MIL-PRF-38534 CERTIFIED FACILITY

M.S.KENNEDY CORP.

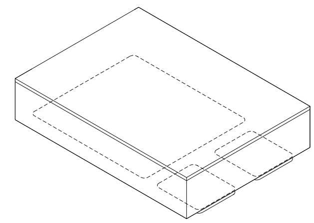
3A LOW NOISE, FIXED OUTPUT LDO REGULATOR

5144 SERIES

4707 Dey Road Liverpool, N.Y. 13088 (315) 701-6751

FEATURES:

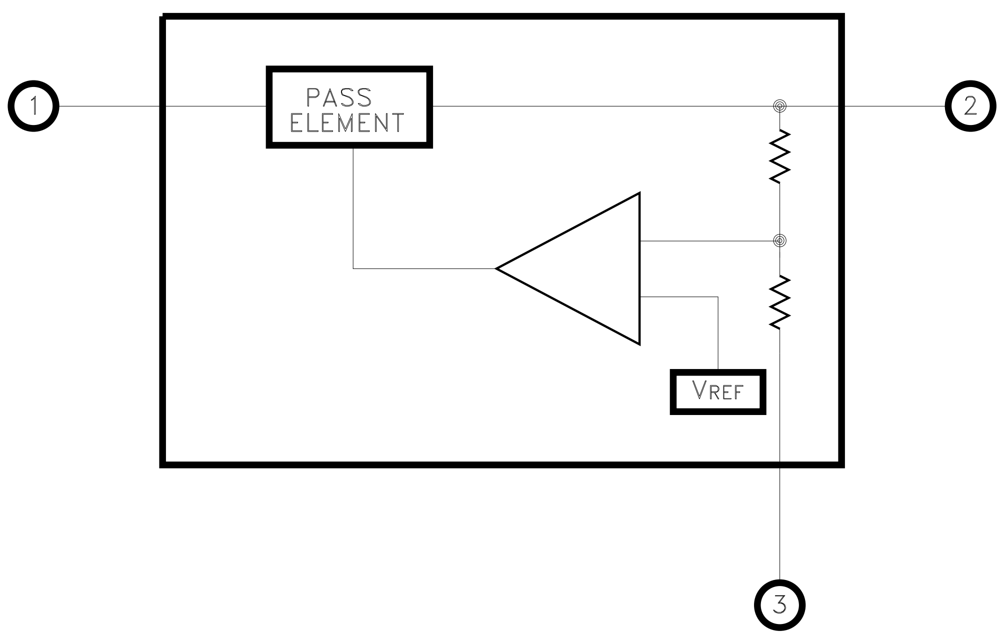
- Fast Transient Response
- Low Dropout Voltage: 340mV @ 3A
- Low Noise: 40uVrms (10Hz to 100KHz)
- 1mA Quiescent Current
- Fixed Output Voltages: 1.5V, 1.7V, 1.8V, 1.9V, 2.0V, 2.5V, 3.3V
- No Protection Diodes Required
- Stable with 10uF Output Capacitor
- Hermetic Surface Mount Package
- Atternate Output Voltages Available
- Contact MSK for MIL-PRF-38534 Qualification Status



DESCRIPTION:

The MSK 5144 series regulators offer a low 430mV dropout voltage while supplying up to 3A of output current. With fast transient response, these regulators have very low output noise. Excellent line and load regulation characteristics ensure accurate performance for multiple applications with a low operating quiescent current of 1mA. These regulators offer internal short circuit current limit, thermal limiting and reverse current protection which eliminates the need for external components and excessive derating. The MSK 5144 series regulators are available in a hermetically sealed space efficient 3 pin power surface mount ceramic package.

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Post Regulator For Switching Power Supplies
- Battery Powered Equipment
- Microprocessor Power Supplies
- Pre-amplifier Power Supplies

PIN-OUT INFORMATION

1 VIN
2 VOUT
3 GND

CASE = ISOLATED

ABSOLUTE MAXIMUM RATINGS ⑩

IN	Supply Voltage	. . . .	20V
I_{OUT}	Output Current	. . . .	3A
VIN	Differential Input Voltage	. . . .	20V
T_C	Case Operating Temperature range		
	MSK 5144H	. . . .	-55°C to +125°C
	MSK 5144	. . . .	-40°C to +85°C
T_{ST}	Storage Temperature Range	. . . .	-65°C to +150°C
T_{LD}	Lead Temperature Range		
	(10 Seconds)	. . . .	300°C
T_J	Junction Temperature	. . . .	+150°C

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ①	Group A Subgroup	MSK 5144H SERIES Min.	MSK 5144H SERIES Typ.	MSK 5144H SERIES Max.	MSK 5144 SERIES Min.	MSK 5144 SERIES Typ.	MSK 5144 SERIES Max.	Units
Minimum Input Voltage ② ③	I_{LOAD}=0.5A	1	-	1.7	-	-	1.9	-	V
	I_{LOAD}=3A	1,2,3	-	2.3	2.7	-	2.3	2.7	V
Regulated Output Voltage ⑧	(VOUT+1V) or VIN min ≤ VIN ≤ 20V I_{OUT}=1mA	1	-1.0	-	1.0	-1.0	-	1.0	%
	VIN=(VOUT+1V) or VIN min I_{OUT}=3A	2,3	-2.5	-	2.5	-	-	-	%
Line Regulation	ΔVIN=(VOUT+1.0V) or VIN min to 20V I_{LOAD}=1mA	1,2,3	-1.0	-	1.0	-1.0	-	1.0	%
Load Regulation	VIN=(VOUT+1.0V) or VIN min	1	-1.0	-	1.0	-1.0	-	1.0	%
	Δ I_{LOAD}=1mA to 3A	2,3	-1.5	-	1.5	-	-	-	%
Dropout Voltage ⑦	I_{LOAD}=3A	1	-	0.43	0.50	-	-	0.55	V
		2,3	-	-	0.70	-	-	-	V
GND Pin Current ②	VIN=VOUT+1V, I_{LOAD}=0mA	1,2,3	-	2.0	2.5	-	2.0	2.5	mA
Output Voltage Noise ②	C_{OUT}=10uF, I_{LOAD}=3A BW=10Hz to 100KHz	-	-	40	-	-	40	-	uVrms
Ripple Rejection ②	VIN-VOUT=1.5VDC, I_{LOAD}=0.75A V_{RIPPLE} (120Hz)=0.5Vpp	1	55	63	-	55	63	-	dB
Current Limit ⑨	VIN=VOUT+1.2V	1,2,3	3.1	-	-	3.1	-	-	A
Reverse Output Current ②	VIN<VOUT	1	-	600	1200	-	600	1200	uA
Thermal Resistance ②	Junction to Case @ 125°C	-	-	4.4	4.8	-	4.4	4.8	°C/W

NOTES:

① The output is decoupled to ground using a 100µF low ESR tantalum capacitor in parallel with a 1µF ceramic capacitor. See figure 1 for typical circuit.
② Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only.
③ Minimum input voltage is as specified or VOUT+ $V_{DROPOUT}$, whichever is greater.
④ Industrial grade devices shall be tested to subgroups 1 unless otherwise requested.
⑤ Military grade devices ("H" suffix) shall be 100% tested to subgroups 1,2 and 3.
⑥ Subgroup 1 TC=+25°C
Subgroup 2 TC=+125°C
Subgroup 3 TC=-55°C
⑦ Not applicable to versions where VIN + $V_{DROPOUT}$ < VIN min. The minimum input voltage requirement must be maintained.
⑧ Reference current limit typical performance curves for input to output differential limitations.
⑨ The output current limit function provides protection from transient overloads but it may exceed the maximum continuous rating. Continuous operation in current limit may damage the device.
⑩ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

APPLICATION NOTES

INPUT BYPASS CAPACITORS

Unless the regulator is located very close to the main input filter capacitor, a 1μF to 10μF low ESR tantalum capacitor should be added to the regulator's input to maximize transient response and minimize power supply transients. A 0.1μF ceramic capacitor should also be used for high frequency bypassing.

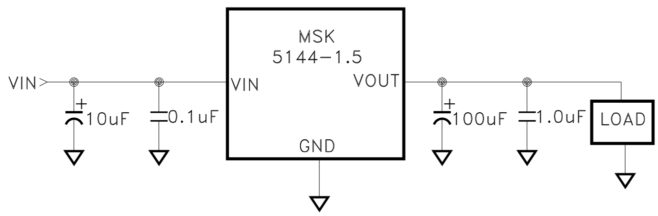


FIGURE 1

OUTPUT CAPACITOR SELECTION

For most applications a 10μF low ESR tantalum capacitor, as close to the regulators output as possible, is all that is required for the MSK 5144 to be stable. When using a 10μF capacitor on the lower output voltage devices, a minimum ESR is required of the capacitor. This requirement decreases from 20mΩ on the 1.5V output regulator to 5mΩ on the 3.3V output regulator. With an increase in capacitance, the minimum ESR requirement decreases. At 100μF, the minimum ESR requirement decreases to 5mΩ for all versions of the MSK 5144. To reduce ringing and improve transient response, capacitors with slightly larger ESR in the range of 20mΩ to 50mΩ provides improved damping. Capacitors with higher ESR can be combined in parallel with low ESR ceramic capacitors for good high frequency response and settling time. The maximum ESR value must be less than 3Ω. Care must be taken when selecting a ceramic type. The X5R and X7R are the best choice for output stability when considering response due to applied voltage and temperature.

REVERSE VOLTAGE PROTECTION

The regulators are protected against reverse input and output voltages. Reverse input voltages up to 20V will be blocked from the input while current flow is limited to less than 1mA. The reverse voltage on the input is also prevented from appearing on the output and the load. When the input voltage is pulled down to ground and the output is held up by a second source, the current flow between them is limited to typically 600μA. See the electrical specifications table.

LOAD REGULATION

In voltage regulator applications where very large load currents are present, the load connection is very important. The path connecting the output of the regulator to the load must be extremely low impedance to avoid affecting the load regulation specifications. As shown in figure 2, any impedance (Rs) in this path will form a voltage divider with the load. For best results the ground pin should be connected directly to the load as shown in figure 2. The direct connection eliminates the effect the potential voltage drop in the power ground path can have on the internal ground sensing, thus improving load regulation. The MSK 5144 ground pin trace must be designed to carry the ground pin current without significant voltage drops. See typical performance curves.

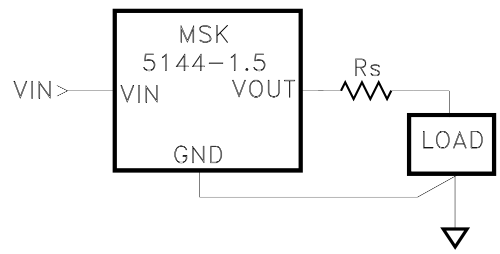


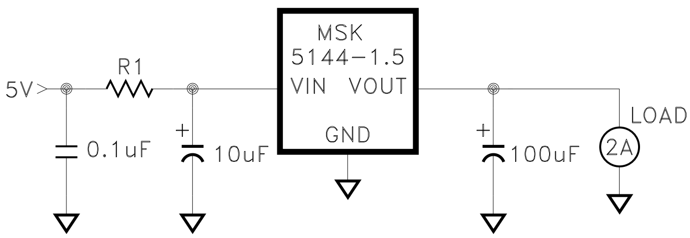
FIGURE 2

OVERLOAD PROTECTION

The MSK 5144 series regulators feature both current limit and thermal overload protection. Within the safe operating region, the regulators will current limit above their 1.6amp rating. As the input to output voltage increases, however, the current limit decreases to keep the output transistor within its power dissipation limitation. See the Current Limit Typical Curves for conditional performance detail. If the device heats enough to exceed its rated die junction temperature due to excessive ambient temperature, improper heat sinking etc., the regulators also shutdown until an appropriate junction temperature is maintained. To bring the regulator out of shutdown, the device input may need to be cycled to zero and power reapplied to eliminate the shutdown condition.

MINIMIZING POWER DISSIPATION:

To maximize the performance and reduce power dissipation of the MSK 5144 series devices, VIN should be maintained as close to dropout or at VIN minimum when possible. See Input Supply Voltage requirements. A series resistor can be used to lower VIN close to the dropout specification, lowering the input to output voltage differential. In turn, this will decrease the power that the device is required to dissipate. Knowing peak current requirements and worst case voltages, a resistor can be selected that will drop a portion of the excess voltage and help to distribute the heating. The circuit below illustrates this method.



The maximum resistor value can be calculated from the following:

$$R1\ max = \frac{VIN\ min - (VOUT\ max + V_{DROP})}{I_{OUT}\ peak + GND\ Pin\ Current}$$

Where:

VIN min = Minimum input voltage
VOUT max = Maximum output voltage across the full temperature range
V_{DROP} = Worst case dropout voltage (Typically 340mV)
I_{OUT} peak = Maximum load current
GND Pin Current = Max. GND Pin Current at I_{OUT} peak

HEAT SINK SELECTION

To select a heat sink for the MSK 5144, the following formula for convective heat flow may be used.

Governing Equation:

$$T_J = P_D \times (R_{\theta JC} + R_{\theta CS} + R_{\theta SA}) + T_A$$

Where

T_J = Junction Temperature
P_D = Total Power Dissipation
$R_{\theta JC}$ = Junction to Case Thermal Resistance
$R_{\theta CS}$ = Case to Heat Sink Thermal Resistance
$R_{\theta SA}$ = Heat Sink to Ambient Thermal Resistance
T_A = Ambient Temperature

Power Dissipation = (VIN-VOUT) x I_{OUT}

Next, the user must select a maximum junction temperature. The absolute maximum allowable junction temperature is 150°C. The equation may now be rearranged to solve for the required heat sink to ambient thermal resistance ($R_{\theta SA}$).

Example:

An MSK 5144 is connected for VIN = +5V and VOUT = +3.3V. I_{OUT} is a continuous 2A DC level. The ambient temperature is +25°C. The maximum desired junction temperature is +125°C.

$R_{\theta JC}$ = 4.8°C/W and $R_{\theta CS}$ = 0.15°C/W for most thermal greases

Power Dissipation = (5V-3.3V) x (2A)
= 3.4 Watts

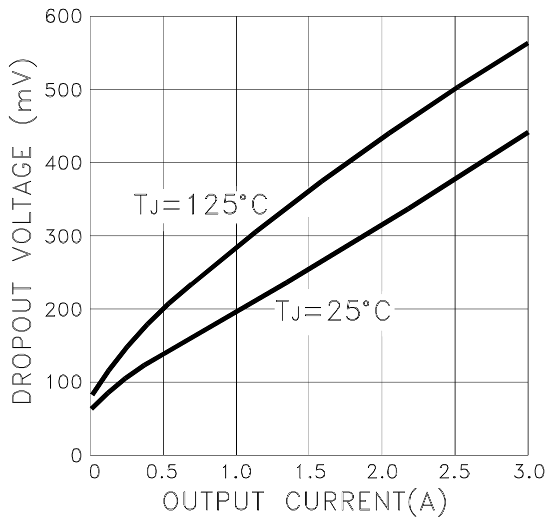
Solve for $R_{\theta SA}$:

$$R_{\theta SA} = \left[\frac{125°C - 25°C}{3.4W}\right] - 4.8°C/W - 0.15°C/W$$
$$= 24.5°C/W$$

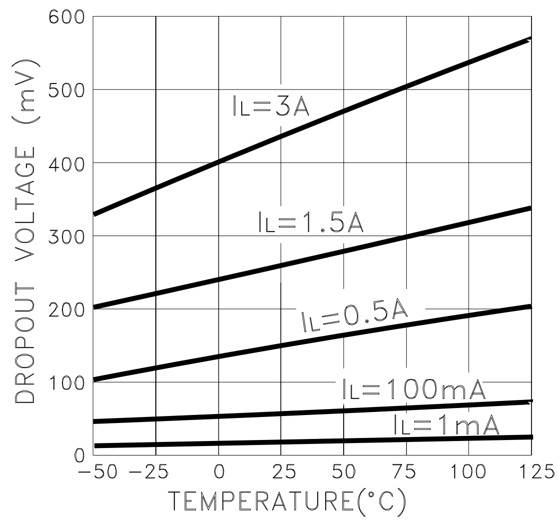
In this example, a heat sink with a thermal resistance of no more than 24.5°C/W must be used to maintain a maximum junction temperature of no more than 125°C.

TYPICAL PERFORMANCE CURVES

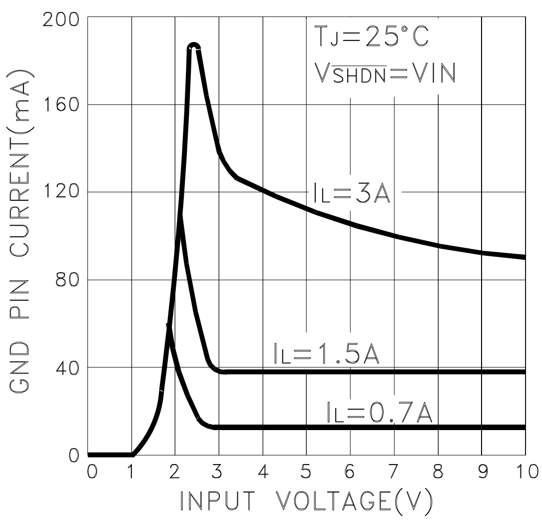
TYPICAL DROPOUT VOLTAGE



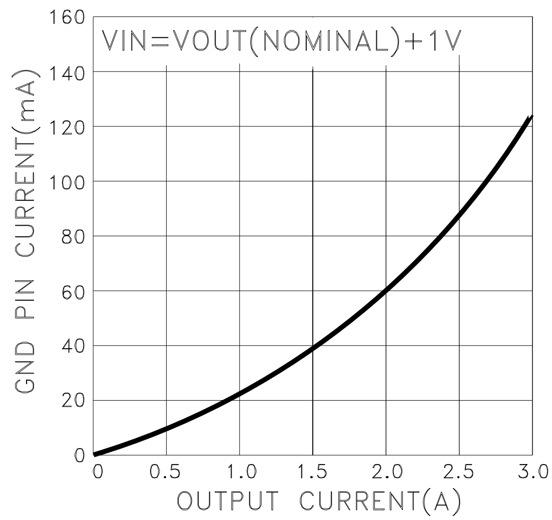
DROPOUT VOLTAGE



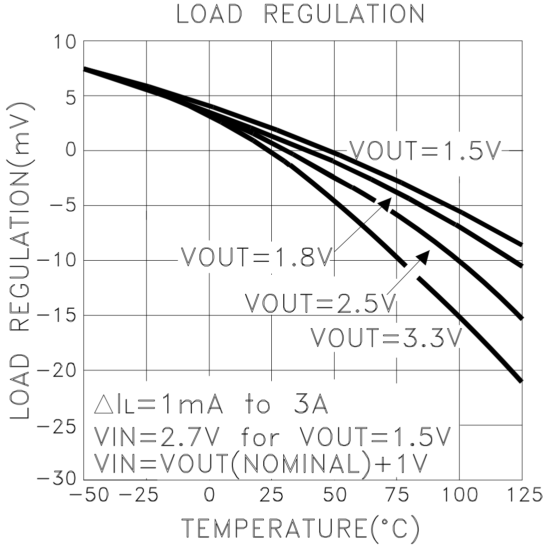
MSK5144 GND PIN CURRENT



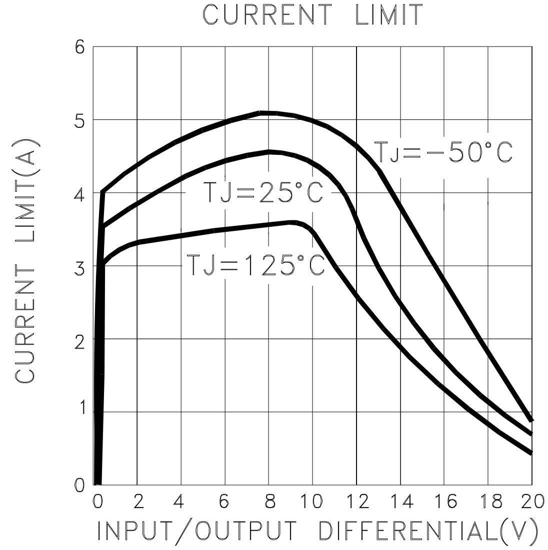
GND PIN CURRENT vs ILOAD



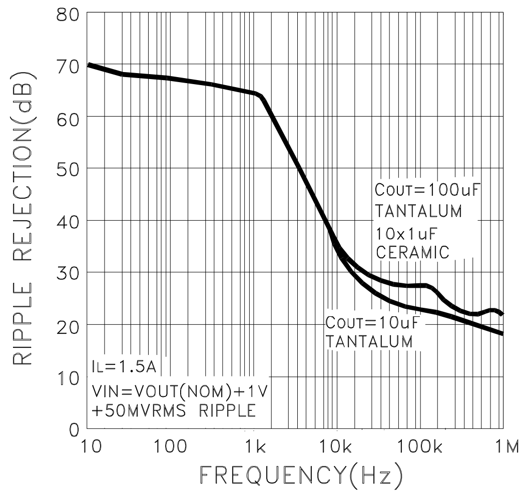
LOAD REGULATION



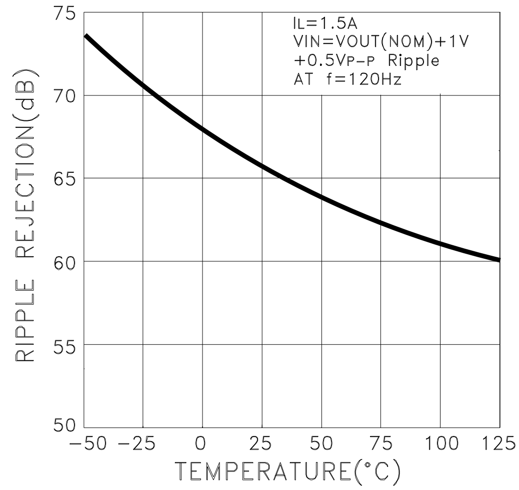
CURRENT LIMIT



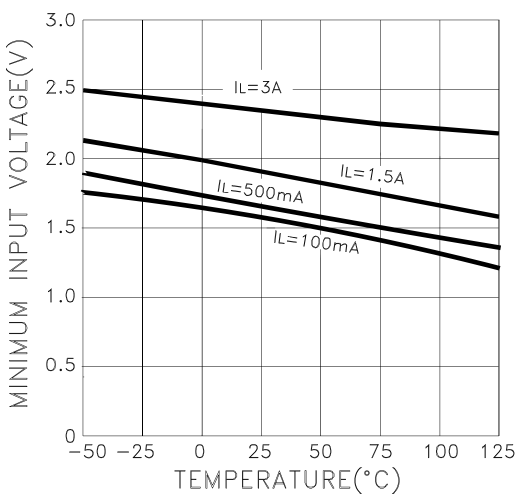
RIPPLE REJECTION



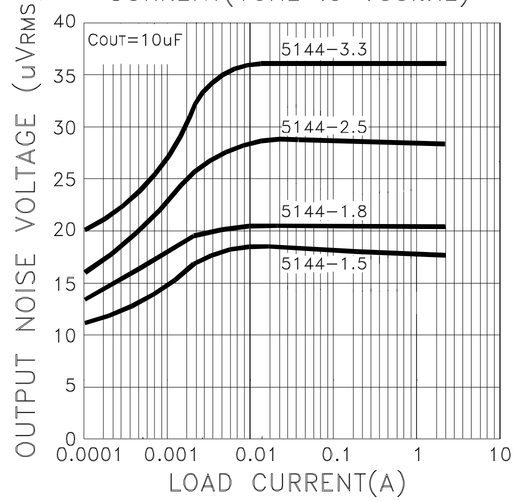
RIPPLE REJECTION



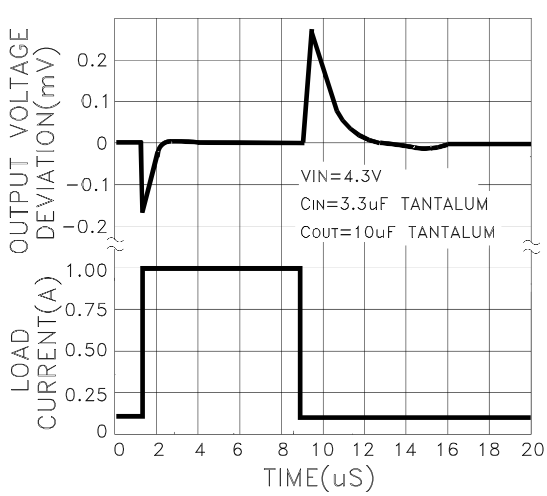
MINIMUM INPUT VOLTAGE



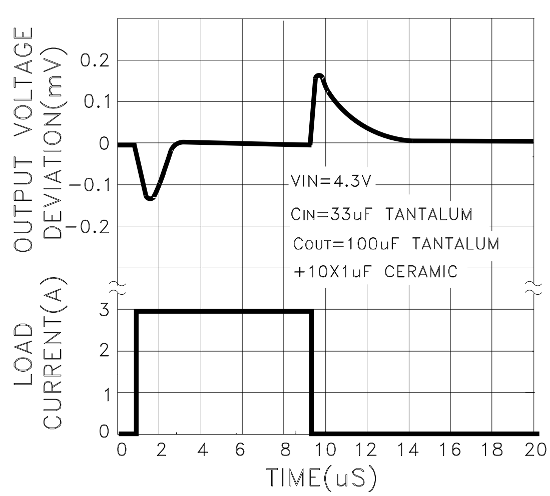
RMS OUTPUT NOISE vs LOAD CURRENT(10Hz to 100kHz)



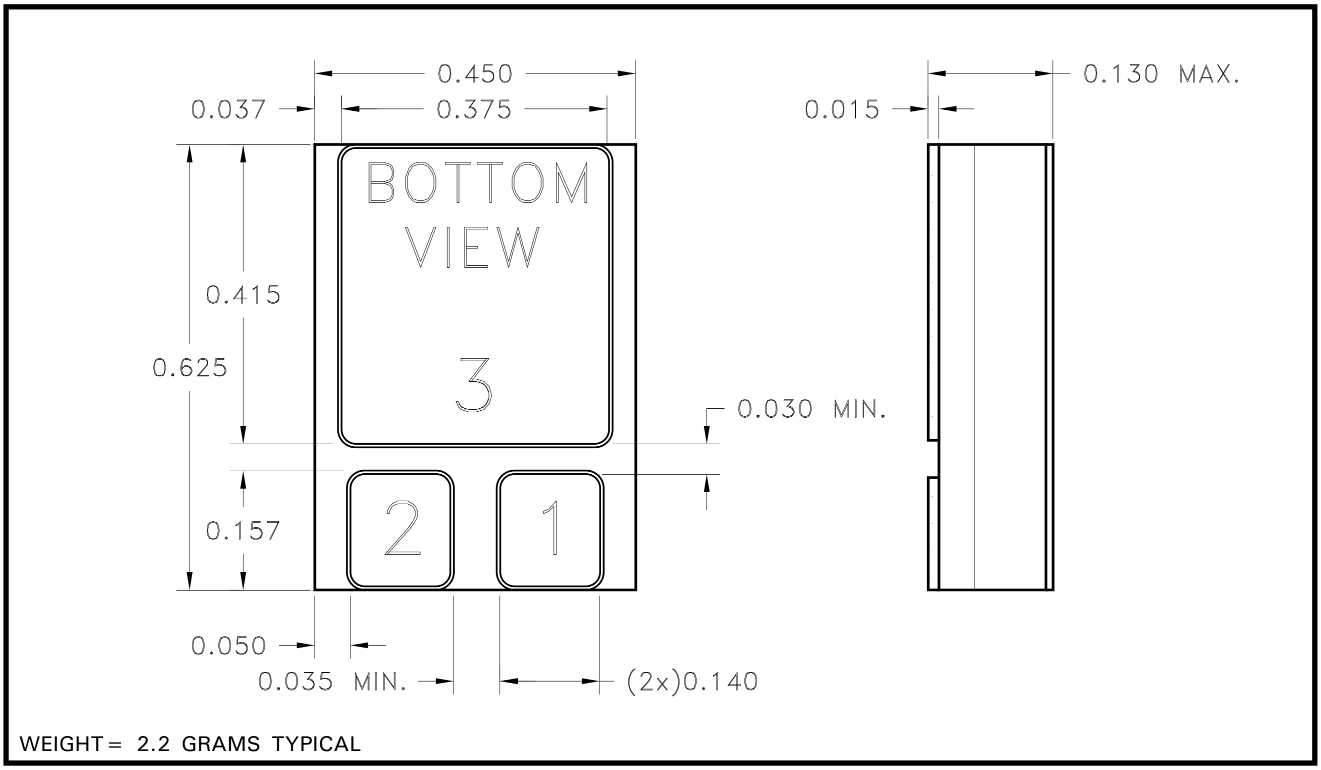
5144−3.3 TRANSIENT RESPONSE



5144−3.3 TRANSIENT RESPONSE



MECHANICAL SPECIFICATIONS



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

ORDERING INFORMATION

MSK5144-3.3 H

SCREENING
BLANK= INDUSTRIAL; H= MIL-PRF-38534, CLASS H

OUTPUT VOLTAGE
1.5=+1.5V; 1.7=+1.7V; 1.8=+1.8V; 1.9=+1.9V; 2.0=+2.0V;
2.5=+2.5V; 3.3=+3.3V

GENERAL PART NUMBER

The above example is a +3.3V, Military regulator.

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