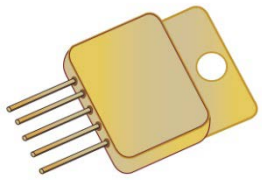
# 3 Amp & 5 Amp ULDO REGULATORS
# MHL8601 / MHL8605 Series
**(Formerly SAT8601 / SAT8605 Series)**
**(Consult Table 4 for Part Number Designations)**

*Levels Available*
***COTS***
***MILITARY***
***SPACE***

## DESCRIPTION

The MHL Series are space qualified, ultra low dropout linear regulators designed for military and space flight applications. Assembled in a hermetic MO-078 package, this series provides an ultra low drop out voltage of 400mV @ 3A, or 500mV at 5A. They are optimized for operation at a +5V input or a +3.3V input. All components are de-rated per internal requirements.

**Important:** For the latest information, visit our website http://www.microsemi.com.



**MO-078 PACKAGE**

## FEATURES

- Rad-Tolerant to 300K rad TID (Note 9)
- Ultra Low Dropout Voltage – 400mV @ 3.0A
- Space-Level screening available
- Shutdown pin for output control
- Thermal Shutdown @ 150°C
- Optimized for operation at an input voltage of 3.3V or 5V
- Available in fixed or adjustable output versions

## APPLICATIONS / BENEFITS

- Ultra low dropout voltages lead to lower losses.
- Some models run from a 3.3V input.

## Table 1 – ABSOLUTE MAXIMUM RATINGS (*Tc = +25°C unless otherwise note*)
## *(Exceeding maximum ratings may damage the device)*

| Parameters / Test Conditions | Symbol | Value | | Unit |
|---|---|---|---|---|
| | | (3A Version) | (5A Version) | |
| DC input Voltage Vin-Vground | $V_{in}$ | 10.0 | 10.0 | V |
| Output Current | $I_o$ | 3.3 | 5.5 | A |
| Power Dissipation Tcase = 25°C | $P_d$ | 25 | 25 | W |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 3.0 | 3.0 | °C/W |
| Storage Temperature | $T_{stg}$ | -65 to +150 | -65 to +150 | °C |
| Operating Temperature Range | $T_j$ | -55 to +125 | -55 to +125 | °C |
| Maximum Soldering Temperature, 10 sec. | $T_{solder}$ | 300 | 300 | °C |

## MECHANICAL and PACKAGING

- See Figure 5 for packaging information

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**Table 2 – ELECTRICAL CHARACTERISTICS**
***($T_A$ = -55°C to +125°C unless otherwise noted) (Nominal reference voltage is 1.265V @ 25°C)***

| Parameters / Test Conditions | Symbol | (3A Version) | | | (5A Version) | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ | Max. | Min. | Typ | Max. | |
| Output Voltage Accuracy, Adjustable Units<br>Vin = 3.3V or 5V as appropriate (Note 4)<br>Vo = Vref, Io = 1A | Vout | 1.24 | 1.265 | 1.29 | 1.24 | 1.265 | 1.29 | V |
| Output Voltage Accuracy, Fixed Voltage Units (Note 4)<br>Io = 1A | Vout | -3 | | +3 | -3 | | +3 | % |
| Input Voltage Range: +3.3V Versions (Note 4)<br>Iout = 2A or 4A as appropriate, $\Delta$Vo $\leq$ 2% | Vin (+3.3) | 2.9 | | 3.6 | 3.0 | | 3.6 | V |
| Input Voltage Range: +5.0V Versions (Note 4)<br>Iout = 2A or 4A as appropriate, $\Delta$Vo $\leq$ 2% | Vin (+5.0) | 4.5 | | 5.5 | 4.5 | | 5.5 | V |
| Dropout Voltage (Note 2)<br>Iout = 3.0A, Vout $\geq$ +2.5V | Vdrop | | | 0.40 | N/A | | | V |
| Dropout Voltage (Note 2)<br>Iout = 5.0A, Vout $\geq$ +2.5V | Vdrop | N/A | | | | | 0.5 | V |
| Current Limit $T_C$ = 25°C<br>Vout = 2.5V or Vfixed as appropriate<br>Vin = 3.3V or 5V as appropriate | Ilatch | 3.3 | | | 5.5 | | | A |
| Ripple Rejection<br>Vin = 3.3V or 5V as appropriate (Note 6)<br>Vr = 500mVpp; 1KHz < f < 10kHz, Iout = 100mA | PSRR | | | -20 | | | -20 | dB |
| Shutdown Input threshold (Note 1)<br>Vout < 0.5V, Vin = 3.3 or 5V as appropriate | Vshdn | 1.0 | | 1.6 | 1.0 | | 1.6 | V |

## Table 3 – POST-RADIATION (Notes 3, 9) $T_A$ = 25°C

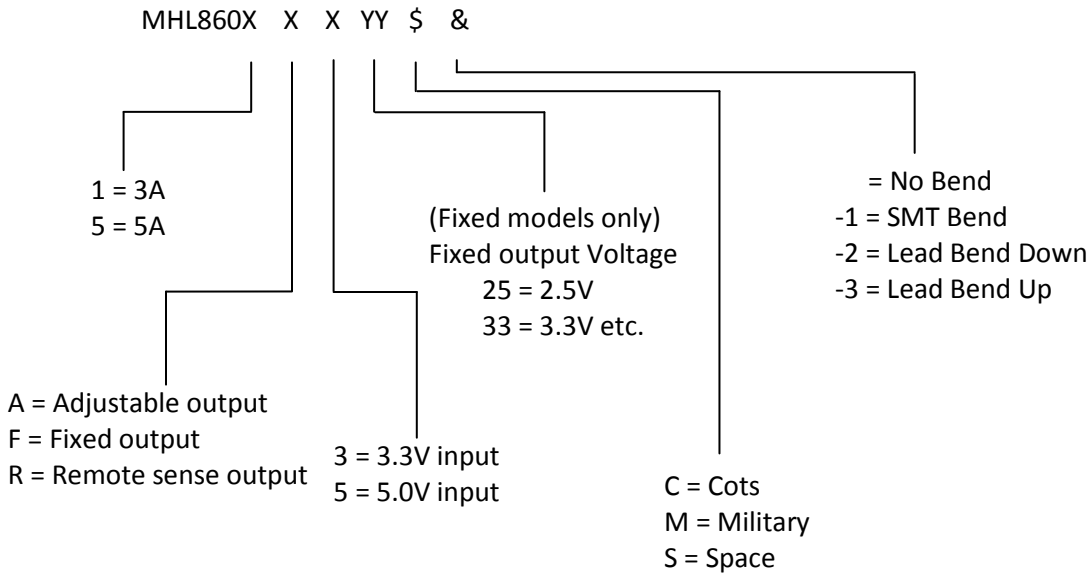
| Parameters / Test Conditions | Symbol | (3A Version) | | | (5A Version) | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ | Max. | Min. | Typ | Max. | |
| Output Voltage Accuracy (Note 4, 5)<br>Vin = 3.3V or 5V as appropriate<br>Vo = Vref, Io = 1A | Vout | -100 | ±25 | +100 | -100 | ±25 | +100 | mV |
| Output Voltage Accuracy, Fixed Voltage Versions<br>Io = 1A (Note 4, 5) | Vout | -8.0 | ±6.6 | +8.0 | -8.0 | ±6.6 | +8.0 | % |
| Input Voltage Range: +3.3V Versions (Note 4)<br>Iout = 2A or 4A as appropriate, ΔVo ≤ 2% | Vin (+3.3) | 2.9 | | 3.6 | 3.0 | | 3.6 | V |
| Input Voltage Range: +5.0V Versions (Note 4)<br>Iout = 2A or 4A as appropriate, ΔVo ≤ 2% | Vin (+5.0) | 4.5 | | 5.5 | 4.5 | | 5.5 | V |
| Dropout Voltage (Note 2)<br>Iout = 3.0A, Vout ≥ +2.5V | Vdrop | | | 0.40 | N/A | | | V |
| Dropout Voltage (Note 2)<br>Iout = 5.0A, Vout ≥ +2.5V | Vdrop | N/A | | | | | 0.50 | V |
| Current Limit $T_C$ = 25°C<br>Vout = 2.5V or Vfixed as appropriate<br>Vin = 3.3V or 5V as appropriate | Ilatch | 3.3 | | | 5.5 | | | A |
| Shutdown Input threshold (Note 1)<br>Vout < 0.5V, Vin = 3.3V or 5V as appropriate | Vshdn | 1.0 | | 1.6 | 1.0 | | 1.6 | V |

## Table 4 – PART NUMBER FUNCTIONAL CHART

| ADJUSTABLE OUTPUT VOLTAGE PART NUMBERS | Input Voltage | Iout Range | Vout Range |
|---|---|---|---|
| MHL8601A3$& | 3.3V | 0 – 3A | 1.265 – 2.5V |
| MHL8605A3$& | 3.3V | 0 – 5A | 1.265 – 2.5V |
| MHL8601A5$& | 5V | 0 – 3A | 1.265 – 4.0V |
| MHL8605A5$& | 5V | 0 – 5A | 1.265 – 4.0V |

| Examples of Part Numbers with Fixed Output Voltages * | Input Voltage | Iout Range | Vout |
|---|---|---|---|
| MHL8601F325$& | 3.3 V | 0 – 3 A | 2.5 V |
| MHL8605F320$& | 3.3 V | 0 – 5 A | 2.0 V |
| MHL8601F530$& | 5.0 V | 0 – 3 A | 3.0 V |
| MHL8605F533$& | 5.0 V | 0 – 5 A | 3.3 V |

* Replace the “F” with an “R” for remote sense versions.



## Table 5 – SCREENING OPTIONS

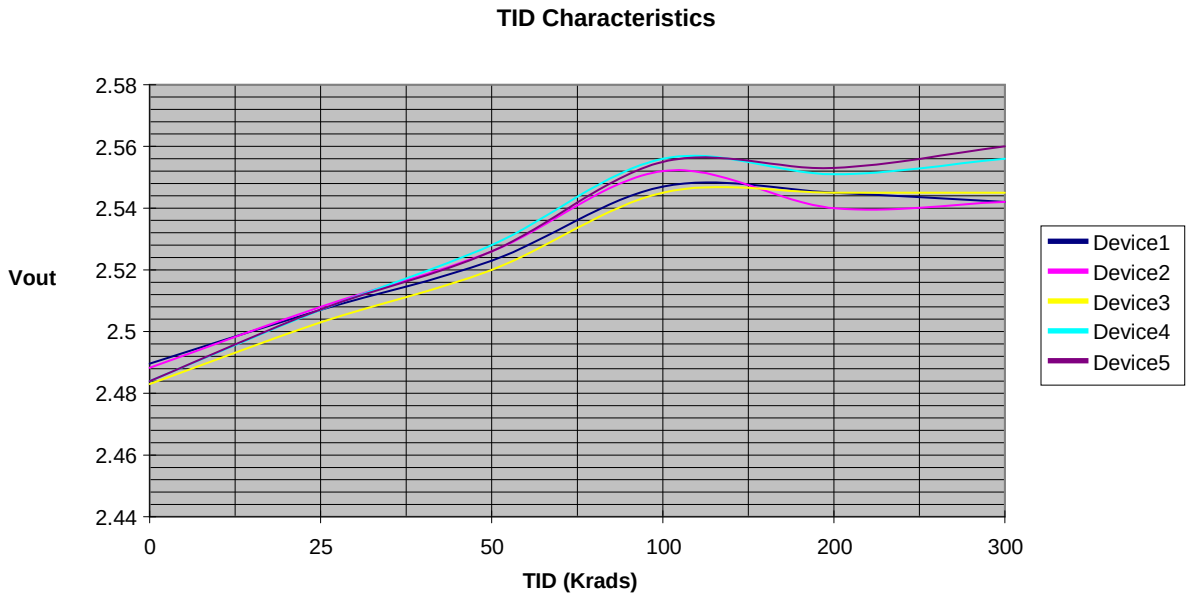
| TESTS | SCREENING LEVELS | | | MIL-STD-883 METHOD |
|---|---|---|---|---|
| | Commercial | MILITARY | SPACE | |
| | COTS | MIL-PRF-38534 Ceritified | | |
| Element Evaluation | N/A | | | Note 7 |
| Non-Destruct Wirebond Pull | N/A | Sample | 100% | 2023 |
| Pre-Cap Visual | N/A | 100% | 100% | 2017 |
| Temperature Cycle | N/A | 100% | 100% | 1010 |
| Constant Acceleration | N/A | 100% | 100% | 2001 |
| PIND | N/A | N/A | 100% | 2020 |
| Pre-Burn-In Electrical | N/A | 100% | 100% | |
| Burn-In | N/A | 100% (160 hours) | 100% (320 hours) | 1015 |
| Final Electrical Tests | 100% (25°C) | 100% | 100% | Note 7 |
| Hermeticity (Fine & Gross Leak) | 100% | 100% | 100% | 1014 |
| X-Ray (Note 8) | N/A | N/A | YES | 2012 |
| External Visual | Sample | 100% | 100% | 2009 |
| Certified | N/A | YES | YES | |

**NOTES:**

1. Shutdown pin voltage must be > 2.0V to initiate output inhibit. Pin should be grounded if not used. Pin input voltage can exceed supply voltage, but not greater than 10V above GND pin.
2. Actual voltage dropout is affected by device operating point. Minimum operating input voltage is 2.9V. As a result, the dropout specification applies to output voltage of 2.5V and higher, and the model numbers specifically designed to operate at these output voltage levels, 3.3V input voltage product only.
3. Radiation testing is per MIL-STD-883, Method 1019.
4. These regulators are optimized for specific Input Voltage ranges. The 860xx3 will have peak performance at +3.0V to +3.6V. The 860xx5 will have peak performance at +4.5V to +5.5V. Input voltages outside of this range can affect short-circuit current, load current capability and create electrical overstress to internal components.
5. Typical post 100K Rad ELDRS radiation performance in the powered mode is < +/-5%. Typical unpowered performance is ±6.6%.
6. Guaranteed by design.
7. Per MIL-PRF-38534.
8. Performed at a DLA approved facility.
9. Certified to Appendix G of MIL-PRF-38534 for Radiation Hardness Assurance (RHA) requirements for Hybrid Microcircuits and Multichip Modules effective June 27, 2013. (See RHA Test Laboratory Suitability)

## RADIATION CHANGES

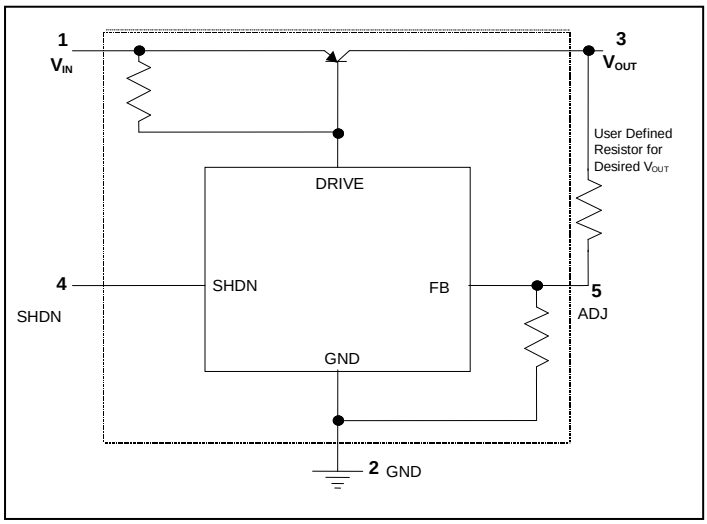
**Figure 1 – Typical Radiation Characteristics – Vout**



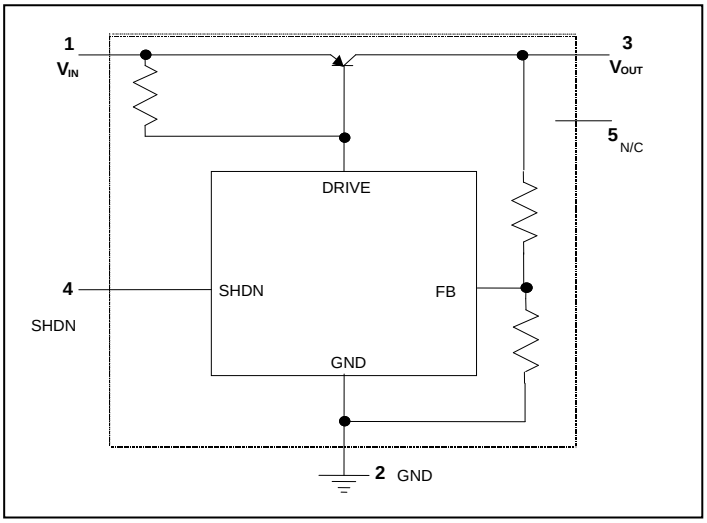
## BLOCK DIAGRAMS

**Figure 2 - External connections for the various versions.**

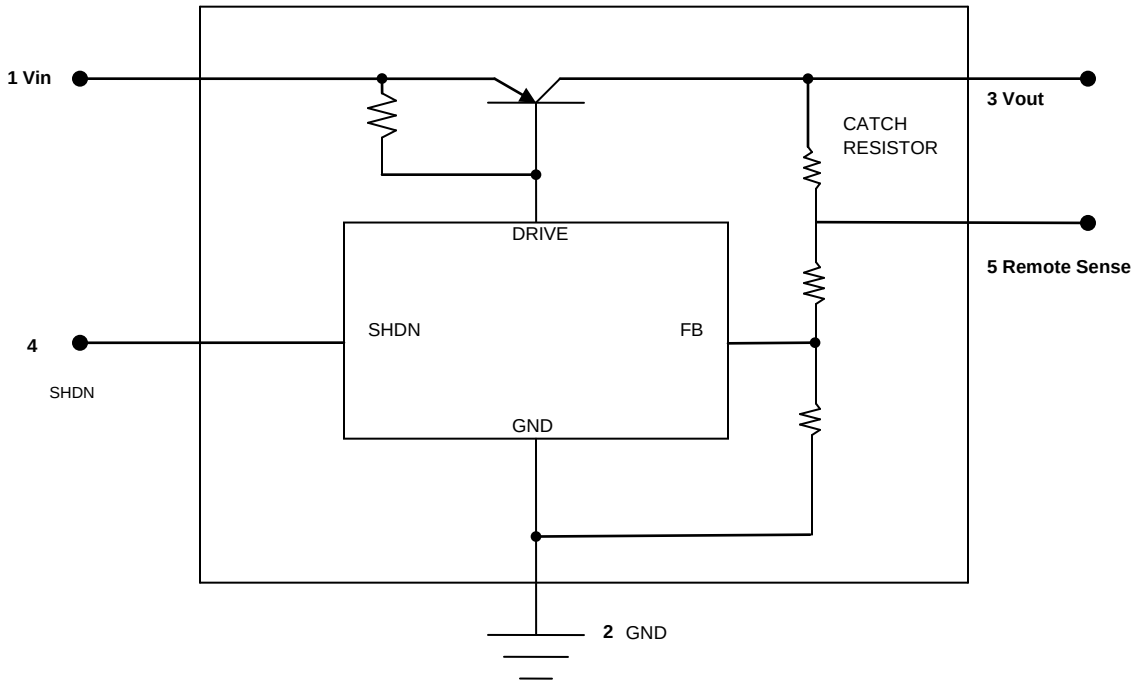
### Adjustable Version




### Fixed Output Version

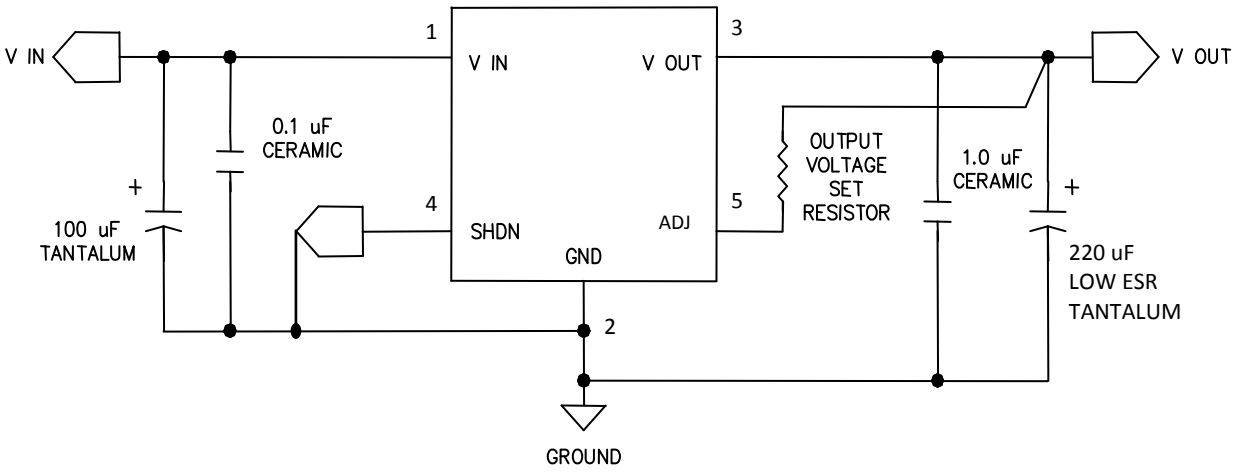



### Remote Sense Version



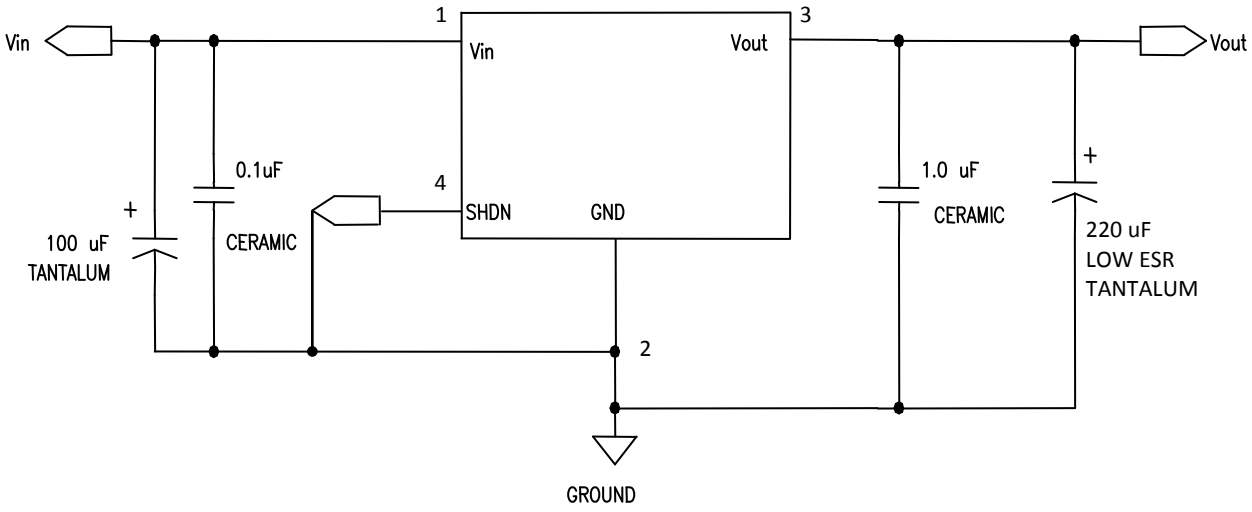
## APPLICATIONS

**Figure 3 – Application Circuit, Adjustable Output Circuit**




$V_{out} = V_{ref}$ x $(1+R_{adj}/1000)$, with Vref~1.265 Volts

**Figure 4 – Fixed Output 3/5 Amp Regulator**



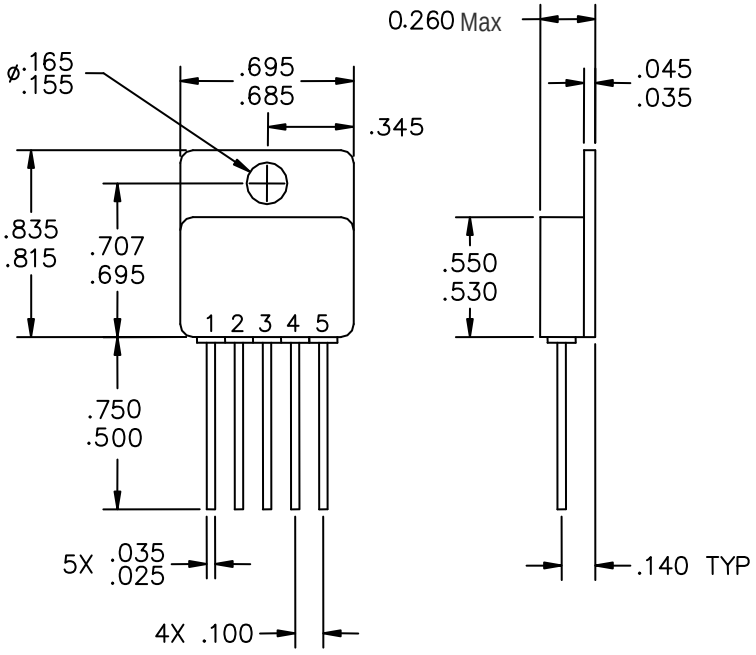
## PACKAGING AND PIN CONNECTIONS

**Figure 5 – Available Package Outlines**

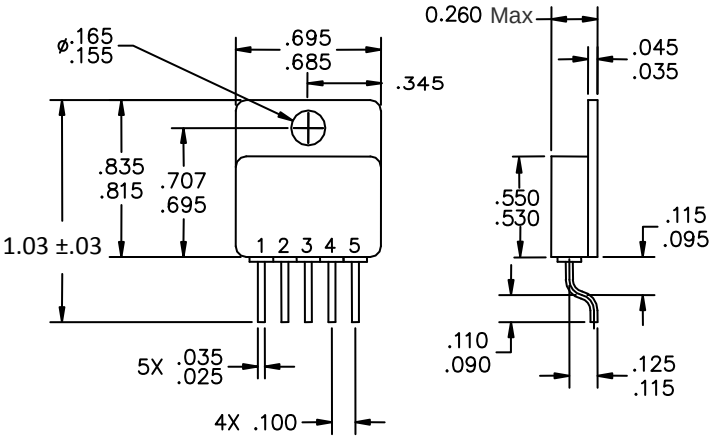
**Pin Assignments Table**

| Pin # | Pin Name | Pin Description |
|---|---|---|
| 1 | Vin | Input Voltage |
| 2 | Gnd | Ground |
| 3 | Vout | Output Voltage |
| 4 | Shdn | Shutdown Pin. Output reset occurs when Vshdn > 1.6V |
| 5 | Adjust / N/C / Sense | Adjust pin for Adjustable Output, Not connected for fixed version. Load sense for remote sense versions. |

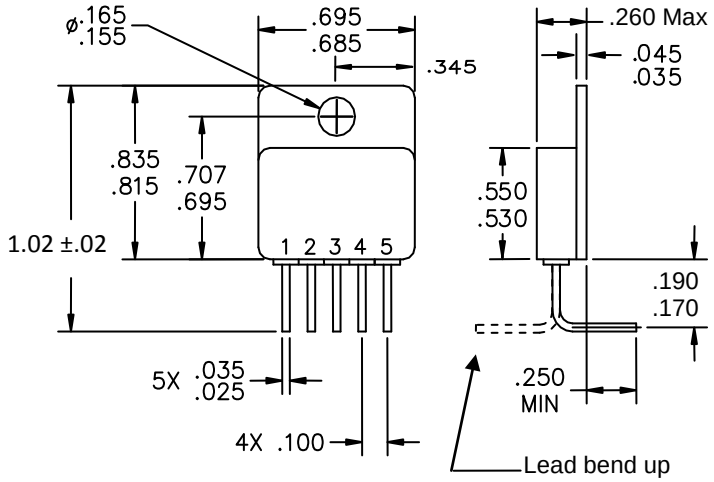
**Straight Lead**




**Surface Mount Outline – 1**




**Right Angle Down Outline – 2 = Down -3 = Up**




Dimensions are in inches
Tolerances .xxx = ±.005”
.xx = ±.01”