RADIATION HARDENED HIGH EFFICIENCY, 4 AMP SWITCHING REGULATORS

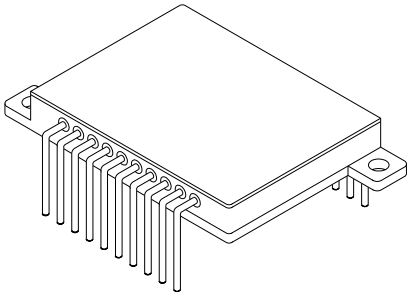
5046RH SERIES

M.S.KENNEDY CORP.
4707 Dey Road Liverpool, N.Y. 13088
(315) 701-6751

FEATURES:

- Up To TBD% Efficiency For 5V Version
- 4 Amp Output Current
- 3.1V to 16V Input Range with Startup Bias
- 12V to 16V Input Range with UVLO (VBias = VIN)
- Preset 1.5V, 2.5V, 3.3V or 5.0V Output Versions
- Custom Output Voltages Available
- 400KHz Switching Frequency
- Hermetic Package with Three Lead Form Options
- -55°C to +125°C Operating Temperature Range
- Total Dose Rated to TBDK RAD

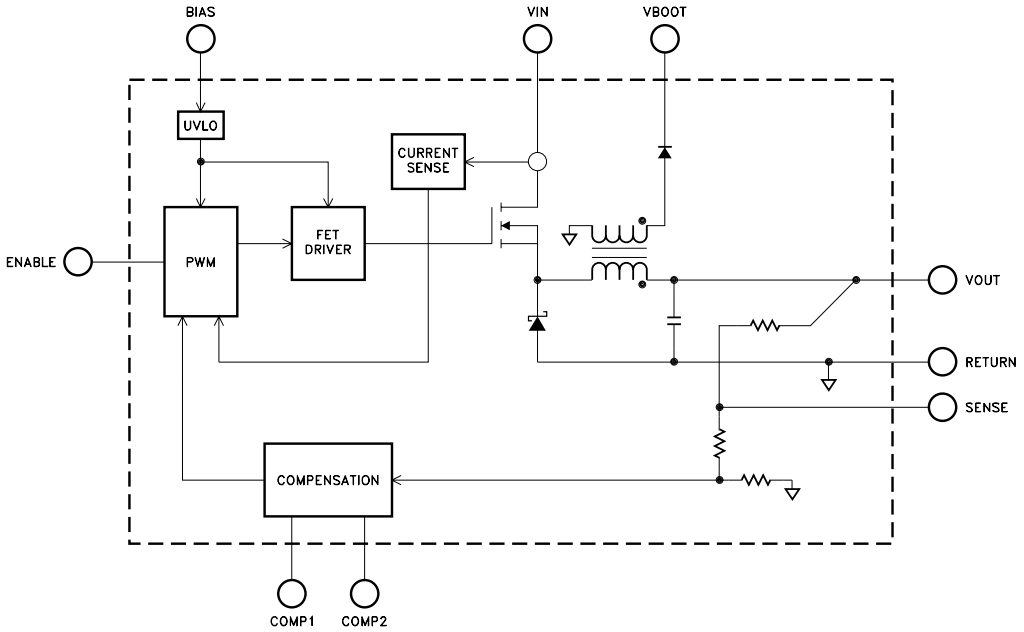
MIL-PRF-38534 CERTIFIED



DESCRIPTION:

The MSK 5046RH series are high efficiency, 4 amp, radiation hardened switching regulators. The output voltage is configured for 1.5V, 2.5V, 3.3V or 5.0V internally with a tolerance of 1% at 1.5 amps. The operating frequency of the MSK 5046RH is 400KHz. A low quiescent current and greater than TBD operating efficiency keep the total internal power dissipation of the MSK 5046RH down to an absolute minimum. The device is packaged in a hermetic power package for high reliability applications, and is available fully compliant 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	TBD	20	TBD
2	TBD	19	TBD
3	TBD	18	TBD
4	TBD	17	TBD
5	TBD	16	TBD
6	TBD	15	TBD
7	TBD	14	TBD
8	TBD	13	TBD
9	TBD	12	TBD
10	TBD	11	TBD

ABSOLUTE MAXIMUM RATINGS

Input Voltage . . . . . -0.3V, +16V
Enable . . . . . -0.3V, 10.5V
Output Current . . . . . 4.0 Amps
Thermal Resistance (@ 125°C) . . . . .TBD°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
MSK5046RH Series . . . . . -40°C to +85°C
MSK5046RH K/H/E Series. . . . . -55°C to +125°C
T_J Junction Temperature . . . . . .+150°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ① ⑪		Group A Subgroup	MSK 5046RH K/H/E Min.	Typ.	Max.	MSK 5046RH Min.	Typ.	Max.	Units
VIN Input Supply Range ⑩ ⑨			1,2,3	Note 10	-	16	Note 10	-	16	V
VBias Input Supply Range ②			1,2,3	12	-	16	12	-	16	V
IBias	IOUT = 1.5A		1	-	40	TBD	-	40	TBD	mA
			2,3	-	40	TBD	-	40	TBD	mA
Under Voltage Lockout	VBias		1	8.4	-	12.0	8.4	-	12.0	V
Output Voltage 5046RH-1.5 ⑧	IOUT = 1.5A		1	1.48	1.50	1.52	1.46	1.50	1.54	V
			2,3	1.42	1.50	1.58	-	-	-	V
		VBoot	1	TBD	TBD	TBD	TBD	TBD	TBD	V
Output Voltage 5046RH-2.5 ⑧	IOUT = 1.5A		1	2.47	2.5	2.55	2.45	2.5	2.55	V
			2,3	2.38	2.5	2.63	-	-	-	V
		VBoot	1	TBD	TBD	TBD	TBD	TBD	TBD	V
Output Voltage 5046RH-3.3 ⑧	IOUT = 1.5A		1	3.27	3.3	3.33	3.23	3.3	3.37	V
			2,3	3.14	3.3	3.47	-	-	-	V
		VBoot	1	TBD	TBD	TBD	TBD	TBD	TBD	V
Output Voltage 5046RH-5.0 ⑧	IOUT = 1.5A		1	4.95	5.0	5.05	4.9	5.0	5.1	V
			2,3	4.75	5.0	5.25	-	-	-	V
		VBoot	1	TBD	TBD	TBD	TBD	TBD	TBD	V
Output Current ②	Within SOA		1	4.0	4.2	-	4.0	4.2	-	A
Load Regulation	0.75A ≤ IOUT ≤ 2.5A		1	-	0.5	1.0	-	0.5	1.5	%
			2,3	-	0.5	1.5	-	-	-	%
Line Regulation	IOUT = 1.5A VBias = 12V VIN Step = 6V to 12V		1	-	0.5	1.0	-	0.5	1.5	%
			2,3	-	0.5	1.5	-	-	-	%
Oscillator Frequency ②	IOUT ≥ 1.5A		4	370	400	430	370	400	430	KHz
Enable Input Voltage ②	Open Circuit Voltage		1,2,3	TBD	TBD	TBD	TBD	TBD	TBD	V
	Low		1,2,3	TBD	TBD	TBD	TBD	TBD	TBD	V
Enable Input Current ②	VEN = 0V		1	-	TBD	TBD	-	TBD	TBD	uA
Disabled Quiescent Current	VEN = 0V		1,2,3	-	TBD	TBD	-	TBD	TBD	mA
Efficiency	5046-1.5RH	VIN = 3.3V IOUT = 2.0A	-	TBD	70	-	TBD	70	-	%
	5046-2.5RH	VIN = 5.0V IOUT = 2.0A	-	TBD	80	-	TBD	80	-	%
	5046-3.3RH	VIN = 5.0V IOUT = 2.0A	-	TBD	85	-	TBD	85	-	%
	5046-5.0RH	VIN = 7.0V IOUT = 2.0A	-	TBD	89	-	TBD	89	-	%

NOTES:

① V_{IN} = 12V, VBias = 12V, I_{OUT} = 1.5A 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 $T_A = T_C = -55°C$
⑧ Alternate output voltages are available. Please contact the factory.
⑨ The device can operate with input voltages as high as 16V, but efficiency is best at lower inputs.
⑩ With VBias connected to a separate source, V_{IN} Min. is approximately 3.1V.
⑪ Contact factory for post radiation limits.

APPLICATION NOTES

INPUT BIAS AND UVLO:

The Bias pin of the MSK 5046RH provides bias to the control circuitry. The Vbias pin can be connected directly to the input bus for 12V to 16V operation or it can be biased separately with a 12V to 16V source to extend the input range of the device refer to the paragraph titled "INPUT VOLTAGE RANGE". The MSK 5046RH's built in under voltage lockout feature prevents damage to downstream devices in the event of a drop in bias voltage. Under voltage lockout occurs at bias voltages of approximately TBD rising and TBD falling. The internal bias draws approximately 40mA under normal operation.

INPUT VOLTAGE RANGE

The MSK 5046RH's input range of 12V to 16V can be further extended down to 3.1V by using a separate bias supply. In this configuration very efficient low V to low V conversion can be achieved.

BOOTSTRAPPING:

The MSK 5046RH's Vboot output can be used to supply bias voltage once the device is operating. Use a diode to "OR" the startup bias supply with the Vboot output if the startup supply voltage is less than Vboot. Use a switching scheme if Vboot is less than or equal to Vstartup. Additional bypass capacitance is required on the Vbias input pin when bootstrapping the MSK 5046RH. The bootstrap voltage is stepped up from the output voltage. Direct biasing of the Vbias input may be more efficient due to the additional conversion involved in bootstrapping.

INPUT CAPACITOR SELECTION:

The MSK 5046RH 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 MSK 5046RH. 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.

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 x RESR. Including the capacitive term, the full equation for ripple in the continuous mode is $V_{NOISE(p-p)} = I_{RIPPLE} \times (R_{ESR} + 1/(2\pi fC))$.

SENSE:

It is very important that the DC voltage returned to the SENSE pin from the output be as noise and oscillation free as possible. This voltage helps to determine the final output and therefore must be a clean voltage. Excessive noise or oscillation can cause the device to have an incorrect output voltage. Proper PC board layout techniques can help to achieve a noise free voltage at the SENSE pin.

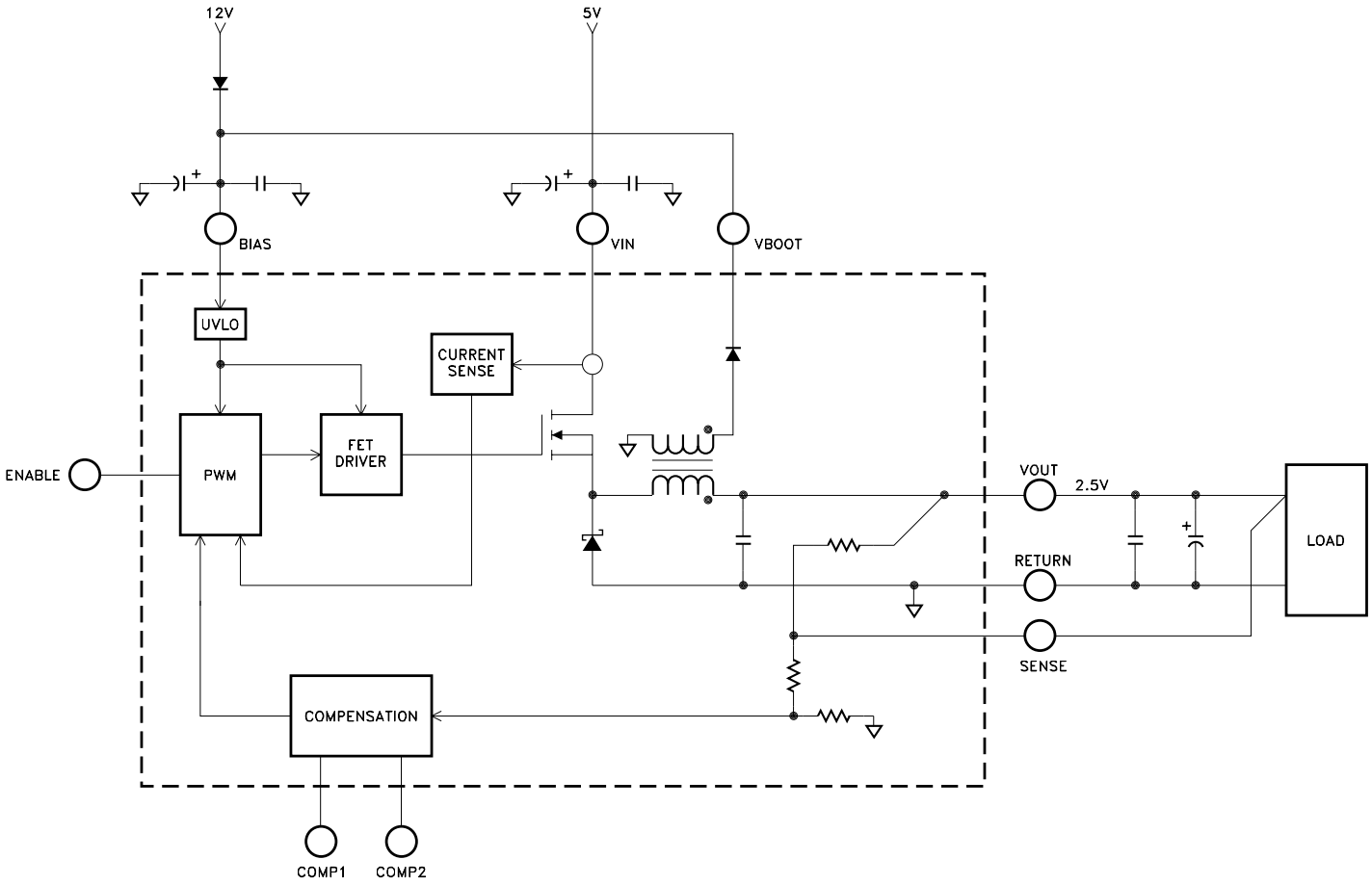
ENABLE FUNCTION:

TBD

COMPENSATION:

TBD

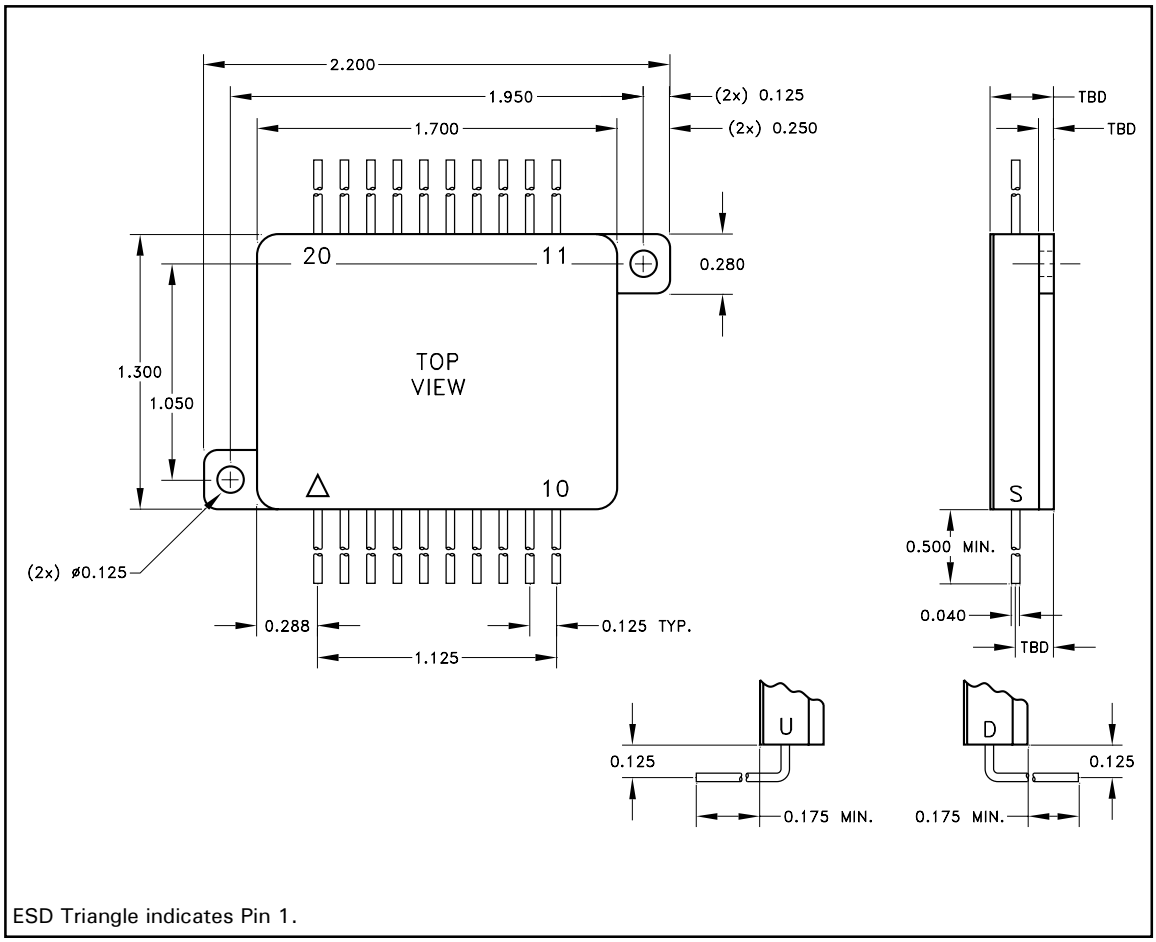
TYPICAL BOOTSTRAPPED APPLICATION



TYPICAL PERFORMANCE CURVES

TBD

MECHANICAL SPECIFICATIONS



ESD Triangle indicates Pin 1.

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

ORDERING INFORMATION

MSK5046-3.3 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
1.5 = +1.5V; 2.5 = +2.5V; 3.3 = +3.3V; 5.0 = +5.0V

GENERAL PART NUMBER

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

M.S. Kennedy Corp.
4707 Dey Road, Liverpool, New York 13088
Phone (315) 701-6751
FAX (315) 701-6752
www.mskennedy.com