QDCM800-EP

Product Specification
500 -800V 600A 3-Axis
Gradient System

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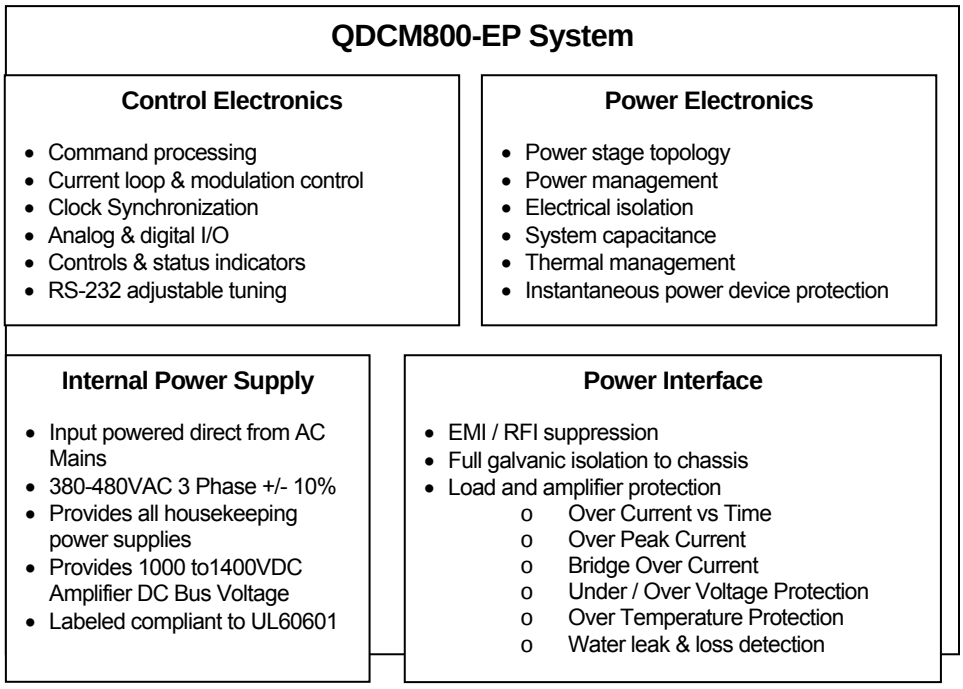
1. Product Overview

The QDCM800-EP is a pulse width modulated gradient system that contains three 800 VDC, 250 Arms, 600 Apk amplifiers and a mains isolated power supply, intended for use in precision control systems. The amplifier operates from 380–480 VAC, 50-60 Hz three phase mains connected power and provides a precisely controlled, high fidelity output current. The amplifier and power supply are water cooled and packaged in a cabinet 700 mm wide with an 1890 mm height and 950 mm depth. This Power Amplifier has been designed to operate in a control room environment. The power amplifier has been tested for EMC when operated as part of an imaging system.



2. Specifications for QDCM800

2.1 Power Supply Input Voltage & Current

• Input Voltage Range:	380 to 480 VAC +/-10% 50/60Hz
• Input Current Rating:	Fused at 80A
• System Input - Continuous Power Rating:	32kVA
• System Input - Peak Power Rating:	50kVA
• DC Bus Voltage – Programmable	500 to 800VDC

2.2 Amplifier Output Voltage & Current

• Output Voltage (with Vbus = 800 VDC):	750 Volts pk-pk
• Output Current	
o Continuous RMS:	250 ARMS (300 S – RMS period)
o Peak RMS:	360 ARMS (1.0 S – RMS period)
o Continuous DC (0 Amps AC):	220 ADC
o Absolute Peak Bi-Polar:	600 Apk (50 mS – t_{on} Maximum)
o Absolute Peak Uni-Polar	600 Apk (50 mS - t_{on} Maximum)

2.3 Load Specifications

• Adaptable LR Range:	180 µH to 8H & 0.04 Ohm to Open
• Maximum Load Capacitance	0.4 µF Output to GND

2.4 Small Signal Bandwidth

The small signal bandwidth	>15.0 kHz

2.5 Full Power Bandwidth

600A peak sine wave frequency	900 Hz (Load = 275uH & 0.1 Ohms)

2.6 Output Current Noise Spectrum

• .5 Hz to 50 Hz	< 100 µA RMS
• 10 Hz to 1 kHz	< 1.0 mA RMS

2.7 THD

The Total Harmonic Distortion plus Noise	< 0.2 % @ 200Hz (100 A RMS)

2.8 DC Stability

• Current Offset Stability	< 100 uA / hour
• Gain Stability	< 10 ppm / °C

2.9 Command Signal Processing

• Differential input impedance:	10 kOhms
• CMRR (circuit performance):	> 70 dB @ 1.0 kHz
• Max input voltage - input to ground	+/- 15V
• Max input voltage - differential input	+/- 15V

2.10 Command Scaling (Fixed)

Scaling adjustment range:	60 Amps/Volt

2.11 Output Offset (Fixed)

Output offset factory adjusted:	0.0 mA +/- 5 mA

2.12 Peak Current Limiter (Fixed)

Peak current limit range:	+/- 650 Apk

2.13 Current Loop: Compensation / Gain Adjustment

The current control compensation network is configurable via RS-232 command. This function allows fully adjustable control using four digital potentiometers (P, I , D & t). Using these controls permits PCI or the user to fine tune the matching between the amplifier and the load for optimal performance. Direct read using the RS-232 interface of the digital pots is provided to allow measurement and control of field adjustments.

2.14 Pulse Width Modulation Technique

• Base switching frequency	25 kHz
• Effective switching frequency	100 kHz

2.15 Clock Synchronization

A provision for PWM clock synchronization is provided, normally all clocks used internal are generated from a single 48 MHz crystal oscillator. A qualified clock synchronization signal is a TTL (wire or fiber-optic) square wave with the following characteristics:

• Frequency:	100 kHz +/- 1%
• Duty cycle between:	20% and 80%

2.16 Rear Panel Connections

The following table outlines various signal and power Inputs & Outputs, associated with the gradient amplifier system, located on the rear of the enclosure:

System Connection		
Name	**Type**	**Comment**
Axis Command	DB9P	Current Command Input - See section 2.20
Clock	Input	100kHz Synch Input - BNC or Agilent HFBR-2522.
Remote Control	DB9P	Various I/O - See section 2.21
RS-232	DB9P	Communication - see section 2.19
Remote Shutoff	BNC	External fault input signal, a ttl logic 0 will force all three amplifiers to disable.
AC Input	M8 Stud	AC phase & Protective Earth; quantity 4
GA Output	M12 Stud	X, Y & Z Gradient Outputs; quantity 6

2.17 Front Panel Switches & Indicators

A control panel interface is provided on the face of the QDCM1400A-LN to indicate status and provides means for resetting faults, enabling amplifier and monitoring operation.

Name	Switch / Indicator Type	Comment
AXIS ENABLE	Switch w/ integral LED (push-button toggle)	Holds amplifier in the disabled state. Push to Enable. Green LED on the ENABLE switch is lit when the amplifier is in the enabled state.
RESET	Switch (momentary)	Resets fault conditions and enables axis amplifiers depending on the state of the AXIS ENABLE switch. Momentary push will assert a RS-232 CLF & ENA signal.
POWER	Switch	Gradient amplifier master enable; in the on state the main power supply is connected to AC mains.
STATUS	Display	Alpha numeric LCD displays current system status when AC power is applied to the system.
COMMAND	BNC	Axis command monitor; 1 volt on BNC = 1 volt at command terminal input.
CURRENT	BNC	Axis output current monitor; 1 volt on BNC = 60 amps of output current.
VOLTAGE	BNC	Axis output voltage monitor; 1 volt on BNC = 150 volts of output voltage.
TUNE	BNC	Axis tuning monitor (error voltage); 1 volt on BNC = 1 amp of error between input current command and output current.

2.18 Fault Protection

The following table outlines the various faults, trigger thresholds, resulting action to the fault:

Fault Name	Trigger Threshold	Source	Action
Over Peak Current	Ipk > 600 A	Axis	• Axis Output Power Stage disables, all transistors turn off – high impedance state • Front panel AXIS ENABLE indicator turns off – dose not illuminate • STATUS displays the fault condition and the FRU that reported the abnormal condition. • The RS-232 communication port reports the fault by sending a CAN message. • Expanded fault data is available via RS-232 communication
Over Current vs. Time	Irms = 300A > 300S Irms = 400A > 1.0S	Axis	
Bridge Over Current	Desaturation (DESAT) Detected	Axis	
Clock	Internal vs. External clock selection & Status	NIC	
Over Temperature	$T_{Heat\ Sink}$ > 85 °C $T_{Filter\ Inductor}$ > 130 °C	Axis P/S	
DC Bus Voltage	VDC High, VDC Low & Fuse Open	P/S	
Gradient Coil Over Power	Customer Set for Coil Power	User	
Power Quality	AC Input outside of specification	P/S	
Self Test	All Field Replaceable Modules (FRU) will report abnormal operation	FRU	
Coolant Leak	Internal	NIC	• Same as above • Power Supply shuts down, discharges the DC bus voltage and disconnects the HV P/S from the mains voltage.

2.19 RS-232 Connector Definition

The following table defines the RS-232 connector I/O:

Pin No.	Signal Type	Comment
2	Output	RD (to System from NIC)
3	Input	TD (to NIC from System)
4	Input	DTR (to NIC from System) - optional
5	Ground	Signal Ground (User Reference)
6	Output	DSR (to System from NIC) - optional
1,7,8,9	N/A	NC

2.20 Axis Command Connector Definition

Three separate axis command signal connectors are provided, the I/O is defined in the below table:

Number	Signal Type	Comment
1	Input	Command (+)
2	Input	Command (-)
3	Ground	Analog ground – user reference
5	Ground	Signal Shield (consult factory)
Connector Case	Chassis	EMI Shield (consult factory)
4, 6-9	N/A	NC

2.21 Remote Control Interface Signals

The following analog and digital signals are provided to control and to monitor the status of the QDCM1400A-LN.

Pin No.	Signal Type	Comment
1	Input	Remote Shutoff #2 (referenced to analog GND)
2	Ground	Analog Ground (User Reference)
3	Output	+5 VDC @ 50mA (referenced to analog GND)
4	Digital Isolated Input	Power UP Interlock (+)
5	Digital Isolated Input	Power UP Interlock (-)
6	Digital Input	Interlock Over-ride (+)
7	Ground	Interlock Over-ride (-) – Analog Ground
8	Digital Isolated Output	System Fault Output (+)
9	Digital Isolated Output	System Fault Output (-)

3. Physical Specifications

The amplifier system is contained in a single stand alone cabinet:

Enclosure Outer Dimensions:

- Width 700mm
- Depth 1050mm
- Height 1890mm

Weight:

- 450 kG

3.1 Environmental

- Operating temperature: +10 to +35 °C ambient
- Storage temperature: -30 to +70 °C ambient
- Humidity (RH): Less than 70% non-condensing

3.2 Thermal Management

The power semiconductors are mounted to water cooled heat sinks. Total cooling water flow for the amplifier cabinet shall be greater than 15 LPM and less than 19 LPM. The maximum inlet fluid temperature is 30ºC, the minimum input fluid temperature is dependent on environmental conditions; contact PCI for specific information. The fluid pressure shall be greater than 70 kPa and less than 175 kPa. The cooling system will accept a wide range of different fluid type, please contact PCI for specific information. Two fans are provided for forced air cooling of all other (non-water cooled) components and condensation control. The fans are powered from an internally generated power supply. A total of 500 CFM of air flow is required.

3.3 Electrical Isolation

The QDCM800-EP is electrically isolated from chassis ground and the control circuits are electrically isolated from the power circuits. This amplifier provided superior RF containment and is designed for compliance to UL 60601.

4. Quality Assurance

4.1 Requirements

- Reliability: The QDCM800-EP calculated MTBF (Mean Time Between Failure) of 10,000 hrs is in process of verification by HALT (Highly Accelerated Life Testing) and service experiences. Supporting documentation is available upon request.
- Life Time: The QDCM800-EP is designed to have a usable life of ten years.
- Infant Mortality: Testing and product burn-in are applied with the intent to ensure infant mortality failures are eliminated prior to delivery. The PCI goal is zero out of box defects and zero failures.

4.2 Quality Program

- The QDCM800-EP was designed and is manufactured in accordance with an ISO 9000 compliant and audited quality program.

4.3 Burn-in

The QDCM800-EP Top Assembly is subjected to a rigorous burn-in process. The burn-in process consists of the following actions:

- Cycle between full rated output power and zero output power for a minimum duration of 24 hours. The burn-in wave form exercises the full peak and RMS rating of the QDCM800-EP at the maximum voltage rating + 5% nominal voltage rating.
- Thermal cycling.

5. Environmental and Standards Requirements

5.1 Standards

The QDCM800-EP is designed to meet the UL Medical Requirement of UL 60601-1, CAN/CSA C22.2 No 601.1 – M90 (R1997) and IEC 60601 -1. The QDCM800-EP is CE marked in accordance with Low Voltage Directive (73/23/EEC), the EMC Directive (89/336/EEC) and the CE Marking Directive (93/68/EEC).