

GAH30S12

DC-DC Converter Technical Manual V1.0

Date: 2012-02-03



Half-Brick DC-DC Converter	36–75 V Input	12 V Output	30 A Current	Negative Logic
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Description

The GAH30S12 is an isolated DC-DC converter that uses an industry-standard half-brick structure, and features high efficiency and power density. It has the dimensions of 12.7 mm x 57.9 mm x 61.0mm (0.50 in. x 2.28 in. x 2.40 in) and provides the rated output voltage of 12 V and the maximum output current of 30 A.



GAH30S12

Operational Features

- Input voltage: 36–75 V
- Output current: 0–30 A
- Low output ripple and noise
- Efficiency: 95.6% (12 V, 15 A)

Mechanical Features

- Industry standard half brick (H x W x D, with a base plate 12.7 mm x 57.9 mm x 61.0mm (0.50 in. x 2.28 in. x 2.40 in.))
- Weight: about 67.6 g

Protection Features

- Input undervoltage protection
- Output overcurrent protection (hiccup mode)
- Output short circuit protection (hiccup mode)
- Output overvoltage protection (hiccup mode)
- Overtemperature protection (self-recovery)

Control Features

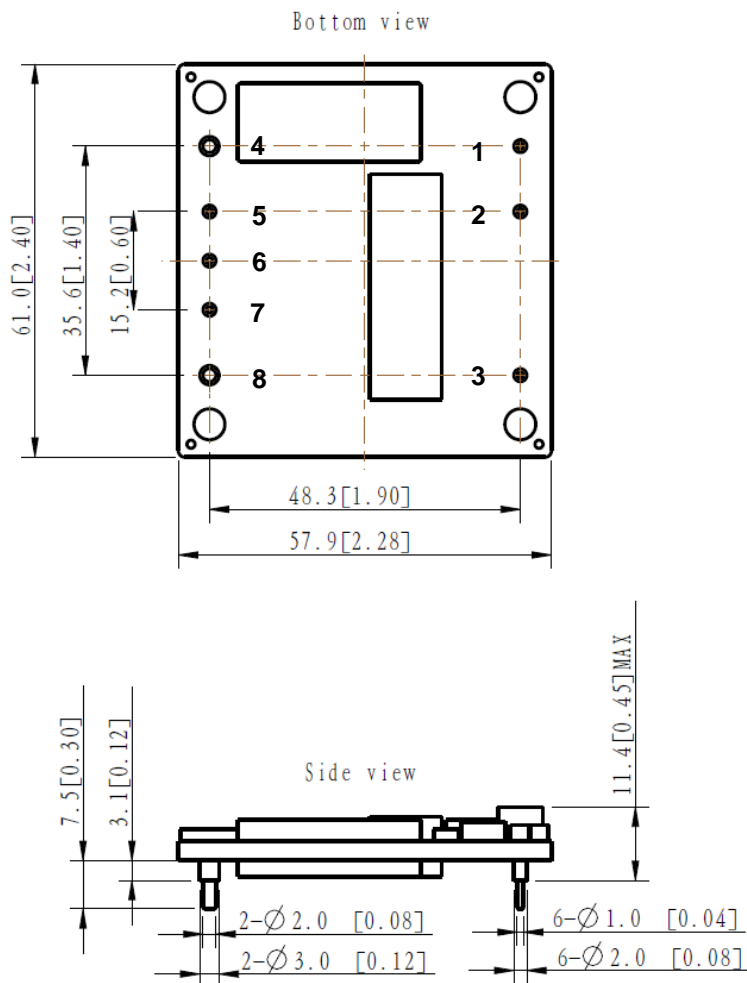
- Remote on/off
- Remote sense
- Output voltage trim

Safety Features

- UL60950-1 and IEC/EN60950
- Underwriters Laboratory (UL) certification
- Class B requirements in FCC and EN55022 (after connecting to an external filtering circuit)
- UL94V-0
- Restriction of the use of certain hazardous substance (RoHS) 6

Mechanical Diagram

Unit of measurement: mm (in.)



Pin description

Pin No.	Function
1	$V_{in} (+)$
2	CNT
3	$V_{in} (-)$
4	$V_{out} (+)$
5	Sense (+)
6	Trim
7	Sense (-)
8	$V_{out} (-)$

Dimensions tolerance

.x	± 0.2 mm (0.007 in.)
.xx	± 0.13 mm (0.005 in.)

Designation Explanation

G A H 30 S 12
 1 2 3 4 5 6

- 1 — Isolated
- 2 — Analog
- 3 — Half-brick
- 4 — Output current
- 5 — Single output
- 6 — Output voltage: 12 V

Electrical Specifications

Conditions: $T_A = 25^\circ\text{C}$ (77°F), Airflow = 1.0 m/s (200 LFM), $V_{in} = 48\text{ V}$, $V_{out} = 12\text{ V}$, unless otherwise specified.

Parameter	Min.	Typ.	Max.	Units	Remarks
Absolute maximum ratings					
Input voltage					
Continuous	-	-	80	V	-
Transient (100 ms)	-	-	100	V	-
Operating ambient temperature	-40	-	85	°C	See the thermal derating curve.
Storage temperature	-55	-	125	°C	-
Operating humidity	10	-	95	% RH	Non-condensing
Input characteristics					
Operating input voltage	36	48	75	V	-
Maximum input current	-	-	11	A	$V_{in} = 36\text{ V}$; $I_{out} = 30\text{ A}$
No-load loss	-	4.3	-	W	$V_{in} = 48\text{ V}$
Input capacitance	100	220	-	μF	Electrolytic capacitor
Inrush transient	-	-	2	A^2s	-
Input reflected ripple current	-	25	80	mA	Please refer to Figure 13.
Output characteristics					
Output voltage setpoint	11.76	-	12.24	V	-
Output power	-	-	360	W	-
Output line regulation	-	-	0.3	% V_o	$V_{in} = 36\text{--}75\text{ V}$; $I_{out} = 30\text{ A}$
Output load regulation	-	-	0.5	% V_o	-
Regulated voltage precision	-	-	3	% V_o	The whole range of V_{in} , I_{out} and T_A
Temperature coefficient	-	-	0.02	% $V_o/^\circ\text{C}$	$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ (-40°F to $+185^\circ\text{F}$)
External capacitance	470	-	10000	μF	Electrolytic capacitor
Output current	0	-	30	A	-
Output ripple and noise	-	117	300	mVp-p	$V_{in} = 36\text{--}75\text{ V}$; Oscilloscope bandwidth: 20 MHz; Please refer to Figure 13.
Output voltage adjustment range(trim)	90	-	110	% V_o	-
Out voltage overshoot	-	-	5	% V_o	The whole range of V_{in} , I_{out} and T_A
Output voltage rise time	-	-	100	ms	The whole range of V_{in} , I_{out} and T_A
Switching frequency	-	280	-	kHz	-

Electrical Specifications

Conditions: $T_A = 25^\circ\text{C}$ (77°F), Airflow = 1.0 m/s (200 LFM), $V_{in} = 48\text{ V}$, $V_{out} = 12\text{ V}$, unless otherwise specified.

Parameter	Min.	Typ.	Max.	Units	Remarks
Protection Features					
Input undervoltage protection					
Startup threshold	31	-	36	V	-
Shutdown threshold	30	-	35	V	-
Hysteresis	1	-	2	V	-
Output overcurrent protection	33	-	42	A	$V_{in} = 36\text{--}75\text{ V}$; Hiccup mode
Output short circuit protection	-	-	-	-	Hiccup mode
Output overvoltage protection	14	-	16.5	V	Hiccup mode
Overtemperature protection					Self-recovery
Threshold	120	-	130	$^\circ\text{C}$	The values are obtained by measuring the temperature of the PCB bottom near the thermal resistor.
Hysteresis	5	10	15	$^\circ\text{C}$	
Dynamic Characteristics					
Overshoot amplitude	-	211	600	mV	Current change rate: 0.1 A/ μs load : 50%–75%–50%
Recovery time	-	0	400	μs	
Overshoot amplitude	-	-	600	mV	Current change rate: 1 A/ μs load : 50%–75%–50% additional 1000 μF load capacitor
Recovery time	-	-	400	μs	
Efficiency					
100% load	-	94.8	-	%	$V_{in} = 48\text{ V}$; $I_{out} = 30\text{ A}$; $T_A = 25^\circ\text{C}$ (77°F)
50% load	-	95.6	-	%	$V_{in} = 48\text{ V}$; $I_{out} = 15\text{ A}$; $T_A = 25^\circ\text{C}$ (77°F)
20% load	-	92.9	-	%	$V_{in} = 48\text{ V}$; $I_{out} = 6\text{ A}$; $T_A = 25^\circ\text{C}$ (77°F)
Isolation characteristics					
Input-to-output Isolation voltage	-	1500	-	V DC	Basic isolation and functional isolation
Other features					
Remote on/off voltage					
Low level	-2	-	0.8	V	-
High level	3.5	-	18	V	-
On/Off current					
Low level	-	-	1.0	mA	-
High level	-	-	-	μA	-
Reliability characteristics					
Mean time between failures (MTBF)	-	1.5	-	Million hours	Airflow = 1.5 m/s (300 LFM); $T_A = 40^\circ\text{C}$ (104°F); 80% load; Telcordia SR332 Method 1 case 3

Qualification Testing

Parameter	Units	Condition
High accelerated life test (HALT)	4	Lowest operating temperature: -60°C (-76°F); highest operating temperature: 110°C (230°F); vibration limit: 40 G
Thermal shock	32	500 temperature cycles between -40°C (-40°F) and $+125^{\circ}\text{C}$ ($+257^{\circ}\text{F}$) with the temperature change rate of 20°C (68°F) per minute Lasting for 30 minutes both at -40°C (-40°F) and $+125^{\circ}\text{C}$ ($+257^{\circ}\text{F}$)
Temperature humidity bias	16	85°C (185°F); 85% RH; 1000 operating hours under lowest load
High Temperature Operation Life (HTOL)	16	Rated input voltage; Air flow: 2.0 m/s(400 LFM); Ambient temperature: 65°C (149°F); 1000 operating hours under 50% load

Characteristic Curves

Figure 1: Efficiency
 ($T_A = 25^{\circ}\text{C}$ or 77°F)

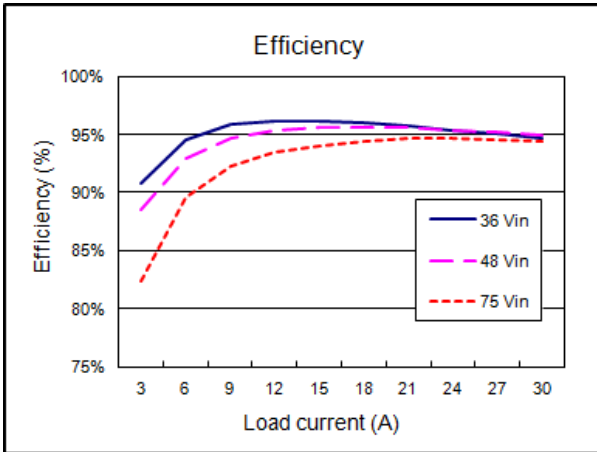


Figure 2: Power dissipation
 ($T_A = 25^{\circ}\text{C}$ or 77°F)

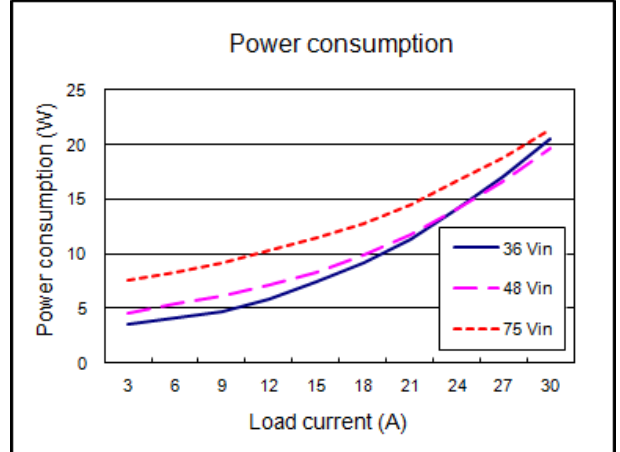


Figure 3: Thermal derating (Air is flowing from Vin to Vout; $V_{in} = 48\text{ V}$; $V_{out} = 12\text{ V}$)

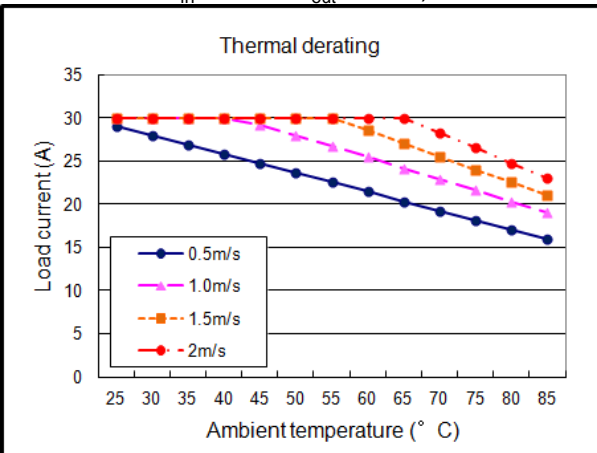


Figure 4: Thermal derating (Air is flowing from Vin(-) to Vin(+); $V_{in} = 48\text{ V}$; $V_{out} = 12\text{ V}$)

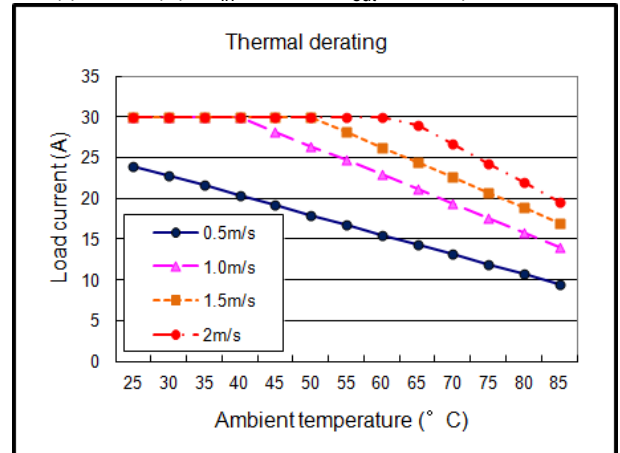


Figure 5: Thermal plot from Vin to Vout
 ($T_A = 25^\circ\text{C}$ (77°F); Airflow = 1.5 m/s (300 FLM);
 Vin = 48V; Vout = 12 V; Iout = 30 A)

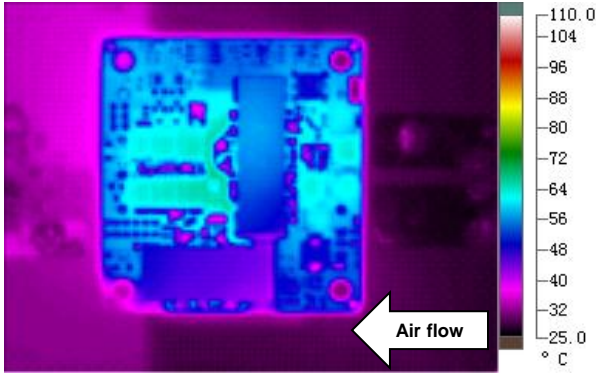
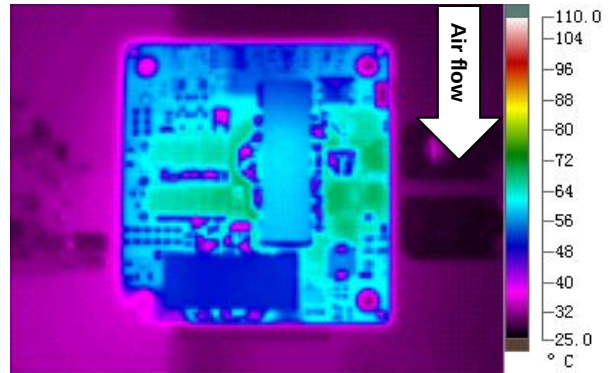


Figure 6: Thermal plot from Vin(-) to Vin(+)
 ($T_A = 25^\circ\text{C}$ (77°F); Airflow = 1.5 m/s (300 FLM);
 Vin = 48 V; Vout =12 V; Iout = 30 A)



Typical Waveforms

Conditions: $T_A = 25^\circ\text{C}$ (77°F), Vin = 48 V.

Figure 7: Startup from CNT

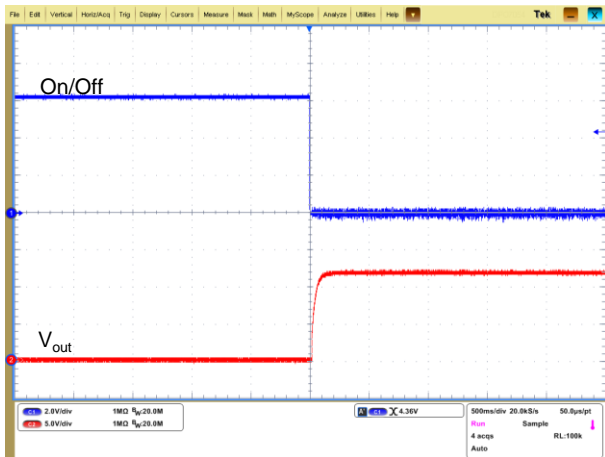


Figure 8: Shutdown from CNT

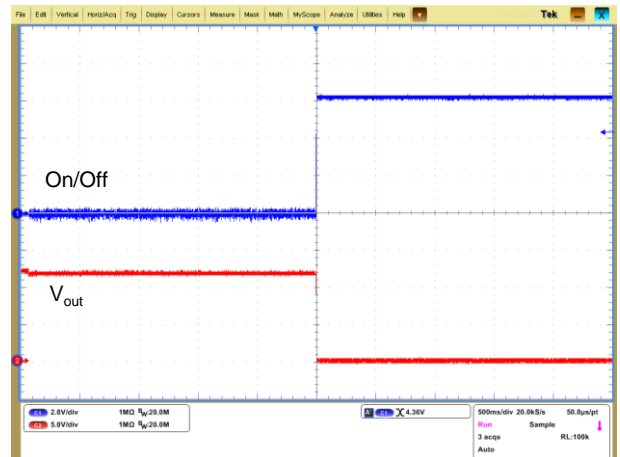


Figure 9: Startup from power on

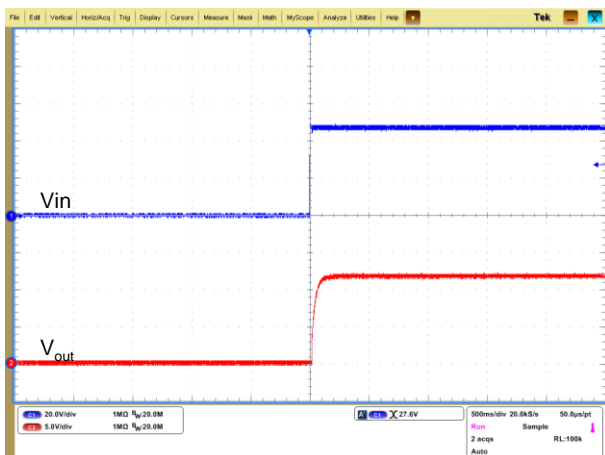


Figure 10: Shutdown from power off

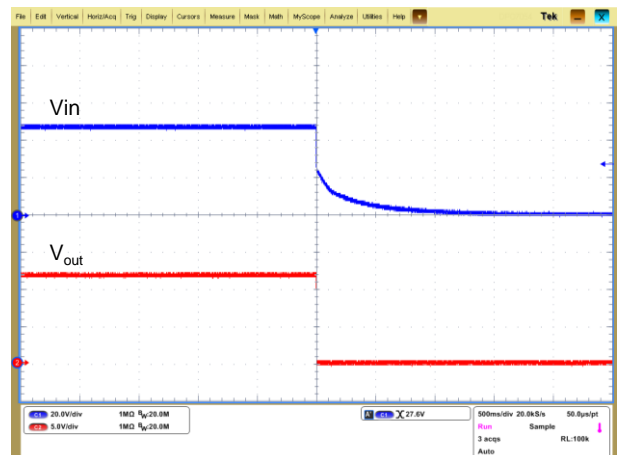


Figure 11: Output voltage response
(Load : 25%–50%–25%, $di/dt=0.1$ A/ μ s)

Figure 12: Output voltage response
(Load 50%–75%–50%, $di/dt=0.1$ A/ μ s)

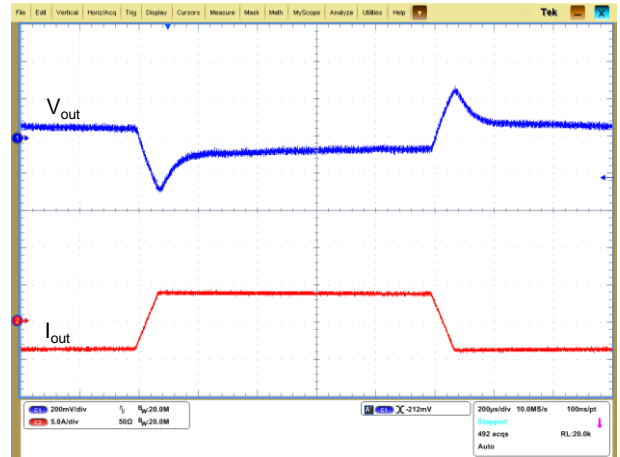
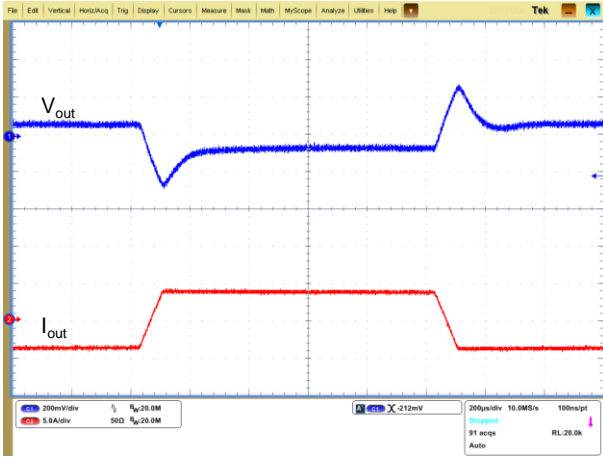
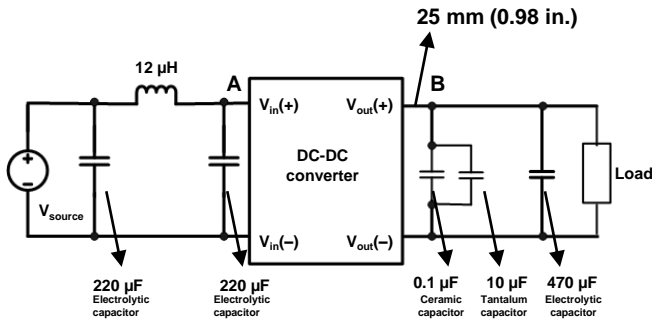


Figure 13: Test set-up diagram



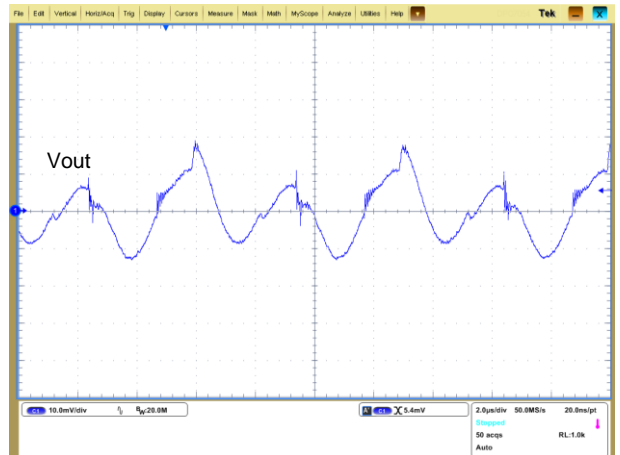
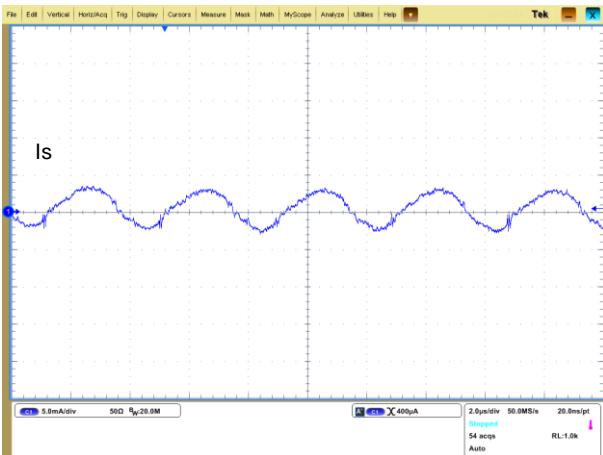
NOTE

1. During the test of input reflected ripple current, the input terminal must be connected to a 12 μ H inductor and a 220 μ F electrolytic capacitor.
2. Point B, which is for testing the output voltage ripple, is 25 mm (0.98 in.) away from the $V_{out}(+)$ pin.

Conditions: $T_A = 25^\circ\text{C}$ (77°F), $V_{in} = 48$ V, $V_{out} = 12$ V, $I_{out} = 30$ A.

Figure 14: Input reflected ripple current
(for point A in the test set-up diagram)

Figure 15: Output voltage ripple
(for point B in the test set-up diagram)

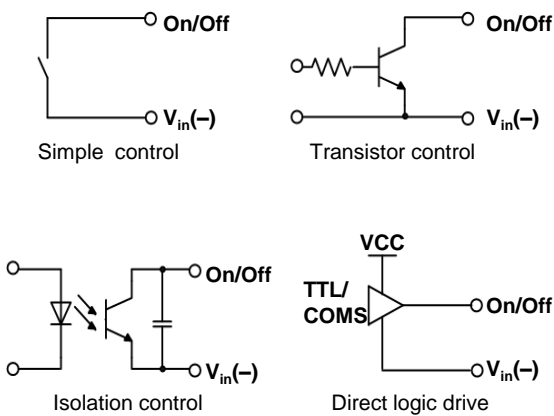


Feature Description

Remote On/Off

Logic Enable	On/Off Pin Level	Status
Negative logic	Low level	Started
	High level or left open	Shut down

The following are some circuits for driving the on/off pin.



Remote Sense

This function is used to compensate for voltage drops on circuits.

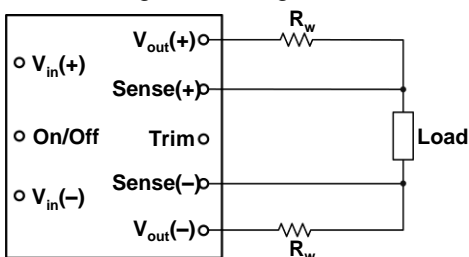
The Sense(+), Sense(-), V_{out}(+), and V_{out}(-) terminals should meet the following requirements:

$$[V_{out}(+) - V_{out}(-)] - [\text{Sense}(+) - \text{Sense}(-)] \leq 10\% \times V_{nom}$$

(V_{nom} is the rated output voltage.)

If the remote sense function is disabled, the Sense(+) terminal connects to the V_{out}(+) terminal and the Sense(-) terminal connects to the V_{out}(-) terminal at the output end.

Figure 16: Configuration diagram for remote sense



R_w indicates the line impedance between the output end and the load.

Output Voltage Trim

The output voltage can be adjusted within the range of 90% V_{nom} to 110% V_{nom} using a trim pin.

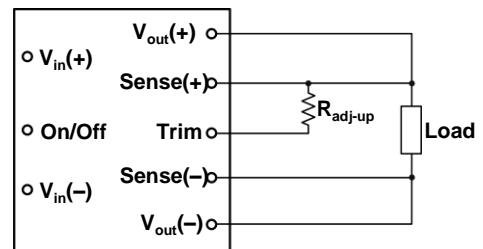
NOTE

If the trim pin is not used, it should be left open.

Trim Up

The output voltage can be increased by installing an external resistor between the trim pin and the Sense(+) terminal.

Figure 15: Configuration diagram for raising the output voltage



The following formula reflects the relationship between R_{adj-up} and V_{nom}:

$$R_{adj-up} = \frac{V_{nom} \times (100 + \Delta)}{1.225 \times \Delta} - \frac{100 + 2 \times \Delta}{\Delta} \text{ (kohm)}$$

$$\text{Where, } \Delta = \frac{V_{trim-up} - V_{nom}}{V_{nom}} \times 100$$

NOTE

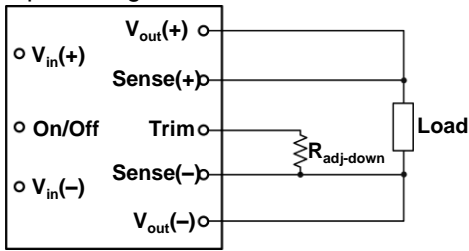
Although the output voltage can be increased by both the remote sense and trim functions, the maximum increase in the output voltage is the larger value, rather than the sum of both values.

The GAH30S12 loading capability decreases as the voltage increases. Therefore, you need to ensure that the actual output power does not exceed the maximum output power when raising the voltage.

Trim Down

The output voltage can be decreased by installing an external resistor between the trim pin and the Sense(-) terminal.

Figure 16: Configuration diagram for lowering the output voltage



The following formula reflects the relationship between $R_{adj-down}$ and V_{nom} :

$$R_{adj-down} = \frac{100}{\Delta} - 2(kohm)$$

$$\text{Where, } \Delta = \frac{V_{nom} - V_{trim-down}}{V_{nom}} \times 100$$

Input Undervoltage Protection

The GAH30S12 is shut down after the input voltage drops below the undervoltage protection threshold for shutdown. The GAH30S12 starts to work again after the input voltage reaches the input undervoltage protection threshold for startup.

Output Overcurrent Protection

When the output current exceeds the overcurrent protection threshold, the GAH30S12 works in hiccup mode until overcurrent disappears. After the output current drops to the specified range, the GAH30S12 starts to work in normal mode.

Output Overvoltage Protection

When the output voltage exceeds the overvoltage protection threshold, the GAH30S12 works in hiccup mode.

Overtemperature Protection

The overtemperature function protects the GAH30S12 from being damaged at high temperatures. When the GAH30S12 temperature exceeds the overtemperature protection threshold, the output is disabled. After the GAH30S12 temperature drops below the threshold, the GAH30S12 starts to work again.

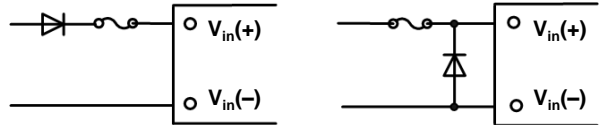
MTBF

The MTBF is calculated according to the Telcordia, SR332 Method 1 Case3. If the GAH30S12 is used at 40°C (104°F), the airflow over it can be increased to retain the MTBF.

Recommended Reverse Polarity Protection Circuit

Reverse polarity protection is recommended under installation and cabling conditions where reverse polarity across the input may occur.

Figure 17: Recommended reverse polarity protection circuits



Recommended Fuse

The GAH30S12 has no internal fuse, but connects to an external fuse in actual use. To meet safety and regulatory requirements, a 20 A fuse is recommended.

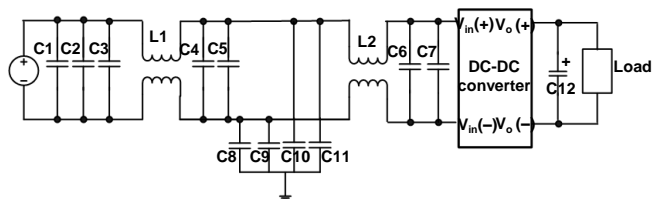
NOTE

The fuse current should be 1.5 to 2 times the maximum operating current in actual use.

EMC

For the acceptance standard, see the *DC-DC Converter EMC Acceptance Manual*.

Figure 18: EMC test set-up diagram



C1/C2/C3/C4/C5: Surface mount device (SMD) ceramic capacitor (100 V/1000 nF/X7R/1210)

C6: SMD ceramic capacitor (100 V/100 nF/±10%/X7R/1206)

L1/L2: Common-mode inductor (single phase, 473 μH/±25%/14 A/ 1 mm x 25.4 mm x 12.7 mm [0.04 in. x 1.0 in. x 0.5 in.].)

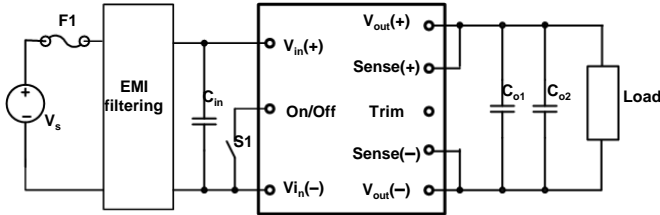
C8/C9/C10/C11: High-pressure resistant chip ceramic capacitor (100 nF/1000 V/X7R/220). meeting the 1 kV pressure resistance requirement.

C7: Electrolytic capacitor (220 μF/100 V)

C12: Electrolytic capacitor (470 μF/25 V)

Typical Application

Figure 19: Typical circuit applications



F1: 20 A fuse (fast blowing)

C_{in}: The high-frequency, low equivalent series resistance (ESR) electrolytic capacitor (220 μF /100 V) is recommended.

C_{o1}: The 1 μF ceramic capacitor is recommended.

C_{o2}: The 470 μF electrolytic capacitor is recommended.

NOTE

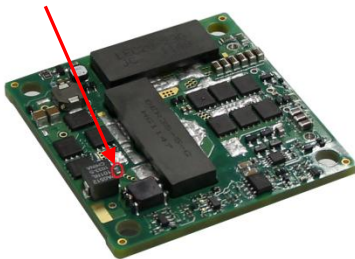
GAH30S12s cannot be connected in parallel.

Thermal Consideration

Sufficient airflow should be provided to help ensure reliable operating of the GAH30S12. Therefore, thermal components are mounted on the top surface of the GAH30S12 to dissipate heat to the surrounding environment by conduction, convection and radiation. Proper airflow can be verified by measuring the temperature of the PCB bottom near the thermal resistor.

Figure 20: Thermal test point

The PCB bottom near the thermal resistor



NOTE

The temperature at the thermal test point on the GAH30S12 cannot exceed 120°C (248°F). Otherwise, the GAH30S12 will be protected against overtemperature and will not operate properly.

Power Dissipation

The GAH30S12 power dissipation is calculated based on efficiency. The following formula reflects the relationship between the consumed power (P_d), efficiency (η), and output power (P_o):

$$P_d = P_o(1-\eta)/\eta$$

Mechanical Considerations

Installation

Although the GAH30S12 can be mounted in any direction, free airflow must be taken. Normally power components are always installed at the end of the airflow path or have separate airflow paths. The installation mode helps keep other system equipment cooler and increase component service life.

Soldering

The GAH30S12 is compatible with standard wave soldering techniques. During wave soldering, the setting parameters should base on the speciality of using flux, such as the preheating temperature and time, the soldering temperature and time and so on. To improve the soldering heighten, it is allowed to improve the preheating and soldering temperature, prolong the preheating and soldering time as the larger thermal capacity of the module. However, it is not allowed to exceed the high temperature limitation of the components that belong to the module.

When soldering the GAH30S12, ensure that the soldering iron is at 425°C (797°F) and contacts pins for a maximum of 3 seconds, because long-time soldering at high temperatures may cause the GAH30S12 interior to be damaged.

The GAH30S12 can be rinsed using the isopropyl alcohol (IPA) solvent or other proper solvents.