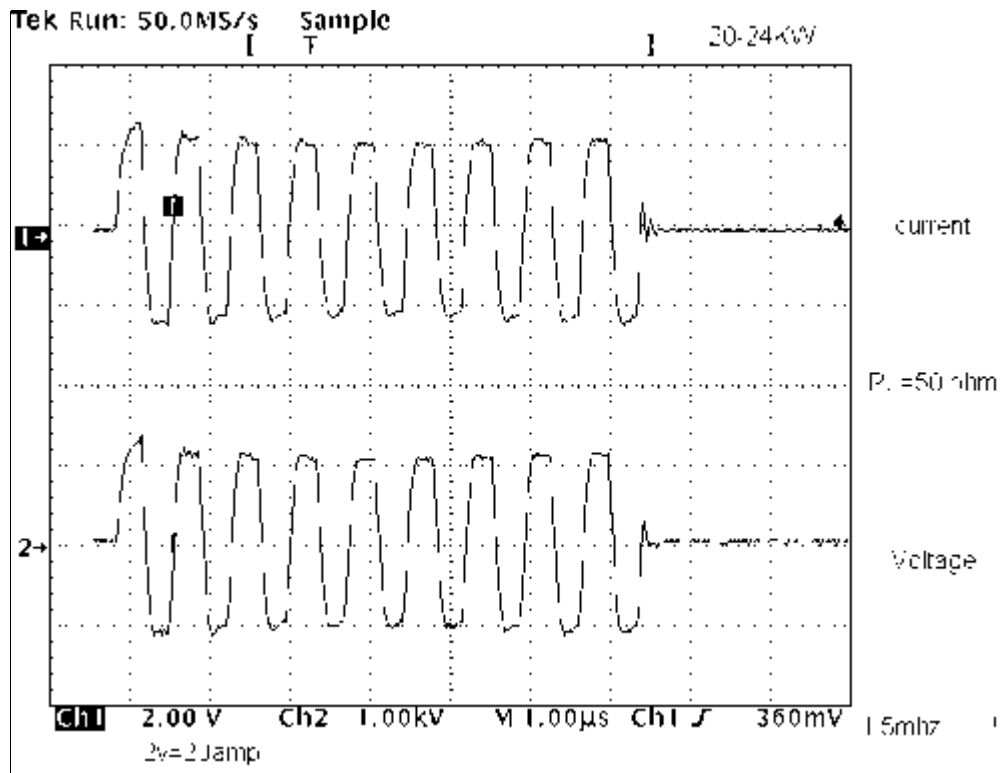


1.6.2. 20Kw RF Pulser


Output power Vs Frequency



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



2. temate® HP Pulser

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

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

* Standard Frequency Configurations. Other options available upon request.

4. temate® TB Amplifiers

The **temate® TB Amplifiers** take low-voltage signals and convert them into high-power pulse trains for the most power-demanding applications.

Our **temate® TB Amplifiers** come standard in 1, 2 and 4 channels and are designed to be used in standard rack-mount configurations to facilitate integration.

Please review section 1.6. in this document for performance charts and additional information.



	1 Channel HB Toneburst	2 Channel HB Toneburst	4 Channel HB Toneburst
Part Number	245A0331	245A0317	245A0318
Output Power Peak	6KW	6KW per channel	6KW per channel
Max. Duty cycle	1% all (.01 duty)		
Maximum PRF	(Hertz x Duty) / (Cycles x Groups of cycles) =PRR Note: 5.5mhz , .01 duty, 10 cycles , 1 group = 5500 PRR		
Output Power Average	60W	60W per channel	60W per channel
Voltage peak to peak	1100 V	1100 V per channel	1100 V per channel
Input signal	Two 5v TTL signals with 20nano-seconds between pulses per TB card		
Signal In	TTL		
Monitor Signal Out	Vout, 10v =550v		
Voltage out settings	Vout p-p : 0, 46, 141, 237, 334, 430, 526, 622, 718, 814, 910, 1006, 1100. (+/- 2V)		
Negative Power off switch (mode)	Rotary		
Frequency range	20khz to 5.5mhz		
Airflow requirement	40 cfm		
Indicators	Each channel: Vout, Fuse, Over temp, Over-load and Vout p-p meter for all channels		
Temperature	25-50 C°		
Humidity	95% non-condensing		
Protection	Short circuit (resettable), Over-temp, Fuse.		
Electric Power Input	95-253 vac @ 4amps max	95-253 vac @ 6.3 amps max	95-253 vac @ 12 amps max
Dimensions	17"W x15.375"D x 1.325 "H with 19" Rack mount panel		
Weight	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
Part Number	245A0105	245A0178	245A0156
Output Power Peak	12kW into 550µH – 2mH		15kW into 550µH – 2mH
Peak Current Intermittent	150A, 1ms Max, Current and Thermally Limited		
Peak Current Repetitive 100A	0.5 Hours On, 10 Minutes Off		0.5 Hours On, 15 Minutes Off
Peak Current Repetitive 75A	Continuous		
Duty Cycle 100Hz	Time On: 2.35ms Max, Time Off: 1.35ms Min		
Input Signal	TTL up to 400Hz		
Input Voltage	150VDC @ 4App, 0.6kW	300VDC @ 5App, 1.5kW	300VDC @ 10App, 3kW
RMS Current	54A Max		
Current Shape	$v(t) = L di(t)/ dt$ for charge $I = E/R(1 - e^{-t/L})$ discharge		
Monitor (O-Scope) connector	None	25 amp = 1 volt	
Airflow requirement	60 cfm		
Indicators	Power on, Volts in, Amps in, Ground Fault	Power on, Over current, IGBT Sat, Over Temp, Ground Fault	
Temperature	32°F (0°C) to 105°F (40°C)		
Humidity	95% non condensing Humidity		
Protection	Thermal, fuse (including open circuit operation)		
Electric Power Input	100/240 VAC 50/60 Hertz		
Dimensions	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)	
Weight	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>Innerspec DataHub-PB</p>  <p>Innerspec DataHub-INT</p>
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	Innerspec DataHub-PB	Innerspec DataHub-INT
Part Number	800A0238	800A0237
Software Applications	See Sensors & Accessories Catalog	Contact A Sales Representative
Form Factor	Portable Device	Rack-Rount
Storage Capabilities	Small (Solid State – SSM)	Large (RAID)
Remote Operation	Yes	
Inspection Results Access	Yes	
Non-Proprietary Export	Yes	
Developer Licensing	No	Yes
Additional Licenses	No	Yes
Unlimited Software Upgrades	Yes	No
Special Device Support Rate	Yes	No
Guaranteed Replacement Program	Yes	No
Discount on Future Upgrades	Yes	No
Temperature	32°F (0°C) to 105°F (40°C)	
Humidity	95% non condensing Humidity	
Dimensions	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
Weight	17 lbs.	0.75 lbs.

8. Laptop PC

To avoid potential hardware incompatibilities, Innerspec Technologies recommends purchasing **temate**[®] 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 temate [®] Software
260A7713	Hardened Laptop (ToughBook or equivalent) with temate [®] Software
260A7714	High Performance Laptop for temate [®] PowerBox 8 with temate [®] 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