

Three Axis Gradient Amplifier

Model QDCM2100D

- 3-Axis 900A Precision Gradient Amplifier System
- 2100 VDC High Performance Power Supply
- 100% Digital D-SERIES[™] Technology
- Hi-Speed, Single Fiber Digital Command
- Rear Panel Utility Access

Description

The QDCM2100D Gradient Amplifier from Performance Controls, Inc. (PCI) is a threeaxis pulse width modulated amplifier system. It is rated at 2100 V / 900 Apk / 375 ARMS / 60 kW and offers unrivaled power for the industry's most precise and demanding gradient control applications. The QDCM2100D's exceptionally low output noise, high bandwidth and rock-solid stability make it ideally suited for demanding power amplifier tasks found in laboratory and medical applications.

PCI's new D-SERIES[™] technology makes its debut with the QDCM2100D; it is the foundation for many new powerful features. Coupled with PCI's new InSight[™] software toolkit, D-SERIES[™] technology gives systems engineers, sequence developers, and field service technicians unprecedented insight and capability for maximizing system performance, lowering overall system costs, and ensuring maximum system uptime.



Applications

- MRI magnetic field gradient control
- Particle beam magnetic steering control
- Any inductive load requiring precise control of large currents across a wide frequency range

Features and Benefits

D-SERIES™ Technology (see separate data sheet)	100% digital amplifier architecture, enabling Advanced System Diagnostics, Integrated Digital Storage Oscilloscope, Sequence Development Assistant and others.
Hi-Speed Fiber Digital Command	Single high-speed fiber optic cable for all 3 axes of command and synchronization. Delivers maximum performance, economy, flexibility, and ease of system integration.
Digitally Adjustable Current Command Delay	User-selectable high-resolution command delay offers independent control for each axis; delay up to 40 usec with 40 nsec delay resolution.
InSight™ Software Toolkit (see separate data sheet)	Single, easy-to-use use graphical user interface for simple control of all amplifier functions.



Specifications

Resistance range0 Ω to 1 Ω (contact PCI for extended range)Maximum capacitance, output to ground0.2 μFMaximum capacitance, output to output0.2 μFAdvanced Digital Amplifier Architecture	Parameter	Value
AC line phase current (max continuous, at low line) 120 A RMS Internal AC line fuses, fast acting 150 A AC line fuses, fast acting 150 A AC line fuiter with transient voltage suppression Yes Input power (max continuous) 71 kVA Power factor (typical) -40 kVA Output power (max continuous) 60 kW Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Advanced Digital Amplifier Architecture 010 d 40 µsec; 40 nsec adjustment resolution 100% digital control loop, from command input to load output Yes Arearced Digital Amplifier Architecture 100 µK NS, 0.5 Hz – 50 Hz 100 µK NS, 0.5 Hz – 50 Hz 200 µA RMS, 0.5 Hz – 50 Hz Command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution sclin (software adjustable) ±50 A	Internal AC/DC Power Supply	
Internal AC line fuses, fast acting 150 A AC line filter with transient voltage suppression Yes Input power (max continuous) 71 kVA Input power (max at 20 kW gradient coil limited) ~40 kVA Power factor (typical) >0.9 Output power (max, load and waveform dependent) ~45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis 60 kW Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to output 0.2 µF Advanced Digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) Cto >15 kHz RMS output current noise (typical) <200 µ A RMS, 0.5 Hz – 50 Hz		380-480 VAC +/-10% at 50-60 Hz
AC line filter with transient voltage suppression Yes Input power (max continuous) 71 kVA Input power (max continuous) -40 kVA Power factor (typical) >0.9 Output power (max continuous) 60 kW Output current, continuous RMS 375 A Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 0.0 to 1 M (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 usec; 40 nsec adjustment resolution Gai (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Badwidth (typical, load dependent) Cto >15 kHz RMS output current noise (typical) <200 µA	AC line phase current (max continuous, at low line)	120 A RMS
Input power (max at 20 kW gradient coil limited) -40 kVA Power factor (typical) >0.9 Output power (max continuous) 60 kW Output power (max continuous) 60 kW Output power (max continuous) 60 kW Output power to load (max, load and waveform dependent) -45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis 900 A Bus voltage 2100 VDC Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Advanced Digital Amplifier Architecture 70 W of 120 (Ansec adjustment resolution Gain (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 AV to ±120 AV (default setting: +90 AV) Bandwidth (typical, load dependent) 200 µA RMS, 10 Hz – 1 kHz Settling time to +/- 0.25% (typical) <200 µA RMS, 10 Hz – 1 kHz	Internal AC line fuses, fast acting	150 A
Input power (max at 20 kW gradient coil limited) -40 kVA Power factor (typical) >0.9 Output power (max continuous) 60 kW Output power to load (max, load and waveform dependent) -45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis	AC line filter with transient voltage suppression	Yes
Power factor (typical) >0.9 Output power (max continuous) 60 kW Output power (max continuous) 60 kW Output power (max continuous) 60 kW Output power to load (max, load and waveform dependent) ~45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis 75 A Output current, ontinuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 100 will station of loop, from command input to load output Yes 200 vito ±120 AV (default setting: +90 AV) Bandwidth (typical, load dependent) DC to ±15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz – 50 Hz	Input power (max continuous)	71 kVA
Output power (max continuous) 60 kW Output power to load (max, load and waveform dependent) ~45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis 75 kW, single or combined axes Bus voltage 2100 VDC Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 100 µH to 1 msc adjustment resolution 10% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz - 50 Hz	Input power (max at 20 kW gradient coil limited)	~40 kVA
Output power to load (max, load and waveform dependent) ~45 kW, single or combined axes DC Bus Voltage and Amplifier Output Current, Per Axis 2100 VDC Bus voltage 2100 VDC Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Advanced Digital Amplifier Architecture 0 to 1 Ω (contact PCI for extended range) Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) 250 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz – 50 Hz	Power factor (typical)	>0.9
DC Bus Voltage and Amplifier Output Current, Per Axis 2100 VDC Bus voltage 2100 VDC Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Inductance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Advanced Digital Amplifier Architecture 100% digital control loop, from command input to load output 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: ±90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz – 50 Hz	Output power (max continuous)	60 kW
Bus voltage 2100 VDC Output current, continuous RMS 375 A Output current, peak (>25 msec) 900 A Load Specifications 100 µH to 1 mH (contact PCI for extended range) Inductance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 100 µH to 1 00, from command input to load output Yes 200 µA CM 0 µsec; 40 nsec adjustment resolution Gain (software adjustable) 450 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µa RMS, 0.5 Hz - 50 Hz	Output power to load (max, load and waveform dependent)	~45 kW, single or combined axes
Output current, continuous RMS 375 Å Output current, peak (>25 msec) 900 Å Load Specifications 100 µH to 1 mH (contact PCI for extended range) Inductance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 µF Advanced Digital Amplifier Architecture 0.2 µF 100 ψH to 1 nlm (contact PCI for extended range) 0.2 µF Advanced Digital Amplifier Architecture 0.2 µF 200 k digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µ ARMS, 0.5 Hz – 50 Hz	DC Bus Voltage and Amplifier Output Current, Per Axis	
Output current, peak (>25 msec) 900 A Load Specifications 100 μH to 1 mH (contact PCI for extended range) Resistance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 μF Advanced Digital Amplifier Architecture 010 to 1 120 (contact PCI for extended range) 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 μsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: ±90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 μa RMS, 0.5 Hz - 50 Hz	Bus voltage	2100 VDC
Load Specifications 100 μH to 1 mH (contact PCI for extended range) Inductance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 μF Maximum capacitance, output to output 0.2 μF Advanced Digital Amplifier Architecture 0 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 μsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 μA RMS, 0.5 Hz – 50 Hz	Output current, continuous RMS	375 A
Inductance range 100 μH to 1 mH (contact PCI for extended range) Resistance range 0 Ω to 1 Ω (contact PCI for extended range) Maximum capacitance, output to ground 0.2 μF Advanced Digital Amplifier Architecture 0.2 μF 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 μsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 AVV to ±120 AVV (default setting: +90 AVV) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 μA RMS, 0.5 Hz – 50 Hz	Output current, peak (>25 msec)	900 A
Resistance range0 Ω to 1 Ω (contact PCI for extended range)Maximum capacitance, output to ground0.2 μFMaximum capacitance, output to output0.2 μFAdvanced Digital Amplifier Architecture	Load Specifications	
Maximum capacitance, output to ground 0.2 μF Maximum capacitance, output to output 0.2 μF Advanced Digital Amplifier Architecture 0.2 μF 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 μsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 μA RMS, 0.5 Hz – 50 Hz	Inductance range	100 µH to 1 mH (contact PCI for extended range)
Maximum capacitance, output to output 0.2 µF Advanced Digital Amplifier Architecture 00% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz – 50 Hz	Resistance range	0Ω to 1Ω (contact PCI for extended range)
Advanced Digital Amplifier Architecture Yes 100% digital control loop, from command input to load output Yes Current command delay (software adjustable, each axis) 0 to 40 µsec; 40 nsec adjustment resolution Gain (software adjustable) ±50 A/V to ±120 A/V (default setting: +90 A/V) Bandwidth (typical, load dependent) DC to >15 kHz RMS output current noise (typical) <200 µA RMS, 0.5 Hz - 50 Hz	Maximum capacitance, output to ground	0.2 µF
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Gain (software adjustable)±50 A/V to ±120 A/V (default setting: +90 A/V)Bandwidth (typical, load dependent)DC to >15 kHzRMS output current noise (typical)<200 µA RMS, 0.5 Hz - 50 Hz <2.0 mA RMS, 10 Hz - 1 kHz	100% digital control loop, from command input to load output	Yes
Bandwidth (typical, load dependent)DC to >15 kHzRMS output current noise (typical)<200 µA RMS, 0.5 Hz – 50 Hz <2.0 mA RMS, 10 Hz – 1 kHz	Current command delay (software adjustable, each axis)	0 to 40 µsec; 40 nsec adjustment resolution
RMS output current noise (typical)<200 µA RMS, 0.5 Hz – 50 Hz <2.0 mA RMS, 10 Hz – 1 kHzSettling time to +/- 0.25% (typical)<200 µsec	Gain (software adjustable)	±50 A/V to ±120 A/V (default setting: +90 A/V)
RMS output current noise (typical)<2.0 mA RMS, 10 Hz – 1 kHzSettling time to +/- 0.25% (typical)<200 µsec	Bandwidth (typical, load dependent)	DC to >15 kHz
Command InputsOne fiber for all three axes and synchronizationHi-speed digital fiberOne fiber for all three axes and synchronizationThree analog inputs with integrated high performance ADC's+/- 10V differentialThree analog inputs with integrated high performance ADC's+/- 5V each signal of complementary pair 20 bit ADC'sCommunication PortsEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedMechanicalEnclosure outer dimensions:• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg	RMS output current noise (typical)	
Hi-speed digital fiberOne fiber for all three axes and synchronizationThree analog inputs with integrated high performance ADC's+/- 10V differential +/- 5V each signal of complementary pair 20 bit ADC'sCommunication PortsEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedMechanicalEnclosure outer dimensions:• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg	Settling time to +/- 0.25% (typical)	<200 µsec
+/- 10V differential +/- 5V each signal of complementary pair 20 bit ADC'sCommunication Ports	Command Inputs	
Three analog inputs with integrated high performance ADC's+/- 5V each signal of complementary pair 20 bit ADC'sCommunication PortsEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedEthernet, CAN Bus, USB, Bluetooth, RS-232SupportedMechanicalImage: SupportedEnclosure outer dimensions:Image: Supported• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg	Hi-speed digital fiber	One fiber for all three axes and synchronization
Ethernet, CAN Bus, USB, Bluetooth, RS-232SupportedMechanicalEnclosure outer dimensions:Enclosure outer dimensions:31 inch 790 mm• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg	Three analog inputs with integrated high performance ADC's	+/- 5V each signal of complementary pair
Ethernet, CAN Bus, USB, Bluetooth, RS-232SupportedMechanicalEnclosure outer dimensions:Enclosure outer dimensions:31 inch 790 mm• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg	Communication Ports	
MechanicalEnclosure outer dimensions:• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg		Supported
Enclosure outer dimensions:• Width31 inch 790 mm• Depth40 inch 1016 mm• Height74 inch 1880 mmWeight (no seismic anchors and no coolant)<760 kg		
Depth 40 inch 1016 mm Height 74 inch 1880 mm Weight (no seismic anchors and no coolant) <760 kg Environmental		
Depth 40 inch 1016 mm Height 74 inch 1880 mm Weight (no seismic anchors and no coolant) <760 kg Environmental	• Width	31 inch 790 mm
Height 74 inch 1880 mm Weight (no seismic anchors and no coolant) <760 kg Environmental		
Weight (no seismic anchors and no coolant) <760 kg	-	
Environmental		
Operating temperature ambient	Operating temperature, ambient	+50 to +95 °F +10 to +35 °C



Model QDCM2100D

Parameter	Value
Storage temperature, ambient	-22 to +158 °F -30 to +70 °C
Relative humidity, non-condensing	< 70%
Thermal Management - Water Cooling	
Components cooled by water	Power semiconductors mounted to high performance water-cooled heat sinks
Water heat load (typical for 3 X 150 Arms, 0.1Ω load)	<17 kW
Thermal Management - Air Cooling	
Active control prevents/minimizes condensation	System tolerates and protects against condensation damage; includes dew point detection and alarm
Air heat load (typical for 3 X 150 Arms, 0.1Ω load)	<1.8 kW
Utility Access	
Water and electrical (power, load) enter at back	Yes
Command and Communication Connections	
Command and communication connections enter at back	Yes
Field Replaceable Units (FRU)	
Multiple FRUs help maintain maximum up-time	Yes
Lightweight FRUs for single person servicing	<22 kg for all FRUs

Certifications and Standards

The QDCM2100D complies with the following certifications and standards.

- UL/CSA Approved, ANSI/AAMI ES60601-1:2005/®2012, CSA CAN/CSA-C22.2 NO. 60601-1:14
- EN60601-1:2006/A11:2011/A1:2013/A12:2014
- IEC60601-1, Edition 3, 3.1, CB Report
- EN50581:2012, RoHS (Europe)
- GB/T 26572-2011, RoHS (China)

D-SERIES™ and InSight™

The QDCM2100D incorporates all the powerful capabilities of D-SERIES[™] technology from PCI. Many of these capabilities are easily accessed using PCI's InSight[™] software toolkit. The 100% digital control loop architecture found in all D-SERIES[™] gradient amplifier systems enables industry-leading features such as:

- High-speed fiber-optic digital command interface
- High-resolution adjustable command time delay (independent control for each axis)
- Advanced System Diagnostics
- Sequence Development Assistant
- Amplifier Replicator
- Guided field software updates
- ... and many more

For more information on D-SERIES[™] and InSight[™] please refer to their respective data sheets.

Options and Customizations

PCI offers the following standard options for the QDCM2100D. Beyond the options described below, PCI is able to provide customizations to meet your special requirements and welcomes your inquiries.

Seismic Anchors

The seismic anchors consist of two angle brackets mounted to the underside of the cabinet. The vertical surface of each bracket has a standardized hole pattern for bolting to a mating bracket (not provided) which is bolted to the floor.

Performance Controls, Inc. (PCI) designs and manufactures high performance PWM (pulse width modulated) amplifiers and motor drives. We specialize in amplifiers characterized by high precision, high power, wide bandwidth, and ruggedized construction. You can select from one of our standard products, have a product customized, or work with us to develop a custom solution that exactly satisfies your application. Performance Controls, Inc. 151 Domorah Drive Montgomeryville, PA 18936 USA Tel: +1 215-619-4920 www.pcipa.com

PCI has a policy of continuous improvement and therefore reserves the right to update this information without notice to correct mistakes or to reflect specification changes. Please contact PCI to ask questions about this product or to confirm its specifications.

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