

### Features

- Wide 2 : 1 Input Voltage Range(9~18V, 18~36V, 36~75V)
- I/O-Isolation Voltage: 4000VACrms
- Isolation Test Voltage 6000VDC
- Extended Operating Temperature Range: -40°C to +85°C
- Output Short Circuit Protection:  
Continuous & Auto Recovery
- Over Voltage Protection: Clamp Mode
- Non-Conductive Black Plastic Case
- Lead Free Design, RoHS Compliant
- 24pin DIP Package with Industry-Standard Footprint
- Customer Design Available



### Description

The HAA5 Series are isolated 5W DC/DC converters. Designed with highly efficiency, allow the operating temperature range of these units to be -40°C to +85°C in a 24 pin DIP package with industry-standard footprint. Further features include wide 2 : 1 input voltage range, short-circuit protection and over voltage protection.

### Applications

These converters are well suitable for battery operated equipment, measurement equipment, telecom, wireless network, Industry control system, medical equipment everywhere where isolated, tightly regulated voltages and compact size are required.

**Technical Specification** All specifications are typical at nominal input, full load and 25°C unless otherwise stated.

Model Number	Input Voltage Range	Output Voltage (V)	Output Current (mA)		Input Current (mA)		Eff. <sup>(1)</sup> (%)	Capacitive Load, max. <sup>(2)</sup> (uF)
			Min. Load	Full. Load	No Load	Full Load		
HAA5-12S0H6	9~18V Nominal:12V	3.3	0	1200	18	446	78	3000
HAA5-12S1H6		5	0	1000	22	541	81	2000
HAA5-12S2H6		12	0	500	35	630	83	470
HAA5-12D2H6		±12	0	±250	36	630	83	±220
HAA5-12D3H6		±15	0	±200	37	630	83	±220
HAA5-24S1H6	18~36V Nominal:24V	5	0	1000	13	265	82	2000
HAA5-24S2H6		12	0	500	13	309	85	470
HAA5-24D2H6		±12	0	±250	19	313	84	±220
HAA5-24D3H6		±15	0	±200	21	309	85	±220
HAA5-48S1H6	36~75V Nominal:48V	5	0	1000	8	135	81	2000
HAA5-48S2H6		12	0	500	9	158	83	470
HAA5-48D2H6		±12	0	±250	11	158	83	±220
HAA5-48D3H6		±15	0	±200	12	158	83	±220

Input Specifications		
Input Voltage	12V nominal input	9~18V
	24V nominal input	18~36V
	48V nominal input	36~75V
Input filter		Pi Type
Input surge voltage (100ms max.)	12V input	25V
	24V input	50V
	48V input	100V
Input reflected ripple current	Nominal Vin and full load	76mA <sub>p-p</sub> max.
Start up time	Nominal Vin and constant resistive load	510ms max.
Environmental Specifications		
Operating ambient temperature	-40°C to +85°C (with derating)	
Maximum case temperature	+95°C	
Storage temperature range	-50°C to +125°C	
Relative humidity	5% to 95% RH	
Temperature coefficient	±0.02% / °C max.	
EMC Characteristics		
EMI	EN55022 (radiation)	Meet class A
Output Specifications		
Output power	6 Watts max.	
Voltage accuracy	Full load and nominal Vin	±1%
Minimum load	See table	
Line regulation	LL to HL at full load	
	25% load to full load	Single
	Balanced load	Dual
Load Regulation	Unbalanced load 25% to 100% full load	
Ripple and Noise(20MHz bandwidth)	3.3V, 5V Output Models	110mV <sub>p-p</sub> typ. 150mV <sub>p-p</sub> max.
	12V Output Models (single output)	70mV <sub>p-p</sub> max.
	Other Output Models	200mV <sub>p-p</sub> typ. 250mV <sub>p-p</sub> max.
Over voltage protection (Zener Diode Clamp)	3.3V <sub>out</sub> models	3.9V
	5V <sub>out</sub> models	6.2V
	12V <sub>out</sub> models	15V
	15V <sub>out</sub> models	18V
Capacitive load	See table	
Over load protection	% of full load	120% min..
Short circuit protection	Continuous, automatic recovery	
Transient response settling time	50% load step change	780μs max.
Transient response over shoot	di/dt=0.8A/μs	≤ ±5% of V <sub>o</sub>

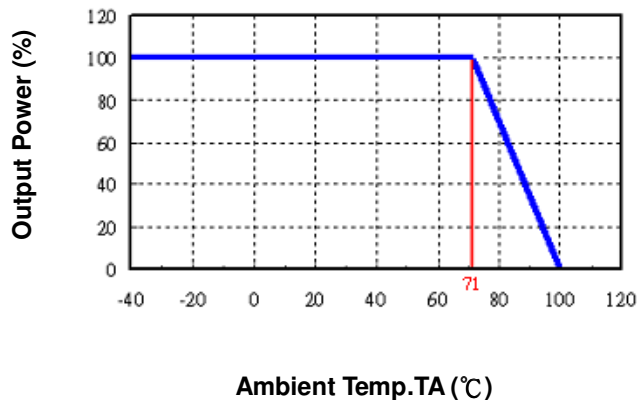
### General Specifications

Efficiency	Nominal input	See table
I/O Isolation voltage(rated)	60 Seconds	4000VACrms min.
I/O Isolation Test Voltage	Flash tested for 1 Second	6000VDC min.
Isolation resistance	500VDC	10 <sup>9</sup> Ohms min.
Isolation capacitance		12pF typ.
Switching frequency		150kHz typ.
Reliability, calculated MTBF		700,000 Hours min.

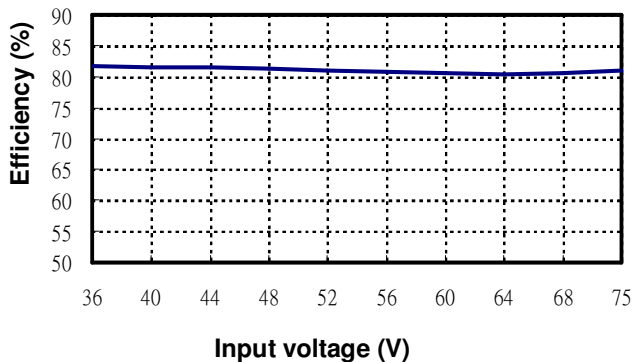
### Physical Specifications

Case material	Non-Conductive Black Plastic
Potting material	Silicon rubber (UL94V-0)
Dimensions	1.25 × 0.80 × 0.5 Inch (31.7 × 20.3 × 12.65 mm)
Weight	16g (0.56oz) (typical)

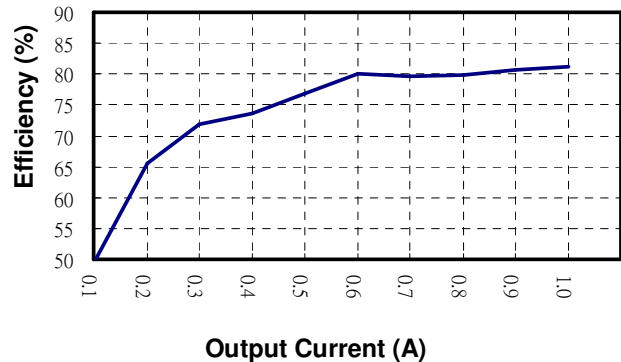
**HAA5Series  
Power Derating Curve(3)**



**HAA5-48S1H6  
Input voltage vs. Efficiency**

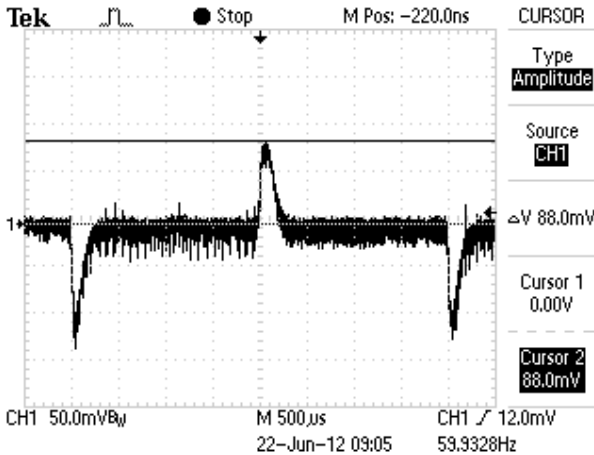


**HAA5-48S1H6  
Output Current vs. Efficiency**



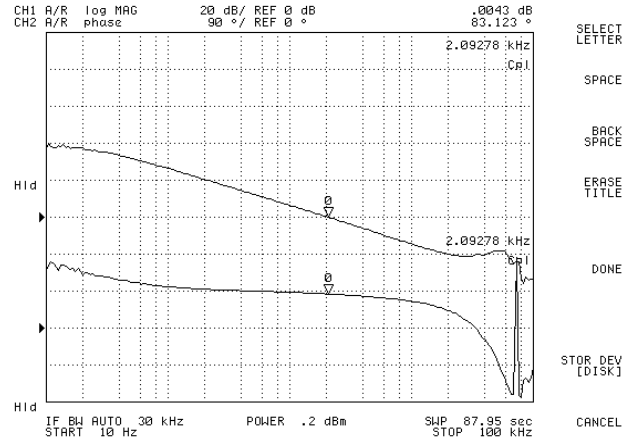
### HAA5-48S1H6

#### Transient Response at 50%~100% Max Load



### HAA5-48S1H6

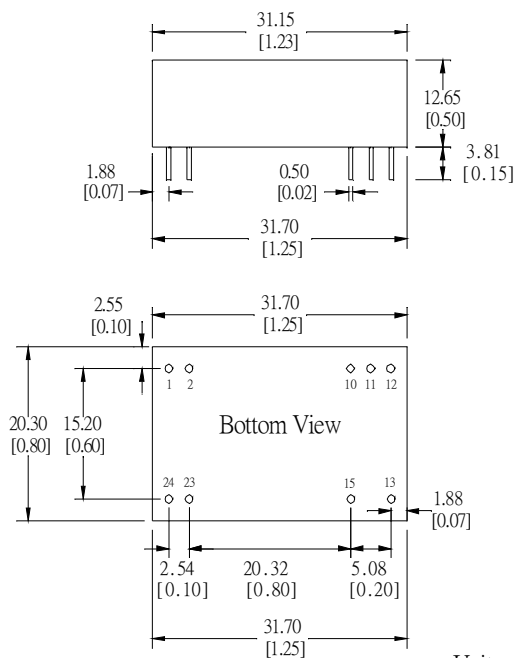
#### Loop Gain & Phase at Vi=48V, Full Load



#### Note

1. Typical value, tested at nominal input and full load.
2. For each output.
3. Based on HAA5-48S1H6.

#### Mechanical Dimensions



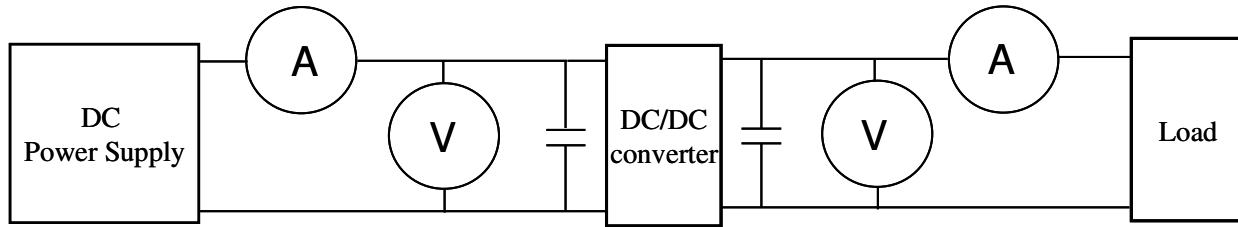
Unit : mm[inch]  
Tolerance : XX.X ±0.5[±0.02]  
XX.XX ±0.25[±0.01]

Pin Assignment		
Pin	Single	Dual
1	+Vin	+Vin
2	+Vin	+Vin
10	NC	Common
11	NC	Common
12	-Vout	NC
13	+Vout	-Vout
15	NC	+Vout
23	-Vin	-Vin
24	-Vin	-Vin

Specifications subject to change without notice.

### Test Configurations

All specifications are typical at nominal input, full load and 25°C unless otherwise stated.



- ⊙DC Power Supply: It offers a wide voltage and current range precisely.
- ⊙Current meter (A): Accuracy → 200μA ~ 200mA 4 ranges  $\pm(0.2\% \text{ rdg} + 2 \text{ digits})$   
2000mA ~ 20A 2 ranges  $\pm(0.3\% \text{ rdg} + 2 \text{ digits})$ .
- ⊙Voltage meter (V): Accuracy →  $\pm(0.03\% \text{ rdg} + 4 \text{ digits})$ .
- ⊙Load: At full load.
- ⊙Wires: The resistance of the wires must be small.

#### 1. Input voltage range: Narrow input voltage range ( $\pm 10\%$ )、wide input voltage range (2:1 and 4:1)。

EX: Narrow input voltage range ( $\pm 10\%$ )

5V nominal input	→	4.5~5.5V
12V nominal input	→	10.8~13.2V
24V nominal input	→	21.6~26.4V

Wide input voltage range 2:1

5V nominal input	→	4.5~9V
12V nominal input	→	9~18V
24V nominal input	→	18~36V
48V nominal input	→	36~75V

Wide input voltage range 4:1 (W)

24V nominal input	→	9~36V
48V nominal input	→	18~75V

#### 2. Input power :

$$P_{in} = V_{in} \times I_{in}$$

$V_{in}$  : Input voltage  
 $I_{in}$  : Input current

#### 3. Output power :

$$P_{out} = V_{out} \times I_{out}$$

$V_{out}$  : Output voltage  
 $I_{out}$  : Output current

#### 4. Efficiency :

$$\text{Efficiency} = \frac{P_{out}}{P_{in}} \times 100\%$$

$P_{out}$ : Output power  
 $P_{in}$ : Input power

#### 5. Voltage accuracy:

$$\frac{|V_{out} - V_{out(nominal)}|}{V_{out}} \times 100\%$$

$V_{out}$  : Output voltage  
 $V_{out(nominal)}$  : Nominal output voltage

6. **Line regulation:** (1) Wide input voltage range and regulated output voltage series.

$$\frac{|V_{out(LL)} - V_{out(HL)}|}{V_{out(LL)}} \times 100\%$$

LL: Low Line input voltage  
HL: High Line input voltage

(2) Narrow input voltage range ( $\pm 10\%$ ) and unregulated output voltage series.

$$\text{Line regulation} = \left| \frac{\Delta V_{out}}{\Delta V_{in}} \right|$$

$$\Delta V_{out} = \frac{V_{out(+10\%)} - V_{out(-10\%)}}{V_{out}} \times 100\%$$

$V_{out(+10\%)}$  : Output voltage at  $V_{in} = 1.1 \times V_{in}(\text{nominal})$  & full load

$V_{out(-10\%)}$  : Output voltage at  $V_{in} = 0.9 \times V_{in}(\text{nominal})$  & full load

$V_{out}$  : Output voltage at  $V_{in} = V_{in}(\text{nominal})$  & full load

$$\Delta V_{in} = \frac{V_{in(+10\%)} - V_{in(-10\%)}}{V_{in}(\text{nominal})} \times 100\%$$

$V_{in(+10\%)}$  : Input voltage =  $1.1 \times V_{in}(\text{nominal})$

$V_{in(-10\%)}$  : Input voltage =  $0.9 \times V_{in}(\text{nominal})$

$V_{in}(\text{nominal})$  : Nominal Input voltage

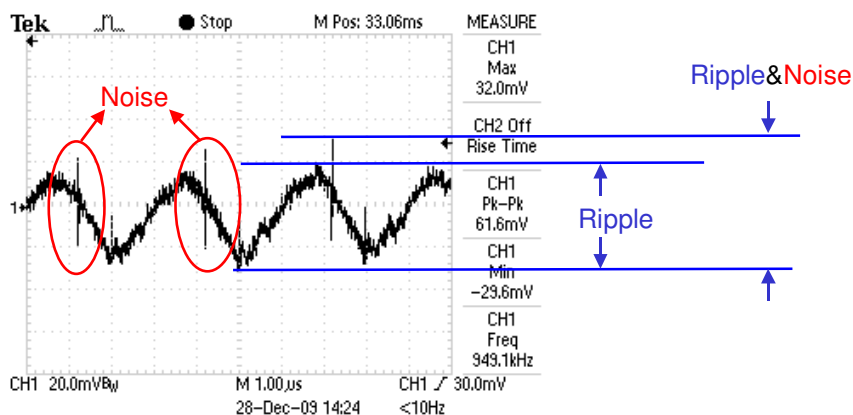
7. **Load regulation :**

$$\frac{|V_{out(FL)} - V_{out(NL)}|}{V_{out(FL)}} \times 100\%$$

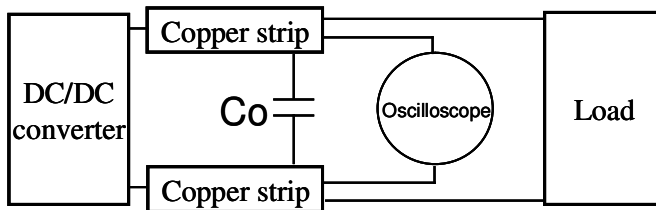
$V_{out(FL)}$ : Output voltage at full load

$V_{out(NL)}$ : Output voltage at 25% full load or 10% full load

8. **Ripple and Noise:** as shown below. The bandwidth is 0-20MHz.

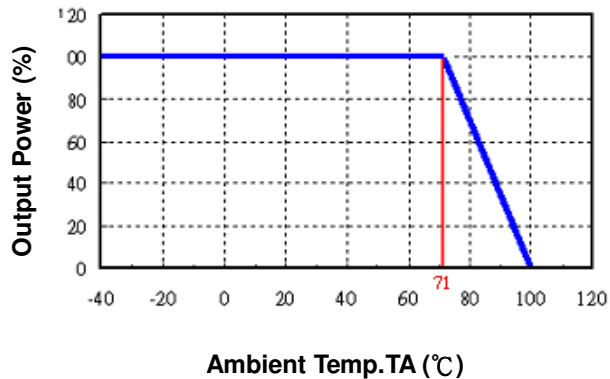


Output Ripple&Noise measurement test circuit: as shown below.



$C_o$ : usually 0.47 $\mu$ F.

9. [Temperature derating curve](#): The DC-DC converter will operate over a wider temperature range if less power is drawn from the output and the device is already running. The temperature derating curve shows the operating power-temperature range. As shown below.



10. [Switching frequency](#): The nominal operating frequency of the DC-DC converters.
11. [Input to output isolation](#): The dielectric breakdown strength test between input and output circuits. This is the isolation voltage the device is capable of withstanding for a specified time, usually 1 second or 1 minute.