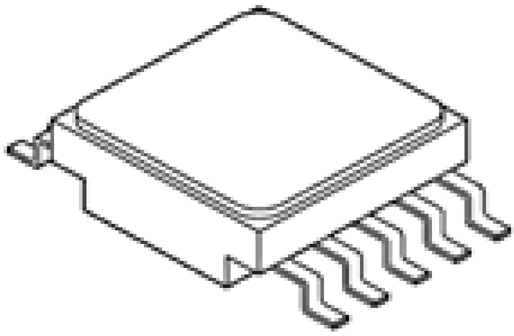
# RAD HARD POSITIVE 0.9A, LOW NOISE, LDO ADJ VOLTAGE REGULATOR

## FEATURES

- Low Dropout of 250mV at 0.5A
- Output Adjustable from 1.2V to 19.5V
- Internal Short Circuit Current Limit
- Low Noise: 40uVRMS (10Hz to 100kHz)
- Output Current Capability < 0.9A
- Internal Thermal Overload Protection
- Shutdown Pin Active Low
- Available in Gull Wing Lead Form
- TID Hardened to 100 Krads
- Comparable to MSK5965HR



## DESCRIPTION

The JTR5965 is a low dropout adjustable linear regulator that is radiation resistant. This device has a low noise output voltage range of 1.2V to 19.5V that may be adjusted. With a 0.5A load, the dropout voltage is generally 250mV. This, combined with the low $R_{\theta JC}$, allows increasing of output current while providing exceptional device efficiency. Furthermore, the JTR5965 has integrated short circuit current and thermal protection, which protects the circuit and reduces the need for unnecessary derating. The shutdown pin allows you to sequence the power supply while using only a few additional components. The JTR5965 is a hermetically sealed 10 pin flatpack with gull wing leads intended particularly for space/satellite applications.

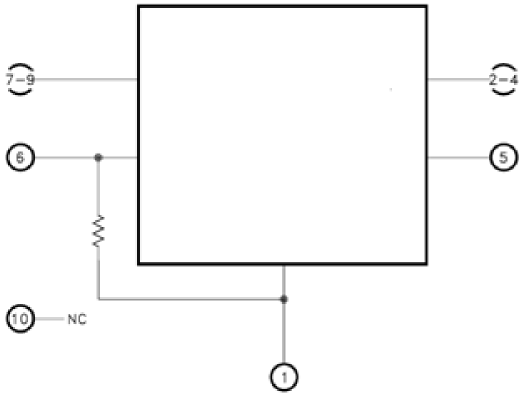
Table 1. Pin description.

| PIN | NAME | PIN | NAME |
|---|---|---|---|
| 1 | GND | 6 | NC |
| 2 | VOUT | 7 | VIN |
| 3 | VOUT | 8 | VIN |
| 4 | VOUT | 9 | VIN |
| 5 | ADJ | 10 | SHDN |
| CASE=ISOLATED | | | |

## TYPICAL APPLICATIONS

- High Efficiency Linear Regulators
- Constant Voltage/Current Regulators
- Space System Power Supplies
- Switching Power Supply Post Regulators
- Very low Voltage Power Supplies
- Low Noise Instrumentation

## EQUIVALENT SCHEMATIC




## ELECTRICAL SPECIFICATIONS

**Table 2. Electrical specifications**

| Parameter | SYM | TEST CONDITION | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $V_{IN}$ | $V_{IN}$ | | 2.3 | - | 21.5 | V |
| Output Voltage Tolerance | $S_T$ | $I_{OUT}$=250mA; $V_{IN}=V_{OUT}+1V$ | - | - | ±2.5 | % |
| Adjustable Pin Voltage | $V_{ADJ}$ | $V_{IN}$=2.3 V, $V_{OUT}=V_{ADJ}$ | 1.16 | | 1.23 | V |
| Ripple Rejection | PSRR | F=120Hz, I. OUT=50mA | 65 | - | - | dB |
| On Resistance | $R_{DS(ON)}$ | $I_{OUT}$=0.5A, $V_{EN}$=5.0 V, $V_{OUT}$=3.3 V | - | - | 200 | mΩ |
| Dropout Voltage | $V_{DROP}$ | $I_{OUT}$ = 0.5A, $V_{OUT}$=3.3 V | - | 0,35 | 0.42 | V |
| Soft Start Time | $T_{SS}$ | | - | 0.27 | - | ms |
| SHDN Pin Logic High Threshold Voltage | $V_{ENL}$ | Disable | 1.0 | - | - | V |
| | $V_{ENH}$ | Enable | - | - | 1.6 | |
| SHDN Pin Pull-Up Current | $I_{EN}$ | SHDN=5V | - | - | 224 | uA |
| | | SHDN=GND | - | - | 19 | |
| Thermal Shutdown Threshold | $T_{SD}$ | | - | 135 | - | °C |
| Quiescent Current | $I_Q$ | No Load | - | 11 | 23 | mA |
| | | Full Load | - | 45 | 55 | |

## APPLICATION NOTES

### PIN FUNCTIONS

**VIN -** The VIN pins are the internal circuitry's input supply pins. To offer a low impedance supply, decoupling capacitors are recommended. For effective operation, all three pins must be connected.

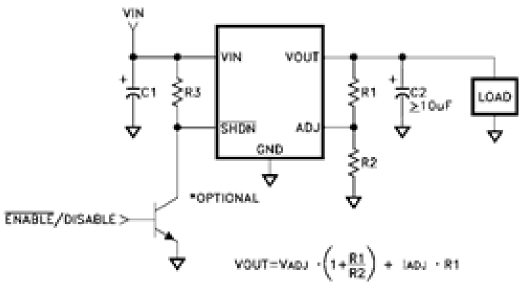
**GND -** For optimal control, connect the bottom of the output voltage feedback divider directly to GND. Outside of the primary power return line, connect the GND pin to the load ground trace.

**VOUT -** The power to the load is supplied through the VOUT pins. A 10F capacitor with an ESR of less than 1 Ω on the output is usually sufficient to maintain stability. To decrease output voltage transients in applications with high output load transients, a higher output capacitor value is required. For effective operation, all VOUT pins must be connected.

**ADJ -** The Adjust pin is the error amplifier's input. Connect to the output voltage feedback divider's center. The ADJ pin value is 1.2V when compared to GND. It typically has a bias current of 1.3A flowing into the pin.

**SHDN -** When the SHDN pin is pulled low, the device enters a low-power mode and the output is turned off. Use logic or an open collector/drain with a pull-up resistor to drive the SHDN pin. Connect the SHDN pin to VIN if it is not already connected. Unless it is connected to the VIN pin, the SHDN pin cannot be driven below GND. The output will turn on if the SHDN pin is driven below GND while VIN is powered. A negative supply rail cannot be addressed by SHDN pin logic.

### TYPICAL APPLICATION CIRCUIT




### OUTPUT VOLTAGE SELECTION

As noted in the above typical applications circuit, the formula for output voltage selection is:

$$V_{OUT} = V_{ADJ} \times \left[1 + \frac{R1}{R2}\right] + I_{ADJ} \times R1$$

### OVERLOAD RECOVERY

The JTR5965, like many IC power regulators, includes safe operating area protection. The safe operating area protection reduces the current limit as the input-to-output voltage grows and keeps the power transistor within a safe operating range for all input-to-output voltage values. Up to the device's breakdown, the protective design supplies some output current at all input-to-output voltage levels. When power is first supplied, the output follows the input voltage as it climbs, allowing the regulator to start up into very heavy loads. Up to the device's breakdown, the protective design supplies some output current at all input-to-output voltage levels. When power is first supplied, the output follows the input voltage as it climbs, allowing the regulator to start up into very heavy loads. With a high input voltage, it is possible that removing an output short will not allow the output to recover. This behavior is shared by other regulators, such as the LT1083/LT1084/LT1085 family, and is not specific to the JTR5965. When the input voltage is high and the output voltage is low, the problem comes with a heavy output load. Common scenarios occur immediately after a short-circuit is removed or when the shutdown pin is pulled high after the input voltage has already been switched on. At two locations, the load line for such a load may intersect the output current curve. If this occurs, the regulator has two stable output operating points. Because of this double intersection, the input power supply may need to be cycled down to zero and then back up to allow the output to recover.

### HEAT SINK SELECTION

To select a heat sink for the JTR5965, the following formula for convective heat flow may be used.

*Governing Equation:* TJ = PD x (RθJC + RθCS + RθSA) + TA

WHERE
TJ = Junction Temperature
PD = Total Power Dissipation
RθJC = Junction to Case Thermal Resistance
RθCS = Case to Heat Sink Thermal Resistance
RθSA = Heat Sink to Ambient Thermal Resistance
TA = Ambient Temperature

Power Dissipation = (VIN-VOUT) x IOUT + (IGND x VIN)

The user must then choose a maximum junction temperature. The highest permissible junction temperature is 150°C. The equation may now be rewritten to calculate the needed heat sink to ambient thermal resistance (RθSA).

### *EXAMPLE:*

For VIN = +5V and VOUT = +3.3V, an JTR5965 is attached. IOUT is a constant 0.5A DC level, while IGND is 20mA. The temperature outside is +25°C. The highest junction temperature desired is +125°C.

Power Dissipation = (5V-3.3V) (0.5A) + (0.02A x 5V)=0.95Watts

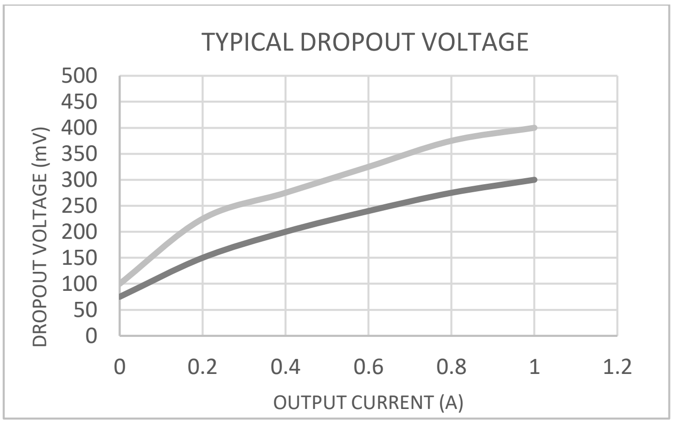
RθJC = 12.08°C/W and RθCS = 0.15°C/W for a most thermal grease.

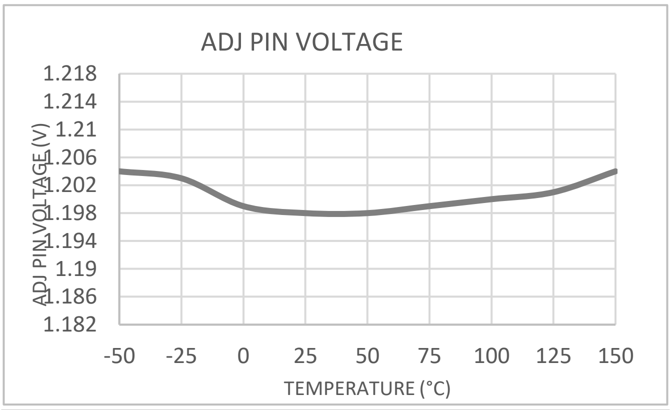
Solve for RθSA:

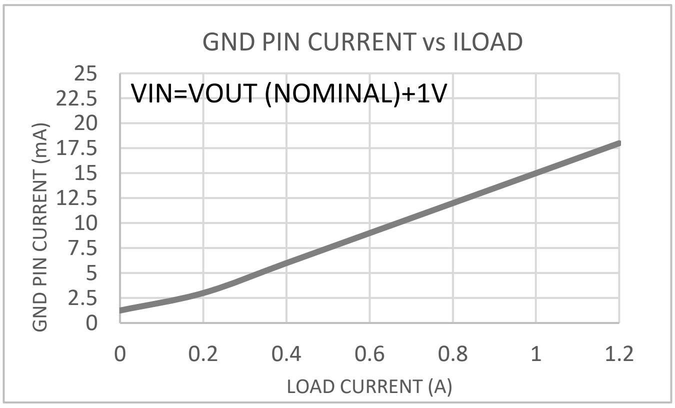
$$\left[\frac{125°C - 25°C}{0.95W}\right] - 12.08°C/W - 0.15°C/W = 93.3°C/W$$

In this case, a heat sink with a thermal resistance of no more than .
93.0°C/W is required to keep the junction temperature below 125°C.

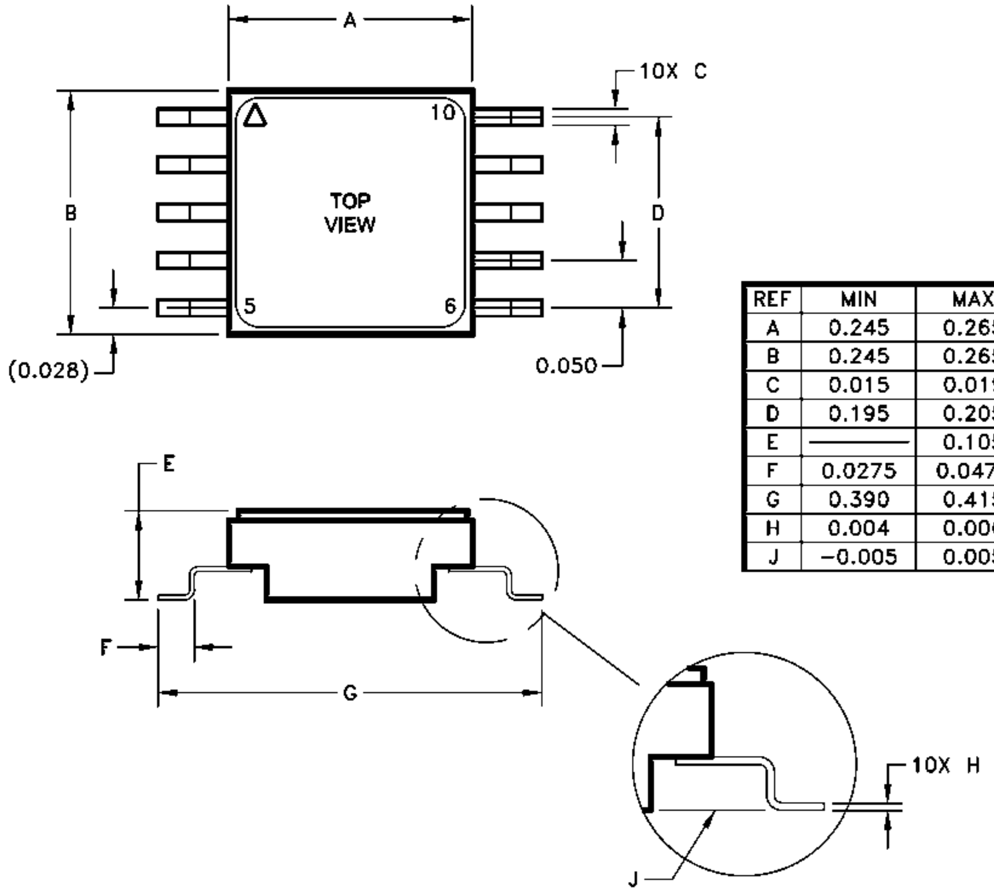
## TYPICAL PERFORMANCE CURVES



## MECHANICAL SPECIFICATION




| REF | MIN | MAX |
|---|---|---|
| A | 0.245 | 0.265 |
| B | 0.245 | 0.265 |
| C | 0.015 | 0.019 |
| D | 0.195 | 0.205 |
| E | ———— | 0.105 |
| F | 0.0275 | 0.0475 |
| G | 0.390 | 0.415 |
| H | 0.004 | 0.006 |
| J | −0.005 | 0.005 |

ESD TRIANGLE INDICATES PIN 1
WEIGHT=0.35 GRAMS TYPICAL

ALL DIMENSIONS ARE SPECIFIED IN INCHES