LAMBDA ADVANCED ANALOG INC.

ATW2800S Series

Single Output, Hybrid - High Reliability
DC/DC Converter

DESCRIPTION

The ATW2800S 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 $28V_{DC}$ inputs with +5, +12V and +15V single outputs. The circuit design incorporates a pulse width modulated push-pull topology operating in the feed-forward mode at a nominal switching frequency of 270KHz. 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. Refer to Part Number section. They are provided in a flanged package for more severe enviroments.

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

- **19 To 40 Volt Input Range ($28V_{DC}$ Nominal)**
- **30 Watts Output Power**
- **Indefinite Short Circuit and Overload Protection**
- **22.8 W/in^3 Power Density**
- **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 83%**
- **Shutdown From External Signal**
- **Military Screening**
- **250,000 Hour MTBF at 85°C**
- **MIL-PRF-38534 Compliant Versions Available**

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5V to 50V
Soldering Temperature	300°C for 10 seconds
Case Temperature	Operating-55°C to +125°C Storage -65°C to +135°C

TABLE I. Electrical Performance Characteristics

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A subgroups	Device types	Limits		Unit
					Min	Max	
Output voltage	V_{OUT}	I_{OUT} = 0	1	All	4.95	5.05	V
			2,3		4.90	5.10	
Output current 1/	I_{OUT}	V_{IN} = 19, 28, and 40 V dc	1,2,3	All	0.0	6000	mA
Output ripple voltage 2/	V_{RIP}	V_{IN} = 19, 28, and 40 V dc B.W. = dc to 2 MHz	1,2,3	All		50	mV p-p
Output power 1/ 3/	P_{OUT}	V_{IN} = 19, 28, and 40 V dc	1,2,3	All	30		W
Line regulation 4/	VR_{LINE}	V_{IN} = 19, 28, and 40 V dc I_{OUT} = 0, 3000, and 6000 mA	1	All		5	mV
			2,3			20	
Load regulation 4/	VR_{LOAD}	V_{IN} = 19, 28, and 40 V dc I_{OUT} = 0, 3000, and 6000 mA	1,2,3	All		30	mV
Input current	I_{IN}	I_{OUT} = 0, inhibit (pin 2) tied to input return (pin 10)	1,2,3	All		18	mA
		I_{OUT} = 0, inhibit (pin 2) = open				40	
Input ripple current 2/	I_{RIP}	I_{OUT} = 6000 mA B.W. = dc to 2 MHz	1,2,3	All		20	mA p-p
Efficiency	E_{FF}	I_{OUT} = 6000 mA, T_C = +25°C	1	All	78		%
Isolation	ISO	Input to output or any pin to case (except pin 7) at 500 V dc, T_C = +25°C	1	All	100		MΩ
Capacitive load 5/ 6/	C_L	No effect on dc performance, T_C = +25°C	4	All		500	µF
Power dissipation load fault	P_D	Overload, T_C = +25°C 7/	1	All		12	W
		Short circuit, T_C = +25°C				9	

See footnotes at end of table.

TABLE I. Electrical Performance Characteristics - Continued.

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A Subgroups	Device Type	Limits		Unit
					Min	Max	
Switching frequency	F_S	I_{OUT} = 6000 mA	4,5,6	01	250	300	kHz
				02	250	270	
				03	275	300	
Output response to step transient load changes 8/	VO_{TLOAD}	4000 mA to/from 6000 mA	4,5,6	All	-500	+500	mV pk
		500 mA to/from 2500 mA	4,5,6	All	-500	+500	
Recovery time step transient load changes 8/ 9/	TT_{LOAD}	4000 mA to/from 6000 mA	4	All		100	µs
			5,6			200	
		500 mA to/from 2500 mA	4	All		100	
			5,6			200	
Turn on overshoot	$VTon_{OS}$	I_{OUT} = 0 and 6000 mA	4,5,6	All		500	mV pk
Turn on delay 10/	Ton_D	I_{OUT} = 0 and 6000 mA	4,5,6	All		12	ms
Load fault recovery 6/ 10/	Tr_{LF}		4,5,6	All		12	ms

Notes:

1/ Parameter guaranteed by line and load regulation tests.
2/ Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
3/ Above +125°C case, derate output power linearly to 0 at +135°C.
4/ Output voltage measured at load with remote sense leads connected across load.
5/ Capacitive load may be any value from 0 to the maximum limit without compromising 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.
6/ Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in Table I.
7/ 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.
8/ Load step transition time between 2 and 10 microseconds.
9/ 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.
10/Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5V to 50V
Soldering Temperature	300°C for 10 seconds
Case Temperature	Operating-55°C to +125°C Storage -65°C to +135°C

TABLE II. Electrical Performance Characteristics

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A subgroups	Device types	Limits		Unit
					Min	Max	
Output voltage	V_{OUT}	I_{OUT} = 0	1	All	4.95	5.05	V
			2,3		4.90	5.10	
Output current 1/	I_{OUT}	V_{IN} = 19, 28, and 40 V dc	1,2,3	All	0.0	6000	mA
Output ripple voltage 2/	V_{RIP}	V_{IN} = 19, 28, and 40 V dc B.W. = dc to 2 MHz	1,2,3	All		50	mV p-p
Output power 1/ 3/	P_{OUT}	V_{IN} = 19, 28, and 40 V dc	1,2,3	All	30		W
Line regulation 4/	VR_{LINE}	V_{IN} = 19, 28, and 40 V dc I_{OUT} = 0, 3000, and 6000 mA	1	All		5	mV
			2,3			20	
Load regulation 4/	VR_{LOAD}	V_{IN} = 19, 28, and 40 V dc I_{OUT} = 0, 3000, and 6000 mA	1,2,3	All		30	mV
Input current	I_{IN}	I_{OUT} = 0, inhibit (pin 2) tied to input return (pin 10)	1,2,3	All		18	mA
		I_{OUT} = 0, inhibit (pin 2) = open				40	
Input ripple current 2/	I_{RIP}	I_{OUT} = 6000 mA B.W. = dc to 2 MHz	1,2,3	All		20	mA p-p
Efficiency	E_{FF}	I_{OUT} = 6000 mA, T_C = +25°C	1	All	78		%
Isolation	ISO	Input to output or any pin to case (except pin 7) at 500 V dc, T_C = +25°C	1	All	100		MΩ
Capacitive load 5/ 6/	C_L	No effect on dc performance, T_C = +25°C	4	All		500	µF
Power dissipation load fault	P_D	Overload, T_C = +25°C 7/	1	All		12	W
		Short circuit, T_C = +25°C				9	

See footnotes at end of table.

TABLE II. Electrical Performance Characteristics - Continued.

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A Subgroups	Device Type	Limits		Unit
					Min	Max	
Switching frequency	F_S	I_{OUT} = 6000 mA	4,5,6	01	250	300	kHz
				02	250	270	
				03	275	300	
Output response to step transient load changes 8/	VO_{TLOAD}	4000 mA to/from 6000 mA	4,5,6	All	-500	+500	mV pk
		500 mA to/from 2500 mA	4,5,6	All	-500	+500	
Recovery time step transient load changes 8/ 9/	TT_{LOAD}	4000 mA to/from 6000 mA	4	All		100	µs
			5,6			200	
		500 mA to/from 2500 mA	4	All		100	
			5,6			200	
Turn on overshoot	$VTon_{OS}$	I_{OUT} = 0 and 6000 mA	4,5,6	All		500	mV pk
Turn on delay 10/	Ton_D	I_{OUT} = 0 and 6000 mA	4,5,6	All		12	ms
Load fault recovery 6/ 10/	Tr_{LF}		4,5,6	All		12	ms
Weight		Flange				75	grams

Notes:

1/ Parameter guaranteed by line and load regulation tests.
2/ Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
3/ Above +125°C case, derate output power linearly to 0 at +135°C.
4/ Output voltage measured at load with remote sense leads connected across load.
5/ Capacitive load may be any value from 0 to the maximum limit without compromising 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.
6/ Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in Table II.
7/ 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.
8/ Load step transition time between 2 and 10 microseconds.
9/ 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.
10/ Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5V to 50V
Soldering Temperature	300°C for 10 seconds
Case Temperature	Operating-55°C to +125°C Storage -65°C to +135°C

TABLE III. Electrical Performance Characteristics

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A subgroups	Device types	Limits		Unit
					Min	Max	
Output voltage	V_{OUT}	I_{OUT} = 0	1	All	14.85	15.15	V
			2,3		14.70	15.30	
Output current 1/	I_{OUT}	V_{IN} = 17, 28, and 40 V dc	1,2,3	All	0.0	1333	mA
Output ripple voltage 2/	V_{RIP}	V_{IN} = 17, 28, and 40 V dc B.W. = dc to 2 MHz	1,2,3	All		60	mV p-p
Output power 1/ 3/	P_{OUT}	V_{IN} = 17, 28, and 40 V dc	1,2,3	All	20		W
Line regulation	VR_{LINE}	V_{IN} = 17, 28, and 40 V dc I_{OUT} = 0, .677, and 1333 mA	1	All		35	mV
			2,3			75	
Load regulation	VR_{LOAD}	V_{IN} = 17, 28, and 40 V dc I_{OUT} = 0, .677, and 1333 mA	1,2,3	All		150	mV
Input current	I_{IN}	I_{OUT} = 0, inhibit (pin 2) tied to input return (pin 10)	1,2,3	All		18	mA
		I_{OUT} = 0, inhibit (pin 2) = open				35	
Input ripple current 2/	I_{RIP}	I_{OUT} = 1333 mA B.W. = dc to 2 MHz	1,2,3	All		50	mA p-p
Efficiency	E_{FF}	I_{OUT} = 1333 mA, T_C = +25°C	1	All	80		%
Isolation	ISO	Input to output or any pin to case (except pin 8) at 500 V dc, T_C = +25°C	1	All	100		MΩ
Capacitive load 4/ 5/	C_L	No effect on dc performance, T_C = +25°C	4	All		200	µF
Power dissipation load fault	P_D	Overload, T_C = +25°C 6/	1	All		6	W
		Short circuit, T_C = +25°C				6	

See footnotes at end of table.

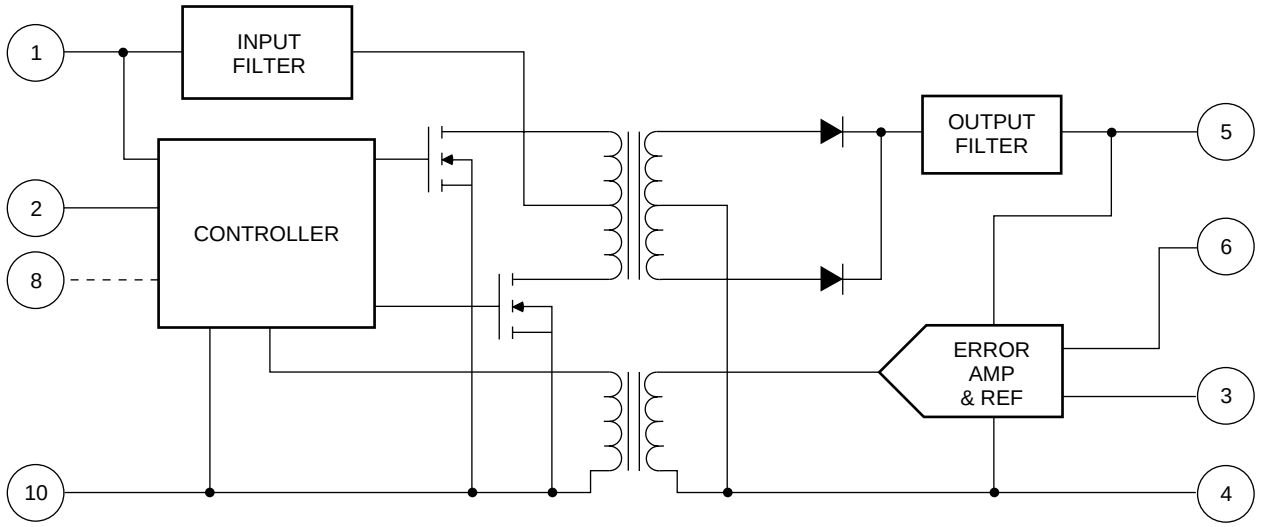
TABLE III. Electrical Performance Characteristics - Continued.

Test	Symbol	Conditions $-55°C \le T_C \le +125°C$ V_{IN} = 28 V dc ±5%, C_L = 0 unless otherwise specified	Group A subgroups	Device types	Limits		Unit
					Min	Max	
Switching frequency	F_S	I_{OUT} = 1333 mA	4,5,6	01	225	275	kHz
				02	225	245	
				03	250	275	
Output response to step transient load changes 7/	VO_{TLOAD}	50 percent load to/from 100 percent load	4	All	-300	+300	mV pk
			5,6		-450	+450	
		No load to/from 50 percent load	4	All	-500	+500	
			5,6		-750	+750	
Recovery time step transient load changes 7/ 8/	TT_{LOAD}	50 percent load to/from 100 percent load	4	All		70	µs
			5,6			100	
		No load to 50 percent load	4,5,6	All		1500	
		50 percent load to no load	4,5,6	All		5	ms
Output response to transient step line changes 5/ 9/	VO_{TLINE}	Input step 17 to 40 V dc	4,5,6	All		500	mV pk
		Input step 40 to 17 V dc	4,5,6	All		-1500	
Recovery time transient line changes 5/ 8/ 9/	TT_{LINE}	Input step 17 to 40 V dc	4,5,6	All		800	ms
		Input step 40 to 17 V dc	4,5,6	All		800	
Turn on overshoot	$VTon_{OS}$	I_{OUT} = 0 and 1333 mA	4,5,6	All		600	mV pk
Turn on delay 10/	Ton_D	I_{OUT} = 0 and 1333 mA	4,5,6	All		10	ms
Load fault recovery 5/	Tr_{LF}		4,5,6	All		10	ms
Weight		Flange				75	grams

Notes:

1/ Parameter guaranteed by line and load regulation tests.
2/ Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
3/ For operation at 16 V dc input, derate output power by 33 percent.
4/ Capacitive load may be any value from 0 to the maximum limit without compromising 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.
5/ Parameter shall be tested as part of design characterization and after design or process changes. Thereafter parameters shall be guaranteed to the limits specified in Table III.
6/ 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.
7/ Load step transition time between 2 and 10 microseconds.
8/ 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.
9/ Input step transition time between 2 and 10 microseconds.
10/ Turn on delay time measurement is for either a step application of power at the input or the removal of a ground signal from the inhibit pin (pin 2) while power is applied to the input.

BLOCK DIAGRAM



Available Screening Levels and Process Variations for ATW 2800S Series

Requirement	MIL-STD-883 method	No Suffix	ES Suffix	HB Suffix	CH Suffix
Temperature Range		-55°C to +85°C	-55°C to +115°C	-55°C to +125°C	-55°C to +125°C
Element Evaluation					MIL-PRF-38534
Internal Visual	2017	◆	✔	✔	✔
Temperature Cycle	1010, Cond C		Cond A	✔	✔
Constant Acceleration	2001, Cond A		500g	5,000g	5,000g
Burn-in	1015		96hrs @105°C	160hrs @125°C	160hrs @125°C
Final Electrical (Group A)	Specification	25°C	25°C	-55, +25, +125°C	-55,+25, +125°C
Seal, Fine & Gross	1014		✔	✔	✔
External Visual	2009	◆	✔	✔	✔

◆ per Commercial Standards

PART NUMBER

ATW 28xx S / x - xxx

Model

Input Voltage

Output Voltage

Single Output

Synchronization Option
Omit for standard
MSTR — Master
SLV — Slave

Temperature Range
Omit for -55°C to +85°C (Industrial)
ES — -55°C to +105°C (Environmental)
HB — -55°C to +125°C (Military Screening)
CH — -55½C to +125°C (DESC Compliant)

TYPICAL CHARACTERISTICS

Waveforms shown are for ATW2805

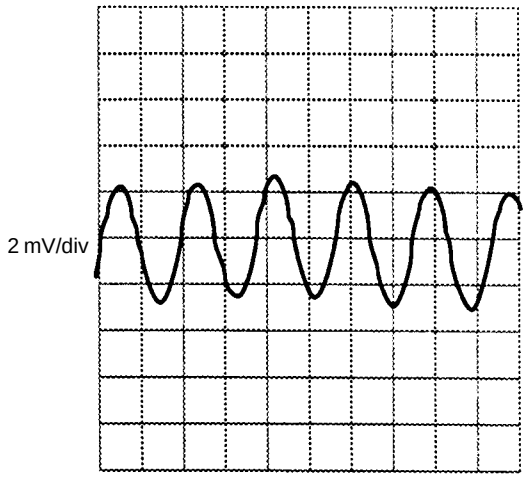


Figure 1 **Output Ripple Voltage**
V_{IN} = 28 V_{DC}, Full Load

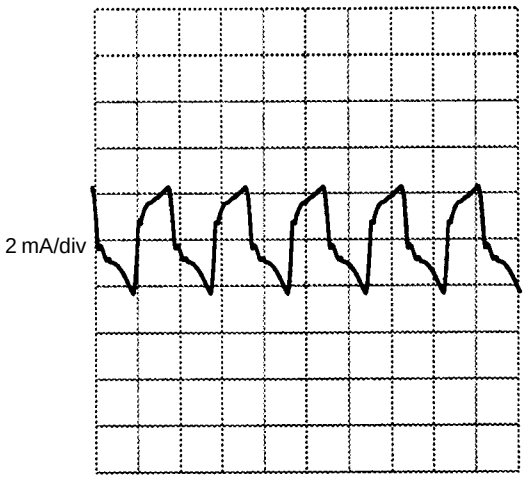


Figure 2 **Input Ripple Voltage**
V_{IN} = 28 V_{DC}, Full Load

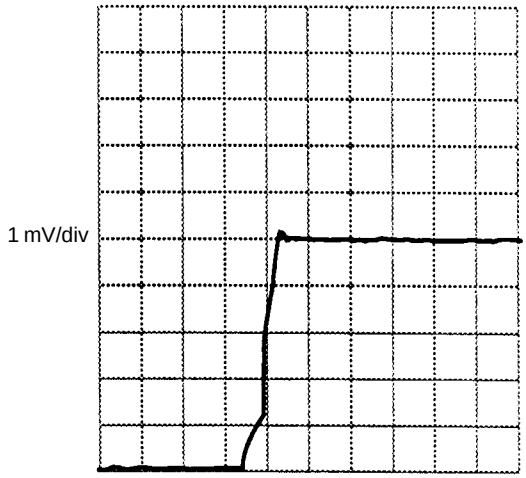


Figure 3 **Turn-on Response** @Full Load

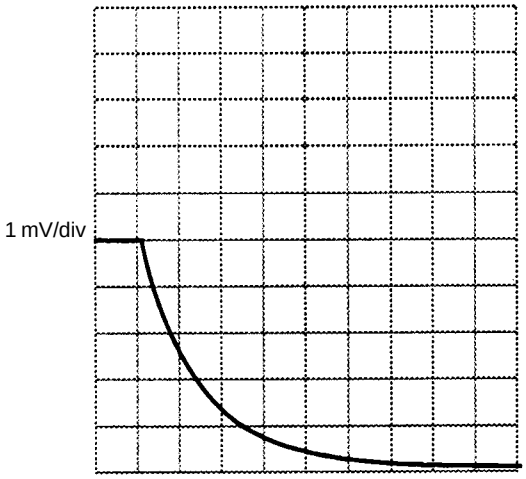


Figure 4 **Turn-on Response**, @Full Load

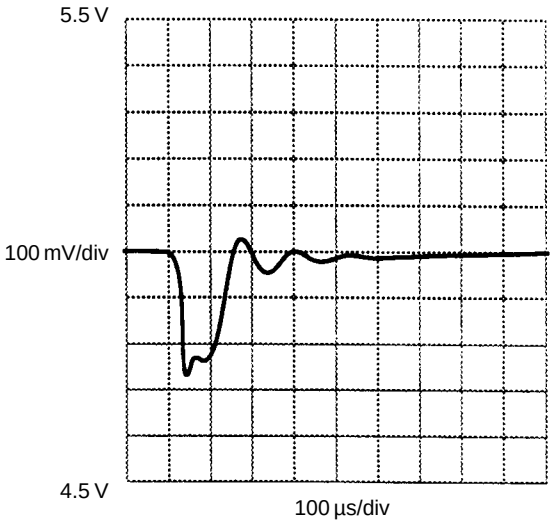


Figure 5 **Load Step Response**
Load Step 0 to 6.0 A_{DC}
(No Load to Full Load)

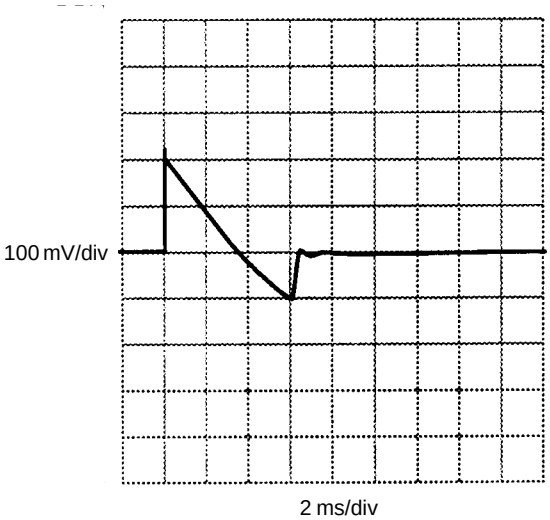


Figure 6 **Load Step Response**
Load Step 3.0 to 0 A_{DC}
(Full Load to No Load)

TYPICAL CHARACTERISTICS (Continued)

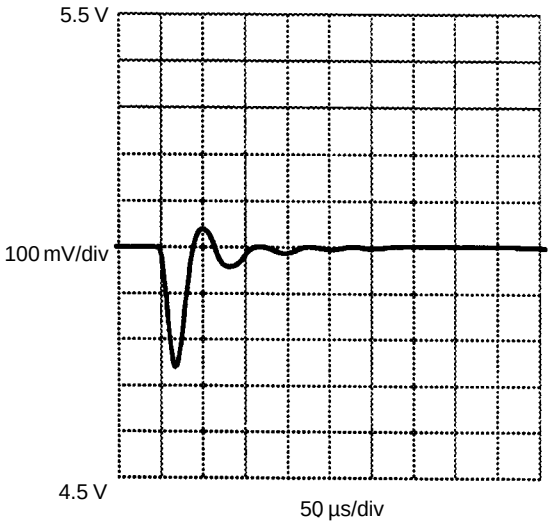


Figure 7 **Load Step Response**
Load Step 3.0 ADC to 6.0 ADC
(Half Load to Full Load)

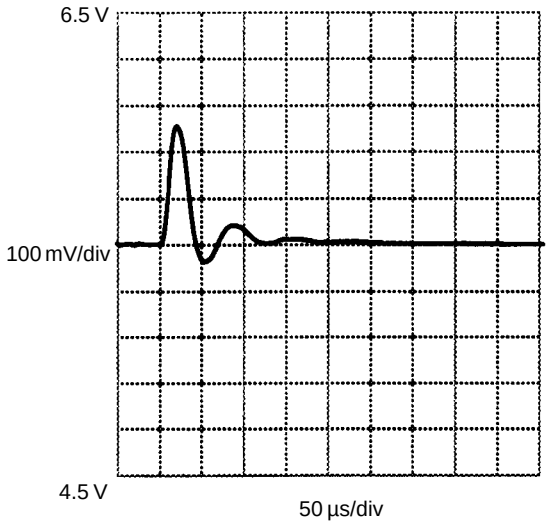


Figure 8 **Load Step Response**
Load Step 6.0 ADC to 3.0 ADC
(Full Load to Half Load)

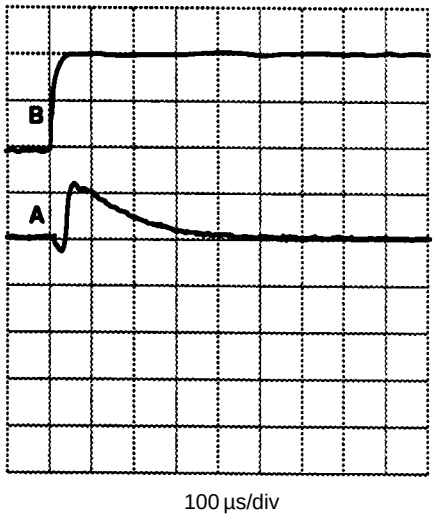


Figure 9 **Line Step Response**
A: Output @ 100 mV V/div, Full Load
B: Input step @ 19 VDC to 40 VDC

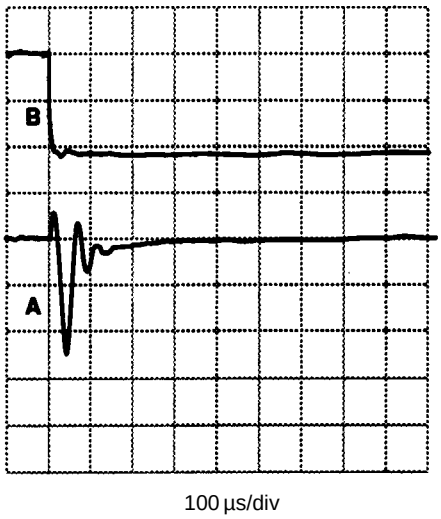


Figure 10 **Line Step Response**
A: Output @ 100 mV/div, Full Load
B: Input Step 40 VDC to 19 VDC

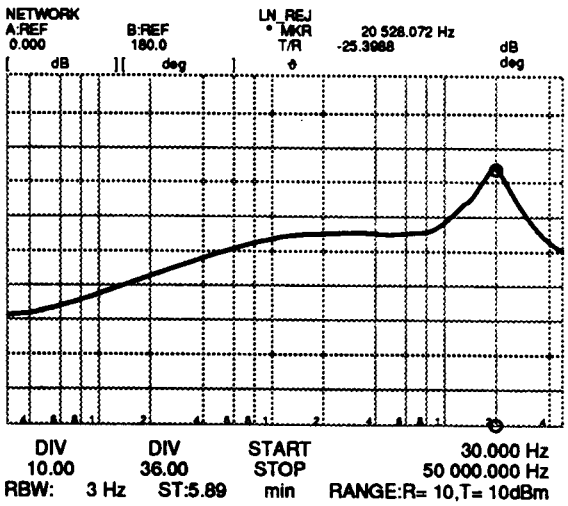


Figure 11 **Audio Rejection**

TYPICAL CHARACTERISTICS (Continued)

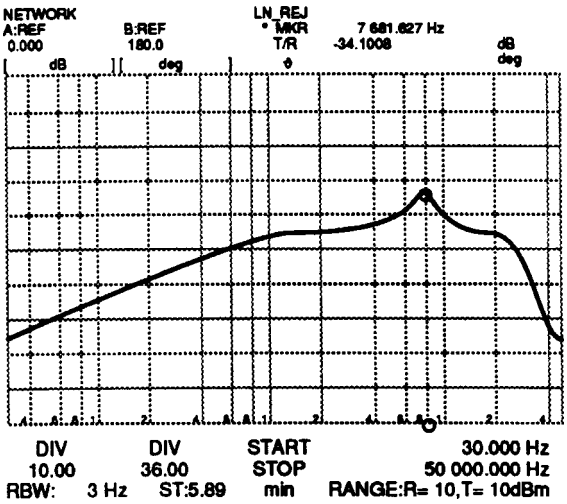
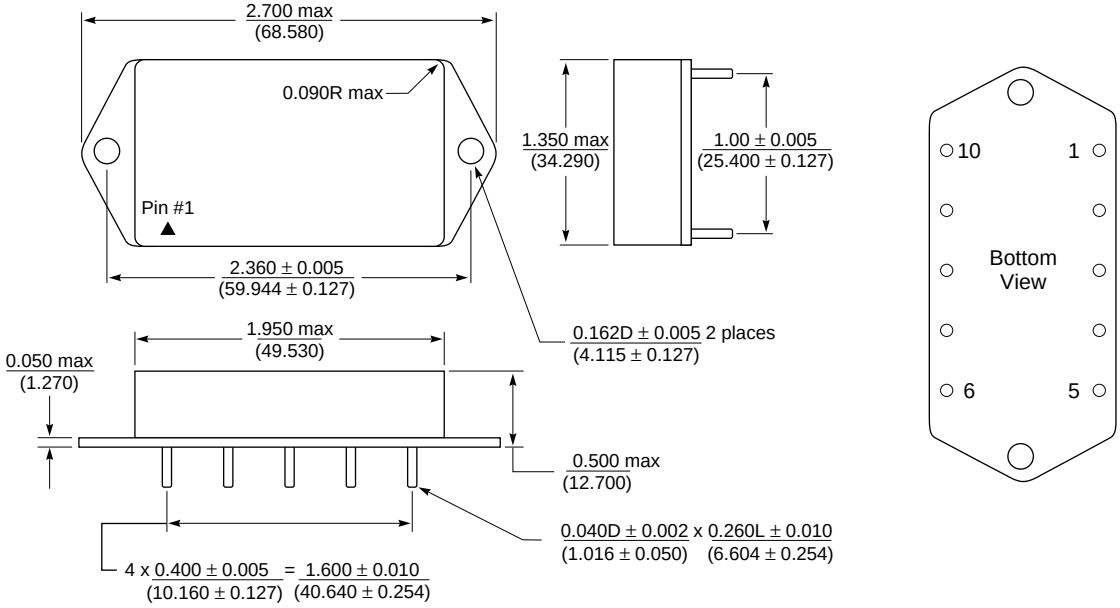


Figure 12 **Audio Rejection with AFC461 EMI Filter**

MECHANICAL OUTLINE



PIN DESIGNATION

Pin 1	Positive input	Pin 10	Input common
Pin 2	Inhibit input	Pin 9	N/C
Pin 3	Neg. remote sense*	Pin 8	N/C**
Pin 4	Output common	Pin 7	Case ground
Pin 5	Positive output	Pin 6	Pos. remote sense*

*ATW2805S only. ATW2812S, ATW2815S have N/C.
**Or synchronization option.

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 µA of current. The open circuit voltage of the inhibit input is 11.5 ±1 VDC.

EMI Filter

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

Remote Sense (ATW2805S only)

Better than 0.1% line and load regulation (case temperature constant) are typical when the remote sense leads are used. If the remote sense leads are left unconnected, then the output voltage (measured at pins 4 and 5) will rise approximately 5.4 VDC.

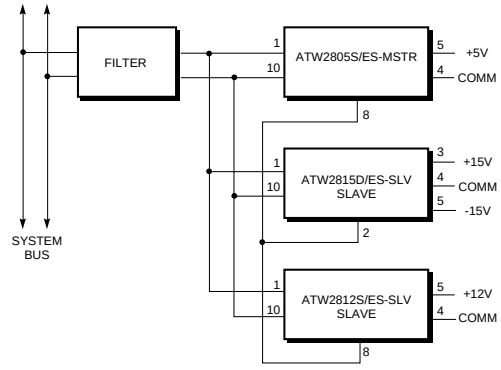
If the remote sense leads are shorted together, the output voltage may rise above 10 VDC depending on load, posibly damaging both the converter and load.

Device Synchronization

Whenever multiple DC/DC converters are utilized in a single system, significant low frequency noise may be generated due to slight differences in the switching frequencies of the converters (beat frequency noise). Because of the low frequency nature of this noise (typically less than 10 KHz), 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 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 8) of the master device is connected to the synchronization input (pin 8) of each slave device. It is advisable to keep this run short to minimize the possibility of radiating the 250 KHz switching frequency.

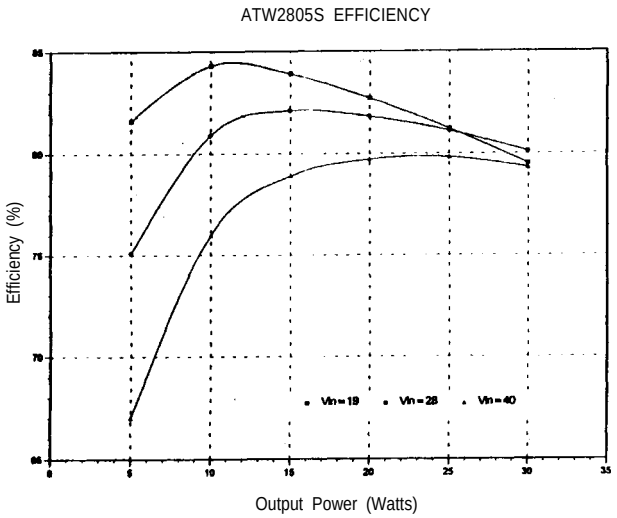
The appropriate parts must be ordered to utilize this feature. After selecting the converters required for the system, a 'MSTR' suffix is added for the master converter part number and a 'SLV' suffix is added for slave part number. See Part Number section.



Typical Synchronization Connection Diagram

STANDARDIZED MILITARY DRAWING CROSS REFERENCE

Standardized military drawing PIN	Vendor CAGE number	Vendor similar PIN
5962-9157904HZX	52467	ATW2805S/CH
5962-9157905HZX	52467	ATW2805S/CH-SLV
5962-9157906HZX	52467	ATW2805S/CH-MSTR
5962-921101HZX	52467	ATW2812S/CH
5962-921102HZX	52467	ATW2812S/CH-SLV
5962-921103HZX	52467	ATW2812S/CH-MSTR
5962-9159904HZX	52467	ATW2815S/CH
5962-9159905HZX	52467	ATW2815S/CH-SLV
5962-9159906HZX	52467	ATW2815S/CH-MSTR



NOTES

LAMBDA ADVANCED ANALOG INC.

MIL-PRF-38534 Certified
ISO9001 Registered

2270 Martin Avenue
Santa Clara CA 95050-2781
(408) 988-4930 FAX (408) 988-2702