PQC600 Series

600W 3" x 5" AC-DC Open Frame Power Supply Converter

Image is an approximation of the actual unit for illustration purposes. Details might vary. See the Mechanical section for more information.

FEATURES

- Certified to IEC 60601 Ed.3 medical (2 x MOPP Pri-Sec; 1 x MOPP Primary-Chassis Ground),1xMOPP output to chassis)
- Applied Part Type B & BF rated (isolation and patient leakage current performance)
- Designed to comply with IEC60601-1-2 4th Edition EMC Standard Requirements[1]
- Operation to 600W with forced airflow at +50°C; no derating with rated input line voltage[2,3]
- 5V 1A Auxiliary and 12V 0.6A fan outputs
- True zero load operation of the Main (V1) output; no minimum load requirements
- 3" x 5" industry standard footprint
- High-efficiency 95%, 230Vac full-load
- Remote sense, Main output[4]
- Output Voltage Adjustment via on board potentiometer
- Universal AC input, EN61000-3-2 Class A Harmonics
- Less than overall 1U height
- IEC62368-1 Ed 2 & Ed 3 certified
- RoHS compliant
- Active inrush protection
- PMBus™/I²C interface
- Enclosure kits with and without end-mounted fan[5]
- Two-year standard warranty

[1] When deployed in end-user systems.
[2] Vin < 100VAC might require power/temperature derating.
[3] Extended operation (with derating) up to +70C.
[4] Remote sense lines accommodated on a separate connector to meet PoE and applied part isolation requirements.
[5] Contact Murata Power Solutions for details and availability.
[6] Performance is based on conditions 25°C Tamb, 230Vac VIN, minimum output capacitance, horizontal mounting unless otherwise noted.
[7] The fan output is not recommended for general use due to its semi-regulated characteristic. It is intended for use to power the fan included with the PQC600-F-COVER (available separately).

Planned Submissions:

Certificate and Test Report

Low Voltage Directive

PRODUCT OVERVIEW

The PQC600 is a series of compact, efficient 3"x 5" low-profile AC-DC, switching power supply converters that provide a main 600W output, available in a wide range of voltages, featuring a robust, 350W convection-cooled rating at 50°C.

A 5V auxiliary output and convenient 12V external fan power are also provided. This power supply converter is fully protected from overcurrent, overvoltage, and thermal faults. A hardware status signal is provided, along with a PMBus™ 1.2 compliant digital communications bus for added flexibility. The low-profile assembly simplifies building into equipment with limited space and airflow. Cover kits with an optional end-mounted fan, are also available for greater deployment options.

The ITE and medical certifications make this power supply converter ideal for providing reliable power in a wide range of applications, such as industrial/automation, audio/video, office/IT equipment as well as health care equipment, hospital beds, and imaging systems.

ORDERING GUIDE

Part Number	Main Output Voltage (V1)			Aux. Output (V2)		Fan Output (V3)		Max. Load capacitance Main Output
	Voltage Vdc	Current @ 50°C 600W	Current @ 70°C[1]	Voltage Vdc	Current	Voltage	Current	
PQC600-12	12	50.00	29.2	5VDC	1.0ADC	12VDC	0.6ADC	6,000µF
PQC600-24	24	25.00	14.6					1,200µF
PQC600-28[2]	28	21.43	12.5					1,200µF
PQC600-36[2]	36	16.67	9.8					1,000µF
PQC600-48[2]	48	12.50	7.3					750µF
PQC600-54[2]	54	11.11	6.5					500µF
PQC600-COVER	Optional cover kit assembly, enclosed, perforated cover, no fan[2]							
PQC600-F-Cover	Optional cover kit assembly, enclosed with fan[2]							

[1] Refer to derating details and ACAN 148 for more information.
[2] Contact Murata Power Solutions for availability.

INPUT CHARACTERISTICS[6]

Parameter	Conditions	Min.	Nom.	Max.	Units
Input Voltage AC Operating Range	AC; 50/60Hz	90	100-240	264	Vac
Turn-On Voltage	Input rising[1]	80	-	85	Vac
Turn-Off Voltage	Input falling[1]	60	-	75	Vac
Input Frequency		47	50/60	63	Hz
AC Input Current	Vin = 100Vac; full load	-	-	7	AAC
AC Inrush Current	264VAC, cold-start	-	-	30	APK
Power Factor	At 230VAC, full load	0.95	-	-	W/VA
Hold-Up Time	$115V_{AC}$; 600W Pout	10	-	-	msec
Efficiency[2]	230VAC; 100% full load	-	95	-	%

[1] Operation outside the specified AC operating range is considered and abnormal condition. The PSU might self-protect under such conditions.
[2] See the efficiency performance plots for details.

MAIN OUTPUT VOLTAGE CHARACTERISTICS[6]

Output Voltage	Parameter	Conditions	Min.	Typ.	Max.	Units
VNOM[1]	Voltage Set Point	50% load	-0.5%	VNOM	+0.5%	VDC
	Voltage Trim Range[3]	50% load	-2	-	+2	%
	Line, Load Regulation		-	-	±1	%
	Minimum Load	Stable Operation	0	-	-	ADC
	Ripple Voltage & Noise[1,2,4]	Zero to Full Load	-	-	±1.5	%

[1] VNOM: 12.0V, 24.0V, 28.0V, 36.0V, 48.0V, 54.0V; 24V Model, 24V model; planned performance
[2] Ripple and noise are measured with 0.1uF ceramic capacitor and 10uF tantalum capacitor. A short coaxial cable with 50 ohm termination is used. 20MHz bandwidth.
[3] Trim pot or PMBus™ - see the Connection Map for location
[4] 12V model only: may exceed the limit slightly for load conditions > 50% full load

5V AUXILIARY OUTPUT (V2) CHARACTERISTICS[6]

Auxiliary Output	Aux Output Voltage	Load Current	Load Capacitance	Line, Load, Cross Regulation	Ripple Voltage & Noise
Aux (V2)	5V	0 to 1A	0 to 220µF	± 5%	120 mVp-p

MAIN OUTPUT CHARACTERISTICS

Parameter	Conditions	Typ.	Max.	Units
Transient Response[1]	10-60%, 50-100% load step, 1A/µsec slew rate and min 0.1A load		±5	%
Settling Time to 1% of Nominal			2	msec
Turn On Delay	After the application of input power		3	sec
Output Voltage Rise	Monotonic		50	msec
Remote Sense	Compensates for up to 250mV of total lead drop (output and return connections) with remote sense connected. Protected against short circuits and reverse connection.		250	mV

[1] Minimum 4s time between consecutive transients. 24V model; planned performance.

ENVIRONMENTAL CHARACTERISTICS

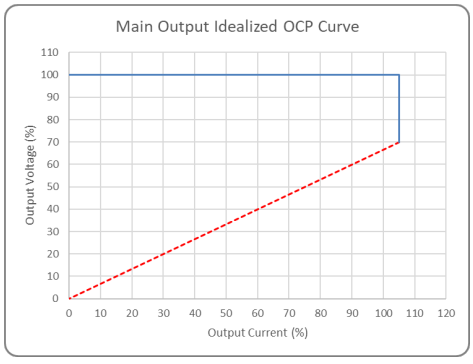
Parameter	Conditions	Min.	Typ.	Max.	Units
Storage Temperature Range		-40		85	°C
Operating Temperature Range	See power derating curves	-20		70	
	Cold Startup: -30°C @ 100V_{AC} minimum input[2]	-30		-	
Operating Humidity	Non-condensing	10		95	%
Operating Altitude		-		5000[1]	m
MTBF	Telcordia SR-332 Issue 3; GB, GC; M1C3 @ 40°C Telcordia SR-332 Issue 3; GB, GC; M1C3 @ 25°C		1,094K 2,200K		hours
Shock	30G, non-operating	Complies			
Operational Vibration	Sine Sweep; 5-150Hz, 2G Random Vibration, 5-500Hz, 1.11G	Complies			
Safety – Medical Standards 2 x MOPP (Primary-Secondary) (Planned Submissions)	IEC 60601-1:2005/AMD1:2012 CAN/CSA-C22.2 No. 60601-1:2014 ANSI/AAMI ES60601-1:2005/A1:2012-08 EN 60601-1:2006/A1:2013				
ITE Standards Audio/Video & Consumer Standards (Pending / Planned Submissions)	IEC 62368-1:2014 & IEC 62368-1:2018 CAN/CSA-C22.2 No. 62368-1:14 UL 62368-1 2nd & 3rd Ed. GB 17625.1-2022(Class A);GB 4943.1-2022;GB/T 9254.1-2021(Class A) EN IEC 62368-1:2020/A11:2020				
Fuses	Dual Fuses; Line and Neutral; 12.5A fast-acting; 250V				
Outside Dimensions	3.0" x 5.0" x 1.44" (76.2mm x 127mm x 35.2mm) nominal				
Weight (approx.)	454				g

[1] 3000m maximum altitude for medical applications.
[2] Ripple, Line/Load regulation, may exceed these limits slightly at Tamb. <-20°C. For initial cold temperature operation at higher load conditions, contact Murata for additional details.

PROTECTION CHARACTERISTICS

Parameter	Conditions	Min.	Typ.	Max.	Units
Over Voltage Protection	V1 (main output) latching[2]	115		140	%
	V2 (aux output) latching[2]				
Over Current Protection	V1, brick wall, foldback, hiccup, Latch[1,2]	105		130	%Amax
	V2, auto-recovery, hiccup[3]	110		250	
	V3, fuse protected, non-resettable, 1.5A[3]	Fuse Protected			
Over Temperature Protection (Primary and Secondary Heatsink Temperature)	Auto-recovery	120		130	°C
Remote Sense Short Circuit Protection			Complies		
Remote Sense Reverse Connection Protection			Complies		

[1] Brick wall shutdown typically occurs between 60% to 90% V_{OUT}; Constant current inception is approximately 105% full-load until V_{OUT} falls to ≤ 75% V_{OUT} at which point, foldback occurs. This repeats up to four times every 10s before latching off. See the OCP curve below for details.
[2] A latch-off state caused by an overvoltage or persistent overcurrent fault requires recycling of the incoming AC source or toggling PS_ON signal to reset.
[3] V3 and V2 share a common converter. V3 is intended to power the fan provided with the "PQC600-F-COVER" kit, available separately. Refer to Note 7 for additional details (Pg.1)



ISOLATION CHARACTERISTICS					
Parameter	**Conditions**	**Min.**	**Typ.**	**Max.**	**Units**
Isolation	Primary to Chassis (1x MOPP)	2121			V_{DC}
	Primary to Secondary (2xMOPP)	5656			
	Secondary Main V1 Output to Chassis[1] (1x MOPP)	2121			
	Output to Output[3]	2250			
Earth Leakage Current (under normal conditions)	V_{IN}: 264V_{AC}, T_{AMB}: 25°C			3.5	mA
Earth Leakage Current (under single fault condition)				10	
Touch Current – Normal				100	µA
Touch Current – Single Fault				500	
Patient Leakage - "B or BF" Normal[2]				100	µADC
Patient Leakage - "B or BF" Single Fault[2]				500	
PoE Isolation (non-medical requirement)	The Main V1 output is provided with the necessary isolation to chassis ground and other outputs and signals (not associated with the main output) to allow compliance with IEEE 802-3bt.				

[1] Complies with the limits of "B" (Body) and "BF" (Body Floating) for voltage isolation and allowable patient leakage current. The power supply PCB mounting holes connect to PE via metal enclosure.
[2] Main output only; auxiliary output, fan output and all hardware and digital signals excluded.
[3] Refers to isolation between Main and 12V fan & 5VAux outputs.

EMISSIONS AND IMMUNITY[1]		
Characteristic	**Standard**	**Compliance**
Input Current Harmonics	IEC/EN 61000-3-2	Class A
Voltage Fluctuation and Flicker	IEC/EN 61000-3-3	Complies[3]
Conducted Emissions	EN 55032	Class B
	FCC Part 15	Class B
Radiated Emissions	CISPR 32 -3 meter	Class B[3]
	FCC 15.109 - 3 meter	Class B[3]
ESD Immunity	IEC/EN 61000-4-2	Level 4, Criterion 2[4]
Radiated Field Immunity	IEC/EN 61000-4-3	Level 3, Criterion A
Electrical Fast Transient Immunity	IEC/EN 61000-4-4	Level 4, Criterion A
Surge Immunity	IEC/EN 61000-4-5	Level 3, Criterion A (Com. Mode: 2kV 12 OHM, Diff. Mode: 1kV, 2 OHM)
Radiated Field Conducted Immunity	IEC/EN 61000-4-6	Level 3, 10V/m, Criterion A[3]
Magnetic Field Immunity	IEC/EN 61000-4-8	Level 3, Criterion A[3]
Voltage dips, interruptions[2]	IEC/EN 61000-4-11	Level 3, Criterion B

[1] Designed to comply with IEC60601-1-2 4th Edition EMC Standard Requirements.
[2] For AC source interruptions that extend beyond 10ms, it is necessary to recycle the incoming AC source. Allow the AC source to be removed for a period of not less than 10s before reapplying.
[3] Compliance to be verified in end-user system.
[4] Tested installed in PQC600-COVER kit (enclosed).

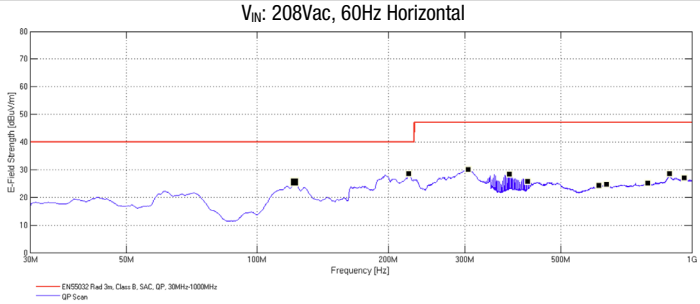
EMI CONSIDERATIONS

For optimum EMI performance, the power supply should be mounted to a metal plate grounded to all 4 mounting holes of the power supply. To comply with safety standards, this plate must be properly grounded to protective earth (see mechanical dimension notes). Pre-compliance testing has shown the stand-alone power supply to comply with EN55032 class B radiated emissions with a metal enclosure with a grounded base plate.

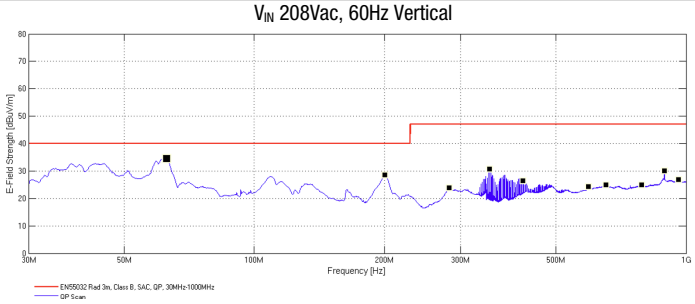
See PQC600-COVER for details testing; pre-compliance testing based on additional Fair-Rite core 0444176451 with two turns both of the V1 output leads and Fair-Rite 0444176451 core L,N, PE input leads, 1 turn. Radiated emission results vary with system enclosure and cable routing paths.

Typical Pre-Compliance Radiated Performance

V_{IN}: 208Vac, 60Hz Horizontal

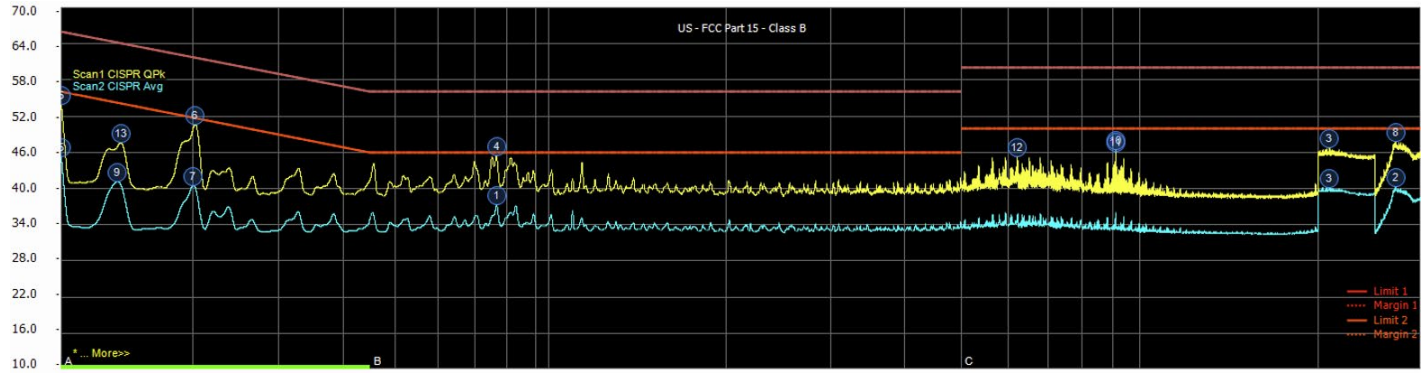


V_{IN} 208Vac, 60Hz Vertical

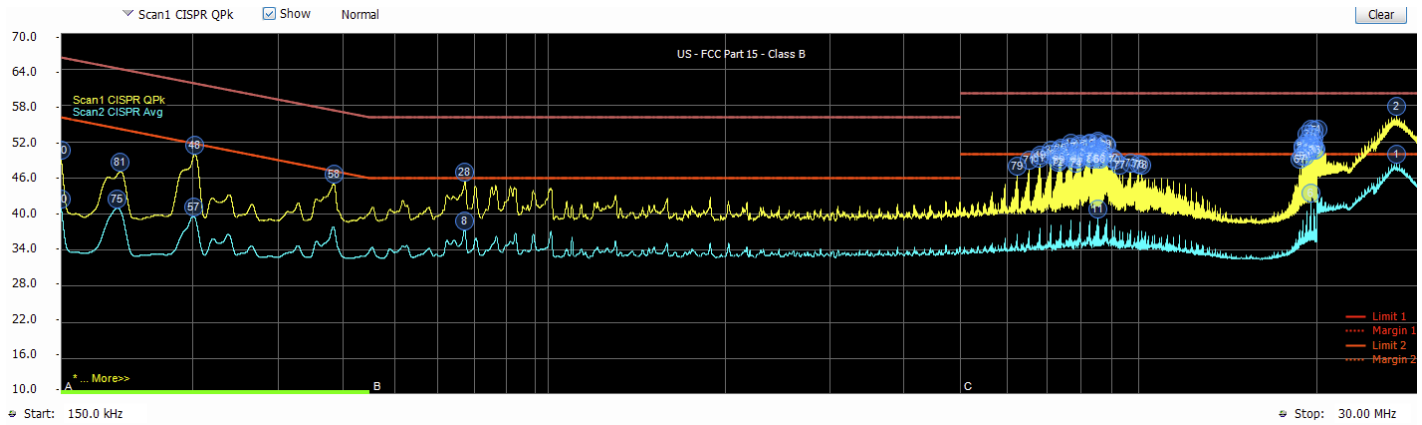


Typical Pre-Compliance Conducted Performance 12V model (Qpk)

V_{IN}: 208Vac, Max. I_{OUT}, L1:



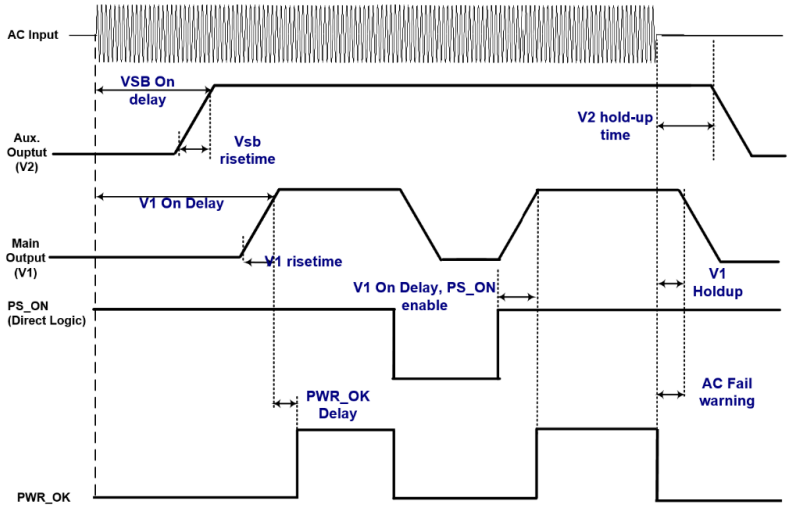
VIN 208Vac, Max. IOUT L2



STATUS AND CONTROL SIGNALS

Signal Name	Models	Conditions
PS_ON	All	This pin can be left unterminated or pulled high to +5V Auxiliary output J301 Pin 1, to turn on the main output. The +5V Auxiliary output is independent of the PS_ON signal and comes up automatically when the input power is applied (within their respective specified operating ranges). If it is desired to turn off the Main Output (during normal operation) then this pin can be pulled "low" (sink current >2mA) to Auxiliary output return
PWR_OK		Open collector logic goes high 40-100ms after the main output is within regulation; it goes low at least 2msecs before the loss of regulation. Internal 10K pull up to +5V_AUX is provided. Applications using the PWR_OK signal should maintain a minimum load of 5W on the main output.
REMOTE_SENSE REMOTE_SENSE_RTN		Remote sense connections are intended to be connected and sense the voltage at the point of load. The sensed voltage interacts with the internal module regulation loop to compensate for voltage drops due to connection resistance between the output connector and the load. If remote sense compensation is not required then these pins can be left un-terminated.
SDA & SCL		serial clock and data lines compatible with PMBus™ Power Systems Management Protocol Part 1 – General Requirements Rev 1.1. No additional internal capacitance is added that would affect the speed of the bus. The signal is provided with a series isolator device to disconnect the internal power supply bus in the event that the power module is unpowered. Refer to ACAN-146 for additional details and supported commands.

TIMING CHARACTERISTICS

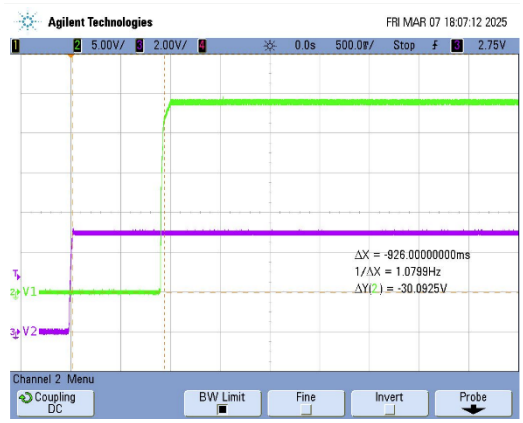


Time	Min.	Typ.	Max.	Notes
V1 Main output Risetime	-	90ms	150ms	VOUT: 10% to 90% VOUT nom.
5V Risetime	-	10ms	20ms	VOUT: 10% to 90% VOUT nom.
V2[1] to Main output turn-on delay	450	670ms	800ms	VOUT: 10% to 90% VOUT nom.
V2[1] Power-on-delay	100ms	-	750ms	From application of valid VIN to Vsb rising to 90% VOUT nom.
V1 Power-on-delay[2]	-	1500ms	3000ms	From application of valid VIN to V1 rising to 90% VOUT nom.
V1 On Delay, PS_ON enable	-	310ms	700ms	V1: 90% Vout nom. Upon V1 on by PS_ON signal
V1 On PWR_OK delay	-	64ms	100ms	V1 = 90% Vout nom to assertion of PWR_OK
AC fail warning	1ms	-	-	Warning time of imminent loss of V1 regulation due to loss of input voltage on
V1 hold-up time	10ms	-	-	100% Max load both output, VIN: 90Vac ; main output falls <90% VOUT nom.
V2[1] hold-up time	1000ms	2000ms	-	100% Max load both output, VIN: 90Vac ; V2 output falls <90% VOUT nom.

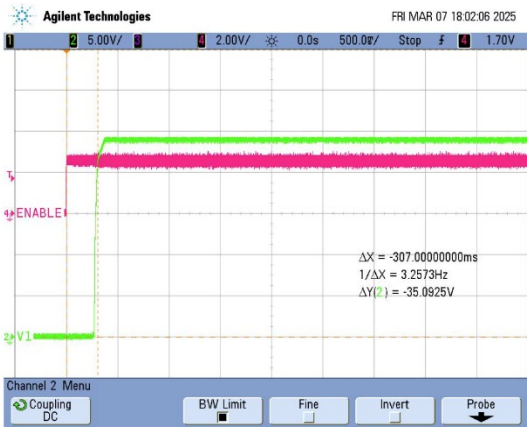
Note: Tamb: 25C
[1] V2 = Auxiliary Output, +5V
[2] Allow >3.1s between loss if Vin and re-application of input power.

PERFORMANCE DATA

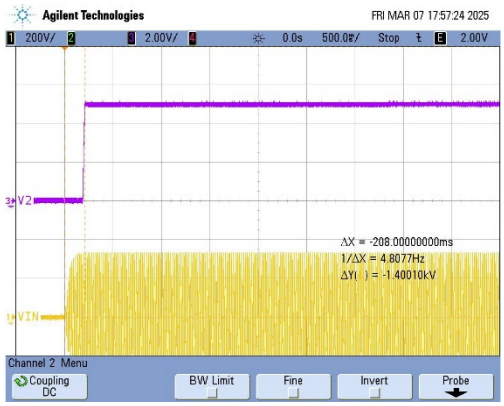
Timing Characteristics (24V model shown)



Startup V1 vs V2
100% load, min load capacitance, V_{IN}:90Vac



Startup by PS_ON
100% load, 230Vac



Startup Vin vs V2
100% load, 230Vac

PWR_OK Delay hold-up
100% load, 230Vac

PWR_O K vs V1 at turn on
100% load, 230Vac

PWR_O K vs V1 at turn on
100% load, 230Vac

THERMAL CONSIDERATIONS

System thermal management is critical to the performance and reliability of the PQC600 series power supplies. Performance derating curves below are provided which can be used as a guideline for what can be achieved in a system configuration with controlled airflow at various input voltage conditions.

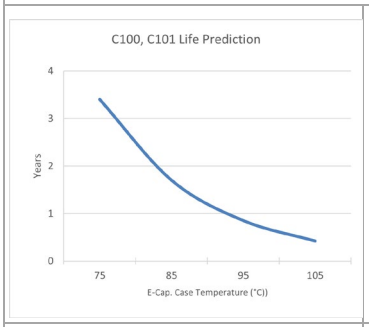
PQC600 is designed to provide 350W using natural convection cooling when mounted horizontally with unobstructed convection current airflow flow at room temperature. At elevated temperatures, the power supply data is taken while it is surrounded by a large vented enclosure to minimize forced crossflows inherent in the elevated temperature test.

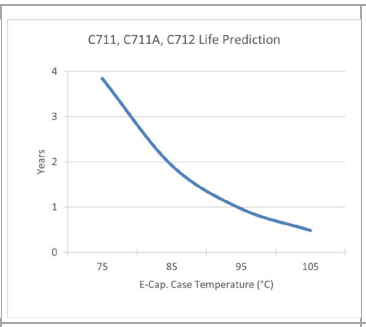
The PQC600 Series also benefits from the provision of forced cooling airflow (generated by an external host system fan). This enables operation at potentially higher local surrounding ambient temperatures. See ACAN-78 for additional details

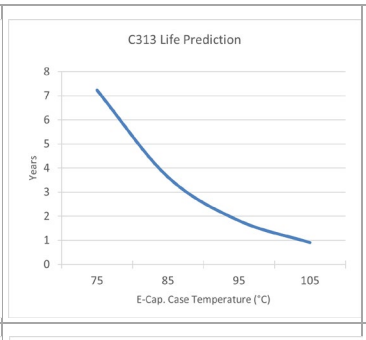
The product is capable of operation when mounted in other orientations; operational/derating curves shall be provided to show the effect of such mounting. See ACAN-77 for additional details

Capacitor Case Temperature and Mounting Orientation:

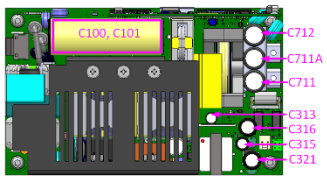
The power supply can operate in any orientation; however, the power supply contains overtemperature protection that will shut off the output as the temperature of the power supply heatsinks approach the limt specified in the protection table. Additionally, the life expectancy of the power supply is inversely proportional to the case temperature of electrolytic capacitors C100, C101, C711, C711A, C712, C313, C315, C316 & C321. The designer of the system in which this power supply is deployed should consider this relationship to ensure optimum product life. The following charts illustrate this relationship:

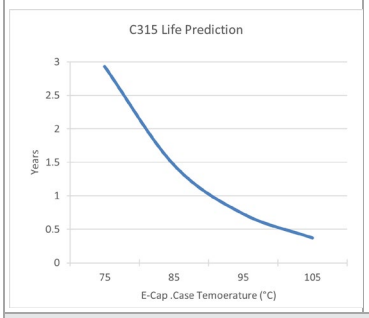


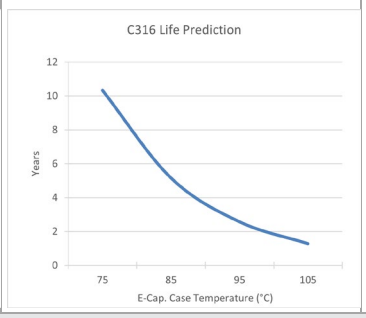


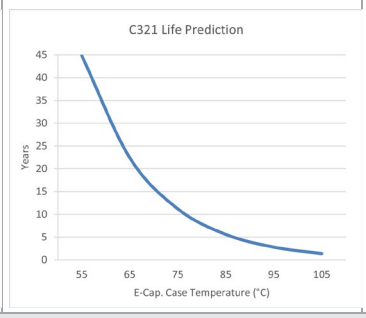


E-Cap Measurement Points

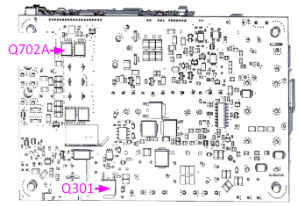






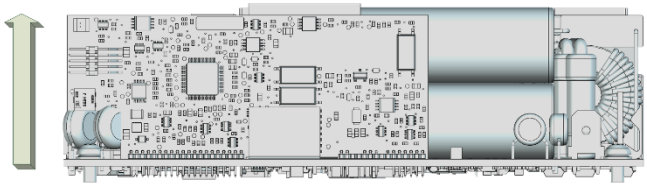


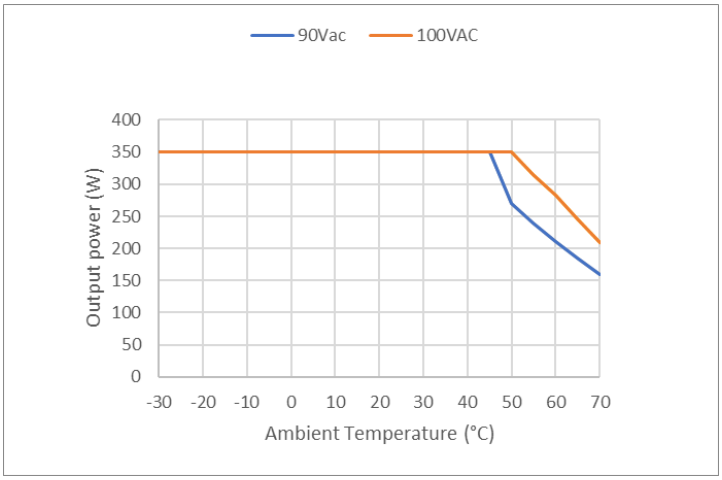
Hot Spot Measurement Points



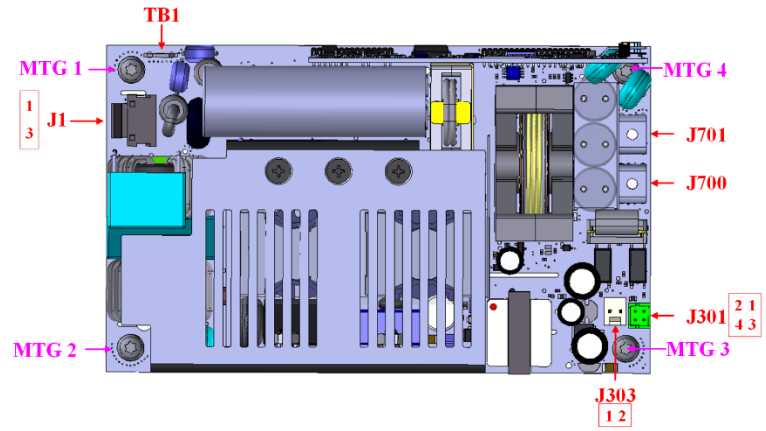
Natural Convection Temperature vs Vin vs Load Derating Curves

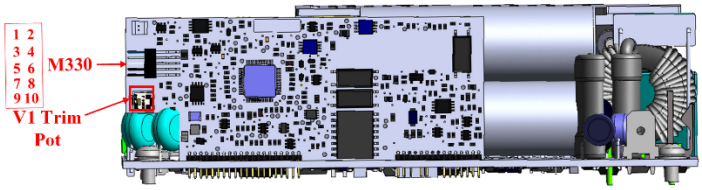
Orientation: horizontal



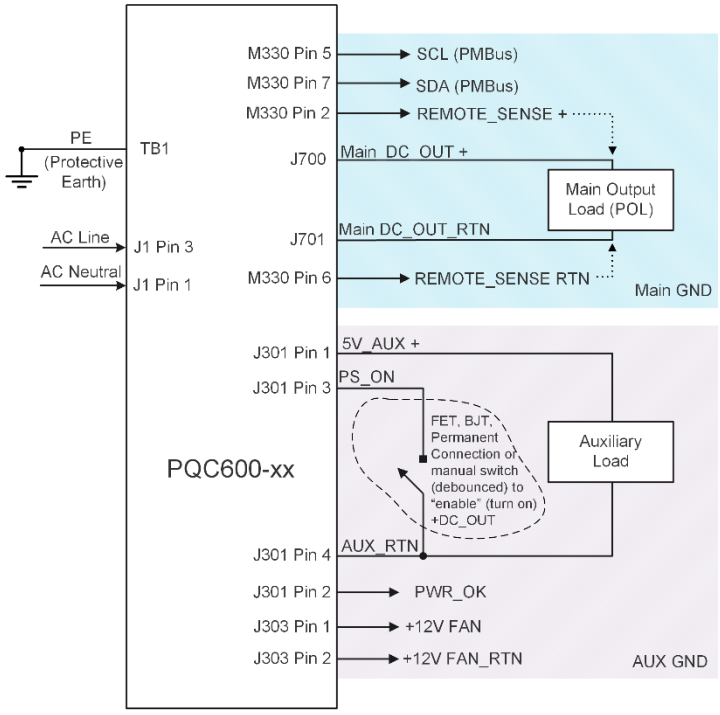


CONNECTION MAP





Wiring Diagram

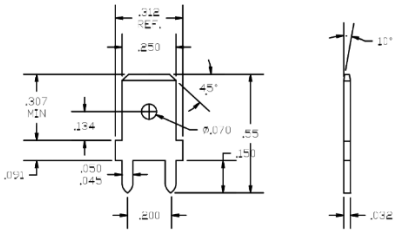


Dotted lines show optional remote sense connections, that can be extended to the Point of Load (POL) which can be some physical distance from the power module output connection terminals.
The intent is to compensate for any voltage drop in the cables to the to maintain voltage regulation at the POL. May Be left open or floating if remote sensing not required

Incoming Power Connection		
Position	**Function**	**Connection (PSU Side)**
J1 Pin 1	Input (AC Neutral)	Housing Molex:09930300
J1 Pin 3	Input (AC Line)	Wire Terminal Molex: 08500105

PE/Ground Connection

The incoming Protective Earth/Ground connection should be terminated (bonded) to a 0.25" x 0.032 "FASTON" tab, designated "TB1"



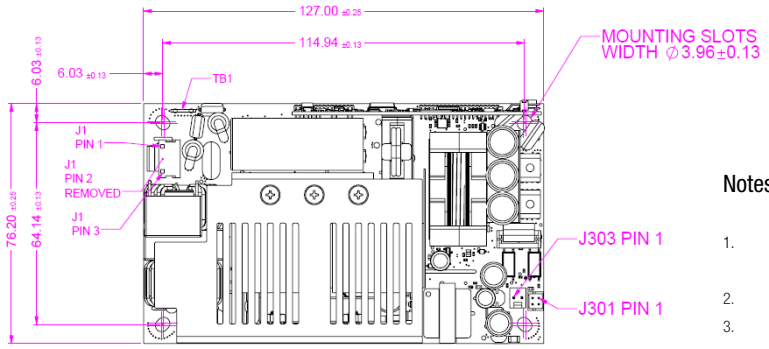
Main Output V1 Connections		
Position	**Function**	**Connection**
J700	Main DC_OUT_+	Screw Terminals, size M3 Screws, included
J701	Main DC_OUT_RTN	

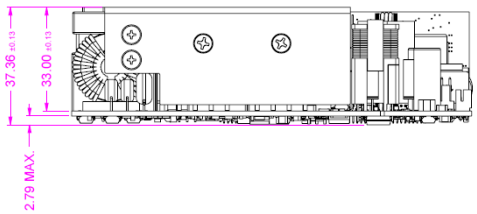
Fan Output Connection		
Position	**Function**	**Connector**
J303 Pin 1	External Fan +12V[7]	Molex 22-23-2021 (PSU)
J303 Pin 2	External Fan[7] +12V_RTN	Molex 22-01-3027 (Housing) Molex 08500113 (Wire crimps)

Auxiliary and Signals Connections		
Position	**Function**	**Connector**
J301 Pin 1	5V_AUX (V2)	LEOCO: 2020P04V000AE22 (PSU)
J301 Pin 4	5V_AUX (V2) RTN	
J301 Pin 2	PWR_OK	Mating Half:
J301 Pin 3	PS_ON	HIROSE ELECTRIC CO LTD DF11-4DS-2C Housing DF11-22SC Wire crimps, 22AWG

PMBus and Remote Sense Signal Connections		
Position	**Function**	**Connector**
M330 Pin 1	make no connection	Samtech FTSH-105-04-L-DH (PSU) Mating half: Any 0.050" / IDC type Housing/receptacle
M330 Pin 2	Remote_Sense +	
M330 Pin 3	make no connection	
M330 Pin 4	make no connection	
M330 Pin 5	SCL	
M330 Pin 6	Remote_Sense_RTN	
M330 Pin 7	SDA	
M330 Pin 8	make no connection	
M330 Pin 9	make no connection	
M330 Pin 10	make no connection	

MECHANICAL DIMENSIONS





Notes:

1. This drawing is a graphical representation of the product and may not show all fine details. Contact Murata for 3D model for details.
2. Reference File: D75090021801_RA_PS_ASSY_CUSTOMER
3. Dimensions in mm, Material: 0.80mm hot dipped galvanized steel, Grade G60 minimum spangle finished with a CR(6+) free corrosion resistant coating.

SAFETY CONSIDERATIONS

1. This power supply is a component-level power supply intended for use in Class I or Class II applications. Secondary ground traces need to be suitably isolated from primary ground traces when used in Class II applications.
2. When the power supply is used in Class II equipment, all ground traces and components connected to the primary side are considered primary for spacing and insulation considerations.
3. Protective bonding conductor from the end product protective earthing terminal must be tied to TB1. For optimum EMI performance, while maintaining Class I safety isolation all 4 mounting holes must be tied to the end product protective earthing terminal. To maintain Class II safety isolation mounting holes MTG1 and MTG2 (Refer to Connector Map for location need to be isolated from protective earth and should use standoffs of non-conductive material.
4. This power supply requires mounting standoffs of minimum 6mm in height. If there is risk of chassis deformation or shorter standoff height is required, an appropriate insulator must be used under the power supply with adequate extension beyond the outline of the power supply. In all cases, the applicable safety standards must be applied to ensure proper creepage and clearance requirements are met.
5. The primary heatsink is considered a live primary circuit, and should not be touched. It is recommended that the primary heatsink be kept at least 3.5mm from chassis, and 7mm from secondary circuits. In all cases, the applicable safety standards must be applied to ensure proper creepage and clearance requirements are met.
6. This product is subject to the following operating requirements and the Life and Safety Critical Application Sales Policy.
7. Used only in non-tropical conditions.

ACCESSORIES

Item	Description	Comments
PQC600-COVER	PQC600 Cover kit	Contact Murata Power Solutions for availability.
PQC600-F-COVER	PQC600 Cover kit with end-mounted fan	
4402196	MVAC400 series adapter kit	

APPLICATION NOTES

Document Number	Description	Comments
ACAN-148	Thermal Deployment Notes	Contact Murata Power Solutions for details.
ACAN-149	PMBus™ Communications Protocol Notes	Contact Murata Power Solutions for details.

Murata Power Solutions, Inc.
129 Flanders Road
Westborough, MA 01581 USA
ISO 9001 REGISTERED

This product is subject to the following operating requirements and the Life and Safety Critical Application Sales Policy: Refer to: https://www.murata.com/products/power/requirements/