LAMBDA ADVANCED ANALOG INC.

ATR2800D Series

Hybrid - High Reliability DC/DC Converters

DESCRIPTION

The ATR2800D 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-704D input requirements, these devices have nominal 28VDC inputs with ±12V and ±15V dual outputs to satisfy a wide range of requirements. The circuit design incorporates a pulse width modulated single forward topology operating in the feed-forward mode at a nominal switching frequency of 550kHz. 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 certified to MIL-PRF-38534. All processes used to manufacture these converters have been qualified to enable Lambda Advanced Analog to deliver compliant devices. Four 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. The ES version is a full temperature device without the full class H screening or element evaluation. The non-suffix device is a low cost limited temperature range option. 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

- **16 - 40 VDC input range (28VDC nominal)**
- **±12V and ±15V outputs available**
- **Indefinite short circuit and overload protection**
- **35W/in^3 power density**
- **30 watt output power**
- **Fast loop response for superior transient characteristics**
- **Operating temperature range from -55°C to +125°C**
- **Popular industry standard pin-out**
- **Resistance seam welded case for superior long term hermeticity**
- **Ceramic feed-thru pins**
- **External synchronization**
- **High Efficiency**
- **Shutdown from external signal**
- **Military screening**

SPECIFICATIONS

T_{CASE} = -55°C to +85°C, V_{IN} = +28 V ±5% unless otherwise specified.

ABSOLUTE MAXIMUM RATINGS

Input Voltage	-0.5 V to +50 V	
Power Output	Internally limited, 36 W typical	
Soldering	300°C for 10 seconds	
Temperature Range[1]	Operating	-55°C + 85°C case
	Storage	-65°C +135°C

Parameter	Conditions	ATR2812D Min	ATR2812D Typ	ATR2812D Max	ATR2815D Min	ATR2815D Typ	ATR2815D Max	Units
STATIC CHARACTERISTICS								
OUTPUT	V_{IN} = 16 to 40V_{DC}							
Voltage	I_{OUT} = 0 to Full Load	±11.76	±12.00	±12.24	±14.70	±15.00	±15.30	V DC
Current[5]		0.0		±1.25	0.0		±1.0	ADC
Ripple	Full Load, 20kHz to 2MHz		40	85		40	85	mV p-p
Accuracy	T_{CASE} = 25°C, Full Load	±11.88	±12.00	±12.12	±14.85	±15.00	±15.15	V DC
Power[1]		30			30			W
REGULATION								
Line	V_{IN} = 16 to 40 V_{DC}			75			75	mV
Load	I_{OUT} = 0 to Full Load			120			150	mV
CROSS REGULATION[6]	V_{IN} = 16, 28 40 VDC			±5			±5	%
INPUT								
Voltage Range		16.0	28.0	40.0	16.0	28.0	40.0	VDC
Current	No Load, pin 2 = open			75			75	mADC
	Inhibited, pin 2 tied to pin 10			18			18	mADC
Ripple Current	Full Load		25	50		25	50	mA p-p
EFFICIENCY	T_{CASE} = +25°C Full Load		82			82		%
CAPACITIVE LOAD	No effect on performance Tc = 25°C Total for both outputs			100			100	μF
LOAD FAULT POWER DISSIPATION	Short Circuit			9			9	W
	Overload, Tc = +25°C			14			14	W
SWITCHING FREQUENCY	I_{OUT} = F.L.	500		600	500		600	kHz
SYNC FREQUENCY RANGE[7]		500		700	500		700	kHz
ISOLATION	Input to Output @ 500 V_{DC}	100			100			MΩ
DYNAMIC CHARACTERISTICS								
STEP LOAD CHANGES								
Output	50% Load to 100% Load		±100			±100		mVpk
Transient	No Load to Half Load		±250			±250		mVpk
Recovery[2]	50% Load to 100% Load		25			25		μs
	No Load to 50% Load		500			500		μs
	50% Load to No Load		3			3		ms
STEP LINE CHANGES								
Output	Input step 16 to 40 V_{DC}		+180			+180		mVpk
Transient	Input step 40 to 16 V_{DC}		-600			-600		mVpk
Recovery[2]	Input step 16 to 40 V_{DC}		5			5		ms
	Input step 40 to 16 V_{DC}		5			5		ms
TURN-ON	V_{IN} = 16 to 40 V_{DC}							
Overshoot	I_{OUT} = 0 to Full Load		0	600		0	600	mVpk
Delay[3]			14	25		14	25	ms
LOAD FAULT RECOVERY	V_{IN} = 16 to 40 V_{DC}		14	25		14	25	ms

Notes:

1. Above +85°C case temperature, derate output power linearly to 0 at +115°C case.
2. Recovery time is measured from the initiation of the input transient to where VOUT has returned to within ±1% of VOUT at 50% load.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the inhibit pin.
4. Load current split equally between +Vout and -Vout.
5. Up to 90% of Full Power is available from either output provided. The total power output does not exceed 30 watts.
6. 3W load on output under test, 3W to 27W on other output.
7. Sync input signal: V_{IL} = -0.5V Min, 0.8V Max; V_{IH} = 2.5V Min, 11.5V Max; 10% to 90% duty cycle

SPECIFICATIONS

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

ABSOLUTE MAXIMUM RATINGS

Input Voltage[1]	-0.5 V to +50 V	
Power Output	Internally limited, 36 W typical	
Soldering	300°C for 10 seconds	
Temperature Range[1]	Operating	-55°C +125°C case
	Storage	-65°C +135°C

Parameter	Conditions	ATR2812D/ES Min	ATR2812D/ES Typ	ATR2812D/ES Max	ATR2815D/ES Min	ATR2815D/ES Typ	ATR2815D/ES Max	Units
STATIC CHARACTERISTICS								
OUTPUT	V_{IN} = 16 to 40V_{DC}							
Voltage	I_{OUT} = 0 to Full Load	±11.76	±12.00	±12.24	±14.70	±15.00	±15.30	V_{DC}
Current[5]		0.0		±1.25	0.0		±1.0	A_{DC}
Ripple	Full Load, 20kHz to 2MHz		40	85		40	85	mV p-p
Accuracy	T_{CASE} = 25°C, Full Load	±11.88	±12.00	±12.12	±14.85	±15.00	±15.15	V_{DC}
Power[1]		30			30			W
REGULATION								
Line	V_{IN} = 16 to 40 V_{DC}			75			75	mV
Load	I_{OUT} = 0 to Full Load			120			150	mV
CROSS REGULATION[6]	V_{IN} = 16, 28 40 VDC			±5			±5	%
INPUT								
Voltage Range		16.0	28.0	40.0	16.0	28.0	40.0	V_{DC}
Current	No Load, pin 2 = open			75			75	mA_{DC}
	Inhibited, pin 2 tied to pin 10			18			18	mA_{DC}
Ripple Current	Full Load		25	50		25	50	mA p-p
EFFICIENCY	T_{CASE} = +25°C Full Load	80	82		79	82		%
CAPACITIVE LOAD	No effect on performance, Tc = 25°C Total for both outputs			100			100	µF
LOAD FAULT POWER DISSIPATION	Short circuit			9			9	W
	Overload, Tc = +25°C			14			14	W
SWITCHING FREQUENCY	I_{OUT} = F.L.	500		600	500		600	kHz
SYNC FREQUENCY RANGE[7]		500		700	500		700	kHz
ISOLATION	Input to Output @ 500 V_{DC}	100			100			MΩ
DYNAMIC CHARACTERISTICS								
STEP LOAD CHANGES								
Output	50% Load to 100% Load		±100			±100		mVpk
Transient	No Load to Half Load		±250			±250		mVpk
Recovery[2]	50% Load to 100% Load		25			25		µs
	No Load to 50% Load		500			500		µs
	50% Load to No Load		3			3		ms
STEP LINE CHANGES								
Output	Input step 16 to 40 V_{DC}		+180			+180		mVpk
Transient	Input step 40 to 16 V_{DC}		-600			-600		mVpk
Recovery[2]	Input step 16 to 40 V_{DC}		5			5		ms
	Input step 40 to 16 V_{DC}		5			5		ms
TURN-ON	V_{IN} = 16 to 40 V_{DC}							
Overshoot	I_{OUT} = 0 to Full Load		0	600		0	600	mVpk
Delay[3]			14	25		14	25	ms
LOAD FAULT RECOVERY	V_{IN} = 16 to 40 V_{DC}		14	25		14	25	ms

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 input transient to where VOUT has returned to within ±1% of VOUT at 50% load.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the inhibit pin.
4. Load current split equally between +Vout and -Vout.
5. Up to 90% of Full Power is available from either output provided. The total power output does not exceed 30 watts.
6. 3W load on output under test, 3W to 27W on other output.
7. Sync input signal: V_{IL} = -0.5V Min, 0.8V Max; V_{IH} = 2.5V Min, 11.5V Max; 10% to 90% duty cycle

SPECIFICATIONS

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

ABSOLUTE MAXIMUM RATINGS

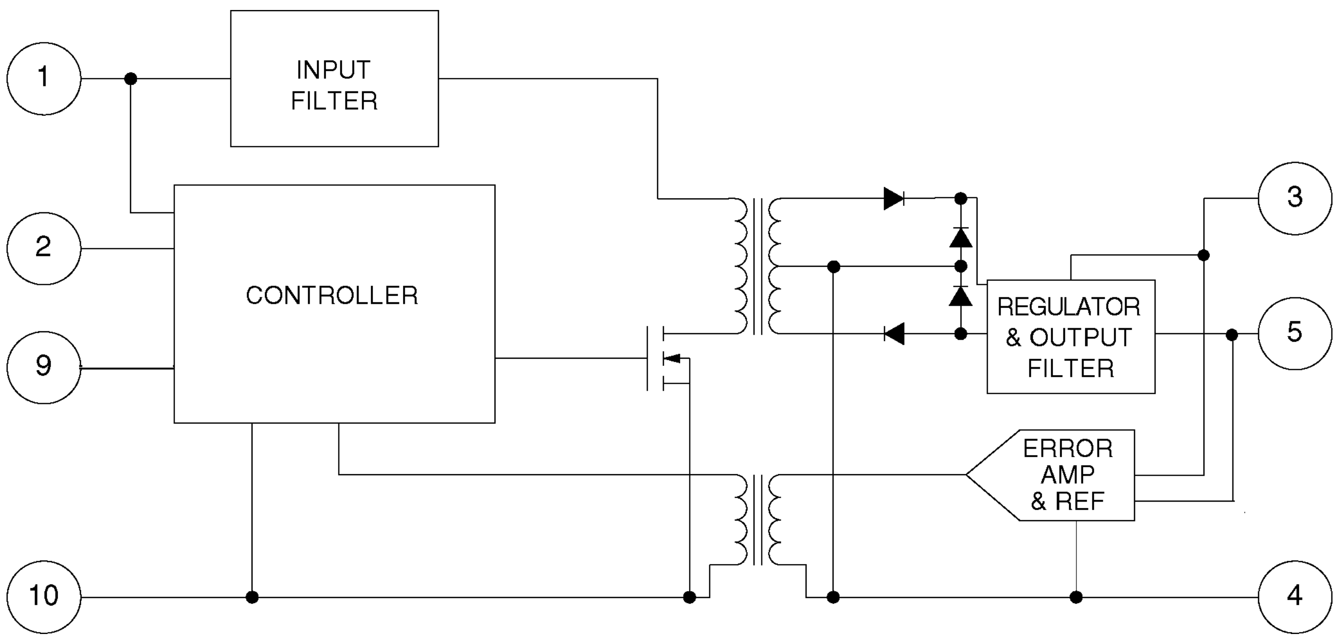
Input Voltage	-0.5 V to +50 V
Power Output	Internally limited, 36 W typical
Soldering	300°C for 10 seconds
Temperature Range[1]	Operating -55°C +125°C case
	Storage -65°C +135°C

Parameter	Conditions	ATR2812D/HB			ATR2815D/HB			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC CHARACTERISTICS								
OUTPUT	V_{IN} = 16 to 40V_{DC}							
Voltage	I_{OUT} = 0 to Full Load	±11.76	±12.00	±12.24	±14.70	±15.00	±15.30	V_{DC}
Current[5]		0.0		±1.25	0.0		±1.0	A_{DC}
Ripple	Full Load, 20kHz to 2MHz		40	85		40	85	mV p-p
Accuracy	T_{CASE} = 25°C, Full Load	±11.88	±12.00	±12.12	±14.85	±15.00	±15.15	V_{DC}
Power[1]		30			30			W
REGULATION								
Line[4]	V_{IN} = 16 to 40 V_{DC}			75			75	mV
Load[4]	I_{OUT} = 0 to Full Load			120			150	mV
CROSS REGULATION[6]	V_{IN} = 16, 28 40 VDC			±5			±5	%
INPUT								
Voltage Range		16.0	28.0	40.0	16.0	28.0	40.0	V_{DC}
Current	No Load, pin 2 = open			75		18	75	mA_{DC}
	Inhibited, pin 2 tied to pin 10			18			18	mA_{DC}
Ripple Current	Full Load		25	50		25	50	mA p-p
EFFICIENCY	T_{CASE} = +25°C Full Load	80	82		79	82		%
CAPACITIVE LOAD	No effect on performance, Tc = 25°C Total for both outputs			100			100	µF
LOAD FAULT POWER DISSIPATION	Short circuit			9			9	W
	Overload Tc = +25°C			14			14	W
SWITCHING FREQUENCY	I_{OUT} = F.L.	500		600	500		600	kHz
SYNC FREQUENCY RANGE[7]		500		700	500		700	kHz
ISOLATION	Input to Output @ 500 V_{DC}	100			100			MΩ
DYNAMIC CHARACTERISTICS								
STEP LOAD CHANGES								
Output[4]	50% Load to 100% Load		±100	±450		±100	±450	mVpk
Transient	No Load to Half Load		±250	±760		±250	±750	mVpk
Recovery[2]	50% Load to 100% Load		25	70		25	70	µs
	No Load to 50% Load		500	1500		500	1500	µs
	50% Load to No Load		3	5		3	5	ms
STEP LINE CHANGES								
Output	Input step 16 to 40 V_{DC}		+180	1200		+180	1500	mVpk
Transient	Input step 40 to 16 V_{DC}		-600	-1500		-600	-1500	mVpk
Recovery[2]	Input step 16 to 40 V_{DC}		5	10		5	10	ms
	Input step 40 to 16 V_{DC}		5	10		5	10	ms
TURN-ON	V_{IN} = 16 to 40 V_{DC}							
Overshoot	I_{OUT} = 0 to Full Load		0	600		0	600	mVpk
Delay[3]			14	25		14	25	ms
LOAD FAULT RECOVERY	V_{IN} = 16 to 40 V_{DC}		14	25		14	25	ms

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 input transient to where VOUT has returned to within ±1% of VOUT at 50% load.
3. Turn-on delay time measurement is for either an application of power at the input or a signal at the inhibit pin.
4. Load current split equally between +Vout and -Vout.
5. Up to 90% of Full Power is available from either output provided. The total power output does not exceed 30 watts.
6. 3W load on output under test, 3W to 27W on other output.
7. Sync input signal: V_{IL} = -0.5V Min, 0.8V Max, V_{IH} = 2.5V Min, 11.5V Max, 10% to 90% duty cycle

BLOCK DIAGRAM (Single Output)



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 400µA 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-461B CEO3.

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 10 kHz), it is difficult to filter out and may interfere with proper operation of sensitive systems (communications, radar or telemetry). Lambda Advanced Analog provides synchronization of multiple ATR converters to match switching frequency of the converter to the frequency fo the system clock, thus eliminating this type of noise.

PIN DESIGNATION

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

PART NUMBER

ATR 28 xx D x / x

Model
Input Voltage

Output Voltage
12–12 VDC
15–15 VDC

Dual Output

Package Option
F—Flange
Omit for standard

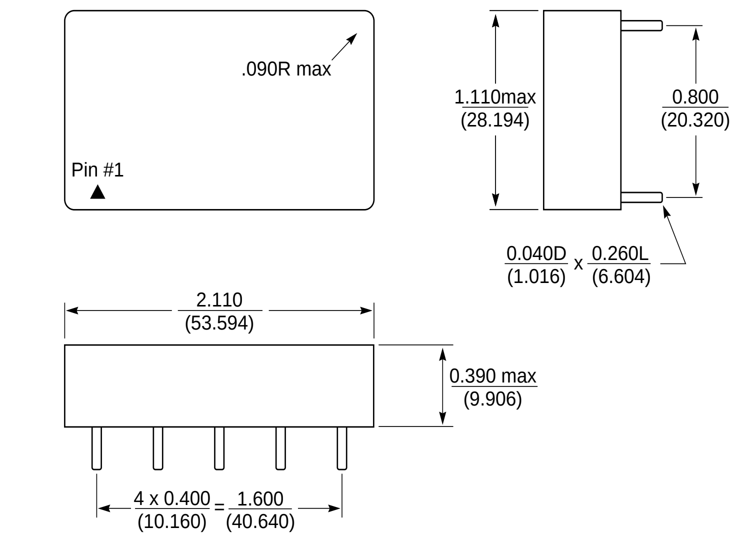
Temperature Range
Omit for -55°C to +85°C
ES— -55°C to +125°C
HB— -55°C to +125°C
CH— -55°C to +125°C

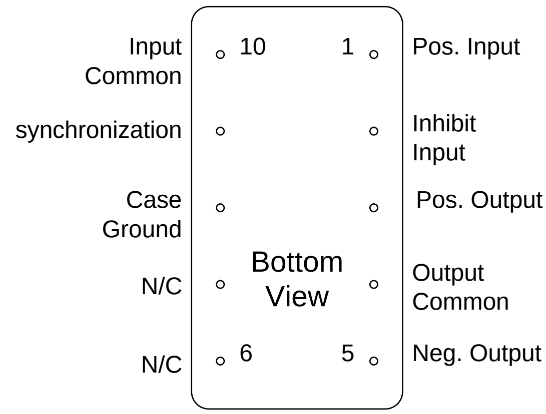
Available Screening Levels and Process Variations for ATR Series

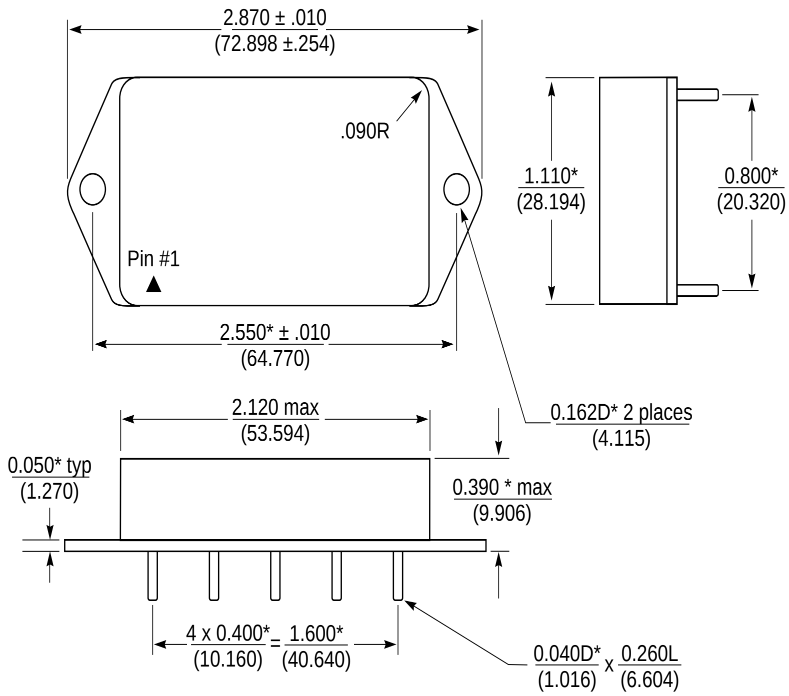
Requirement	MIL-STD-883 Method	No Suffix	ES Suffix	HB Suffix	CH Suffix
Temperature Range		-20 to +85°C	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C
Element Evaluation					MIL-PRF-38534
Internal Visual	2017	*	Yes	Yes	Yes
Temperature Cycle	1010		Cond B	Cond C	Cond C
Constant Acceleration	2001		500g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

* Per Commercial Standards

MECHANICAL OUTLINE







Weight
Standard—60 grams max.
Flange—65 grams max.

Thermal Management

Assuming that there is no forced air flow, the package termperature rise above ambient (ΔT) may be calculated using the following expression:

$$\Delta T \approx 80\ A^{-0.7}\ p^{0.85}\ (\,^{\circ}C)$$

where A = the effective surface area in square inches (including heat sink if used;) P = power dissipation in watts.

The total surface area of the ATR standard package is 7.34 square inches. If a worse case full load efficiency of 78% is assumed, then the case temperature rise can be calculated as follows:

$$P = P_{OUT}\left[\frac{1}{Eff} - 1\right] = 30\left[\frac{1}{.78} - 1\right] = 8.5\ W$$

$$\Delta T = 80\ (7.34)^{-0.7}\,(8.5)^{0.85} = 122^{\circ}C$$

Hence, if $T_{AMBIENT}$ = +25°C, the DC/DC converter case temperature will be approximately 147°C if no heat sink or air flow is provided.

To calculate the heat sink area required to maintain a specific case temperature rise, the above equation may be manipulated as follows:

$$A_{HEAT\ SINK} = \left[\frac{\Delta T}{80P^{0.85}}\right]^{-1.43} - A_{PKG}$$

As an example, if a maximum case temperature rise of 50°C above ambient is desired, then the required effective heat sink area is:

$$A_{HEAT\ SINK} = \left[\frac{50}{80\ (8.5)^{0.85}}\right]^{-1.43} - 7.34 = 19.1\ in.^2$$

LAMBDA ADVANCED ANALOG INC.

MIL-PRF-38534 Certified

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