



M.S.KENNEDY CORP.

**DUAL OUTPUT
RADIATION HARDENED
HIGH EFFICIENCY, 9 AMP
SWITCHING REGULATORS**

**5047RH
SERIES**

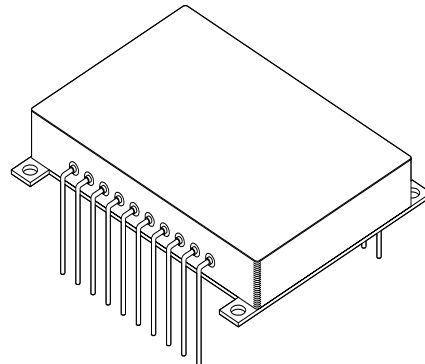
4707 Dey Road Liverpool, N.Y. 13088

(315) 701-6751

FEATURES:

- Up To 85% Efficiency
- 9 Amp Total Output Current
- 4.5V to 16V Input Range with Startup Bias
- 4.5V to 5.5V Input Range with $V_{Bias} = V_{IN}$
- Preset 3.3V/2.5V, 3.3V/1.5V or 2.5V/1.5V Output Voltage Combinations
- Custom Output Voltages Available
- 300KHz Switching Frequency
- Hermetic Package with Three Lead Form Options
- -55°C to +125°C Operating Temperature Range
- 100K RAD Total Dose Rated

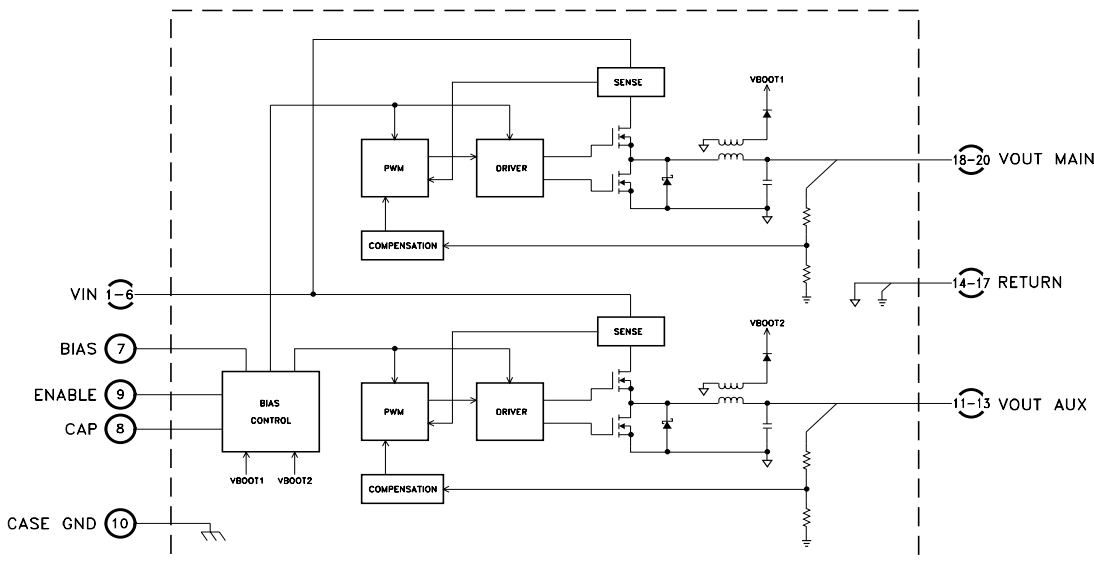
MIL-PRF-38534 CERTIFIED



DESCRIPTION:

The MSK5047RH series are high efficiency, 9 amp, radiation hardened switching regulators. The output voltages are configured for 3.3V/2.5V, 3.3V/1.5V or 2.5V/1.5V internally with a tolerance of 1% at 4.0 amps. The operating frequency of the MSK5047RH is 300KHz. A low quiescent current and greater than 80% operating efficiency keep the total internal power dissipation of the MSK5047RH down to an absolute minimum. The device is packaged in a hermetic power package for high reliability applications, and is available fully screened to MIL-PRF-38534 Class H or K.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Step-down Switching Regulator
- Microprocessor, FPGA Power Source
- High Efficiency Low Voltage Subsystem Power Supply

PIN-OUT INFORMATION

1 VIN	20 VOUT MAIN
2 VIN	19 VOUT MAIN
3 VIN	18 VOUT MAIN
4 VIN	17 RETURN
5 VIN	16 RETURN
6 VIN	15 RETURN
7 VBIAS	14 RETURN
8 CAP	13 VOUT AUX
9 ENABLE	12 VOUT AUX
10 CASE GND	11 VOUT AUX

ABSOLUTE MAXIMUM RATINGS

Input Voltage -0.3V, +16V
 Bias Voltage -0.3V, +5.5V
 Enable -0.3V, 10.5V
 Output Current 9.0 Amps Total
 Thermal Resistance (@ 125°C) 9.0°C/W

T_{ST} Storage Temperature Range -65°C to +150°C
 T_{LD} Lead Temperature Range 300°C
 (10 Seconds)
 T_c Case Operating Temperature
 MSK5047RH Series -40°C to +85°C
 MSK5047RH K/H/E Series -55°C to +125°C
 T_J Junction Temperature +150°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ①	Group A Subgroup	MSK 5047RH K/H/E			MSK 5047RH			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
V _{IN} Input Supply Range ②		1,2,3	4.5	-	16	4.5	-	16	V
V _{Bias} Input Supply Range ②		1,2,3	4.5	-	5.5	4.5	-	5.5	V
Bias Current	Startup	1,2,3	-	480	TBD	-	480	TBD	mA
	Operating	1,2,3	-	1	TBD	-	1	TBD	mA
Output Voltage 1.5V _{OUT} (Aux) ⑦		1	1.48	1.50	1.52	1.46	1.50	1.54	V
		2,3	1.42	1.50	1.58	-	-	-	V
Output Voltage 2.5V _{OUT} (Aux or Main) ⑦		1	2.47	2.5	2.55	2.45	2.5	2.55	V
		2,3	2.38	2.5	2.63	-	-	-	V
Output Voltage 3.3V _{OUT} (Main) ⑦		1	3.27	3.3	3.33	3.23	3.3	3.37	V
		2,3	3.14	3.3	3.47	-	-	-	V
Output Ripple		4	-	-	TBD	-	-	TBD	mVp-p
Output Current (Main) ②	Within SOA	1	5.0	5.2	-	5.0	5.2	-	A
Output Current (Aux) ②	Within SOA	1	4.0	4.2	-	4.0	4.2	-	A
Load Regulation (Either Output)	1.0A ≤ I _{OUT} ≤ 4.0A	1	-	0.5	1.0	-	0.5	1.5	%
		2,3	-	0.5	1.5	-	-	-	%
Line Regulation (Either Output)	V _{Bias} = 5V V _{IN} Step = 6V to 12V	1	-	0.5	1.0	-	0.5	1.5	%
		2,3	-	0.5	1.5	-	-	-	%
Cross Regulation	1.0A ≤ I _{OUT} ≤ 4.0A	1	-	0.5	1.0	-	0.5	1.0	%
		2,3	-	0.5	1.5	-	-	-	%
Oscillator Frequency	I _{OUT} > 1.5A	4	270	300	330	270	300	330	KHz
Enable Input Voltage	Open Circuit Voltage	1,2,3	TBD	4.5	TBD	TBD	4.5	TBD	V
	Logic Low Disabled	1,2,3	TBD	4.0	TBD	TBD	4.0	TBD	V
Enable Input Current	V _{EN} = 0V	1	-	1	TBD	-	1	TBD	mA
Disabled Quiescent Current	V _{EN} = 0V	1,2,3	-	4	TBD	-	4	TBD	mA
Efficiency	5047-2515RH	1	TBD	78	-	TBD	78	-	%
	5047-3315RH	1	TBD	79	-	TBD	79	-	%
	5047-3325RH	1	TBD	81	-	TBD	81	-	%

NOTES:

- ① V_{Bias} = V_{IN} = 5.0V, I_{OUT} = 4.0A, C_{IN} = 100μF, C_{OUT} = 200μF each output unless otherwise specified.
- ② Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only.
- ③ All output parameters are tested using a low duty cycle pulse to maintain T_J = T_c.
- ④ Industrial grade and 'E' suffix devices shall be tested to subgroup 1 unless otherwise specified.
- ⑤ Military grade devices ('H' and 'K' suffix) shall be 100% tested to subgroups 1,2 and 3.
- ⑥ Subgroup 1 T_A = T_c = +25°C
 Subgroup 2 T_A = T_c = +125°C
 Subgroup 3 T_A = T_c = -55°C
- ⑦ Alternate output voltages are available. Please contact the factory.

APPLICATION NOTES

INPUT VBIAS:

The VBias pin of the MSK5047RH provides bias to the control circuitry for initial startup only. The Vbias pin can be connected directly to the input bus for 4.5V to 5.5V operation or it can be biased separately with a 4.5V to 5.5V source to extend the maximum input voltage of the device from 5.5V to 16V. The bias pin draws approximately 480mA during initial startup and drops down to approximately 1mA once the internal bootstrap takes over. The startup supply operates at approximately 175KHz for approximately TBD mS. After the bootstrap takes over the startup supply stops switching.

INPUT CAPACITOR SELECTION:

The MSK5047RH should have an external high frequency ceramic capacitor (0.1uF) between VIN and GND. Connect a low-ESR bulk capacitor directly to the input pin of the MSK5047RH. Select the bulk input filter capacitor according to input ripple-current requirements and voltage rating, rather than capacitor value. Electrolytic capacitors that have low enough ESR to meet the ripple-current requirement invariably have more than adequate capacitance values. Aluminum-electrolytic capacitors are preferred over tantalum types, which could cause power-up surge-current failure when connecting to robust AC adapters or low-impedance batteries. When operating the MSK5047RH with a separate bias supply the VBias pin requires TBD capacitance to ground. Additionally the MSK5047RH requires TBD μ F of capacitance on the cap pin.

OUTPUT CAPACITOR SELECTION:

The output capacitor values are generally determined by the ESR and voltage rating requirements rather than capacitance requirements for stability. Low ESR capacitors that meet the ESR requirement usually have more output capacitance than required for stability. Only specialized low-ESR capacitors intended for switching-regulator applications, such as AVX TPS, Sprague 595D, Sanyo OS-CON, Nichicon PL series or Kemet T510 series should be used.

The output ripple is usually dominated by the ESR of the filter capacitors and can be approximated as $IRIPPLE \times RESR$. Including the capacitive term, the full equation for ripple in the continuous mode is $VNOISE(p-p) = IRIPPLE \times (RESR + 1/(2IfC))$. The MSK5047RH can support up to TBD μ F capacitive load on each output.

ENABLE FUNCTION:

The enable function of the MSK5047RH is configured for open collector drive. Leaving the pin open allows normal operation. Pulling the pin low disables the device.

CAP PIN:

The cap pin of the MSK5047RH provides bulk storage and high frequency decoupling for the bootstrap supply. This pin requires 1 μ F ceramic and TBD bulk capacitance for normal operation.

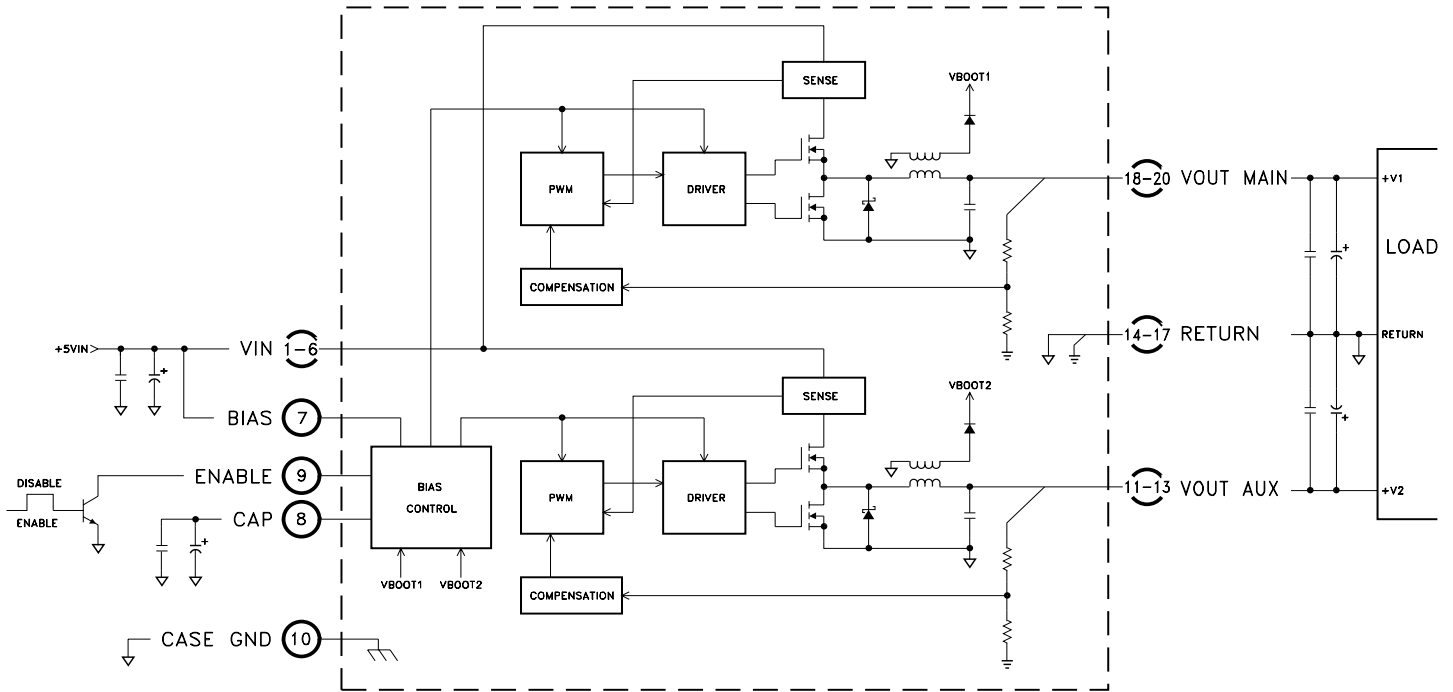
CROSS REGULATION:

TBD

DROPOUT VOLTAGE:

TBD

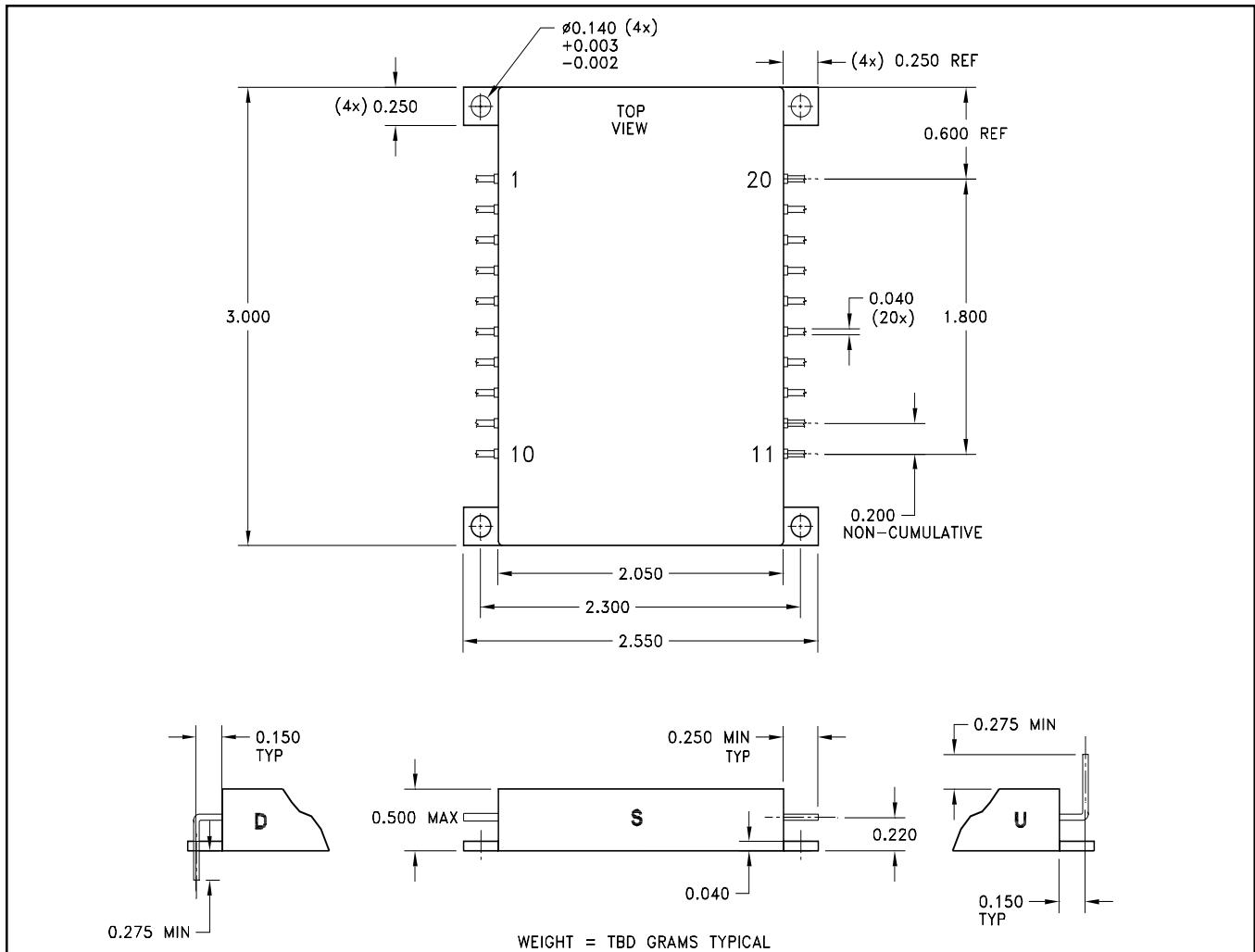
TYPICAL VBIAS = VIN APPLICATION



TYPICAL PERFORMANCE CURVES

TBD

MECHANICAL SPECIFICATIONS



NOTE: ALL DIMENSIONS ARE ± 0.010 INCHES UNLESS OTHERWISE LABELED.

ORDERING INFORMATION

MSK5047- 3325 H RH U

LEAD CONFIGURATIONS

S = STRAIGHT; U = BENT UP; D = BENT DOWN

RADIATION HARDENED

SCREENING

BLANK = INDUSTRIAL; E = EXTENDED RELIABILITY

H = MIL-PRF-38534 CLASS H; K = MIL-PRF-38534 CLASS K

OUTPUT VOLTAGE MAIN/AUX

3325 = 3.3V/2.5V; 3315 = 3.3V/1.5V; 2515 = 2.5V/1.5V

GENERAL PART NUMBER

The above example is a +3.3V Main, +2.5V Aux, Military regulator with leads bent up.

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The information contained herein is believed to be accurate at the time of printing. MSK reserves the right to make changes to its products or specifications without notice, however, and assumes no liability for the use of its products.

Please visit our website for the most recent revision of this datasheet.

Contact MSK for MIL-PRF-38534 Class H, Class K and Appendix G (radiation) status.