

**ADVANCED ANALOG
RADIATION TOLERANT
DC/DC CONVERTERS**

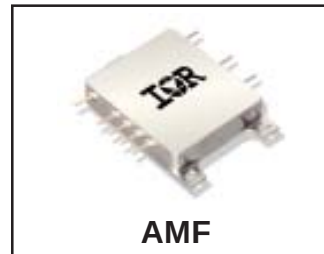
Description

The AMF28XXS 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 ART, ARH and G-Series converters. 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 AMF28XXS Series.

The physical configuration of the AMF28XXS series permits mounting directly to a heat dissipation surface without the necessity of signal leads penetrating the heat sink surface. This package configuration permits greater independence in mounting and more mechanical security than traditional packages. Advanced Analog's rugged ceramic seal pins are used exclusively in the package thereby assuring long term hermeticity.

The AMF28XXS has been designed for high density using chip and wire hybrid technology that complies with the class H requirements of MIL-PRF-38534. Finished products are fabricated in a facility fully qualified to MIL-PRF-38534. The standard processing adopted for the AMF28XXS 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.

**AMF28XXS SERIES
28V Input, Single Output**



Features

- 12 Watts Output Power
- Available in 3.3, 5, 12 and 15 Volt Outputs
- 16 - 40 VDC Input Range (28 VDC Nominal)
- Low Input/Output Noise
- Total Ionizing Dose > 25KRads (Si)
- No SEE to LET > 60 MeV-cm²/mg
- -55°C to +125°C Operating Range
- Indefinite Short Circuit Protection
- Flexible Mounting
- High Power Density
- Fully Isolated - Input to Output and to Case
- Complimentary EMI Filter Available
- Synchronizable From An External Source
- Electrical Performance Similar to AHF28XXS Series

AMF28XXS Series

Specifications

International
IRF Rectifier

Absolute Maximum Ratings

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

Recommended Operating Ratings

Input Voltage Range	+16V to +40VDC
Output Power	Less than or equal to 12W
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
Input Voltage			16	28	40	V
Output Voltage		$V_{\text{in}} = 28 \text{ Volts, } 0\% \text{ load}$				
AMF2803R3S	1		3.25	3.30	3.35	V
AMF2805S	1		4.95	5.00	5.05	V
AMF2807R5SS	1		6.97	7.50	7.58	V
AMF2812S	1		11.88	12.00	12.12	V
AMF2815S	1		14.85	15.00	15.15	V
AMF2803R3S	2, 3		3.20		3.40	V
AMF2805S	2, 3		4.90		5.10	V
AMF2807R5SS	2, 3		7.35		7.65	V
AMF2812S	2, 3		11.76		12.24	V
AMF2815S	2, 3		14.70		15.30	V
Output Current ¹		$V_{\text{in}} = 16, 28, 40 \text{ Volts}$				
AMF2803R3S	1, 2, 3		0		3000	mA
AMF2805S	1, 2, 3		0		2400	mA
AMF2807R5SS	1, 2, 3		0		1600	mA
AMF2812S	1, 2, 3		0		1000	mA
AMF2815S	1, 2, 3		0		800	mA
Output Power ¹		$V_{\text{in}} = 16, 28, \text{ and } 40 \text{ V dc}$				
AMF2803R3S	1, 2, 3				10	W
All Others	1, 2, 3				12	W
Output Ripple Voltage ²	1, 2, 3	$V_{\text{in}} = 16, 28, 40 \text{ Volts,}$ $\text{BW} = 20 \text{ Hz to } 2 \text{ MHz}$		25	60	mV _{pp}
Output Voltage Regulation		$V_{\text{in}} = 16, 28, 40 \text{ Volts}$ $I_{\text{out}} = 0\%, 50\%, \text{ and } 100\%$ max				
Line						
AMF2803R3S	1, 2, 3			10	25	mV
AMF2805S	1, 2, 3			10	25	mV
AMF2807R5SS	1, 2, 3			10	50	mV
AMF2812S	1, 2, 3			10	50	mV
AMF2815S	1, 2, 3			10	50	mV
Load	All			10	50	mV

For Notes to Specifications, refer to page 5

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

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
Input Current	No Load	$V_{\text{IN}}=28\text{V}$, $I_{\text{out}}=0$, Inhibit (pin 1)=open		20	30	mA
	Inhibit	Inhibit (pin 1) shorted to input return (pin 7)		8	12	mA
Input Ripple Current	1, 2, 3	$V_{\text{IN}} = 16, 28, 40 \text{ Volts}$, 100% load, BW = 20 Hz to 2 MHz		20	50	mA_{PP}
Efficiency	AMF2803R3S	100% load	72			%
	AMF2805S		76			%
	AMF2807R5S		77			%
	AMF2812S		78			%
	AMF2815S		78			%
	AMF2803R3S		70			%
	AMF2805S		72			%
	AMF2807R5S		73			%
	AMF2812S		75			%
	AMF2815S		75			%
Isolation	1	Input to output or any pin to case (except pin 6) at 500Vdc	100			$\text{M}\Omega$
Capacitive Load ^{3, 4}	AMF2803R3S	No effect on dc performance			500	μF
	AMF2805S				500	μF
	AMF2807R5S				300	μF
	AMF2812S				200	μF
	AMF2815S				200	μF
Short Circuit Power Dissipation	1, 2, 3				6	watts
Short Circuit Recovery ⁴	4, 5, 6	0% load to 100% Load			20	ms
Switching Frequency	4, 5, 6	100% load	500	550	600	KHz
MTBF		MIL-HDBK-217F SF @ $T_c = 35^{\circ}\text{C}$	750			Khrs
Weight					36	g

For Notes to Specifications, refer to page 5

AMF28XXS Series

International
IRF Rectifier

Dynamic Characteristics -55°C ≤ T_{CASE} ≤ +125°C, V_{IN}=28 V_{DC} ±5%, C_L=0, unless otherwise specified.

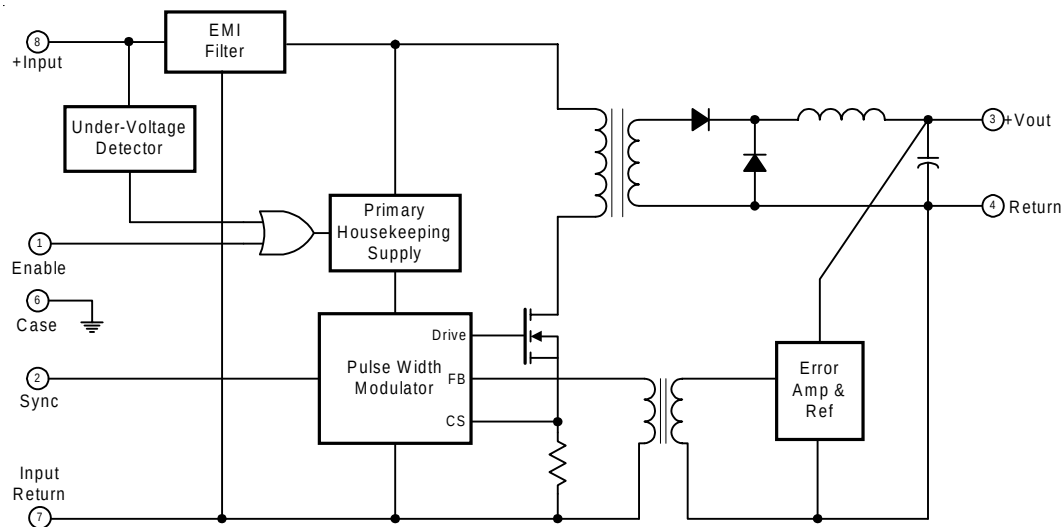
Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
Synchronization Input						
Frequency Range	4, 5, 6		500		700	KHz
Pulse Amplitude, Hi ⁴			2.5		10	V
Pulse Amplitude, Lo ⁴			-0.5		0.8	V
Pulse Rise time ⁴					100	ns
Pulse Duty Cycle ⁴			20		80	%
Output Response To Step Transient Load Changes⁵						
All	4, 5, 6	Load step 50% ⇔ 100%	-300		+300	mV pk
AMF2803R3S	4, 5, 6	Load step 0% ⇔ 50%	-400		+400	mV pk
AMF2805S	4, 5, 6		-500		+500	mV pk
AMF2807R5S	4, 5, 6		-750		+750	mV pk
AMF2812S	4, 5, 6		-750		+750	mV pk
AMF2815S	4, 5, 6		-750		+750	mV pk
Recovery Time, Step Transient Load Changes^{5, 6}						
AMF2803R3S	4, 5, 6	Load step 50% ⇔ 100%			70	μs
AMF2805S	4, 5, 6				70	μs
AMF2807R5S	4, 5, 6				100	μs
AMF2812S	4, 5, 6				100	μs
AMF2815S	4, 5, 6				100	μs
All	4, 5, 6	Load step 0% ⇔ 50%			2	mS
Output Response Transient Step Line Changes^{4, 7}						
AMF2803R3S	4, 5, 6	Input step 16 ⇔ 40Vdc 100% Load	-500		+500	mV pk
AMF2805S	4, 5, 6		-500		+500	mV pk
AMF2807R5SS	4, 5, 6		-1200		+1200	mV pk
AMF2812S	4, 5, 6		-1500		+1500	mV pk
AMF2815S	4, 5, 6		-1500		+1500	mV pk
Recovery Time Transient Step Line Changes^{4, 7}	4, 5, 6	Input step 16 ⇔ 40Vdc, 100% load			800	μs
Turn On Overshoot⁸						
AMF2803R3S	4, 5, 6	0% load to 100% load			400	mV pk
AMF2805S	4, 5, 6				600	mV pk
AMF2807R5SS	4, 5, 6				600	mV pk
AMF2812S	4, 5, 6				600	mV pk
AMF2815S	4, 5, 6				750	mV pk
Turn On Delay⁸	4, 5, 6	0% load to 100% load			20	ms

For Notes to Specifications, refer to page 5

Notes to Specifications

- 1 Parameter guaranteed by line and load regulation tests.
- 2 Bandwidth guaranteed by design. Tested for 20 Hz to 2 MHz.
- 3 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.
- 4 Parameter shall be tested as part of design characterization and after design or process changes. Therefore this Parameters shall be guaranteed to the limit specified.
- 5 Load step transition time between 2 and 10 microseconds.
- 6 Recovery time is measured from the initiation of the transient to where V_{OUT} has returned to within $\pm 1\%$ of V_{OUT} at 50 percent load.
- 7 Input step transition time between 1 and 10 microseconds. Parameter guaranteed by design but not 100% tested.
- 8 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.

AMF28XXS Block Diagram



Application Information

Inhibit Function

Connecting the enable input (Pin 1) to input common (Pin 7) will cause the converter to shut down. It is recommended that the enable pin be driven by an open collector device capable of sinking at least 400 μ A of current. The open circuit voltage of the enable input is 10.0 $\pm 1 V_{DC}$.

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 AMF type converters to match switching frequency of the converter to the frequency of the system clock, thus eliminating this type of noise.

AMF28XXS Series

International
IR Rectifier

Standard Process Screening for AMF28XXS Series

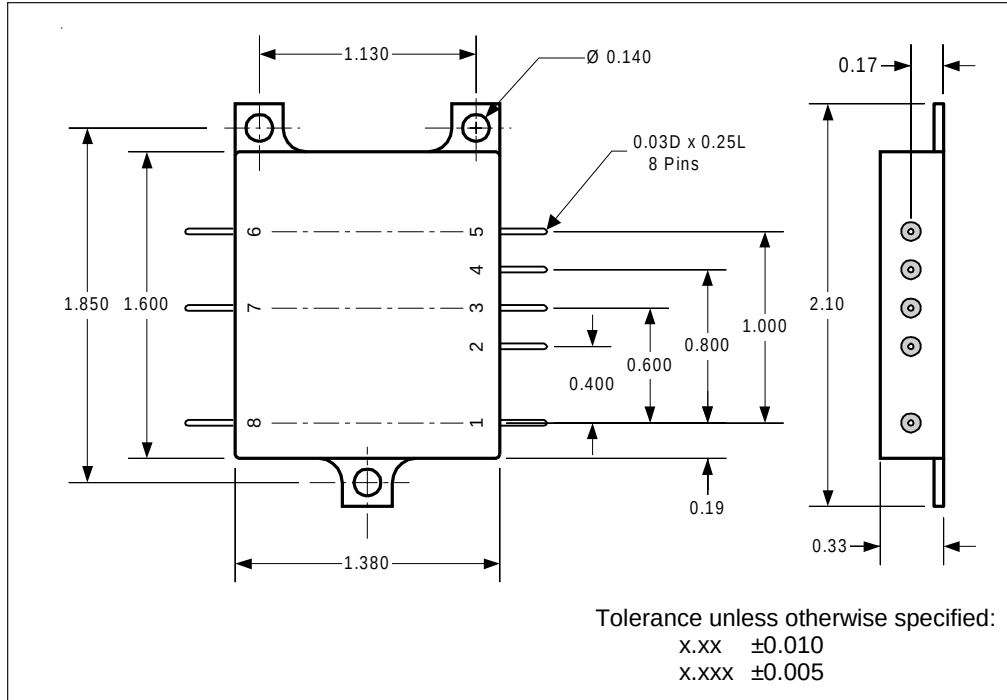
Requirement	MIL-STD-883 Method	Engineering Model (/EM)	CH+ Limits (No-Suffix)
Temperature Range		-55°C to +125°C	-55°C to +125°C
Element Evaluation		—	MIL-PRF-38534
Internal Visual	2017	*	✓
Temperature Cycle	1010		Condition C
Constant Acceleration	2001		Condition A, (3000g)
PIND	2020		Condition A
Burn-in, T _{case} = +125°C	1015		160 hrs
Interim Electrical			+ 25°C
Burn-in, T _{case} = +125°C		48 hrs	160 hrs
Final Electrical (Group A)	MIL-PRF-38534 & Specification	-55°C, +25°C, +125°C Read & Record Data	-55°C, +25°C, +125°C Read & Record Data
PDA (25C, interim to final)		—	2%
Radiographic Inspection	2012	—	Yes
Fine & Gross	1014		Condition A, C
External Visual	2009	*	Yes

* Per IR internal standards

Radiation Specification

Parameter	Condition	Min	Typ	Max	Unit
Total Ionizing Dose	MIL-STD-883, Method 1019.4 Operating bias applied during exposure	25	—	—	KRads (Si)
Heavy Ion (Single event effects)	BNL Dual Van de Graf Generator	60	—	—	MeV •cm ² /mg

AMF28XXS Case Outline



Pin Designation

Pin No.	Designation
1	Enable
2	Sync Input
3	Positive Output
4	Output Common
5	N/C
6	Case Ground
7	Input Return
8	Positive Input

Part Numbering

AMF 28 05 S / EM

Model
 Input Voltage
 28 = 28V
 Output Voltage
 03R3 = 3.3V, 05 = 5V,
 12 = 12V, 15 = 15V
 Screening
 Blank = Flight Model (CH+)
 /EM = Engineering Model
 Outputs
 S = Single
 D = Dual