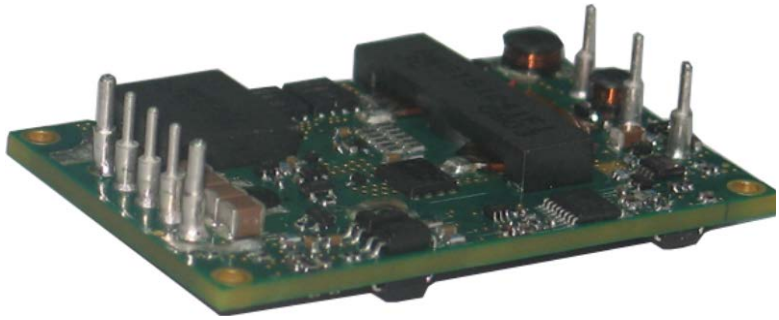
AGQ300-48S1V2

72 Watts

Quarter-brick Converter

Total Power:	72 Watts
Input Voltage:	36 to 75 Vdc
# of Outputs:	Single



Special Features

- Industry standard quarter brick
- Basic isolation
- Ultra high efficiency
- Improved thermal performance
- High power density
- Low output noise
- Industry standard pinout
- 2:1 wide input voltage of 36V~75V
- CNT function
- Remote sense
- Trim function
- Over-temperature protection
- Output over-current protection (hiccup)
- Output over-voltage protection (hiccup)
- RoHS compliant
- CNT function logic optional
- Pin length optional

Safety

EN60950
UL1950

Product Descriptions

The AGQ300-48S1V2 is a single output DC/DC converter with standard quarter-brick form factor and pin configuration. It delivers up to 60A output current with 1.2V output, provides CNT and trim functions. Ultra-high 85% efficiency and excellent thermal performance makes it an ideal choice for use in use in computing and telecommunication applications and can operate over an ambient temperature range of -40 ^{O}C ~ +85 ^{O}C, for most applications a heatsink is not required.

Applications

Telecom/ Datacom

ARTESYN™
EMBEDDED TECHNOLOGIES

Model Numbers

Standard	Output Voltage	Structure	Remote ON/OFF logic	RoHS Status
AGQ300-481V2-4L	1.2Vdc	Open-frame	Negative	R6
AGQ300-48S1V2P-4L	1.2Vdc	Open-frame	Positive	R6
AGQ300-48S1V2B-4L	1.2Vdc	Baseplate	Negative	R6
AGQ300-48S1V2PB-4L	1.2Vdc	Baseplate	Positive	R6

Ordering information

AGQ300	-	48	S	1V2	P	B	-	4	L
①		②	③	④	⑤	⑥		⑦	⑧

①	Model series	AGQ300: series name
②	Input voltage	48: 36V ~ 75V input range, rated input voltage 48V
③	Output number	S: single output; D: dual output
④	Rated output voltage	1V2: 1.2V output
⑤	Remote ON/OFF logic	P: Positive logical control, default is negative logic control
⑥	Baseplate	B: Baseplated. By default, no baseplate.
⑦	Pin length	4: 4.80 mm±0.5mm 6: 3.80 mm±0.5mm 8: 2.80 mm±0.25mm Default is 5.8 mm±0.5mm
⑧	RoHS status	L: RoHS, R6; Y: RoHS, R5

Options

None

Electrical Specifications

Absolute Maximum Ratings

Stress in excess of those listed in the “Absolute Maximum Ratings” may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply’s reliability.

Table 1. Absolute Maximum Ratings:

Parameter	Model	Symbol	Min	Typ	Max	Unit
Input Voltage						
Operating -Continuous	All	$V_{IN,DC}$	-	-	80	Vdc
Non-operating -100mS	All		-	-	100	Vdc
Maximum Output Power	All	$P_{O,max}$	-	-	72	W
Basic Input-output Isolation	All		-	-	2000	Vdc
Ambient Operating Temperature	All	T_A	-40	-	+85	^{O}C
Operating Board Temperature	All	Tc	-	-	-	^{O}C
Storage Temperature	All	T_{STG}	-55	-	+125	^{O}C
Humidity (non-condensing)						
Operating	All		5	-	95	%
Non-operating	All		5	-	95	%

Input Specifications

Table 2. Input Specifications:

Parameter	Conditions[1]	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, DC	All	$V_{IN,DC}$	36	48	75	Vdc
Maximum Input Current ($I_O = I_{O,max}$)	$V_{IN,DC}$ = 0 to $V_{IN,max}$	$I_{IN,max}$	-	-	2.5	A
Recommended Input Fuse[2]	Fast blow external fuse recommended		-	-	10	A
Input Reflected Ripple Current (Rated Input and Output)		I_I	-	10	20	mA_{PK-PK}
Supply Voltage Rejection (120Hz)			50	60	-	dB
Operating Efficiency	T_A=25 ^{O}C $I_O = I_{O,max}$ $V_{IN} = V_{IN,nom}$	η	-	85	-	%

Note 1 - Ta = 25 ^{O}C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.
Note 2 - This power module is not internally fused. An input line fuse must always be used.

Output Specifications

Table 3. Output Specifications:

Parameter		Condition[1]	Symbol	Min	Typ	Max	Unit
Factory Set Voltage		T_A=25 ^{O}C $V_{IN,DC}$ = $V_{IN,min}$ to $V_{IN,max}$ I_O=$I_{O,max}$	V_O	1.18	1.2	1.22	Vdc
Output Voltage Line Regulation		All	$\pm V_O$	-	3	5	mV
Output Voltage Load Regulation		All	$\pm V_O$	-	5	10	mV
Output Voltage Temperature Regulation		All	$\%V_O$	-	-	0.02	%/^{O}C
Output Voltage Trim Range		All	$\%V_O$	80	-	110	%
Output Ripple, pk-pk		T_A:25^{O}C, Air velocity: 200LFM, V_{IN}: 48V, $V_{O,nom}$, $I_{O,nom}$,10u tantalum(ESR≤100 mΩ)// 1µ ceramic capacitor, 0 to 20MHz bandwidth	V_O	-	-	100	mV_{PK-PK}
		Whole range, 0 to 20MHz bandwidth	V_O	-	-	100	mV_{PK-PK}
Output Current		All	I_O	0	-	60	A
Output DC current-limit inception[2]		All	I_O	66	-	84	A
V_O Load Capacitance		All	C_O	470	-	30000	uF
V_O Dynamic Response[3]	Peak Deviation Settling Time	V_{IN}=$V_{IN,nom}$, T_A:25^{O}C 25% $I_{O,nom}$ step from 50%$I_{O,nom}$, slew rate = 0.1A/us	$\pm V_O$ T_s	- -	- -	90 400	mV uS
	Peak Deviation Settling Time	V_{IN}=$V_{IN,nom}$, T_A:25^{O}C 75% $I_{O,nom}$ step from 50% $I_{O,nom}$, slew rate = 0.1A/us	$\pm V_O$ T_s	- -	- -	140 -	mV uS
	Peak Deviation Settling Time	V_{IN}=$V_{IN,nom}$, T_A:25^{O}C; 10% $I_{O,nom}$ to 100% $I_{O,nom}$, slew rate = 0.1A/us	$\pm V_O$ T_s	- -	- -	200 -	mV uS
Turn-on time		I_O = $I_{O,max}$ V_O within 1%	$T_{turn-on}$	-	10	20	mS
Isolation Capacitance		-	-	-	-	-	PF

Note 1 - Ta = 25 ^{O}C, airflow rate = 400 LFM, Vin = 48Vdc, nominal Vout unless otherwise noted.

Note 2 - Hiccup: auto-restart when over-current condition is removed.

Note 3 - Additional 470µF load capacitor.

Output Specifications

Table 3. Output Specifications, con't:

Parameter		Condition[1]	Symbol	Min	Typ	Max	Unit
Isolation Resistance		-	-	10	-	-	MΩ
Switching frequency		All	f_{SW}	-	300	-	KHz
Enable pin voltage	Logic Low	All	-	-0.7	-	1.2	Vdc
	Logic High	All	-	3.5	-	12	Vdc
Enable pin current	Logic Low	All	-	-	-	1.0	mA
	Logic High	Leakage current, @10V	-	-	-	-	uA
Output over-temperature protection[4]		Board (for open-frame)	T	110	120	135	^{O}C
		Hysteresis (for open-frame)		5	-	-	
Output voltage overshoot		$I_O=I_{O,max}$ $T_A=25^{O}C$	$\%V_O$	-	-	5	%
MTBF		V_{IN}: 48V, $I_{O,nom}$, Board $T_A=25^{O}C$		-	2	-	10^6 h
Vibration(Sine wave)		Vibration level: 3.5mm (2 ~ 9Hz), 10m/s^2 (9 ~ 200HZ),15m/s^2 (200 ~ 500Hz) Directions and time: 3 axis (X, Y, Z), 30 minutes each Sweep velocity: 1oct / min					
Shock (Half-sine wave)		Peak acceleration: 300m/s^2 Duration time: 6ms Continuous shock 3 times at each of 6 directions (±X, ±Y, ±Z)					

Note 4 - Auto recovery.

AGQ300-48S1V2 Performance Curves

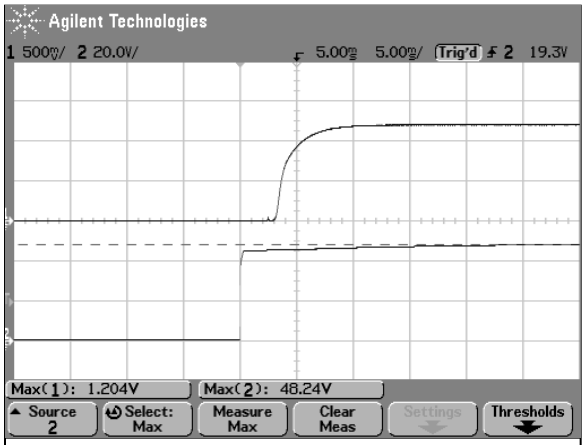


Figure 1: AGQ300-48S1V2 Output Voltage Startup Characteristic

Ch 1: Vo (500mV/div) Ch2: Vin (20V/div)

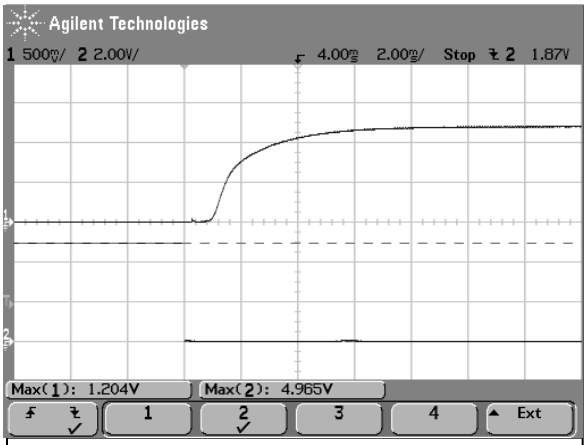


Figure 2: AGQ300-48S1V2 Remote ON Waveform

Ch 1: Vo (500mV/div) Ch2: CNT (2V/div)

Figure 3: AGQ300-48S1V2 Transient Response
25%~50%~25% load change, 0.1A/uS slew rate

Ch 1: Vo (20mV/div)

Figure 4: AGQ300-48S1V2 Transient Response
10%~100%~10% load change, 0.1A/uS slew rate

Ch 1: Vo (50mV/div)

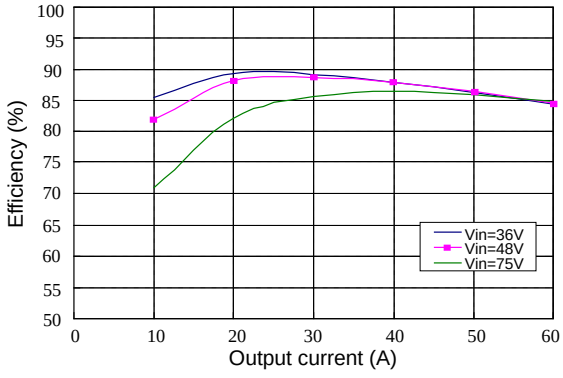


Figure 5: AGQ300-48S1V2 Efficiency Curves @ 25 ^{O}C

Loading: Io = 0A increase to 60A

Protection Function Specification

Over Voltage Protection (OVP)

The output over-voltage protection consists of circuitry that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over voltage protection threshold, the module will shut down and attempt to restart normally after about 500mS.

The protection mechanism is such that the unit can continue in this condition until the fault is cleared.

Parameter	Min	Nom	Max	Unit
V_O Output Overvoltage	120	/	140	%V

Over Current Protection (OCP)

AGQ300-48S1V2 features foldback current limiting as part of their Over-current Protection (OCP) circuits. When output current exceeds 110 to 140% of rated current, such as during a short circuit condition, the module will shut down and attempt to restart normally after about 500mS.

Parameter	Min	Nom	Max	Unit
V_O Output Overcurrent	110	/	140	%A

Over-Temperature Protection (OTP)

These modules feature an over-temperature protection circuit to safeguard against thermal damage. The module will work on intermittent mode when the maximum device reference temperature is exceeded. When the over-temperature condition is removed, the converter will automatically restart.

Input Reverse Voltage Protection

Under installation and cabling conditions where reverse polarity across the input may occur, reverse polarity protection is recommended. Protection can easily be provided as shown in Figure 6. In both cases the diode used is rated for 10A/100V. Placing the diode across the inputs rather than in-line with the input offers an advantage in that the diode only conducts in a reverse polarity condition, which increases circuit efficiency and thermal performance.

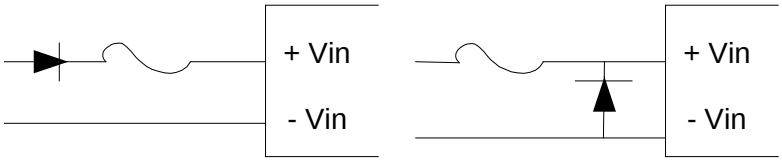
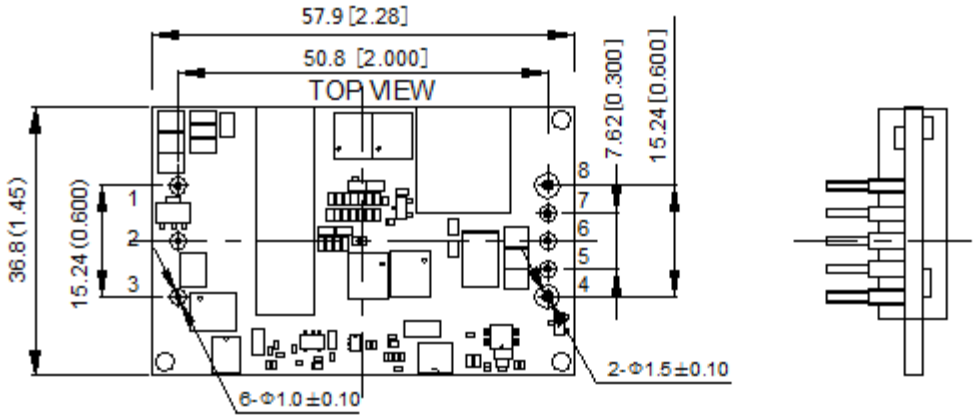


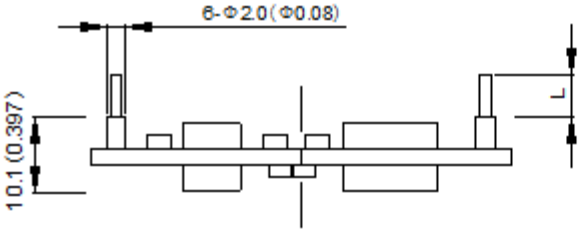
Figure 6 Reverse polarity protection circuit

Mechanical Specifications

Mechanical Outlines – Open-Frame Module

AGQ300-48S1V2





Pin Length Option

Device Code Suffix	L
-4	4.8mm +/- 0.5mm
-6	3.8mm +/- 0.5mm
-8	2.8mm +/- 0.25mm
NONE	5.8mm +/- 0.5mm

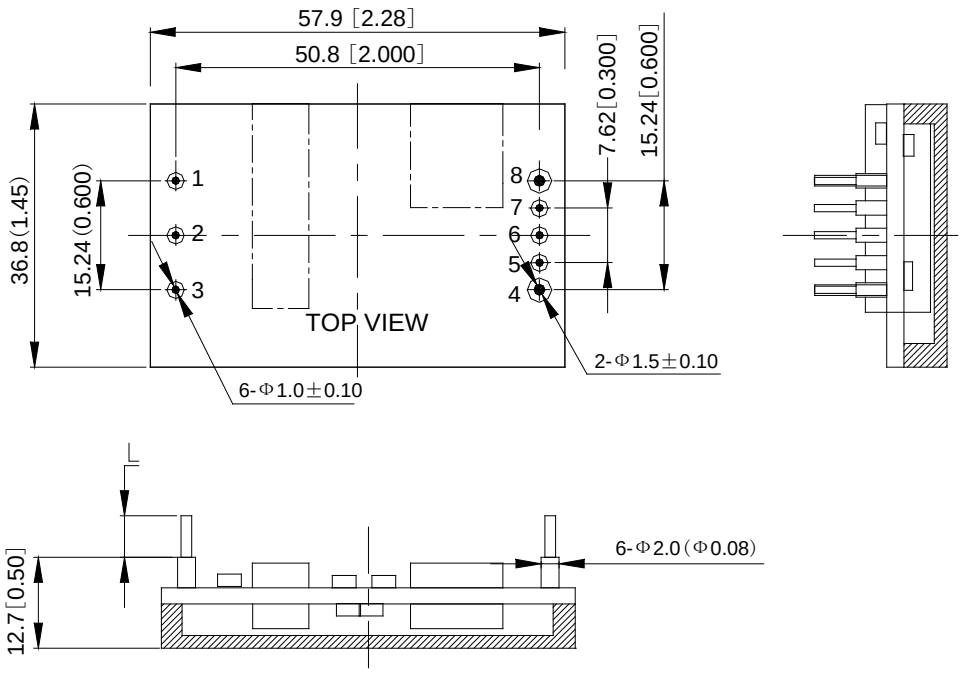
TOLERANCES: X.Xmm=+/-0.5mm

X.XXmm=+/-0.25mm

.

Mechanical Outlines – Baseplate Module

AGQ300-48S1V2B



TOLERANCES: X.Xmm=+/-0.5mm

X.XXmm=+/-0.25mm

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Pin Length Option

Device code suffix	L
-4	4.8mm±0.5 mm
-6	3.8mm±0.5 mm
-8	2.8mm±0.25 mm
None	5.8mm±0.5 mm

Pin Designations

Pin No	Name	Function
1	+Vin	Positive input voltage
2	CNT	Remote ON/OFF control
3	-Vin	Negative input voltage
4	-Vo	Negative output voltage
5	-Sense	Negative remote sense
6	Trim	Output voltage trim
7	+Sense	Positive remote sense
8	+Vo	Positive output voltage

Environmental Specifications

EMC

For conditions where EMI is a concern, a different input filter can be used. Figure 7 shows the filter designed to reduce EMI effects for AGQ300-48S1V2.

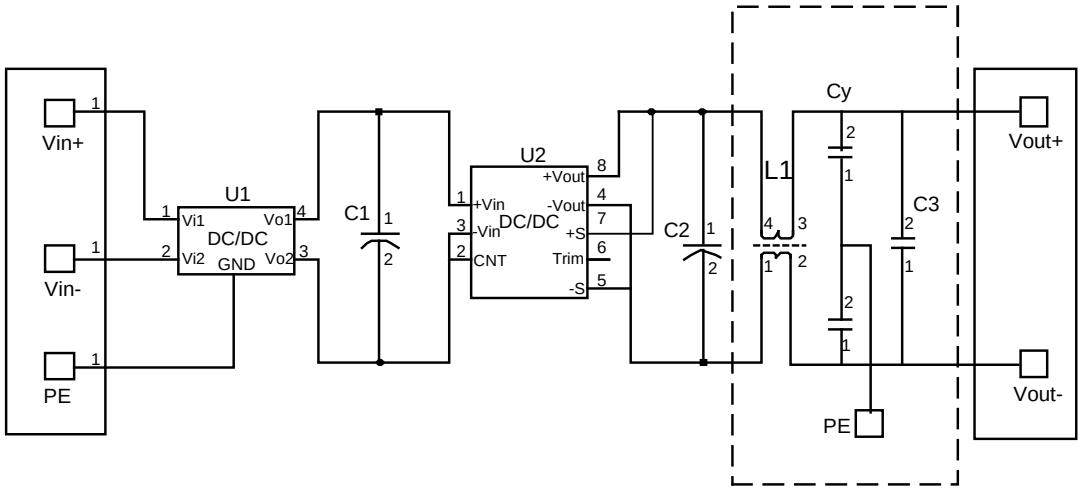

Figure 7 EMI reduction filter

Component	Value/rating	Type	Description
C1	100uF/100V	Aluminum Electrolytic	08010262: alum capacitor -100V-100μF-±20%-10*20-RoHS
C2	470uF/10V	Aluminum Electrolytic	08010373: alum capacitor -10V-470μF-±20%-10*12.5-5000hrs-RoHS

U1: 5A input filter module

Dashed part output filter: not needed

Safety Certifications

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards, i.e., UL1950 and EN60950.

AGQ300-48S1V2 input-to-output isolation is a basic insulation. The DC/DC power module should be installed in end-use equipment, in compliance with the requirements of the ultimate application, and is intended to be supplied by an isolated secondary circuit. When the supply to the DC/DC power module meets all the requirements for SELV (<60Vdc), the output is considered to remain within SELV limits (level 3). If connected to a 60Vdc power system, double or reinforced insulation must be provided in the power supply that isolates the input from any hazardous voltages, including the AC mains. One input pin and one output pin are to be grounded or both the input and output pins are to be kept floating. Single fault testing in the power supply must be performed in combination with the DC/DC power module to demonstrate that the output meets the requirement for SELV. The input pins of the module are not operator accessible.

Note: Do not ground either of the input pins of the module, without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pin and ground.

Table 4. Safety Certifications for AGQ300-48S1V2 series power supply system

Document	File #	Description
UL1950		US Requirements
EN60950		European Requirements

Fusing

AGQ300-48S1V2 has no internal fuse. An external fuse must always be employed! To meet international safety requirements, a 250 Volt rated fuse should be used. If one of the input lines is connected to chassis ground, then the fuse must be placed in the other input line.

Standard safety agency regulations require input fusing. Recommended rating is 10A for AGQ300-48S1V2.

Note: The fuse is fast blow type.

Operating Temperature

The AGQ300-48S1V2 power supplies will start and operate within stated specifications at an ambient temperature from -40 ^{O}C to 85 ^{O}C under all load conditions. The storage temperature is -55 ^{O}C to 125 ^{O}C.

Thermal Considerations

AGQ300-48S1V2 has ultra high efficiency at full load. With less heat dissipation and temperature-resistant components such as ceramic capacitors, these modules exhibit good performance during pro-longed exposure to high temperatures. Maintaining the operating board temperature within the specified range helps keep internal component temperatures within their specifications, which in turn helps keep MTBF from falling below the specified rating. Proper cooling of the power modules is also necessary for reliable and consistent operation. Measuring the board temperature of the module as the method shown in Figure 8 can verify the proper cooling. If the module has a baseplate, the measurement location is at the center of the baseplate.

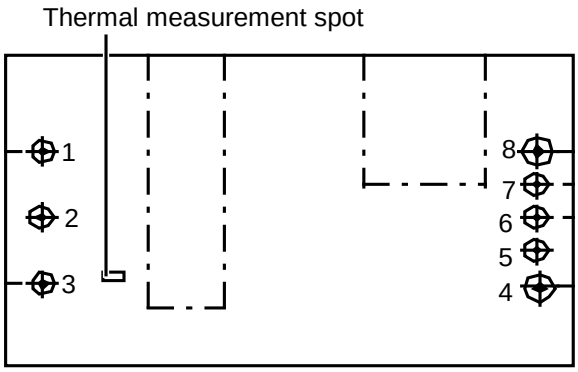

Figure 8 Temperature measurement spot

The module should work under 70 ^{O}C ambient for the reliability of operation and the board temperature must not exceed 105 ^{O}C while operating in the final system configuration. The measurement can be made with a surface probe after the module has reached thermal equilibrium. No heatsink is mounted, make the measurement as close as possible to the indicated position. It makes the assumption that the final system configuration exists and can be used for a test environment. Note that the board temperature of module must always be checked in the final system configuration to verify proper operation due to the variation in test conditions. Thermal management acts to transfer the heat dissipated by the module to the surrounding environment. The amount of power dissipated by the module as heat (PD) is got by the equation below:

PD = PI-PO

Where: PI is input power; PO is output power; PD is dissipated power.

Also, module efficiency (η) is defined as the following equation: η = PO/PI

By eliminating the input power term, we can get the equation below from the above two equations:

PD = PO (1-η)/η

The module power dissipation then can be calculated through the equation.

Module Derating

With 48V input, 25 ^{O}C ambient temperature, and 200LFM airflow, AGQ300-48S1V2 is rated for full power. The board temperature should be used to determine maximum temperature limits. The module cannot work continuously when the board temperature is over 100 ^{O}C. The minimum operating temperature for AGQ300-48S1V2 is -40 ^{O}C. The derating curve for open-frame is shown in Figure 9 and the derating curve with baseplate is shown in Figure 10.

Increasing airflow over the module enhances heat transfer via convection.

The module is not designed to operate for a long time with the baseplate temperature being above 100^{O}C.

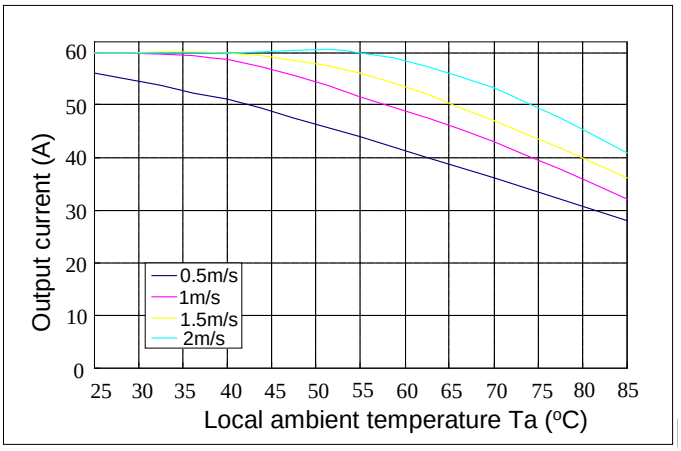

Figure 9 Derating curve of the module for open-frame, airflow rate from -Vin to +Vin

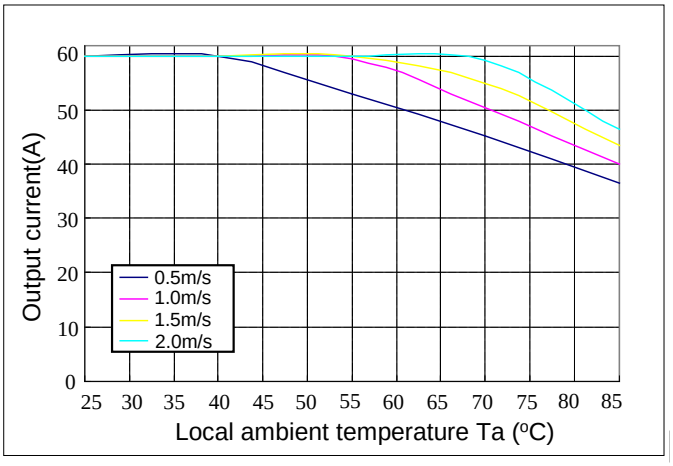

Figure 10 Derating curve of the module with baseplate, airflow rate from –Vin to +Vin

Application Notes

Typical Application

Below is the typical application of the AGQ series power supply.

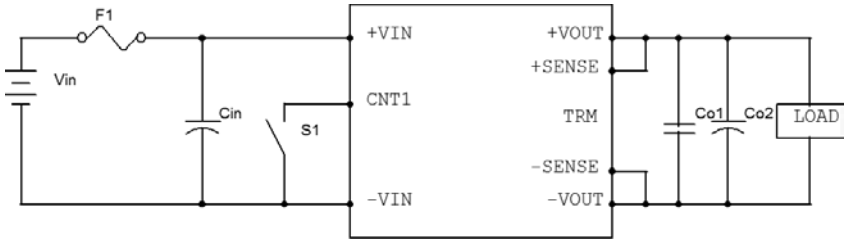

Figure 11 Typical application

F1: Fuse*: 10A fuse (fast blow type)

Cin: Recommended input capacitor, 100μF/100V high frequency low ESR electrolytic type capacitor

Co1: Recommended 1μF /25V ceramic capacitor

Co2: Recommended output capacitor Recommended 220μF/16V high frequency low ESR electrolytic type capacitor.

If Ta ＜-5 ^{O}C: use 220μF tantalum capacitor parallel with Co2.

Note: The AGQ300 modules cannot be used in parallel mode directly!

CNT Function

Two CNT logic options are available. The CNT logic, CNT voltage and the module working state are as the following table.

	L	H	OPEN
N	ON	OFF	OFF
P	OFF	ON	ON

N--- means “Negative Logic”

P--- means “Positive Logic”

L--- means “Low Voltage”, -0.7V ≤ L ≤ 1.2V

H--- means “High Voltage”, 3.5V ≤ H ≤ 12V

ON--- means “Module is on”, OFF--- means “Module is off”

Open--- means “CNT pin is left open”

Note: Normally, V_{CNT} ≤ 12V.

The following figure shows a few simple CNT circuits.

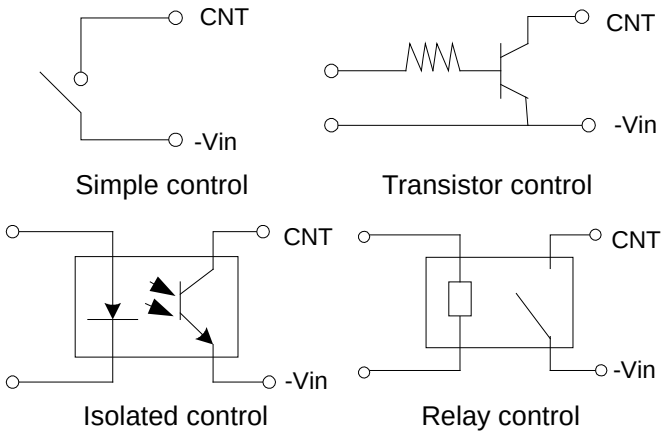

Figure 12 CNT circuit

Trim Characteristics

The +Vo output voltage of AGQ300-48S1V2 can be trimmed using the trim pin provided. Applying a resistor to the trim pin through a voltage divider from the output will cause the +Vo output to increase by up to 10% or decrease by up to 20%. Trimming up by more than 10% of the nominal output may activate the OVP circuit or damage the converter. Trimming down more than 20% can cause the converter to regulate improperly. If the trim pin is not needed, it should be left open.

Trim up

With an external resistor connected between the Trim and +Sense pins, the output voltage set point increases (see Figure 13).

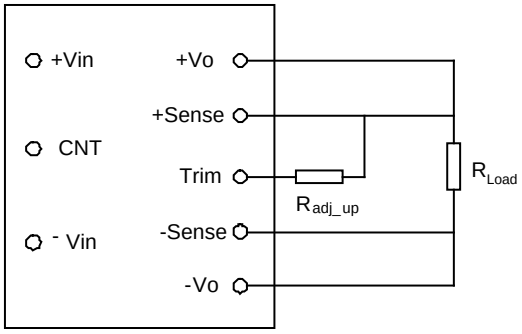

Figure 13 Trim up circuit

The following equation determines the required external-resistor value to obtain a percentage output voltage change of %.

$$R_{adj-up} = \frac{9.769 \times V_{nom} \times (100 + \Delta)}{0.6 \times \Delta} - \frac{1299.1}{\Delta} - 33.49 (k\Omega)$$

Note: △= (Vo-Vnom) % 100/Vnom

Trim down

With an external resistor between the Trim and -Sense pins, the output voltage set point decreases (see Figure 14).

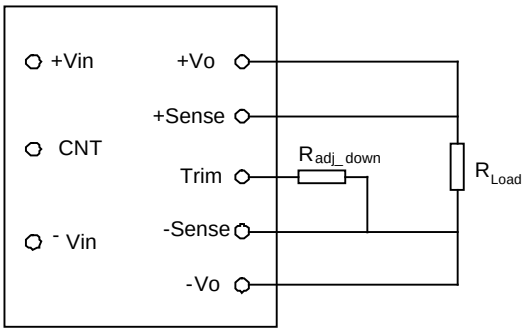

Figure 14 Trim down circuit

Trim Characteristics, con't

The following equation determines the required external-resistor value to obtain a percentage output voltage change of %.

$$R_{adj-down} = \frac{1299.1}{\Delta} - 33.49(\ k\Omega)$$

Note: △= (Vnom-Vo)% 100/Vnom

Although the output voltage can be increased by both the remote sense and the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim.

Note that at elevated output voltages the maximum power rating of the module remains the same, and the output current capability will decrease correspondingly.

Remote Sense

AGQ300-48S1V2 can remotely sense both lines of its output which moves the effective output voltage regulation point from the output terminals of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of AGQ300-48S1V2 in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load.

When the converter is supporting loads far away, or is used with undersized cabling, significant voltage drop can occur at the load. The best defense against such drops is to locate the load close to the converter and to ensure adequately sized cable is used. When this is not possible, the converter can compensate for a drop of up to 10%V_o, through use of the sense leads.

When used, the +Sense and -Sense leads should be connected from the converter to the point of load as shown in Figure 15, using twisted pair wire, or parallel pattern to reduce noise effect. The converter will then regulate its output voltage at the point where the leads are connected. Care should be taken not to reverse the sense leads. If reversed, the converter will trigger over-voltage protection (OVP).

When not used, the +Sense lead must be connected with +Vo, and -Sense with -Vo. Although the output voltage can be increased by both the remote sense and the trim, the maximum increase for the output voltage is not the sum of both.

The maximum increase is the larger of either the remote sense or the trim.

Note that at elevated output voltages the maximum power rating of the module remains the same, and the output current capability will decrease correspondingly.

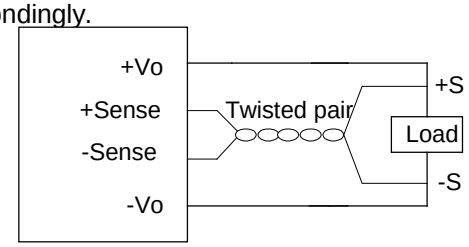

Figure 15 Sense connections

Minimum Load Requirements

There is no minimum load requirement for AGQ300-48S1V2.

Output Capacitance

High output current transient rate of change (high di/dt) loads may require high values of output capacitance to supply the instantaneous energy requirement to the load. To minimize the output voltage transient drop during this transient, low equivalent series resistance (ESR) capacitors may be required, since a high ESR will produce a correspondingly higher voltage drop during the current transient.

When the load is sensitive to ripple and noise, an output filter can be added to minimize the effects. A simple output filter to reduce output ripple and noise can be made by connecting a capacitor C1 across the output as shown in Figure 16. The recommended value for the output capacitor C1 is 470µF.

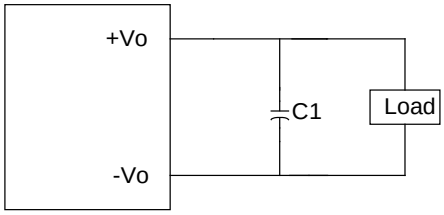

Figure 16 Output ripple filter

Extra care should be taken when long leads or traces are used to provide power to the load. Long lead lengths increase the chance for noise to appear on the lines. Under these conditions C1 can be added across the load, with a 1µF ceramic capacitor C2 in parallel generally as shown in Figure 17.

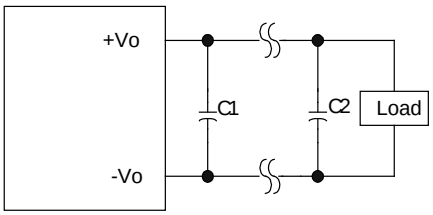

Figure 17 Output ripple filter for a distant load

Decoupling

Noise on the power distribution system is not always created by the converter. High speed analog or digital loads with dynamic power demands can cause noise to cross the power inductor back onto the input lines. Noise can be reduced by decoupling the load. In most cases, connecting a 10µF tantalum or ceramic capacitor in parallel with a 0.1µF ceramic capacitor across the load will decouple it. The capacitors should be connected as close to the load as possible.

Ground Loops

Ground loops occur when different circuits are given multiple paths to common or earth ground, as shown in Figure 18 Multiple ground points can slightly different potential and cause current flow through the circuit from one point to another. This can result in additional noise in all the circuits. To eliminate the problem, circuits should be designed with a single ground connection as shown in Figure 19.

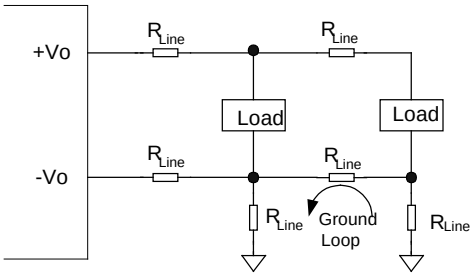

Figure 18 Ground loops

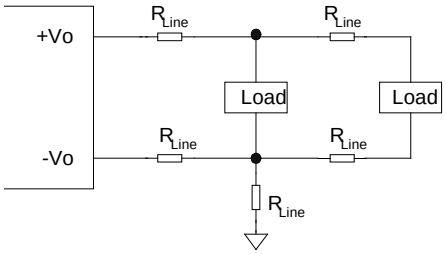

Figure 19 Single point ground

MTBF

The MTBF, calculated in accordance with Bellcore TR-NWT-000332, is 2,500,000 hours. Obtaining this MTBF in practice is entirely possible. If the board temperature is expected to exceed +25 ^{O}C, then we also advise to orient the module for the best possible cooling in the air stream.

Artesyn Embedded Technologies can supply replacements for converters from other manufacturers, or offer custom solutions. Please contact the factory for details.

Weight

The AGQ300-48S1V2 series weight is 28g.typ. for open frame module.

Installation

Although AGQ300-48S1V2 can be mounted in any orientation, free air-flowing must be taken. Normally power components are always put at the end of the airflow path or have separate airflow paths. This can keep other system equipment cooler and increase component life spans.

Note:

1. There should be no electrical connection between the case and the PE or any module ports.

2. The fixing screw of the heatsink should not be too long. Please refer to the mechanical chart for detail.

Soldering

AGQ300-48S1V2 is compatible with standard wave soldering techniques. When wave soldering, the converter pins should be preheated for 20~30 seconds at 110 ^{O}C, and wave soldered at 260 ^{O}C for less than 10 seconds.

When hand soldering, the iron temperature should be maintained at 425 ^{O}C and applied to the converter pins for less than 3 seconds. Longer exposure can cause internal damage to the converter. Cleaning can be performed with cleaning solvent IPA or with water.

Hazardous Substances Announcement (RoHS of China R6)

Parts	Hazardous Substances					
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
AGQ300-48S1V2	x	x	x	x	x	x

x: Means the content of the hazardous substances in all the average quality materials of the part is within the limits specified in SJ/T-11363-2006

√: Means the content of the hazardous substances in at least one of the average quality materials of the part is outside the limits specified in SJ/T11363-2006

Artesyn Embedded Technologies has been committed to the design and manufacturing of environment-friendly products. It will reduce and eventually eliminate the hazardous substances in the products through unremitting efforts in research. However, limited by the current technical level, the following parts still contain hazardous substances due to the lack of reliable substitute or mature solution:

1. Solders (including high-temperature solder in parts) contain plumbum.
2. Glass of electric parts contains plumbum.
3. Copper alloy of pins contains plumbum

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