*MIL-PRF-38534 CERTIFIED*

# DUAL RAD HARD +/- VOLTAGE REGULATOR

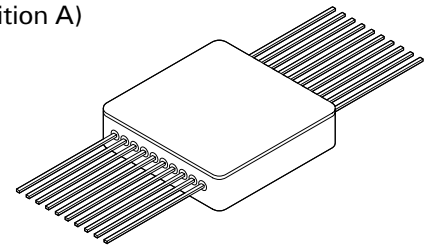
# 5901RH SERIES

M.S.KENNEDY CORP.

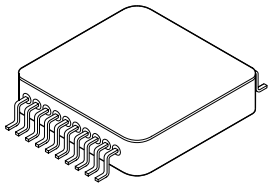
4707 Dey Road Liverpool, N.Y. 13088 (315) 701-6751

## *FEATURES:*

- Total Dose Tested to 50K RAD(Si) (Method 1019.7 Condition A)
- Internal Thermal Overload Protection
- Output Current to 1.5 Amps
- Output Voltage Internally Trimmed to ±1% Accuracy
- Lead Form Options: Straight and Gull Wing
- Alternate Voltage Combinations Available
- Contact MSK for MIL-PRF-38534 Qualification Status



**MSK590XRH**

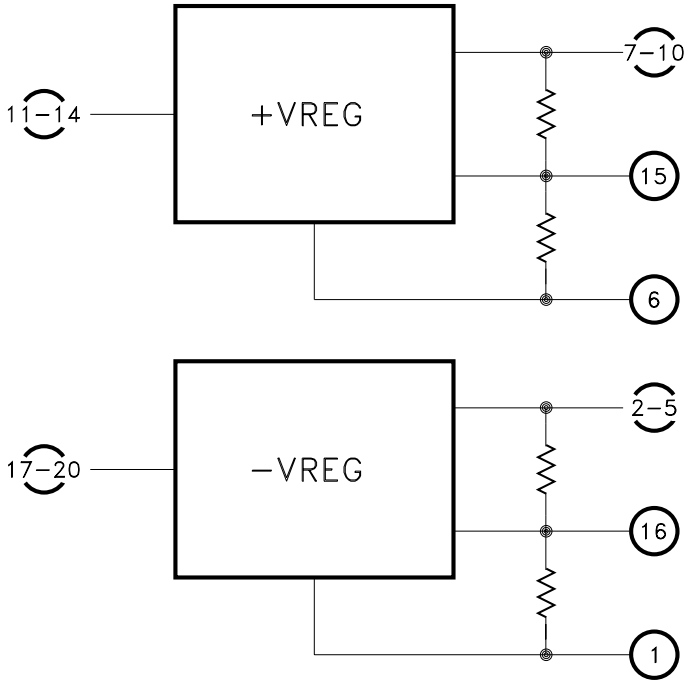


**MSK590XRHG**

## *DESCRIPTION:*

The MSK 5901RH series are dual Radiation Hardened +/- voltage regulators offering low dropout and output accuracy to ±1% maximum. Excellent line and load regulation characteristics ensure highly accurate performance. The MSK 5901RH series regulators are equipped with internal thermal overload protection. The devices are packaged in a space efficient 20 pin flatpack with two lead form options, straight and gull wing.

## EQUIVALENT SCHEMATIC




## TYPICAL APPLICATIONS

- Switching Power Supply Post Regulators
- Constant Voltage/Current Regulators
- High Efficiency Linear Regulators

## PIN-OUT INFORMATION

| | | | |
|---|---|---|---|
| 1 | -VRTN | 20 | -VIN |
| 2 | -VOUT | 19 | -VIN |
| 3 | -VOUT | 18 | -VIN |
| 4 | -VOUT | 17 | -VIN |
| 5 | -VOUT | 16 | -Ccomp |
| 6 | +VRTN | 15 | +Ccomp |
| 7 | +VOUT | 14 | +VIN |
| 8 | +VOUT | 13 | +VIN |
| 9 | +VOUT | 12 | +VIN |
| 10 | +VOUT | 11 | +VIN |

## ABSOLUTE MAXIMUM RATINGS ⑦

| | | | |
|---|---|---|---|
| $+V_{IN}$ | +Input Voltage ($V_{IN}$-$V_{OUT}$) . . . . . +40VDC | $T_{ST}$ | Storage Temperature Range . . . . -65°C to +150°C |
| $-V_{IN}$ | -Input Voltage ($V_{IN}$-$V_{OUT}$) . . . . . -40VDC | $T_{LD}$ | Lead Temperature Range . . . . . 300°C (10 Seconds) |
| $P_D$ | Power Dissipation . . . . . Internally Limited | $T_C$ | Case Operating Temperature |
| $+I_{OUT}$ | +Output Current . . . . . 1.5A | | MSK 5901RH-5909RH . . . . . -40°C to +85°C |
| $-I_{OUT}$ | -Output Current . . . . . 1.5A | | MSK 5901RH-5909RH(K/H/E) . . -55°C to +125°C |
| $T_J$ | Junction Temperature . . . . . +150°C | | |

## ELECTRICAL SPECIFICATIONS

| Parameter | Test Conditions ⑧ | Group A Subgroup ④ | MSK 590XRH K/H/E ③ Min. | Typ. | Max. | MSK 590XRH ② Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|---|---|
| **POSITIVE OUTPUT REGULATORS:** | | | | | | | | | |
| Output Voltage Tolerance | $I_{OUT}$=10mA; $V_{IN}$=$V_{OUT}$+3V | 1 | - | ±0.2 | ±1.0 | - | ±0.2 | ±1.5 | % |
| | | 2,3 | - | ±0.8 | ±3.0 | - | - | - | % |
| | Post Radiation | 1 | - | ±1.0 | ±2.7 | - | ±1.0 | ±3.0 | % |
| Dropout Voltage | $I_{OUT}$=0.5A; $\Delta V_{OUT}$=1% | 1 | - | 1.6 | 3.0 | - | 1.6 | 3.5 | V |
| | | 2,3 | - | 1.9 | 3.0 | - | - | - | V |
| Load Regulation | 10mA≤$I_{OUT}$≤0.5A | 1 | - | ±0.2 | ±2.0 | - | ±0.2 | ±2.5 | % |
| | $V_{IN}$=$V_{OUT}$+3V | 2,3 | - | ±0.4 | ±2.5 | - | - | - | % |
| | Post Radiation | 1 | - | ±1.0 | ±3.0 | - | ±1.0 | ±3.0 | % |
| Line Regulation | $I_{OUT}$=10mA | 1 | - | ±0.6 | ±1.5 | - | ±0.6 | ±2.0 | % |
| | $V_{OUT}$+3V≤$V_{IN}$≤35V | 2,3 | - | ±1.0 | ±2.5 | - | - | - | % |
| Thermal Resistance ① | JUNCTION TO CASE @ 125°C | - | - | 9.5 | 10.5 | - | 9.5 | 11.0 | °C/W |
| **NEGATIVE OUTPUT REGULATORS:** | | | | | | | | | |
| Output Voltage Tolerance | $I_{OUT}$=10mA; $V_{IN}$=$V_{OUT}$ -3V | 1 | - | ±0.2 | ±1.0 | - | ±0.2 | ±1.5 | % |
| | | 2,3 | - | ±0.8 | ±3.0 | - | - | - | % |
| | Post Radiation | 1 | - | ±1.5 | ±2.7 | - | ±1.5 | ±3.0 | % |
| Dropout Voltage | $I_{OUT}$=0.5A; $\Delta V_{OUT}$=1% | 1 | - | 1.9 | 3.0 | - | 1.9 | 3.0 | V |
| | | 2,3 | - | 1.5 | 3.0 | - | - | - | V |
| Load Regulation | 10mA≤$I_{OUT}$≤0.5A | 1 | - | ±0.2 | ±2.0 | - | ±0.2 | ±2.5 | % |
| | $V_{IN}$=$V_{OUT}$ -3V | 2,3 | - | ±0.4 | ±2.5 | - | - | - | % |
| | Post Radiation | 1 | - | ±1.5 | ±3.0 | - | ±1.5 | ±3.0 | % |
| Line Regulation | $I_{OUT}$=10mA | 1 | - | ±0.1 | ±1.5 | - | ±0.1 | ±2.0 | % |
| | -30V≤$V_{IN}$≤$V_{OUT}$-3V | 2,3 | - | ±0.2 | ±2.5 | - | - | - | % |
| Thermal Resistance ① | JUNCTION TO CASE @ 125°C | - | - | 11.5 | 12.5 | - | 11.5 | 13.0 | °C/W |

*NOTES:*

① Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only.
② Industrial grade and "E" suffix devices shall be tested to subgroup 1 unless otherwise specified.
③ Military grade devices shall be 100% tested to subgroups 1,2 and 3.
④ Subgroup 1 $T_A$=$T_C$=+25°C
Subgroup 2 $T_A$=$T_C$=+125°C
Subgroup 3 $T_A$=$T_C$=-55°C
⑤ Please consult the factory if alternate output voltages are required.
⑥ For positive regulator, output decoupled to ground using 1μF minimum tantalum capacitor unless otherwise specified. For negative regulator, output decoupled to ground using 1μF minimum tantanlum capacitor.
⑦ Continuous operation at or above absolute maximum ratings may adversly effect the device performance and/or life cycle.
⑧ Pre and post irradiation limits at 25°C, up to 25Krad TID, are identical unless otherwise specified.

| PART NUMBER ⑤ | OUTPUT VOLTAGES | |
|---|---|---|
| | POSITIVE | NEGATIVE |
| MSK5901 | 5.0 | 5.0 |
| MSK5902 | 5.0 | 5.2 |
| MSK5903 | 12.0 | 5.0 |
| MSK5904 | 12.0 | 12.0 |
| MSK5905 | 15.0 | 15.0 |
| MSK5906 | 15.0 | 5.0 |
| MSK5907 | 5.0 | 12.0 |
| MSK5908 | 5.0 | 15.0 |
| MSK5909 | 10.0 | 10.0 |

## APPLICATION NOTES

### CAPACITOR SELECTION

#### *POSITIVE REGULATOR*

INPUT CAPACITOR:

An input bypass capacitor is recommenced when using the MSK 5901 series regulators. This is especially true if the regulator is located farther than 6 inches from the power supply filter capacitors. For most applications a 1$\mu$F solid tantalum capacitor will be suitable.

OUTPUT CAPACITOR:

A minimum of a 1$\mu$F solid tantalum capacitor should also be used at the output to insure stability. Any increase of this output capacitor larger than 10$\mu$F will only improve output impedance.

+CCOMP CAPACITOR:

For improved ripple rejection, +Ccomp can be bypassed to ground with a 10$\mu$F tantalum capacitor. This bypass capacitor will provide 80dB ripple rejection. Increased capacitance above 10$\mu$F does not improve the ripple rejection at frequencies above 120Hz. If the Ccomp bypass capacitor is used, it may be necessary to add a protection diode to protect the regulator from capacitor discharge damage. See Typical Applications Circuit for clarification. If the bypass capacitor is not used, it should be left open since it is internally connected to the regulator.

#### *NEGATIVE REGULATOR*

INPUT CAPACITOR:

Once again, if the regulator will be farther than 6 inches from power supply filter capacitors, then an input capacitor will be required on the negative regulator. It is recommended that a 1$\mu$F solid tantalum capacitor be used.

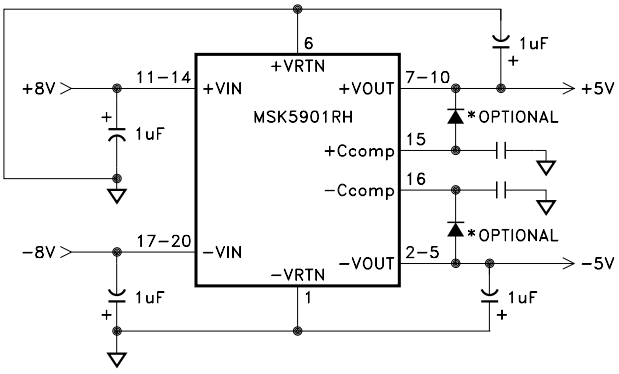
OUTPUT CAPACITOR:

A minimum of a 1$\mu$F solid tantalum capacitor should also be used at the output to insure stability. Any increase of this output capacitor larger than 10$\mu$F will only improve output impedance.

-CCOMP CAPACITOR:

For improved ripple rejection, -Ccomp can be bypassed to ground with a 10$\mu$F tantalum capacitor. This bypass capacitor will provide 80dB ripple rejection. Increased capacitance above 10$\mu$F does not improve the ripple rejection at frequencies above 120Hz. If the Ccomp bypass capacitor is used, it may be necessary to add a protection diode to protect the regulator from capacitor discharge damage. See Typical Applications Circuit for clarification. If the bypass capacitor is not used, it should be left open since it is internally connected to the regulator.

### TYPICAL APPLICATION CIRCUIT




### LOAD REGULATION

It is important to keep the output connection between the regulator and the load as short as possible since this directly affects the load regulation. For example, if 20 gauge wire were used which has a resistance of about 0.008 ohms per foot, this would result in a drop of 8mV/ft at 1Amp of load current. It is also important to follow the capacitor selection guidelines to achieve best performance.

### HEAT SINKING

To determine if a heat sink is required for your application and if so, what type, refer to the thermal model and governing equation below.

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
$T_c$ = Case Temperature
$T_a$ = Ambient Temperature
$T_s$ = Heat Sink Temperature

EXAMPLE:

This example demonstrates an analysis where the output currents are at 0.5 amp each and both inputs are 8V.

Conditions for MSK 5901RH:

+Vin = +8.0V; Iout = 0.5A Positive Regulator

1.) Assume 45° heat spreading model.
2.) Find positive regulator power dissipation:

$P_d = (V_{in} - V_{out})(I_{out})$
$P_d = (+8V-5V)(0.5A)$
$P_d = 1.5W$

3.) For conservative design, set $T_j$ = +125°C Max.
4.) For this example, worst case $T_a$ = +90°C.
5.) $R_{\theta jc}$ = 10.5°C/W from the Electrical Specification Table.
6.) $R_{\theta cs}$ = 0.15°C/W for most thermal greases.
7.) Rearrange governing equation to solve for $R_{\theta sa}$:

$R_{\theta sa}$ = ($(T_j - T_a)/P_d$) - ($R_{\theta jc}$) - ($R_{\theta cs}$)
= (125°C-90°C)/1.5W - 10.5°C/W - 0.15°C/W
= 12.7°C/W

The same exercise must be performed for the negative regulator.

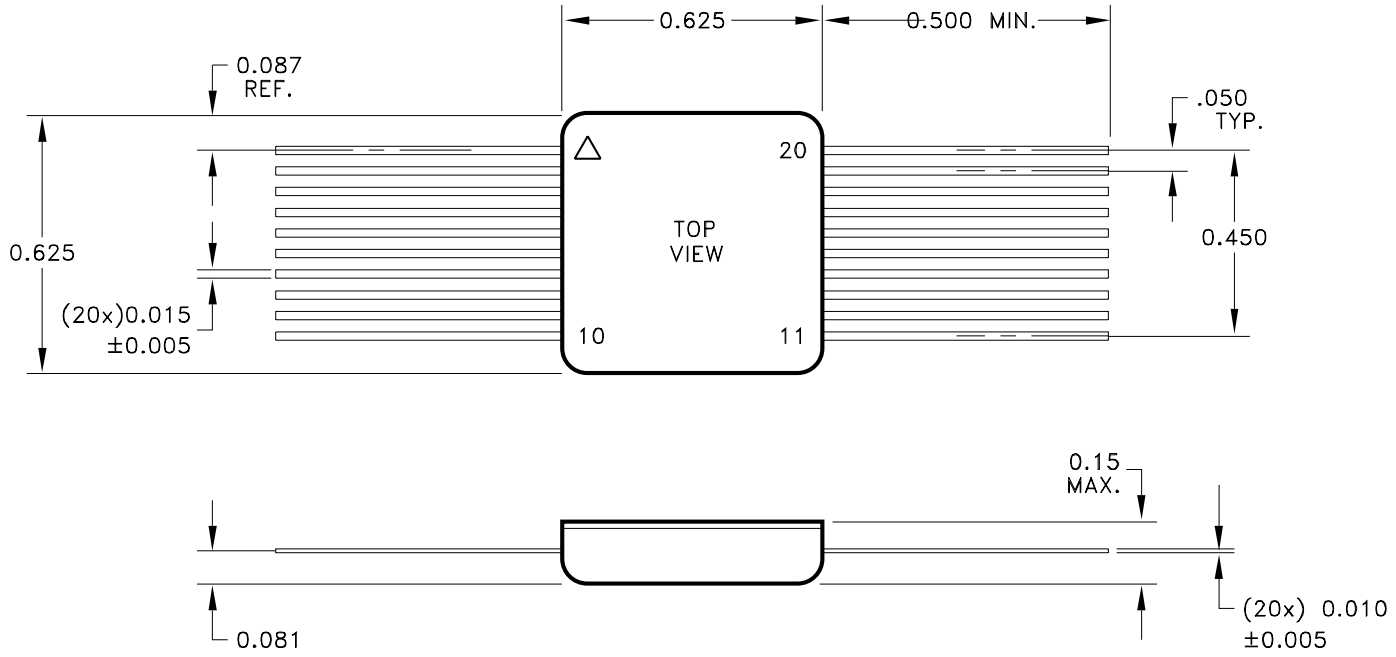
### *TOTAL DOSE RADIATION TEST PERFORMANCE*

Radiation performance curves for TID testing have been generated for all radiation testing performed by MS Kennedy. These curves show performance trends throughout the TID test process and can be located in the MSK 5901RH radiation test report. The complete radiation test report is available in the RAD HARD PRODUCTS section on the MSK website.

**http://www.mskennedy.com/store.asp?pid=9951&catid=19680**

## MECHANICAL SPECIFICATIONS

**MSK590XRH**




WEIGHT = 3.3 GRAMS TYPICAL

NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.
ESD Triangle indicates pin 1.

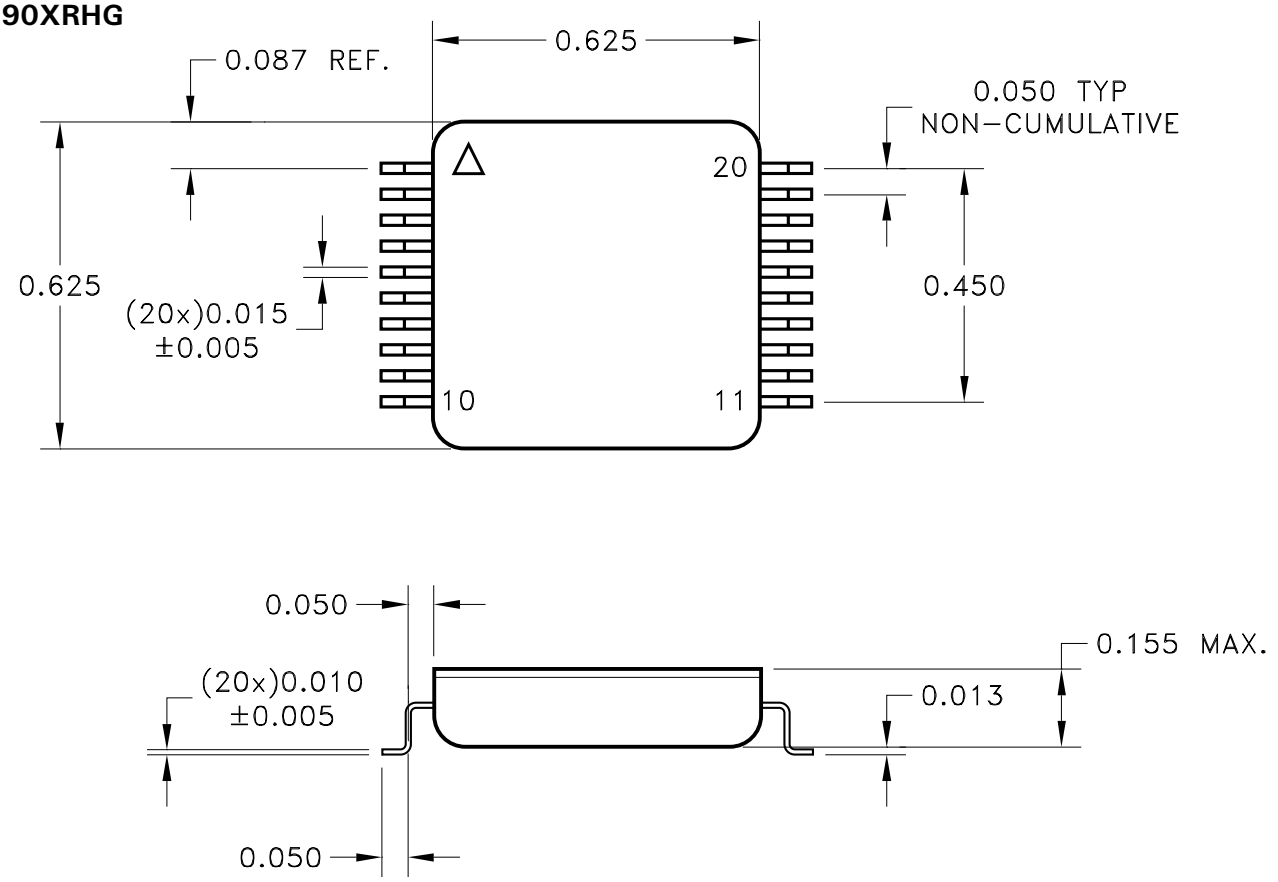
## *ORDERING INFORMATION*

| Part Number | Screening Level |
|---|---|
| MSK590XRH | Industrial |
| MSK590XHRH | MIL-PRF-38534 CLASS H |
| MSK590XKRH | MIL-PRF-38534 CLASS K |
| MSK590XERH | EXTENDED RELIABILITY |
| DSCC SMD TBD | TBD |

X - Designates voltage selection (MSK 5901-5909) See Page 2

## MECHANICAL SPECIFICATIONS CONTINUED

**MSK590XRHG**




WEIGHT = 3.3 GRAMS TYPICAL

NOTE: ALL DIMENSIONS ARE ±0.010 INCHES UNLESS OTHERWISE LABELED.
ESD Triangle indicates pin 1.

## *ORDERING INFORMATION*

| Part Number | Screening Level |
|---|---|
| MSK590XRHG | Industrial |
| MSK590XHRHG | MIL-PRF-38534 CLASS H |
| MSK590XKRHG | MIL-PRF-38534 CLASS K |
| MSK590XERHG | EXTENDED RELIABILITY |
| DSCC SMD TBD | TBD |

X - Designates voltage selection (MSK 5901-5909) See Page 2

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