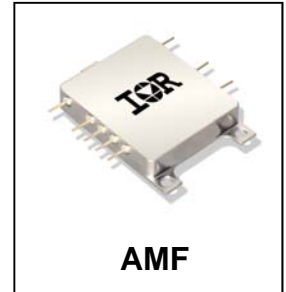


**HYBRID-HIGH RELIABILITY  
RADIATION TOLERANT  
DC-DC CONVERTER****28V Input, Single Output****Description**

The AMF28XXXXS Series of DC-DC converter modules has been specifically designed for operation in moderate radiation environments supplementing the higher radiation performance available in the IR HiRel 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 AMF28XXXXS Series.

The physical configuration of the AMF28XXXXS 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 mechanical security than traditional packages. IR HiRel rugged ceramic seal pins are used exclusively in the package thereby assuring long term hermeticity.

The AMF28XXXXS has been designed for high density using chip and wire hybrid technology that complies with the class H requirements of MIL-PRF-38534. Manufactured in a facility fully qualified to MIL-PRF-38534, these converters are fabricated utilizing DLA qualified processes. For available screening options, refer to device screening table in the data sheet. Applicable generic lot qualification test data including radiation performance can be made available on request. Consult IR HiRel San Jose for special requirements.

**Features**

- 12 Watts Output Power
- Available in 3.3, 5, 7.5, 12 and 15 Volt Outputs
- 16- 40 V<sub>DC</sub> Input Range (28 V<sub>DC</sub> Nominal)
- Low Input/Output Noise
- Total Ionizing Dose > 25 kRads(Si)
- SEE Hardened to LET up to 60 MeV.cm<sup>2</sup>/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
- Standard Microcircuit Drawings Available

## Specifications

Absolute Maximum Ratings		Recommended Operating Conditions	
Input voltage range	-0.5V <sub>DC</sub> to +50V <sub>DC</sub>	Input voltage range	+16V <sub>DC</sub> to +40V <sub>DC</sub>
Soldering temperature	300°C for 10 seconds	Output power	Less than or equal to 12W
Storage case temperature	-65°C to +135°C	Operating temperature	-55°C to +125°C

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

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
Input Voltage			16	28	40	V
Output Voltage						
AMF2803R3S	1	$V_{\text{IN}} = 28$ Volts, 0% load	3.25	3.30	3.35	V
AMF2805S	1		4.95	5.00	5.05	
AMF2807R5S	1		6.97	7.50	7.58	
AMF2812S	1		11.88	12.00	12.12	
AMF2815S	1		14.85	15.00	15.15	
AMF2803R3S	2, 3		3.20		3.40	
AMF2805S	2, 3		4.90		5.10	
AMF2807R5S	2, 3		7.35		7.65	
AMF2812S	2, 3		11.76		12.24	
AMF2815S	2, 3		14.70		15.30	
Output Current <sup>1</sup>						
AMF2803R3S	1, 2, 3	$V_{\text{IN}} = 16, 28, 40$ Volts	0		3000	mA
AMF2805S	1, 2, 3		0		2400	
AMF2807R5S	1, 2, 3		0		1600	
AMF2812S	1, 2, 3		0		1000	
AMF2815S	1, 2, 3		0		800	
AMF2815S	1, 2, 3		0		800	
Output Power <sup>1</sup>						
AMF2803R3S	1, 2, 3	$V_{\text{IN}} = 16, 28, \text{ and } 40$ Volts			10	W
All Other Models	1, 2, 3				12	
Output Ripple Voltage <sup>2</sup>	1, 2, 3	$V_{\text{IN}} = 16, 28, 40$ Volts, BW = 20 Hz to 2 MHz		25	60	mV <sub>PP</sub>
Output Voltage Regulation						
Line						
AMF2803R3S	1, 2, 3	$V_{\text{IN}} = 16, 28, 40$ Volts $I_{\text{OUT}} = 0\%, 50\%, \text{ and } 100\%$ max		10	25	mV
AMF2805S	1, 2, 3			10	25	
AMF2807R5S	1, 2, 3			10	50	
AMF2812S	1, 2, 3			10	50	
AMF2815S	1, 2, 3			10	50	
AMF2815S	1, 2, 3			10	50	
Load	All Models			10	50	

For Notes to Electrical Performance Characteristics, refer to page 4

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

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
Input Current	No Load	$V_{\text{IN}} = 28V$ , $I_{\text{OUT}} = 0$ , Inhibit (pin 1) = open (AMF2812S and AMF2815S) (All other Models)		30 20	50 30	mA
	Inhibit	Inhibit (pin 1) shorted to input return (pin 7) (All Models)		8.0	12	
Input Ripple Current	1, 2, 3	$V_{\text{IN}} = 16, 28, 40$ Volts, 100% load, BW = 20 Hz to 2 MHz		20	50	$\text{mA}_{\text{PP}}$
Efficiency	AMF2803R3S	100% load	71			%
	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 $500V_{\text{DC}}$	100			$\text{M}\Omega$
Capacitive Load <sup>3,4</sup>	AMF2803R3S	No effect on dc performance			500	$\mu\text{F}$
	AMF2805S		4		500	
	AMF2807R5S		4		300	
	AMF2812S		4		200	
	AMF2815S		4		200	
Short Circuit Power Dissipation	1, 2, 3	AMF2803R3S All other Models			7.0 6.0	W
Short Circuit Recovery <sup>4</sup>	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 Electrical Performance Characteristics, refer to page 4

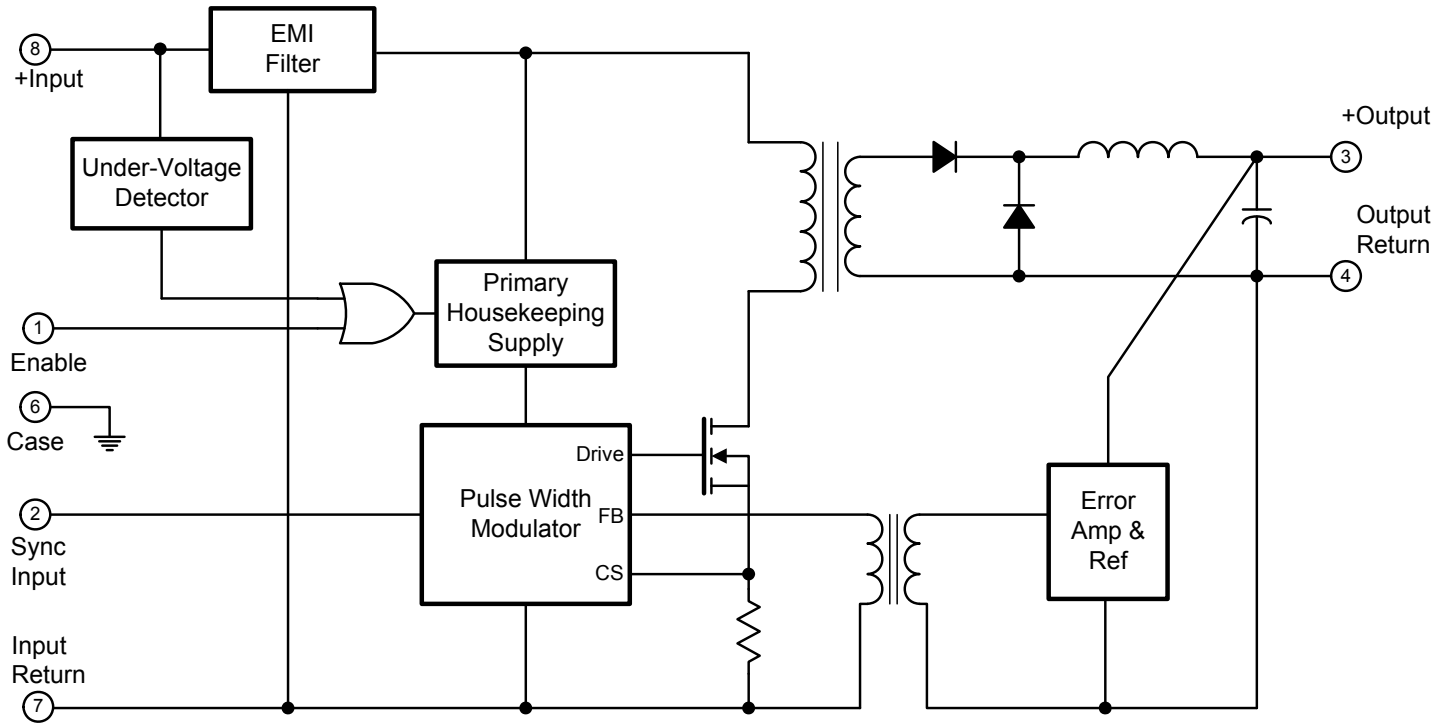
**Dynamic Characteristics**  $-55^{\circ}\text{C} \leq T_{\text{CASE}} \leq +125^{\circ}\text{C}$ ,  $V_{\text{IN}} = 28\text{V}_{\text{DC}} \pm 5\%$ ,  $C_{\text{L}} = 0$ , unless otherwise specified.

Parameter	Group A Subgroups	Test Conditions	Min	Nom	Max	Unit
Synchronization Input						
Frequency Range	4, 5, 6		500		700	kHz
Pulse Amplitude, Hi <sup>4</sup>			2.5		10	V
Pulse Amplitude, Lo <sup>4</sup>			-0.5		0.8	V
Pulse Rise time <sup>4</sup>					100	ns
Pulse Duty Cycle <sup>4</sup>			20		80	%
Output Response to Step Transient Load Changes <sup>5</sup>						
All Models	4, 5, 6	Load step 50% $\leftrightarrow$ 100%	-300		+300	mVpk
AMF2803R3S	4, 5, 6		-400		+400	
AMF2805S	4, 5, 6	Load step 0% $\leftrightarrow$ 50%	-500		+500	
AMF2807R5S	4, 5, 6		-750		+750	
AMF2812S	4, 5, 6		-750		+750	
AMF2815S	4, 5, 6		-750		+750	
Recovery Time, Step Transient Load Changes <sup>5,6</sup>						
AMF2803R3S	4, 5, 6	Load step 50% $\leftrightarrow$ 100%			70	$\mu\text{s}$
AMF2805S	4, 5, 6		70			
AMF2807R5S	4, 5, 6		100			
AMF2812S	4, 5, 6		100			
AMF2815S	4, 5, 6		100			
All Models	4, 5, 6	Load step 0% $\leftrightarrow$ 50%			2.0	ms
Output Response Transient Step Line Changes <sup>4,7</sup>						
AMF2803R3S	4, 5, 6	Input step 16 $\leftrightarrow$ 40V <sub>DC</sub> , 100% Load	-500		+500	mVpk
AMF2805S	4, 5, 6		-500		+500	
AMF2807R5S	4, 5, 6		-1200		+1200	
AMF2812S	4, 5, 6		-1500		+1500	
AMF2815S	4, 5, 6		-1500		+1500	
Recovery Time Transient Step Line Changes <sup>4,7</sup>	4, 5, 6	Input step 16 $\leftrightarrow$ 40V <sub>DC</sub> , 100% load			800	ms
Turn On Overshoot <sup>8</sup>						
AMF2803R3S	4, 5, 6	0% load to 100% load			400	mVpk
AMF2805S	4, 5, 6		600			
AMF2807R5S	4, 5, 6		600			
AMF2812S	4, 5, 6		600			
AMF2815S	4, 5, 6		750			
Turn On Delay <sup>8</sup>	4, 5, 6	0% load to 100% load			20	ms

**Notes to Specifications**

- Parameter guaranteed by line and load regulation tests.
- Bandwidth guaranteed by design. Tested for 20 Hz to 2.0MHz.
- Capacitive value 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. Thereafter, parameters shall be guaranteed to the limit specified.
- Load step transition time between 2 and 10 microseconds.
- Recovery time is measured from initiation of the transient to where  $V_{\text{OUT}}$  has returned to within  $\pm 1\%$  of  $V_{\text{OUT}}$  at 50% load.
- Input step transient time between 1 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.

**Block Diagram**



**Application Information**

**Inhibit Function (Enable)**

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  $\mu$ A of current. Because it is internally pulled up, the open circuit voltage of the enable input is 10 +1.0  $V_{DC}$ .

**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**

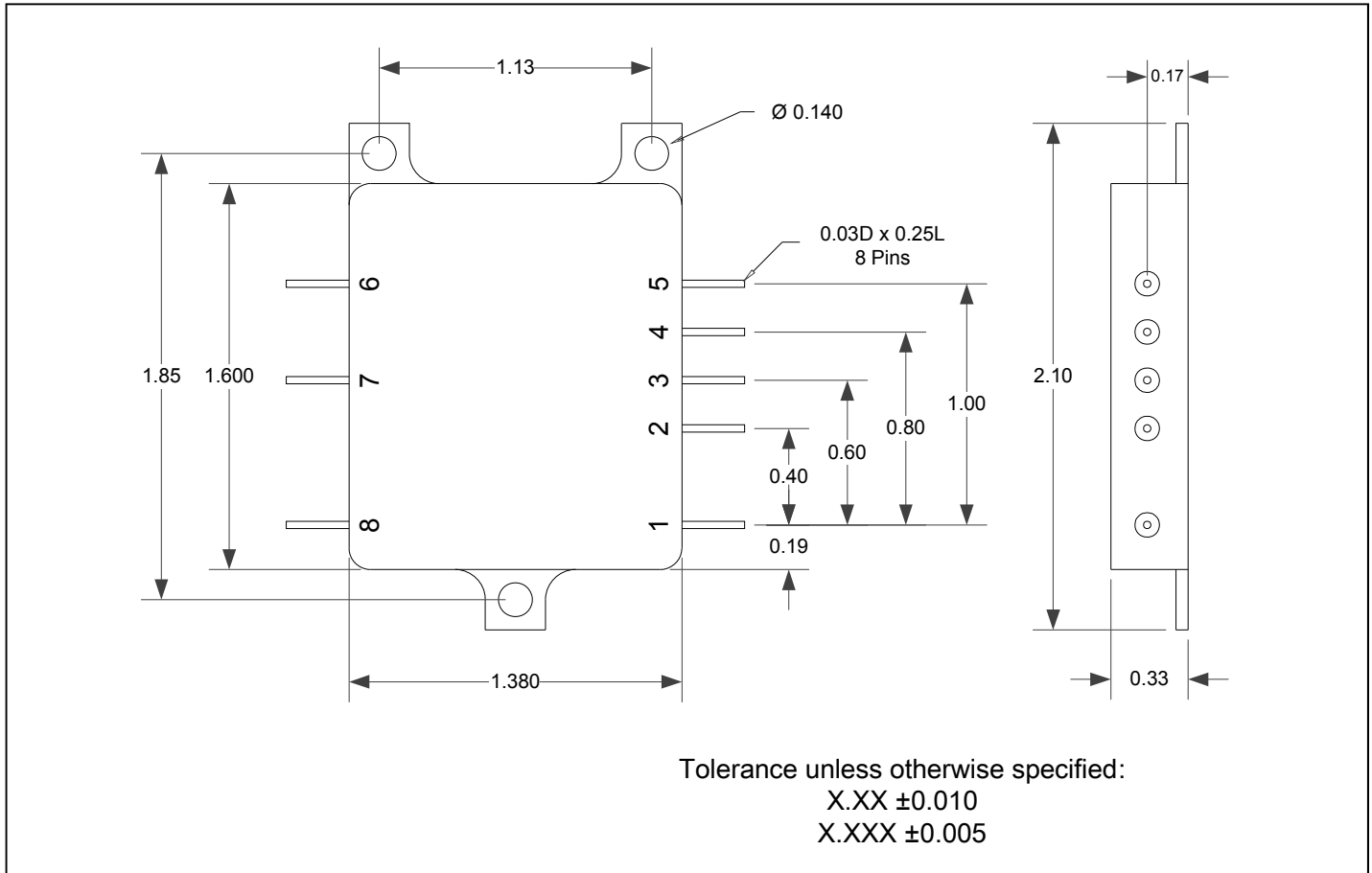
When multiple DC-DC converters are utilized in a single system, significant low frequency noise may be generated due to a small difference in the switching frequency of the converters (beat frequency noise). Because of the low frequency nature of this noise (typically less than 10 kHz), it is difficult to filter out and may interfere with proper operation of sensitive systems (communication, radar or telemetry). IR HiRel 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.

**Radiation Specifications**

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 <sup>2</sup> /mg

IR HiRel currently does not have a DLA certified Radiation Hardness Assurance Program.

**Mechanical Outline**



**Pin Designation**

Pin #	Designation
1	Enable
2	Sync Input
3	+ Output
4	Output Return
5	NC
6	Case Ground
7	Input Return
8	+ Input

**Standard Microcircuit Drawing Equivalence**

Standard Microcircuit Drawing Number	IR HiRel Standard Part Number
5962-04252	AMF2805S
5962-04253	AMF2812S
5962-04254	AMF2815S
5962-10223	AMF2803R3S

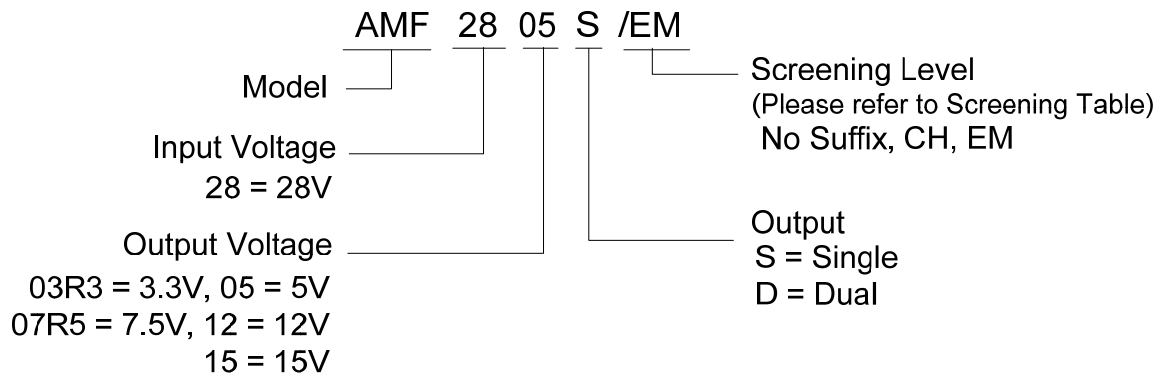
**Device Screening**

Requirement	MIL-STD-883 Method	No Suffix ②	CK ②	EM ③
Temperature Range	—	-55°C to +125°C	-55°C to +125°C	-55°C to +85°C
Element Evaluation	MIL-PRF-38534	Class H	Class H	N/A
Non-Destructive Bond Pull	2023	N/A	N/A	N/A
Internal Visual	2017	Yes	Yes	①
Temperature Cycle	1010	Cond C	Cond C	Cond C
Constant Acceleration	2001, Y1 Axis	3000 Gs	3000 Gs	3000 Gs
PIND	2020	Cond A	Cond A	N/A
Burn-In	1015	320 hrs @ 125°C (2 x 160 hrs)	320 hrs @ 125°C (2 x 160 hrs)	48 hrs @ 125°C
Final Electrical (Group A)	MIL-PRF-38534 & Specification	-55°C, +25°C, +125°C	-55°C, +25°C, +85°C	-55°C, +25°C, +85°C
PDA	MIL-PRF-38534	2%	2%	N/A
Seal, Fine and Gross	1014	Cond A, C	Cond A, C	Cond A
Radiographic	2012	Yes	Yes	N/A
External Visual	2009	Yes	Yes	①

**Notes:**

- ① Best commercial practice.
- ② Devices with "/CH" suffix is a DLA class H compliant without radiation performance. No suffix is a radiation rated device but not available as a DLA qualified SMD per MIL-PRF-38534.
- ③ Any Engineering Model (EM) build with the "EM" Suffix shall only be form, fit and functional equivalent to its Flight Model (FM) counterpart, and it may not meet the radiation performance. The EM Model shall not be expected comply with MIL-PRF-38534 flight quality/workmanship standards, and configuration control. An EM build may use electrical equivalent commercial grade components. IR HiRel will provide a list of non-compliance items upon request.

**Part Numbering**



### **IMPORTANT NOTICE**

The information given in this document shall be in no event regarded as guarantee of conditions or characteristic. The data contained herein is a characterization of the component based on internal standards and is intended to demonstrate and provide guidance for typical part performance. It will require further evaluation, qualification and analysis to determine suitability in the application environment to confirm compliance to your system requirements.

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