

# LAMBDA ADVANCED ANALOG INC.

## AHE2800S Series Hybrid - High Reliability DC/DC Converters

### DESCRIPTION

The AHE2800S Series of DC/DC converters feature high power density and an extended temperature range for use in military and industrial applications. Designed to MIL-STD-704 input requirements, these devices have nominal 28V<sub>DC</sub> inputs with +5v, +12v and +15v single outputs to satisfy a wide range of requirements. The circuit design incorporates a pulse width modulated push-pull topology operating in the feed-forward mode at a nominal switching frequency of 250 KHz. Input to output isolation is achieved through the use of transformers in the forward and feedback circuits.

The advanced feedback design provides fast loop response for superior line and load transient characteristics and offers greater reliability and radiation tolerance than devices incorporating optical feedback circuits.

Three standard temperature grades are offered with screening options. Refer to Part Number section. They can be provided in a standard plug-in package for PC mounting or in a flanged package for more severe environments.

These converters are manufactured in a facility fully qualified to MIL-PRF-38534. All processes used to manufacture these converters have been qualified to enable Lambda Advanced Analog to deliver compliant devices. Two screening grades are available to satisfy a wide range of requirements. The CH grade converters are fully compliant to MIL-PRF-38534 class H. The HB grade converters are processed to full class H screening but do not have class H element evaluation as required by MIL-PRF-38534. Both grades are fully tested and operate over the full military temperature range without derating of output power. Variations in electrical, mechanical and screening can be accommodated. Extensive computer simulation using complex modeling enables rapid design modification to be provided. Contact Lambda Advanced Analog with specific requirements.

### FEATURES

- 17-40V<sub>DC</sub> input range (28V<sub>DC</sub> nominal)
- 5V, 12V and 15V outputs available
- Indefinite short circuit and overload protection
- 17W/in<sup>3</sup> power density
- 15 and 20 watts output power models
- Fast loop response for superior transient characteristics
- Operating temperature range from -55°C to + 125°C available
- Popular industry standard pin-out
- Resistance seam welded case for superior long term hermeticity
- Efficiencies up to 84%
- Shutdown from external signal
- Military screening
- 325,000 hour MTBF at 85°C (AUC)

## SPECIFICATIONS

TCASE = -55°C to +85°C, VIN = + 28V ±5% unless otherwise specified.

### ABSOLUTE MAXIMUM RATINGS

Input Voltage <sup>1</sup>	-0.5V to +50V
Power Output	Internally Limited, 17.5W typical for AHE2805S, 22.5W typical for AHE2812S and AHE2815S
Soldering	300°C for 10 seconds
Temperature Range <sup>1</sup>	Operating -55°C to +125°C case Storage -65°C to + 135°C

Parameter	Conditions	AHE2805S			AHE2812S			AHE2815S			Units
	-55°C - Tc - +85°C, VIN - 28 Vdc ±5%, C=0, unless otherwise specified	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
STATIC CHARACTERISTICS											
OUTPUT	VIN = 17 TO 40 Vdc	4.90 0.0	5.00	5.10 3000	11.76 0.0	12.00	12.24 1667	14.70 0.0	15.00	15.30 1333	Vdc mADC mVpp Vdc W
Voltage	IOUT = 0 TO Full Load										
Current	Full Load, DC to 1MHz										
Ripple	TCASE = 25°C, IOUT = 0										
Accuracy		4.95	5.00	5.05	11.88	12.00	12.12	14.85	15.00	15.15	
Power <sup>1</sup>		15			20			20			
REGULATION											
Line	VIN = 17 to 40Vdc		±0.5	±1.0		±0.5	±1.0		±0.5	±1.0	%
Load	IOUT = 0 to Full Load		±0.5	±1.0		±0.5	±1.0		±0.5	±1.0	%
INPUT		17.0	28.0	40.0	17.0	28.0	40.0	17.0	28.0	40.0	Vdc mADC mADC mV p-p
Voltage Range <sup>4</sup>	Inhibited										
Current	No Load										
Ripple Current	Full Load										
EFFICIENCY	TCASE = +25°C Half Load to Full Load	80	82		79	83		80	84		%
CAPACITIVE LOAD	No effect on performance	500			200			200			µF
LOAD FAULT POWER DISSIPATION <sup>4</sup>				6			6			6	W
ISOLATION	Input to Output @ 500Vdc	100			100			100			MΩ
DYNAMIC CHARACTERISTICS											
STEP LOAD CHANGES											
Output	50% Load 100% Load		±150			±200			±200		mVpk mVpk mVpk µsec µsec msec
Transient	No Load 50% Load										
	50% Load No Load										
Recovery <sup>2</sup>	50% Load 100% Load										
	No Load 50% Load	25	25	25		25		25			
	No Load 50% Load	500	500	500		500		500			
	50% Load No Load	7	7	7		7		7			
STEP LINE CHANGES											
Output	Input step 17 to 40Vdc		+180			+180			+180		mVpk mVpk µsec µsec
Transient	Input step 40 to 17Vdc										
Recovery <sup>2</sup>	Input step 17 to 40Vdc										
	Input step 40 to 17Vdc										
TURN-ON											
Overshoot	VIN = 17 to 40Vdc	0	500			300	600		300	500	mVpk msec
Delay <sup>3</sup>	IOUT = 0 to Full Load										
LOAD FAULT RECOVERY <sup>4</sup>	VIN = 17 to 40Vdc		8	14		8	14		8	14	msec
WEIGHT	Standard Package		55			55				55	grams
	Flange Package		58			58				58	grams

#### Notes:

1. Above +85°C case temperature, derate output power linearly to 0 and maximum input voltage linearly to 42V at 115°C case.
2. Recovery time is measured from the initiation of the transient to where VOUT has returned to within ±1% of VOUT at 50% load. See typical waveforms.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the shutdown pin.
4. For operation at 16Vdc, derate output power by 33%.

## SPECIFICATIONS

TCASE = -55°C to +105°C, VIN = + 28V ±5% unless otherwise specified.

### ABSOLUTE MAXIMUM RATINGS

Input Voltage <sup>5</sup>	-0.5V to +50V
Power Output	Internally Limited, 17.5W typical for AHE2805S/ES, 22.5W typical for AHE2812S/ES and AHE2815S/ES
Soldering	300°C for 10 seconds
Temperature Range <sup>1</sup>	Operating -55°C to +125°C case Storage -65°C to + 135°C

Parameter	Conditions -55°C - Tc - +105°C, VIN - 28 Vdc ±5%, C=0, unless otherwise specified	AHE2805S/ES			AHE2812/ES			AHE2815S/ES			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
STATIC CHARACTERISTICS											
OUTPUT Voltage Current Ripple Accuracy Power <sup>1</sup>	VIN = 17 TO 40 VDC IOUT = 0 TO Full Load  Full Load, DC to 1MHz TCASE = 25°C, IOUT = 0	4.90 0.0  4.95 15	5.00  20 5.00	5.10 3000 60 5.05	11.76 0.0  11.88 20	12.00  30 12.00	12.24 1667 60 12.12	14.70 0.0  14.85 20	15.00  30 15.00	15.30 1333 60 15.15	Vdc mAdc mVpp Vdc W
REGULATION Line Load	VIN = 17 to 40VDC IOUT = 0 to Full Load		±0.5 ±0.5	±1.0 ±1.0		±0.5 ±0.5	±1.0 ±1.0		±0.5 ±0.5	±1.0 ±1.0	% %
INPUT Voltage Range <sup>4</sup> Current  Ripple Current	  Inhibited No Load Full Load	17.0	28.0 8 20	40.0 18 35 50	17.0	28.0 8 25	40.0 18 35 50	17.0	28.0 8 25	40.0 18 35 50	Vdc mAdc mAdc mV p-p
EFFICIENCY	TCASE = +25°C Half Load to Full Load	78	82		79	83		80	84		%
CAPACITIVE LOAD	No effect on performance	500			200			200			µF
LOAD FAULT POWER DISSIPATION <sup>4</sup>				6			6			6	W
ISOLATION	Input to Output @ 500VDC	100			100			100			MΩ
DYNAMIC CHARACTERISTICS											
STEP LOAD CHANGES Output Transient  Recovery <sup>2</sup>	50% Load 100% Load No Load 50% Load 50% Load No Load 50% Load 100% Load No Load 50% Load 50% Load No Load		±150 -300 +300 25 500 7			±200 -400 +400 25 500 7			±200 -400 +400 25 500 7		mVpk mVpk mVpk µsec µsec msec
STEP LINE CHANGES Output Transient Recovery <sup>2</sup>	Input step 17 to 40VDC Input step 40 to 17VDC Input step 17 to 40VDC Input step 40 to 17VDC		+180 -600 400 400			+180 -600 400 400			+180 -600 400 400		mVpk mVpk µsec µsec
TURN-ON Overshoot Delay <sup>3</sup>	VIN = 17 to 40VDC IOUT = 0 to Full Load		0 8	500 14		300 8	600 14		300 8	750 14	mVpk msec
LOAD FAULT RECOVERY <sup>4</sup>	VIN = 17 to 40VDC		8	14		8	14		8	14	msec
WEIGHT	Standard Package Flange Package		60 65			60 65			60 65		grams grams

#### Notes:

1. Above +105°C case temperature, derate output power linearly to 0 at 125°C case.
2. Recovery time is measured from the initiation of the transient to where VOUT has returned to within ±1% of VOUT at 50% load. See typical waveforms.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the shutdown pin.
4. For operation at 16Vdc, derate output power by 33%.
5. Above +85°C case temperature, derate maximum input voltage linearly to 33V at +125°C case.

## SPECIFICATIONS

TCASE = -55°C to +125°C, VIN = + 28V ±5% unless otherwise specified.

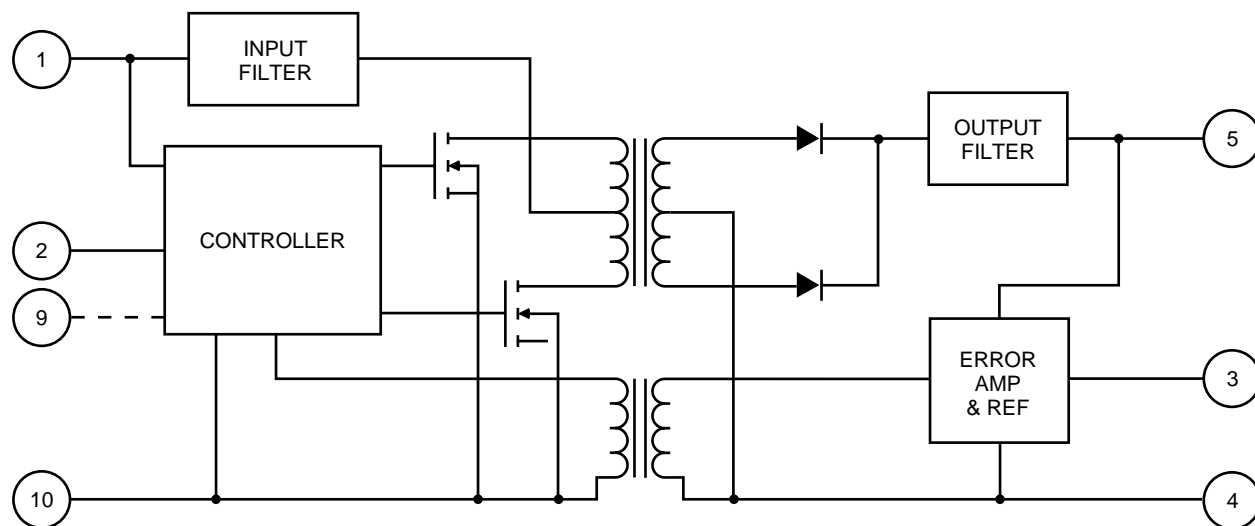
ABSOLUTE MAXIMUM RATINGS	
Input Voltage <sup>1</sup>	-0.5V to +50V
Power Output	Internally Limited, 17.5W typical for AHE2805S/HB&CH, 22.5W typical for AHE2812S/HB&CH and AHE2815S/HB&CH
Soldering	300°C for 10 seconds
Temperature Range <sup>1</sup>	Operating -55°C to + 125°C case Storage -65°C to + 135°C

Parameter	Conditions	AHE2805S/HB&CH			AHE2812S/HB&CH			AHE2815S/HB&CH			Units
	-55°C - Tc - +125°C, VIN - 28 Vdc ±5%, C=0, unless otherwise specified	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
STATIC CHARACTERISTICS											
OUTPUT	VIN = 17 TO 40 VDC	4.90 0.0 4.95 15	5.00 20 5.00	5.10 3000 60 5.05	11.76 0.0 11.88 20	12.00 30 12.00	12.24 1667 60 12.12	14.70 0.0 14.85 20	15.00 30 15.00	15.30 1333 60 15.15	Vdc mAdc mV p-p Vdc W
Voltage	IOUT = 0 TO Full Load										
Current	Full Load, DC to 1MHz										
Ripple	TCASE = 25°C, IOUT = 0										
Accuracy											
Power <sup>1</sup>											
REGULATION											
Line	VIN = 17 to 40VDC		1025		30	60		40	75	mv	
	TCASE = 25°C			5			30			35	
Load	IOUT = 0 to Full Load		10	50		50	120		50	150	mv
INPUT											
Voltage Range <sup>4</sup>		17.0	28.0	40.0	17.0	28.0	40.0	17.0	28.0	40.0	Vdc
Current	Inhibited		8	18		8	18		8	18	mAdc
	No Load			35			35			35	mAdc
Ripple Current	Full Load		20	50		25	50		25	50	mV p-p
EFFICIENCY	TCASE = +25°C Full Load	80	82		80	83		80	84		%
CAPACITIVE LOAD	No effect on performance	500	1000		200	1000		200	1000		µF
LOAD FAULT POWER DISSIPATION	Short Circuit Tc = 25°C			4.5			4.5			4.5	W
	Overload Tc = 25°C			6			6			6	W
ISOLATION	Input to Output @ 500Vdc	100			100			100			MΩ
DYNAMIC CHARACTERISTICS											
STEP LOAD CHANGES											
Output Tc = 25°C	50% Load 100% Load		±150	±300		±200	±300		±200	±300	mVpk
Transient	No Load 50% Load		-300	-500		-400	-500		-400	-500	mVpk
	50% Load No Load		+300	+500		+400	+500		+400	+500	mVpk
Recovery <sup>2</sup>	50% Load 100% Load		25	70		25	70		25	70	µsec
	No Load 50% Load		100	200		500	1500		500	1500	µsec
	50% Load No Load			5			5			5	msec
STEP LINE CHANGES											
Output Tc = 25°C	Input Step 17 to 40Vdc		+180	+300		+180	+500		+180	+500	mVpk
Transient	Input Step 40 to 17Vdc		-600	-1000		-600	-1500		-600	-1500	mVpk
Recovery <sup>2</sup>	Input Step 17 to 40Vdc		400	800		400	800		400	800	µsec
	Input Step 40 to 17Vdc		400	800		400	800		400	800	µsec
TURN-ON											
Overshoot	VIN = 17 to 40Vdc										
Delay <sup>3</sup>	IOUT = 0 to Full Load		0	550		300	600		300	500	mVpk
			8	10		8	10		8	10	msec
LOAD FAULT RECOVERY <sup>4</sup>	VIN = 17 to 40Vdc		8	10		8	10		8	10	msec
WEIGHT											
	Standard Package			55			55			55	grams
	Flange Package			58			58			58	grams

### Notes:

1. Above +125°C case temperature, derate output power linearly to 0 at 135°C case.
2. Recovery time is measured from the initiation of the transient to where VOUT has returned to within ±1% of VOUT at 50% load. See typical waveforms.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the shutdown pin.
4. For operation at 16Vdc, derate output power by 33%.

## BLOCK DIAGRAM



## APPLICATION INFORMATION

### Inhibit Function

Connecting the inhibit input (Pin 2) to input common (Pin 10) will cause the converter to shut down. It is recommended that the inhibit pin be driven by an open collector device capable of sinking at least 400 $\mu$ A of current. The open circuit voltage of the inhibit input is 11.5  $\pm$  1VDC.

### EMI Filter

An optional EMI filter (AFC461) will reduce the input ripple current to levels below the limits imposed by MIL-STD-461 CEO3.

### Output Adjust (AHE2805) only

The output voltage of the AHE2805 can be adjusted upward by connecting Output Adjust (Pin 3) and Output Common (Pin 4) as shown in Table 1.

Resistance Pin 3 to 4	Output Voltage Increase %
$\times$	0
390k	+ 1%
145k	+ 2%
63k	+ 3%
22k	+ 4%
0	+ 5%

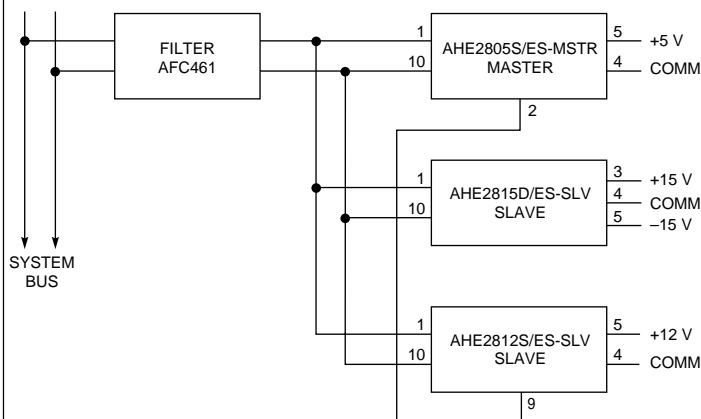
Table 1 Output adjustment resistor values

### Device Synchronization

Whenever multiple DC/DC converters are utilized in a single system, significant low frequency noise may be generated due to slight difference in the switching frequencies of the converters (beat frequency noise). Because of the low frequency nature of this noise (typically less than 10KHz), it is difficult to filter out and may interfere with proper operation of sensitive systems (communications, radar or telemetry). Lambda Advanced Analog offers an option which provides synchronization of multiple AHE/ATW/ATO type converters, thus eliminating this type of noise.

To take advantage of this capability, the system designer must assign one of the converters as the master. Then, by definition, the remaining converters become slaves and will operate at the masters' switching frequency. The user should be aware that the synchronization system is fail-safe; that is, the slaves will continue operating should the master frequency be interrupted for any reason. The layout must be such that the synchronization output (pin 9) of the master device is connected to the synchronization input (pin 9) of each slave device. It is advisable to keep this run short to minimize the possibility of radiating the 250KHz switching frequency.

The appropriate parts must be ordered to utilize this feature. After selecting the converters required for the system, an 'MSTR' suffix is added for the master converter part number and an 'SLV' suffix is added for slave part number. See Part Number section.



Typical Synchronization Connection Diagram

## PIN DESIGNATION

Pin 1 Positive Input  
Pin 2 Inhibit Input  
Pin 3 Output adjust\*  
Pin 4 Output common  
Pin 5 Positive output  
Pin 10 Input common  
Pin 9 N/C or sync  
Pin 8 Case gnd  
Pin 7 N/C  
Pin 6 N/C

\*AHE2805S only. AHE2812S/2815S have N/C on Pin 3

## PART NUMBER

**AHE 28 xx S x / x - xxx**

Model \_\_\_\_\_  
Input Voltage \_\_\_\_\_  
Output Voltage \_\_\_\_\_  
05 – 5VDC  
12 – 12VDC  
15 – 15VDC  
Single Output \_\_\_\_\_  
Synchronization Option  
MSTR—Master  
SLV—Slave  
Temperature Range  
Omit for -55°C to +85°C  
ES – -55°C to +105°C  
HB – -55°C to +125°C  
Package option  
F – Flange  
Omit Standard

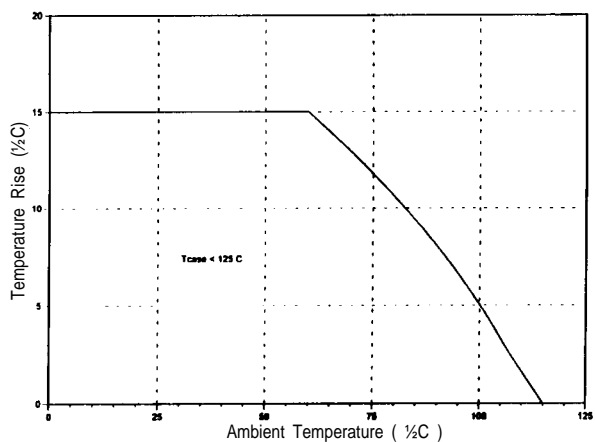
## STANDARDIZED MILITARY DRAWING CROSS REFERENCE

Standardized military drawing PIN	Vendor CAGE number	Vendor similar PIN
5962-8968301HXX	52467	AHE2805S/CH
5962-8968301HZX	52467	AHE2805SF/CH
5962-8968302HXX	52467	AHE2805S/CH-SLV
5962-8968302HZX	52467	AHE2805SF/CH-SLV
5962-8968303HXX	52467	AHE2805S/CH-MSTR
5962-8968303HZX	52467	AHE2805SF/CH-MSTR

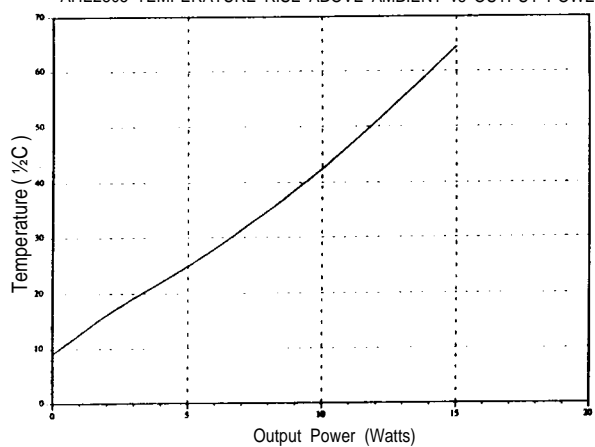
Standardized military drawing PIN	Vendor CAGE number	Vendor similar PIN
5962-9158001HXX	52467	AHE2812S/CH
5962-9158001HZX	52467	AHE2812SF/CH
5962-9158002HXX	52467	AHE2812S/CH-SLV
5962-9158002HZX	52467	AHE2812SF/CH-SLV
5962-9158003HXX	52467	AHE2812S/CH-MSTR
5962-9158003HZX	52467	AHE2812SF/CH-MSTR

Standardized military drawing PIN	Vendor CAGE number	Vendor similar PIN
5962-9162501HXX	52467	AHE2815S/CH
5962-9162501HZX	52467	AHE2815SF/CH
5962-9162502HXX	52467	AHE2815S/CH-SLV
5962-9162502HZX	52467	AHE2815SF/CH-SLV
5962-9162503HXX	52467	AHE2815S/CH-MSTR
5962-9162503HZX	52467	AHE2815SF/CH-MSTR

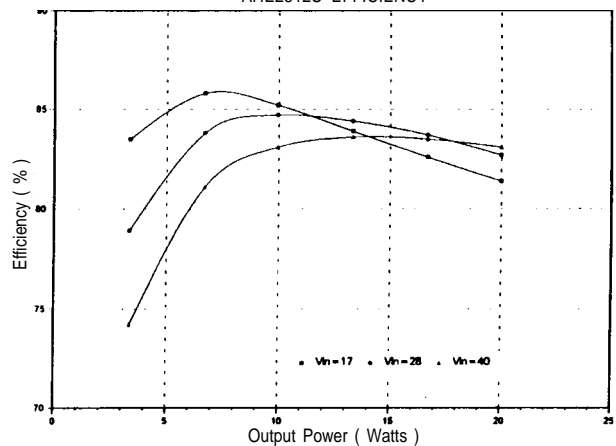
AHE2805S OUTPUT POWER DERATING vs AMBIENT TEMPERATURE



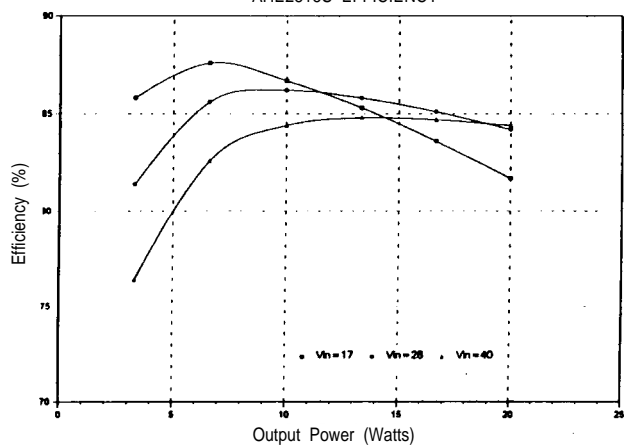
AHE2805S TEMPERATURE RISE ABOVE AMBIENT vs OUTPUT POWER



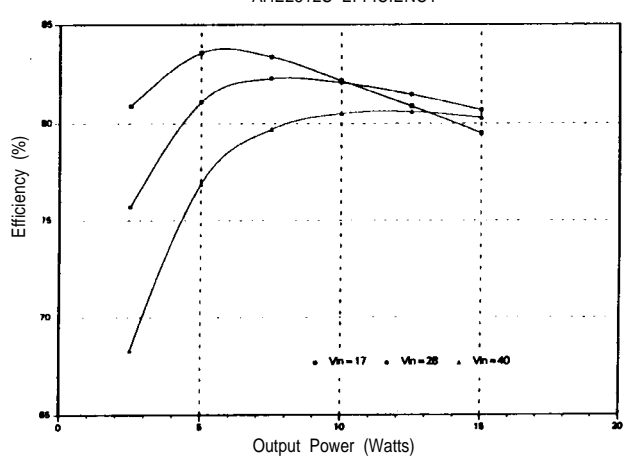
AHE2812S EFFICIENCY

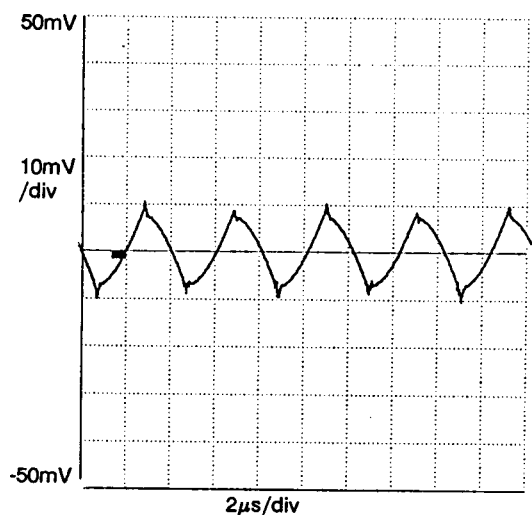


AHE2815S EFFICIENCY

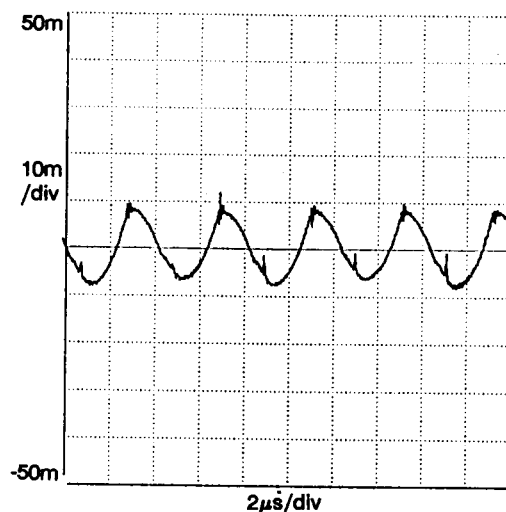


AHE2812S EFFICIENCY

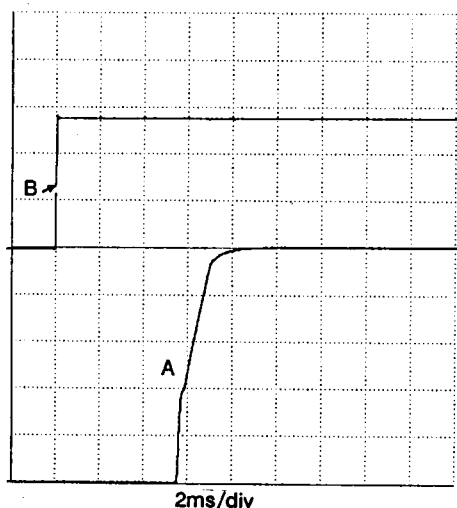




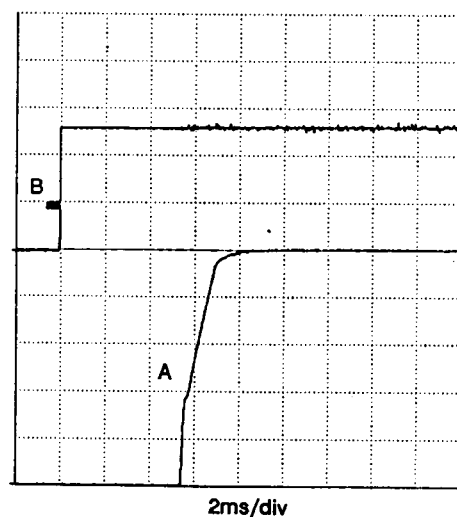
**Figure 1** Output Voltage Ripple  
 $V_{IN} = 28V_{DC}$ , Full Load



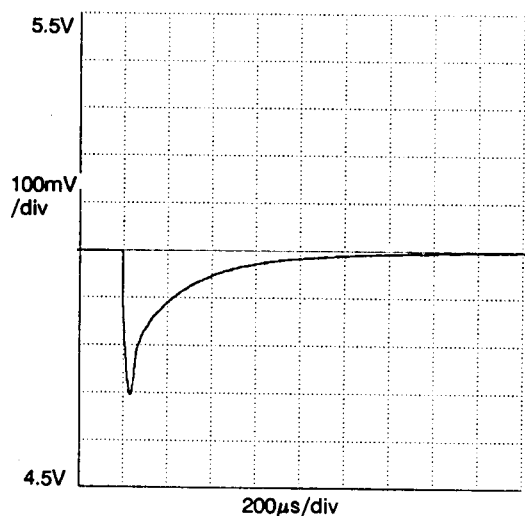
**Figure 2** Input Ripple Current  
 $V_{IN} = 28V$ , Full Load



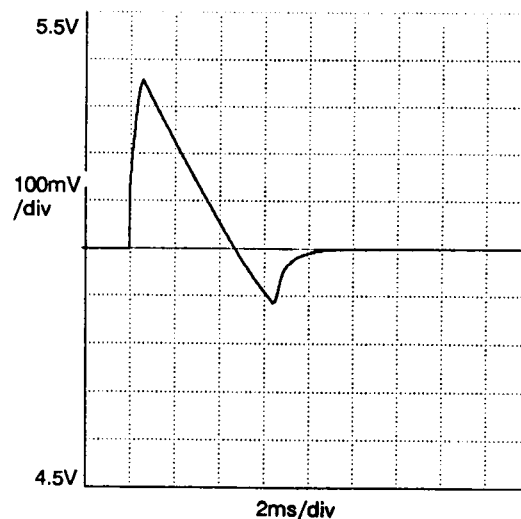
**Figure 3** Turn-on Response  
 A: Output @ 1V/DIV, Full Load  
 B: Input @ 10V/DIV (OV  $\rightarrow$  28V step)



**Figure 4** Turn-on Response from Inhibit  
 A: Output @ 1V/DIV, Full Load  
 B: Inhibit (Pin 2) @ 5V/DIV

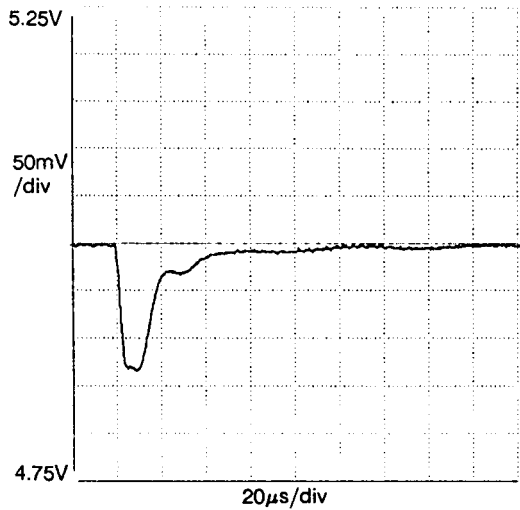


**Figure 5** Load Step Response  
 Load Step 0 to 1.5Apc  
 (No Load to Half Load)

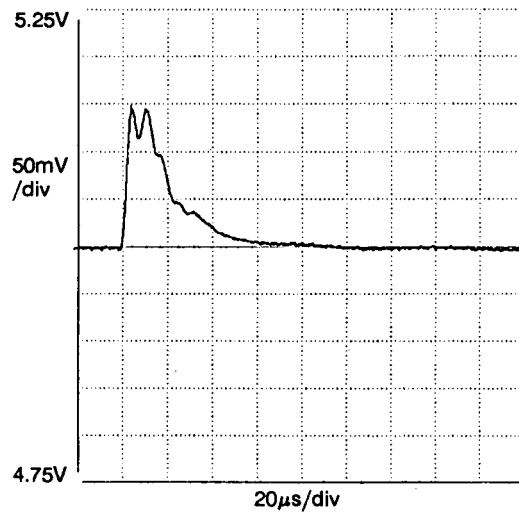


**Figure 6** Load Step Response  
 Load Step 1.5Apc to 0 Apc  
 (Half Load to No Load)

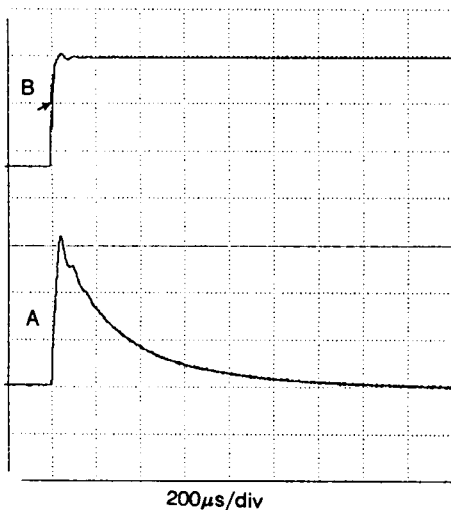




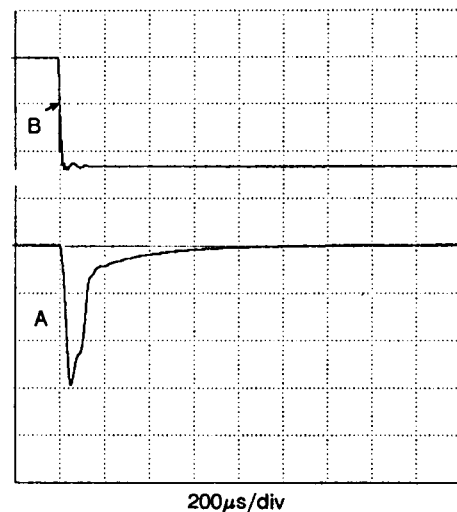
**Figure 7** Load Step Response  
Load Step 1.5A to 3.0A  
(Half Load to Full Load)



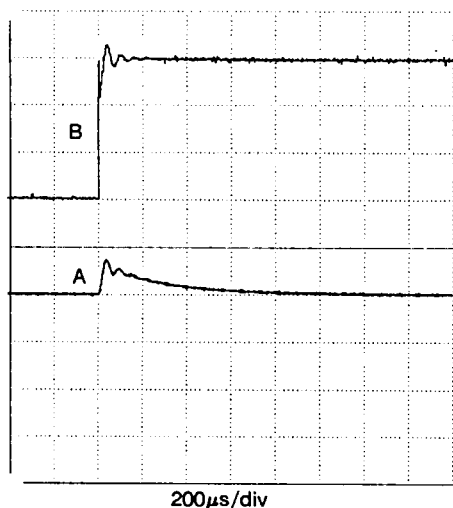
**Figure 8** Load Step Response  
Load Step 3.0A to 1.5A  
(Full Load to Half Load)



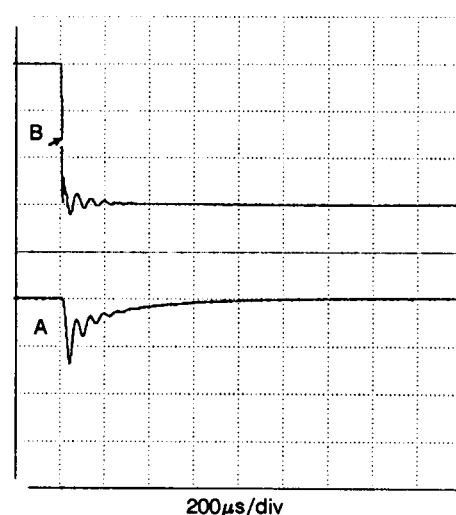
**Figure 9** Line Step Response  
A: Output @ 50mV/DIV, Full Load  
B: Input step 17V to 40V



**Figure 10** Line Step Response  
A: Output @ 200mV/DIV, Full Load  
B: Input Step 40V to 17V

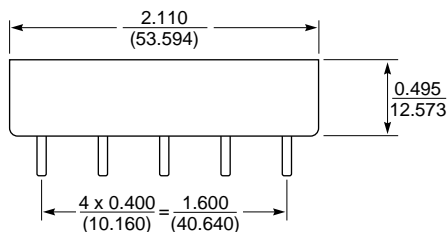
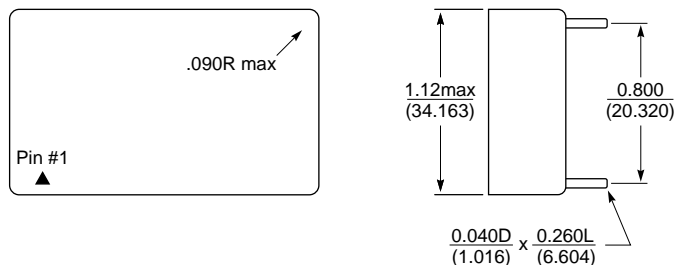


**Figure 11** Line Step Response  
A: Output @ 50mV/DIV, Full Load  
B: Input Step 28V to 34V

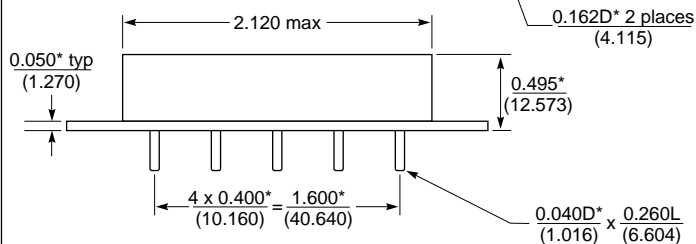
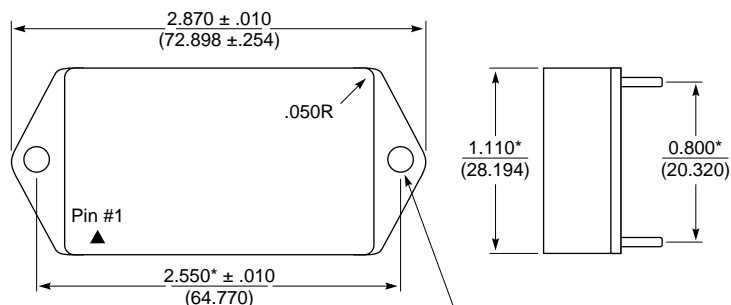


**Figure 12** Line Step Response  
A: Output @ 50mV/DIV, Full Load  
B: Input Step 28V to 22V

## MECHANICAL OUTLINE



*Standard*



\*±0.005 (±0.127)

*F option*

Input Common	◦10	1◦	Pos. Input
N/C or sync	◦9	◦	Inhibit Input
Case Ground	◦	Bottom View	Output Adjust
	◦	◦	Output Common
N/C	◦6	5◦	Pos. Output

AHE2805S

Input Common	◦10	1◦	Pos. Input
N/C or sync	◦9	◦	Inhibit Input
Case Ground	◦	Bottom View	N/C
	◦	◦	Output Common
N/C	◦6	5◦	Pos. Output

AHE2812S/AHE2815S

## HB & CH SCREENING PROCESS

Per MIL-STD-883

Test Inspection	Method	Condition
Pre-Seal Internal Visual	2017	
Stabilization Bake	1008	C
Temperature Cycling	1010	C
Constant Acceleration	2001	A, Y1 direction
Burn-in	1015	TC = +125°C
Final Electrical Test		TC = -55,+25,+125°C
External Visual	2009	
Gross Leak	1014	C
Fine Leak	1014	A

## ES SCREENING PROCESS

Same as HB screening except as follows:

Test Inspection	Method
Constant Acceleration	2001, 500g's
Burn-in	1015, 96 hrs.
Final Electrical	25°C only

## NOTES