LAMBDA ADVANCED ANALOG INC.

PRELIMINARY

AHV2800 Series

Hybrid - High Reliability
DC/DC Converters

DESCRIPTION

The AHV series of DC/DC converters are designed to replace the AHE/ATO family of converters in applications requiring compliance to MIL-STD-704A through E, in particular the input surge requirement of 80 volts specified in MIL-STD-704A. The converters are designed to withstand transient input voltage of 80 volts. No input voltage or output power derating is necessary over the full military temperature range.

These converters are packaged in an extremely rugged, low profile package that meets all requirements of MIL-STD-883 and MIL-PRF-38534. Parallel seam weld sealing and the use of ceramic pin feedthru seals assure long term hermeticity after exposure to extended temperature cycling.

The basic circuit is a push-pull forward topology using power MOSFET switches. The nominal switching frequency is 500 KHz. A unique current injection circuit assures current balancing in the power switches. All AHV series converters use a single stage LC input filter to attenuate input ripple current. A low power 11.5 volt series regulator provides power to an epitaxial CMOS custom pulse width modulator integrated circuit. This single integrated circuit provides all PWM primary circuit functions. Power is transferred from primary to secondary through a ferrite core power transformer. An error voltage signal is generated by comparing a highly stable reference voltage with the converter output voltage and drives the PWM through a unique wideband magnetic feedback circuit. This proprietary feedback circuit provides an extremely wide bandwidth, high gain control loop, with high phase margin. The feedback control loop gain is insensitive to temperature, radiation, aging, and variations in manufacturing. The transfer function of the feedback circuit is a function of the feedback transformer turns ratio which cannot change when subjected to enviromental extremes.

Manufactured in a facility fully qualified to MIL-PRF-38534, these converters are available in four screening grades to satisfy a wide range of requirements. The CH grade is fully compliant to the requirements of MIL-PRF-38534 for class H. The HB grade is processed and screened to the class H requirement, but may not necessarily meet all of the other MIL-PRF-38534 requirements, e.g., element evaluation and Periodic Inspection (P.I.) not required. Both grades are tested to meet the complete group "A" test specification over the full military temperature range without output power deration. Two grades with more limited screening are also available for use in less demanding applications. Variations in electrical, mechanical and screening can be accommodated. Contact Lambda Advanced Analog for special requirements.

FEATURES

- **80 Transient (100 msec max.) Absolute Maximum Input**
- **50 V_{DC} Absolute Maximum Input (Continuous)**
- **16-40 V_{DC} Input Range**
- **Single, Dual, and Triple Outputs**
- **15 Watt Output Power (No Temperature Derating)**
- **Low Input/Output Noise**
- **Full Military Temperature Range**
- **Wideband PWM Control Loop**
- **Magnetic Feedback**
- **Low Profile Hermetic Package (.405")**
- **Short Circuit and Overload Protection**
- **Constant Switching Frequency (500 KHz)**
- **True Hermetic Package (Parallel Seam Welded, Ceramic Pin Feedthru**

SPECIFICATIONS (SINGLE OUTPUT MODELS)

T_{CASE} = -55°C to +125°C, V_{IN} = +28 V ±5% unless otherwise specified

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5 V to 50 VDC (Continuous) 80 V (100ms)
Power Output	Internally limited, 17.5W typical
Soldering	300°C for 10 seconds (1 pin at a time)
Temperature Range	Operating -55°C to 135°C case[9]
	Storage -65°C to +135°C

Test	Symbol	Conditions -55°C - Tc - +125°C, VIN = 28 VDC ±5%, CL=0, unless otherwise specified	Group A Subgroups	AHV2805S Min	AHV2805S Max	AHV2812S Min	AHV2812S Max	AHV2815S Min	AHV2815S Max	Units
STATIC CHARACTERISTICS										
OUTPUT	VOUT	VIN = 16, 28, and 40 VDC	1	4.95	5.05	11.88	12.12	14.85	15.15	V
Voltage		IOUT = 0	2,3	4.90	5.10	11.76	12.24	14.70	15.30	V
Current	IOUT	VIN = 16, 28, and 40 VDC	1,2,3	0.0	3.00	0.0	1.25	0.0	1.00	A
Ripple Voltage [1]	VRIP	VIN = 16, 28, and 40 VDC BW = DC to 1 MHz	1,2,3		60		60		60	mV p-p
Power	POUT	VIN = 16, 28, and 40 VDC	1,2,3	15		15		15		W
REGULATION										
Line	VRLINE	VIN = 16, 28, and 40 VDC	1		5		30		35	mV
		IOUT = 0, Half Load and Full Load	2,3		25		60		75	mV
Load	VRLOAD	VIN = 16, 28, and 40 VDC IOUT = 0, Half Load and Full Load	1,2,3		50		120		150	mV
INPUT										
Current	IIN	IOUT = 0, Inhibit (pin 2) = 0	1,2,3		18		18		18	mA
		IOUT = 0, Inhibit (pin 2) = Open			50		50		50	mA
Ripple Current	IRIP	IOUT = Full Load	1,2,3		50		50		50	mA p-p
EFFICIENCY	EFF	IOUT = Full Load Tc = +25°C	1	72		72		72		%
ISOLATION	ISO	Input to output or any pin to case (except pin 8) at 500 VDC, Tc = +25°C	1	100		100		100		MΩ
CAPACITIVE LOAD [2, 3]	CL	No effect on DC performance Tc = +25°C	4		500		200		200	µF
LOAD FAULT POWER DISSIPATION	PD	Overload, Tc = +25°C [4]	1		8.5		8.5		8.5	W
		Short circuit, Tc = +25°C			8.5		8.5		8.5	W
SWITCHING FREQUENCY	FS	IOUT = Full Load	4	450	550	450	550	450	550	KHz
DYNAMIC CHARACTERISTICS										
STEP LOAD CHANGES										
Output Transient [5]	VOTLOAD	50% Load 135 100% Load	4	-300	+300	-300	+300	-300	+300	mVpk
		No Load 135 50%	4	-500	+500	-750	+750	-750	+750	mVpk
Recovery [5,6]	TTLOAD	50% Load 135 100% Load	4		70		70		70	µS
		No Load 335 50% Load	4		200		1500		1500	µS
		50% Load 335 No Load	4		5		5		5	ms
STEP LINE CHANGES										
Output Transient	VOTLINE	Input step 16 to 40 VDC [3,7]	4		300		500		500	mVpk
		Input step 40 to 16 VDC [3,7]	4		-1000		-1500		-1500	mVpk
Recovery	TTLINE	Input step 16 to 40 VDC [3,6,7]	4		800		800		800	µS
		Input step 40 to 16 VDC [3,6,7]	4		800		800		800	µS
TURN-ON										
Overshoot	VTON OS	IOUT = OA and Full Load	4,5,6		550		750		750	mVpk
Delay	TON D	IOUT = O and Full Load [8]	4,5,6		10		10		10	ms
LOAD FAULT RECOVERY	trLF	VIN = 16 TO 40 VDC	4,5,6		10		10		10	ms

Notes:
1. Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
2. Capacitive load may be any value from 0 to the maximum limit without affecting dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but will interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn-on.
3. Parameter shall be tested as part of design characterization and after design or process changes. Thereafter shall be guaranteed to the limits specified.
4. An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
5. Load step transition time between 2 and 10 microseconds.
6. Recovery time is measured from the initiation of the transient to where VOUT has returned to within ±1 percent of VOUT at 50 percent load.
7. Input step transition time between 2 and 10 microseconds.
8. Turn on delay time measurement is for either a step application of power at input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.
9. Above 125°C case temperature, derate output power linearly to 0 at 135°C case.

SPECIFICATIONS (DUAL OUTPUT MODELS)

T_{CASE} = -55°C to +125 °C, V_{IN} = +28 V ±5% unless otherwise specified

ABSOLUTE MAXIMUM RATINGS	
Input Voltage	-0.5 V to 50 VDC (Continuous) 80 V (100ms)
Power Output	Internally limited, 17.5W typical
Soldering	300°C for 10 seconds (1 pin at a time)
Temperature Range	Operating -55°C to 135°C case [13] Storage -65°C to +135°C

Test	Symbol	Conditions -55°C - Tc - +125°C, V_{IN} = 28 V_{DC} ±5%, C_L=0, unless otherwise specified	Group A Subgroups	AHV2812D Min	AHV2812D Max	AHV2815D Min	AHV2815D Max	Units
STATIC CHARACTERISTICS								
OUTPUT								
Voltage [1]	V_{OUT}	I_{OUT} = 0	1	±11.88	±12.12	±14.85	±15.15	V
			2,3	±11.76	±12.24	±14.70	±15.30	V
Current [1,2]	I_{OUT}	V_{IN} = 16, 28, and 40 V_{DC}	1,2,3	0.0	±625	0.0	±500	mA
Ripple Voltage [1,3]	V_{RIP}	V_{IN} = 16, 28, and 40 V_{DC} BW = DC TO 2 MHz	1,2,3		60		60	mV p-p
Power [1,2,4]	P_{OUT}	V_{IN} = 16, 28, and 40 V_{DC}	1,2,3	15		15		W
REGULATION								
Line [1,5]	V_{RLINE}	V_{IN} = 16, 28, and 40 V_{DC}	1		30		35	mV
	I_{OUT}	I_{OUT} = 0, Half Load and Full Load	2,3		60		75	mV
Load [1]	V_{RLOAD}	V_{IN} = 16, 28, and 40 V_{DC} I_{OUT} = 0, Half Load and Full Load	1,2,3		120		150	mV
INPUT								
Current	I_{IN}	I_{OUT} = 0, inhibit (pin 2) Tied to input return (pin 10)	1,2,3		18		18	mA
		I_{OUT} = 0, inhibit (pin 2) = open			65		65	mA
Ripple Current [3]	I_{RIP}	I_{OUT} = Full Load BW = DC to 2MHz	1,2,3		50		50	mA p-p
EFFICIENCY	E_{FF}	I_{OUT} = FULL LOAD, T_C = +25°C	1	72		72		%
ISOLATION	ISO	Input to output or any pin to case (except pin 8) at 500 V_{DC}, T_C = +25°C	1	100		100		MΩ
CAPACITIVE LOAD [6,7]	C_L	No effect on DC performance, T_C = +25°C	4		200		200	µf
LOAD FAULT POWER DISSIPATION	P_D	Over Load, T_C = +25°C [8]	1		8.5		8.5	W
		Short Circuit, T_C = +25°C			8.5		8.5	W
SWITCHING FREQUENCY	F_S	I_{OUT} = FULL LOAD	4	450	550	450	550	KHz
DYNAMIC CHARACTERISTICS								
STEP LOAD CHANGES								
Output Transient [9]	VO_{TLOAD}	50% Load 135 100% Load	4	-300	+300	-300	+300	mVpk
		No Load 135 50% Load	4	-500	+500	-500	+500	mVpk
Recovery [9,10]	TT_{LOAD}	50% Load 135 100% Load	4		70		70	µs
		No Load 335 50% Load	4		1500		1500	µs
		50% Load 335 No Load	4		5		5	ms
STEP LINE CHANGES								
Output Transient [7,11]	VO_{TLINE}	Input step 16 to 40 V_{DC}	4		1200		1500	mVpk
		Input step 40 to 16 V_{DC}	4		-1500		-1500	mVpk
Recovery [7,10,11]	TT_{LINE}	Input step 16 to 40 V_{DC}	4		4		4	ms
		Input step 40 to 16 V_{DC}	4		4		4	ms
TURN-ON								
Overshoot [1]	$V_{TON\ OS}$	I_{OUT} = O and Full Load	4,5,6		600		600	mVpk
Delay [1,12]	$T_{ON\ D}$	I_{OUT} = O and Full Load	4,5,6		10		10	ms
LOAD FAULT RECOVERY [7]	t_{rLF}		4,5,6		10		10	ms

Notes:
1. Tested at each output
2. Parameter guaranteed by line and load regulation tests.
3. Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
4. Total power at both outputs.
5. When operating with unbalanced loads, at least 25% of the load must be on the positive output to maintain regulation.
6. Capacitive load may be any value from 0 to the maximum limit without affecting dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn-on.
7. Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified.
8. An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
9. Load step transition time between 2 and 10 microseconds.
10. Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within ± 1 percent of V_{OUT} at 50 percent load.
11. Input step transition time between 2 and 10 microseconds.
12. Turn on delay time measurement is for either a step application of power at input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.
13. Above 125°C case temperature, derate output power linearly to 0 at 135°C case.

SPECIFICATIONS (TRIPLE OUTPUT MODELS)

T_{CASE} = -55°C to +125°C, V_{IN} = +28 V ±5% unless otherwise specified

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5 V to 50 VDC (Continuous) 80 V (100ms)
Power Output	Internally limited, 17.5W typical
Soldering	300°C for 10 seconds (1 pin at a time)
Temperature Range	Operating -55°C to 135°C case [8]
	Storage -65°C to +135°C

Test	Symbol	Conditions -55°C - Tc - +125°C, V_{IN} = 28 VDC ±5%, CL=0, unless otherwise specified	Group A Subgroups	AHV2812T Min	 Max	AHV2815T Min	 Max	Unit
STATIC CHARACTERISTICS								
OUTPUT								
Voltage [1]	VOUT	IOUT = 0 (main)	1	4.95	5.05	4.95	5.05	V
			2,3	4.90	5.10	4.90	5.10	V
		IOUT = 0 (dual)[1]	1	±11.88	±12.12	±14.85	±15.15	V
			2,3	±11.76	±12.24	±14.70	±15.30	V
Current [1,2,3]	IOUT	VIN = 16, 28, and 40 VDC (main)	1,2,3	0.0	2000	0.0	2000	mA
		VIN = 16, 28, and 40 VDC (dual)[1]	1,2,3	0.0	±208	0.0	±167	mA
Ripple Voltage [1,4]	VRIP	VIN = 16, 28, and 40 VDC BW = DC TO 2 MHz (main)	1,2,3		80		80	mV p-p
		VIN = 16, 28, and 40 VDC BW = DC TO 2 MHz (main)	1,2,3		40		40	mV p-p
Power [1,2,3]	POUT	VIN = 16, 28, and 40 VDC (main)	1,2,3	10		10		W
		(+dual)	1,2,3	2.5		2.5		W
		(-dual)	1,2,3	2.5		2.5		W
		(total)	1,2,3	15		15		W
REGULATION								
Line [1,3]	VRLINE	VIN = 16, 28, and 40 VDC IOUT = 0, 1000, 2000 mA (main)	1,2,3		25		25	mV
		VIN = 16, 28, and 40 VDC IOUT = 0, ±104, ±208 mA (±12V) (dual)	1		±30		±35	mV
		IOUT = 0, ±84, ±167 mA (±15v)	2,3		±60		±75	mV
Load [1,3]	VRLOAD	VIN = 16, 28, and 40 VDC IOUT = 0, 1000, 2000 mA (main)	1,2,3		50		50	mV
		VIN = 16, 28, and 40 VDC IOUT = 0, ±104, ±208 mA (±12V) (dual) IOUT = 0, ±84, ±167 mA (±15v)	1,2,3		±60		±75	mV
INPUT								
Current	IIN	IOUT = 0 inhibit (pin 8) tied to input return (pin 10)	1,2,3		15		15	mA
		IOUT = 0 inhibit (pin 2) = open	1,2,3		50		50	mA
Ripple Current [4]	IRIP	IOUT = 2000 mA (main) IOUT = ±208 mA (±12V) IOUT = ±167 mA (±15V) BW = DC to 2MHz	1,2,3		50		50	mA p-p
EFFICIENCY	EFF	IOUT = 2000 mA (main) IOUT = ±208 mA (± 12V) IOUT = ±167 mA (±15V)	1	72		72		%
ISOLATION	ISO	Input to output or any pin to case (except pin 7) at 500 Vdc, Tc = +25C	1	100		100		MΩ
LOAD FAULT POWER DISSIPATION [3]	PD	Over Load, TC = +25C[5]	1		8.5		8.5	W
		Short Circuit, TC = +25C	1		8.5		8.5	W
SWITCHING FREQUENCY[1]	FS	IOUT = 2000 mA (main) IOUT = ±208 mA (±12V) IOUT = ±167 mA (±15V)	4	450	550	450	550	KHz
CAPACITIVE LOAD [6,7]	CL	No effect on DC performance, TC = +25C (main)	4		500		500	µf
		(dual)			200		200	µf
DYNAMIC CHARACTERISTICS								
STEP LOAD CHANGES								
Output Transient [9]	VOTLOAD	50% Load 135 100% Load	4	-300	+300	-300	+300	mVpk
		No Load 135 50% Load	4	-400	+400	-400	+400	mVpk
Recovery [9,10]	TTLOAD	50% Load 135 100% Load	4		100		100	µs
		No Load 335 50% Load	4		2000		2000	µs
		50% Load 335 No Load	4		5		5	ms

STEP LINE CHANGES								
Output Transient [7,11]	V_{OTLINE}	Input step 16 to 40 V_{DC}	4		1200		1200	mVpk
		Input step 40 to 16 V_{DC}	4		-1500		-1500	mVpk
Recovery [7,10,11]	T_{TLINE}	Input step 16 to 40 V_{DC}	4		4		4	ms
		Input step 40 to 16 V_{DC}	4		4		4	ms
TURN-ON								
Overshoot [1]	$V_{TON\ OS}$	I_{OUT} = 0 and ±625 mA	4		750		750	mVpk
Delay [1,12]	$T_{ON\ D}$	I_{OUT} = 0 and ±625 mA	4		15		15	ms
LOAD FAULT RECOVERY [7]	t_{RLF}		4		15		15	ms

Notes:
1. Tested at each output
2. Parameter guaranteed by line and load regulation tests.
3. At least 25 percent of the total power should be taken from the (+5 volt) main output.
4. Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
5. An overload is that condition with a load in excess of the rated load but less than that necessary to trigger the short circuit protection and is the condition of maximum power dissipation.
6. Capacitive load may be any value from 0 to the maximum limit without affecting dc performance. A capacitive load in excess of the maximum limit will not disturb loop stability but may interfere with the operation of the load fault detection circuitry, appearing as a short circuit during turn-on.
7. Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified.
8. Above 125°C case temperature, derate output power linearly to 0 at 135°C case.
9. Load step transition time between 2 and 10 microseconds.
10. Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within ± 1 percent of V_{OUT} at 50 percent load.
11. Input step transition time between 2 and 10 microseconds.
12. Turn on delay time measurement is for either a step application of power at input or the removal of a ground signal from the inhibit pin (pin 8) while power is applied to the input.

PART NUMBER

AHV 28xx x F / xx

- Model: AHV
- Input Voltage: 28
- Output Voltage: xx
  - 05 - 5VDC
  - 12 - 12VDC
  - 15 - 15VDC
- Output Option: x
  - S - Single Output
  - D - Dual Output
  - T - Triple Output
- Package: F
  - F - Flange
- Screening: xx (see table below)
  - Omit for industrail
  - ES— Environmental screening
  - HB— Military screening
  - CH— Fully compliant and SMD

STANDARD MILITARY DRAWING CROSS REFERENCE

Lambda Advanced Analog part no.	Standardized ** military dwg.
AHV2805 SF/CH	5962-91773
AHV2812 SF/CH	5962-92112
AHV2815 SF/CH	5962-92113
AHV2812 DF/CH	5962-92114
AHV2815 DF/CH	5962-92774
AHV2812 TF/CH	5962-92115
AHV2815 TF/CH	5962-92116

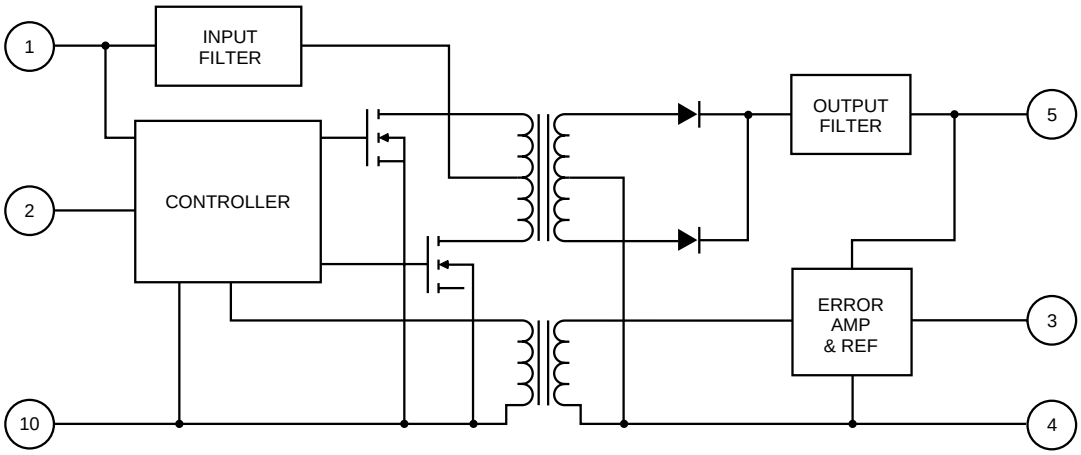
** Pending consult factory for status.

SCREENING DETAILS

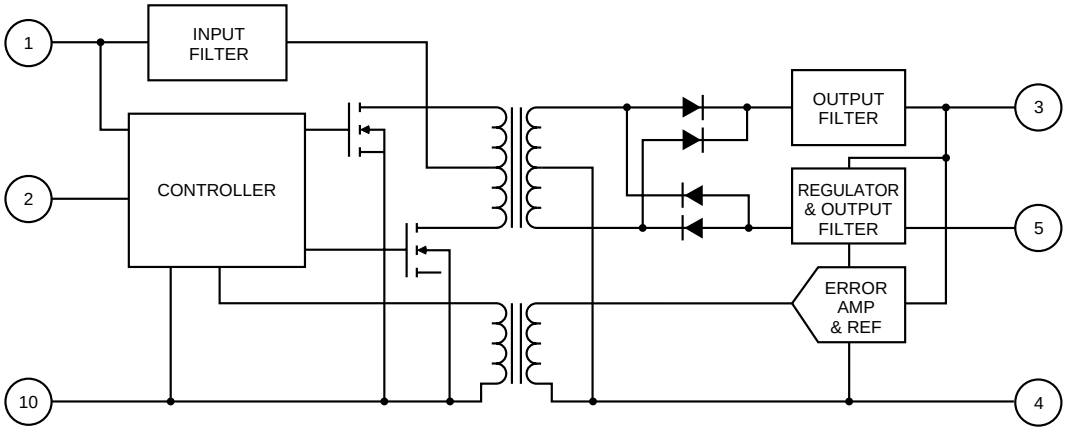
Requirement	MIL-STD-883 Method	No Suffix	ES Suffix	HB Suffix	CH Suffix
Temperature Range		-20°C to +85°C	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C
Element Evaluation					MIL-PRF-38534
Internal Visual	2017	✍	✓	✓	✓
Temperature Cycle	1010		Cond B	Cond C	Cond C
Constant Acceleration	2001		500g	Cond A	Cond A
Burn-in	1015		96 hrs @125°C	160 hrs @125°C	160 hrs @125°C
Final Electrical (Group A)	MIL-STD-38534 & Specification	25°C	25°C	-55, +25, +125°C	-55, +25, +125°C
Seal, Fine & Gross	1014	Cond A	Cond A, C	Cond A, C	Cond A, C
External Visual	2009	✍	✓	✓	✓

✍ per Commercial Standards

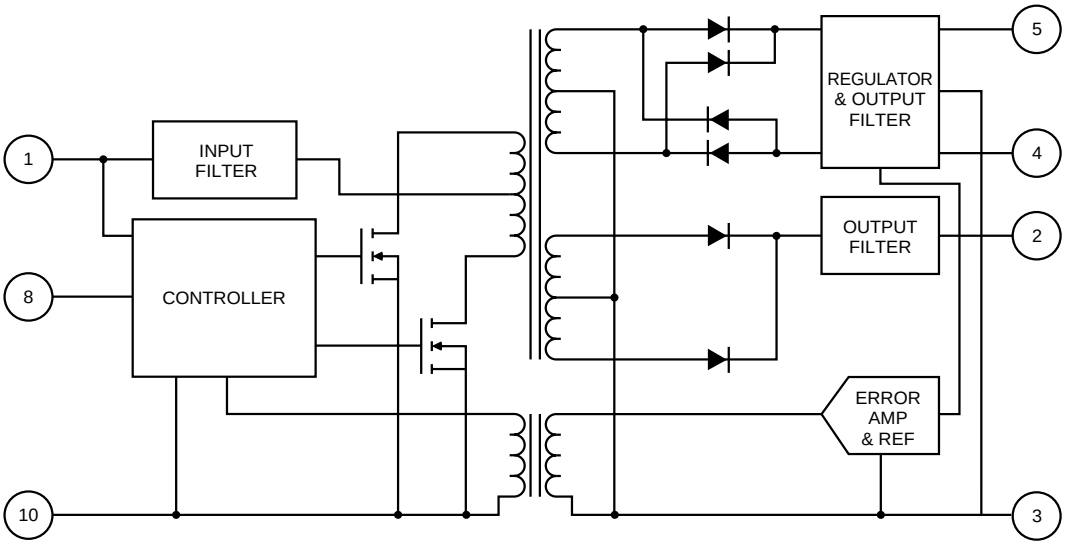
BLOCK DIAGRAMS



Single Output Models

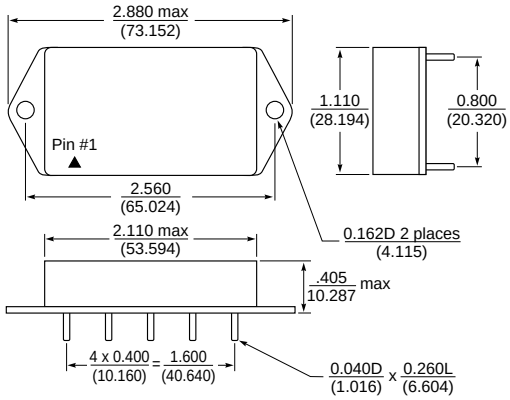


Double Output Models

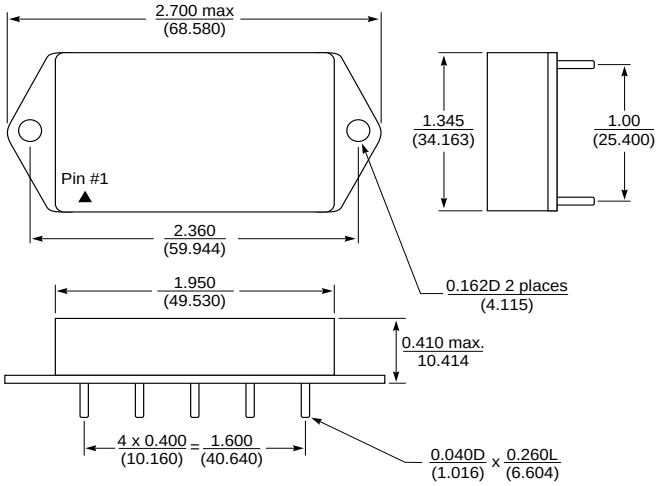


Triple Output Models

MECHANICAL OUTLINE



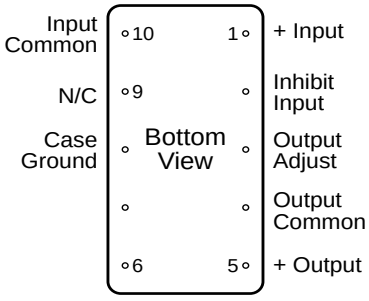
Single and Dual Output Models



Flange

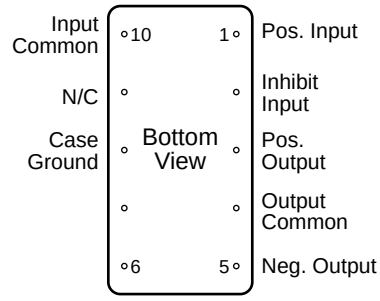
Triple Output Models

PIN DESIGNATION



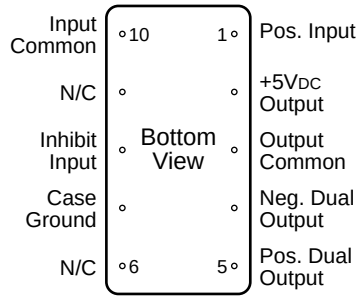
Single Output Models

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



Dual Output Models

Pin 1 Positive Input	Pin 10 Input common
Pin 2 Inhibit Input	Pin 9 N/C
Pin 3 Positive output	Pin 8 Case gnd
Pin 4 Output common	Pin 7 N/C
Pin 5 Negative output	Pin 6 N/C



Triple Output Models

Pin 1 Positive Input	Pin 10 Input common
Pin 2 +5VDC output	Pin 9 N/C
Pin 3 Output common	Pin 8 Inhibit Input
Pin 4 Neg. Dual output (12/15VDC)	Pin 7 Case gnd
Pin 5 Pos. Dual output (12/15VDC)	Pin 6 N/C

APPLICATION INFORMATION

Inhibit function

Connecting the inhibit pin (Pin 2 of single and dual models, pin 8 of triple models) to the input return (Pin 10) will cause the converter to shut down and operate in a low power standby mode. Power consumption in this mode is calculated by multiplying Vin times the input current inhibited, typically 225mw at Vin equal to 28 volts. The input current inhibited is relatively constant with changes in Vin. The open circuit inhibit pin voltage is typically 11.5 volts and can be conveniently driven by an open collector driver. An internal pullup resistor enables the user to leave this pin floating if the inhibit function is not used in their particular application. All models use identical inhibit internal circuits. Forcing inhibit pin to any voltage between 0 and 6 volts will assure the converter is inhibited. The input current to this pin is 500µa maximum at Vpin2 = to 0 volts. The converter can be turned on by opening Pin 2 or forcing a voltage from 10 to 50 volts. Inhibit pin current from 10 to 50 volts is less than ±50µa.

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 (Single Output Models Only)

The output voltage of the AHV28XXS can be adjusted upward by connecting Output Adjust (Pin 3) and Output Common (Pin 4) as shown in Table 1.

Resistance, ohm Pin 3 to 4	**Output Voltage Increase, % 5V**	**12V**	**15V**
x	0	0	0
390 K	+1.0 %	+1.6%	+1.7 %
145 K	+2.0 %	+3.2 %	+3.4 %
63 K	+3.1 %	+4.9 %	+5.1 %
22 K	+4.1 %	+6.5 %	+6.8 %
0	+5.0 %	+7.9 %	+8.3 %

Table 1: Output Adjustment Resistor Values

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The information in this data sheet has been carefully checked and is believed to be accurate; however no responsibility is assumed for possible errors. These specifications are subject to change without notice.

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