

## ADVANCED ANALOG RADIATION TOLERANT DC/DC CONVERTERS

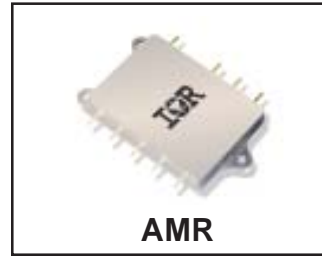
### Description

The AMR28XXS series of DC/DC converter modules has been specifically designed for operation in moderate radiation environments supplementing the higher radiation performance available in the Advanced Analog ART2815T converter series. Environments presented to space vehicles operating in low earth orbits, launch boosters, orbiting space stations and similar applications requiring a low power, high performance converter with moderate radiation hardness performance will be optimally served by the AMR28XXS Series.

The physical configuration of the AMR28XXS series permits mounting directly to a heat conduction surface without the necessity of signal leads penetrating the heat sink surface. This package configuration permits greater independence in mounting and more secure mechanical attachment than traditional radially leaded packages. Advanced Analog's rugged ceramic seal pins are used exclusively in the package thereby assuring long term hermeticity.

The AMR28XXS has been designed for high density using chip and wire hybrid technology that complies with the class H requirements of MIL-PRF-38534. Finished product are fabricated in a facility fully qualified to MIL-PRF-38534. The standard processing adopted for the AMR2805S meets the requirements of MIL-PRF-38534 for class H but with enhanced screening steps and includes element evaluation. Applicable generic lot qualification test data including radiation performance can be made available on request. Consult Advanced Analog for special requirements.

## AMR28XXS SERIES 28V Input, Single Output



### Features

- 30 Watts Output Power
- Available in 3.3, 5, 12 and 15 Volt Outputs
- 18 - 40 VDC Input Range (28 VDC Nominal)
- Total Ionizing Dose > 25KRads (Si)
- No SEE to LET > 60 MeV-cm<sup>2</sup>/mg
- -55°C to +125°C Operating Range
- Indefinite Short Circuit Protection
- External Synchronization
- Shutdown from External Signal
- Flexible Mounting
- Fully Isolated - Input to Output and to Case
- Complimentary EMI Filter Available
- Electrical Performance Similar to ATR28XXS Series

**AMR28XXS Series**  
**Specifications**

<b>Absolute Maximum Ratings</b>	
Input Voltage Range	-0.5V to +50VDC (Continuous), 80V (100ms)
Soldering Temperature	300°C for 10 seconds
Storage Case Temperature	65°C to +135°C
<b>Recommended Operating Conditions</b>	
Input Voltage Range	+16V to +40VDC
Output Power	Less than or equal to 30W
Operating Case Temperature	-55°C to +125°C

**Static Characteristics**  $-55^{\circ}\text{C} \leq T_{\text{CASE}} \leq +125^{\circ}\text{C}$ ,  $V_{\text{IN}}=28 \text{ VDC} \pm 5\%$ ,  $C_L=0$ , unless otherwise specified.

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
<b>Input Voltage</b>			16	28	40	V
<b>Output Voltage</b>		$I_{\text{out}}=0$				
AMR2803R3S	1		3.25	3.30	3.35	V
AMR2805S	1		4.95	5.00	5.05	V
AMR2812S	1		11.88	12.00	12.12	V
AMR2815S	1		14.85	15.00	15.15	V
AMR2803R3S	2, 3		3.20		3.40	V
AMR2805S	2, 3		4.90		5.10	V
AMR2812S	2, 3		11.70		12.30	V
AMR2815S	2, 3		14.60		15.40	V
<b>Output Current</b> <sup>1</sup>		$V_{\text{in}} = 18, 28, 40 \text{ Volts}$				
AMR2803R3S	1, 2, 3				7500	mA
AMR2805S	1, 2, 3				6000	mA
AMR2812S	1, 2, 3				2500	mA
AMR2815S	1, 2, 3				2000	mA
<b>Output Power</b>		100% load				
AMR2803R3S	1, 2, 3				25	W
All Others	1, 2, 3				30	W
<b>Output Ripple Voltage</b> <sup>2</sup>		$V_{\text{in}} = 18, 28, 40 \text{ Volts}$ $\text{BW} = 20 \text{ Hz to } 2 \text{ MHz}$				
AMR2803R3S	1, 2, 3				60	mV <sub>PP</sub>
AMR2805S	1, 2, 3				60	mV <sub>PP</sub>
AMR2812S	1, 2, 3				60	mV <sub>PP</sub>
AMR2815S	1, 2, 3				75	mV <sub>PP</sub>
<b>Output Voltage Regulation</b> <sup>3</sup>		$V_{\text{in}} = 18, 28, 40 \text{ Volts}$ $I_{\text{out}} = 0, 50\%, \text{ and } 100\% \text{ load}$				
<b>Line</b> AMR2803R3S	1, 2, 3			±10	±30	mV
AMR2805S	1, 2, 3			±10	±30	mV
AMR2812S	1, 2, 3			±30	±60	mV
AMR2815S	1, 2, 3			±40	±75	mV
<b>Load</b> AMR2803R3S	1, 2, 3			±10	±50	mV
AMR2805S	1, 2, 3			±10	±50	mV
AMR2812S	1, 2, 3			±50	±120	mV
AMR2815S	1, 2, 3			±50	±150	mV

For Notes to Specifications, refer to page 4

**Static Characteristics** (Continued)  $-55^{\circ}\text{C} \leq T_{\text{CASE}} \leq +125^{\circ}\text{C}$ ,  $V_{\text{IN}}=28 \text{ V}_{\text{DC}} \pm 5\%$ ,  $C_{\text{L}}=0$ , unless otherwise specified.

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
<b>Input Current</b> No Load	AMR2803R3S	I <sub>out</sub> =0, Inhibit =open		20	50	mA
	AMR2805S			20	50	mA
	AMR2812S			20	75	mA
	AMR2815S			20	100	mA
	All				8	18
<b>Inhibited</b>	All	Inhibit shorted to input return				mA
<b>Input Ripple Current</b> <sup>2</sup>	1, 2, 3	V <sub>in</sub> = 16, 28, 40 Volts, 100% load, BW = 20 Hz to 2 MHz			50	mA <sub>pp</sub>
<b>Efficiency</b>	AMR2803R3S	100% load	1	74		%
	AMR2805S		1	76		%
	AMR2812S		1	80		%
	AMR2815S		1	79		%
	AMR2803R3S		2, 3	70		%
	AMR2805S		2, 3	72		%
	AMR2812S		2, 3	75		%
	AMR2815S		2, 3	75		%
<b>Isolation</b>	1	Input to output or any pin to case (except case ground pin) at 500Vdc	100			MΩ
<b>Capacitive Load</b> <sup>4,5</sup>	4	No effect on dc performance			500	μF
<b>Short Circuit Power Dissipation</b>	1, 2, 3				19	watts
<b>Switching Frequency</b>	4, 5, 6	100% load	500	550	600	KHz
<b>Sync Frequency Range</b>	4, 5, 6	100% load	500		700	KHz
<b>MTBF</b>		MIL-HDBK-217F, N2 SF @ T <sub>c</sub> = 35°C	940			Khrs
<b>Weight</b>					68	g

For Notes to Specifications, refer to page 4

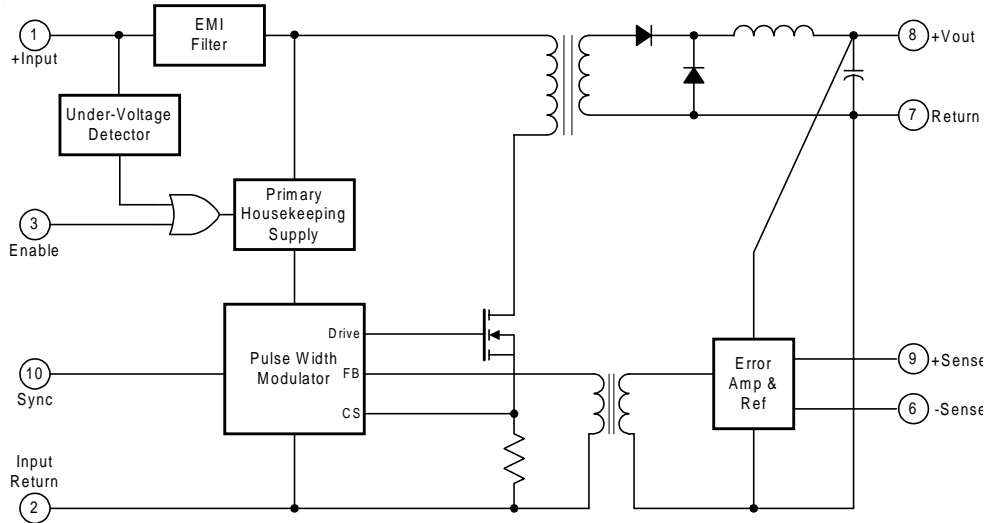
**Dynamic Characteristics**  $-55^{\circ}\text{C} \leq T_{\text{CASE}} \leq +125^{\circ}\text{C}$ ,  $V_{\text{IN}}=28 \text{ V}_{\text{DC}} \pm 5\%$ ,  $C_{\text{L}}=0$ , unless otherwise specified.

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
<b>Output Response To Step Transient Load Changes</b> <sup>7</sup>						
AMR2803R3S		Load step 50% ⇔ 100%	-500		+500	mV pk
AMR2805S	4, 5, 6		-500		+500	mV pk
AMR2812S	4, 5, 6		-800		+800	mV pk
AMR2815S	4, 5, 6		-1000		+1000	mV pk
AMR2803R3S		Load step 8% ⇔ 50%	-500		+500	mV pk
AMR2805S	4, 5, 6		-500		+500	mV pk
AMR2812S	4, 5, 6		-1000		+1000	mV pk
AMR2815S	4, 5, 6		-1000		+1000	mV pk
<b>Recovery Time, Step Transient Load Changes</b> <sup>7, 8</sup>	4, 5, 6	Load step 50% ⇔ 100% or Load step 8% ⇔ 50%			200	μs
<b>Output Response Transient Step Line Changes</b> <sup>5, 9</sup>						
AMR2803R3S	4, 5, 6	Input step from/to 18 to 40Vdc, 100% load	-500		+500	mV pk
AMR2805S	4, 5, 6		-500		+500	mV pk
AMR2812S	4, 5, 6		-1200		+1200	mV pk
AMR2815S	4, 5, 6		-1500		+1500	mV pk
<b>Recovery Time Transient Step Line Changes</b> <sup>5, 8, 9</sup>	4, 5, 6	Input step from/to 18 to 40Vdc, 100% load			10	ms
<b>Turn On Overshoot</b>						
AMR2803R3S	4, 5, 6	0% load to 100% load			500	mV pk
AMR2805S	4, 5, 6				500	mV pk
AMR2812S	4, 5, 6				800	mV pk
AMR2815S	4, 5, 6				1000	mV pk
<b>Turn On Delay</b> <sup>10</sup>	4, 5, 6	0% load to 100% load			25	ms
<b>Short Circuit Recovery</b> <sup>5, 10</sup>	4, 5, 6				25	ms

Notes to Specifications

- Parameter guaranteed by line and load regulation tests.
- Bandwidth guaranteed by design. Tested for 20 KHz to 2 MHz.
- Output voltage measured at load with remote sense leads connected across load.
- 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.
- Parameter shall be tested as part of design characterization and after design or process changes. Parameters shall be guaranteed to the limit specified in Electrical Specifications.
- Load step transition time between 2 and 10 microseconds.
- Recovery time is measured from the initiation of the transient to where  $V_{\text{OUT}}$  has returned to within  $\pm 1\%$  of  $V_{\text{OUT}}$  at 50 percent load.
- Input step transition time between 2 and 10 microseconds.
- 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 while power is applied to the input.

AMR28XXS Block Diagram



Application Information

Inhibit Function

Connecting the inhibit input to input common 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  $10.0 + 1 V_{DC}$ .

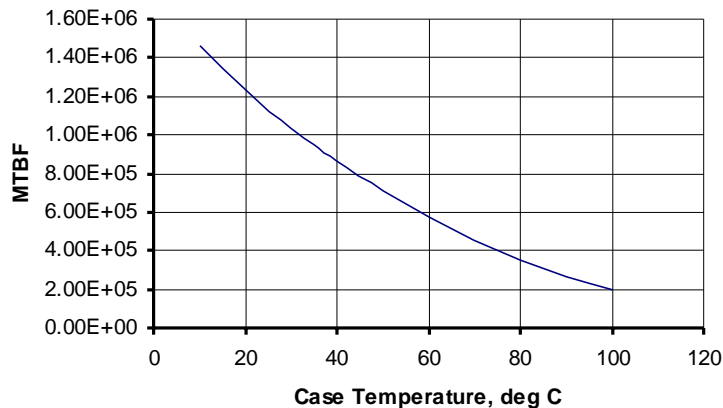
EMI Filter

An optional EMI filter is available (AFH461) that will reduce the input ripple current to levels below the limits imposed by MIL-STD-461 CE03.

Device Synchronization

When multiple DC/DC converters are utilized in a single system, significant low frequency noise may be generated due to a small difference in the switching frequency 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 (communication, radar or telemetry). Advanced Analog provides synchronization of multiple AMR type converters to match switching frequency of the converter to the frequency of the system clock, thus eliminating this type of noise.

MTBF vs Case Temperature for AMR2803R3S



## AMR28XXS Series

International  
 Rectifier

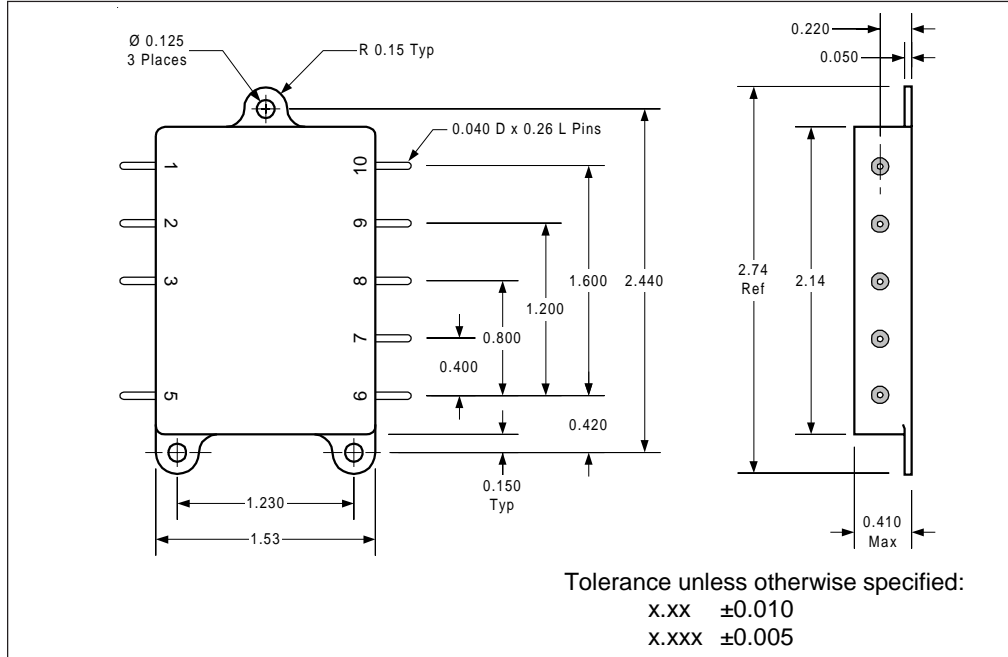
### Standard Process Screening for AMR28XXS Series

Requirement	MIL-STD-883 Method	EM Limits	Flight Limits (CH +)
Temperature Range		-55°C to +125°C	-55°C to +125°C
Element Evaluation		None	MIL-PRF-38534, for Class H
Internal Visual	2017	AA Standards	Yes
Temperature Cycle	1010	-	Condition C
Constant Acceleration	2001	-	Condition A, (3000g)
PIND	2020	-	Condition A
Burn-in @ 125°C	1015	48 Hrs	160 hrs
Interim Electrical		N/A	Group A, Subgroup 1
Burn-in	1015	N/A	160 hrs @ +125°C
Final Electrical (Group A) Read & Record Data	MIL-PRF-38534	-55°C, +25°C, +125°C	-55°C, +25°C, +125°C
PDA (25°C, interim to final)		N/A	2%
Radiographic Inspection	2012	N/A	Yes
Fine & Gross Leak	1014	Cond C	Condition A, C
External Visual	2009	AA Standards	Yes

### Radiation Specification

Parameter	Conditions	Min	Typ	Max	Unit
Total Ionizing Dose	MIL-STD-883, Method 1019.4 Operating bias applied during exposure	30	—	—	KRads (Si)
Heavy Ion (Single event effects)	BNL Dual Van de Graf Generator	60	—	—	MeV•cm <sup>2</sup> /mg

**AMR28XXS Case Outline**



**Pin Designation**

Pin No.	Designation
1	Positive Input
2	Input Return
3	Enable
4	—
5	Case
6	Return Sense
7	Output Return
8	Positive Output
9	Positive Sense
10	Synchronization Input

**Part Numbering**

**AMR 28 05 S / EM**

Model ————  
 Input Voltage ————  
 28 = 28V Nominal  
 Output Voltage ————  
 03R3 = 3.3V, 05 = 5V,  
 12 = 12V,  
 15 = 15V

Screening  
 Blank = Flight Model  
 / EM = Engineering Model

Outputs  
 S = Single, D = Dual  
 T = Triple