# GM7230

**150KHz, 3A STEP DOWN VOLTAGE SWITCHING REGULATORS**

## Description

GM7230 series is designed to provide all the active function for a step-down (buck) switching regulator, and drives a maximum load current as high as 3A line and load regulations. GM7230 is available in fixed output voltages of 3.3V, 5V, and a versatile Adjustable output version.

These regulators are simple to use and require minimum number of external components. The features include internal frequency compensation and a fixed-frequency oscillator.

The GM7230 is high-efficiency replacements for popular three-terminal linear regulators, and is requiring a smaller heat sink or even no need heat sink.

GM7230 performs well with standard inductors from most of manufacturers, and simplifying the design of switch-mode power supplies. External shutdown is included with 80 µA (typical) standby current. The output switch has cycle-by-cycle current limiting as well as thermal shutdown for full protection under fault conditions.

GM7230 operates at a switching frequency of 150 kHz which allowing smaller size filter components than what would be needed with lower frequency switching regulators.

GM7230 series are available in a standard 5-lead TO-220, TO220B and TO263 packages.

## Features

- **3.3V, 5V, 12Vand Adjustable output versions**
- **Adjustable version output voltage range 1.23V to 37V**
- **$V_{OUT}$ accuracy is to ±2% under specified input voltage the output load conditions**
- **Input voltage range up to 40V**
- **Requires only 4 external components with High efficiency**
- **TTL shutdown capability, low power standby mode**
- **Built-in thermal shutdown, current limit protection**
- **Uses standard inductors**
- **150 kHz fixed frequency internal oscillator**

## Application

**Pre-regulator for linear regulators**

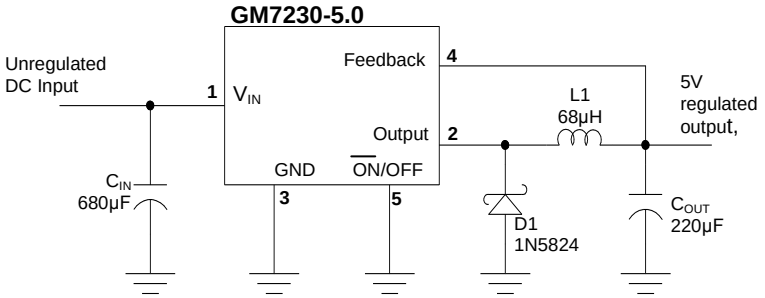
**High-efficiency step-down buck regulator**

**On-card/board switching regulators**

**Positive to negative converter (buck-boost)**

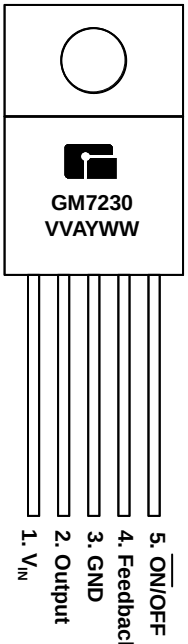
**LCD Monitors**

## Typical Application Circuits

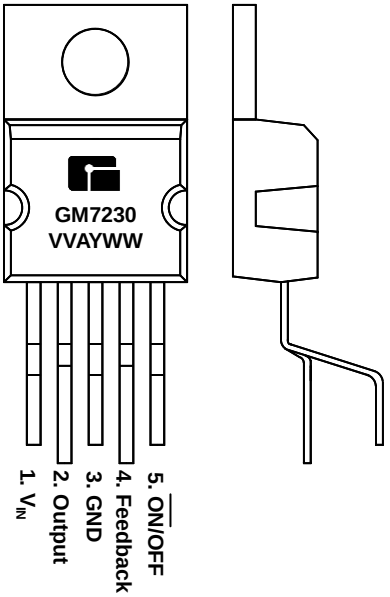


## Marking Information and Pin Configurations (Top View)

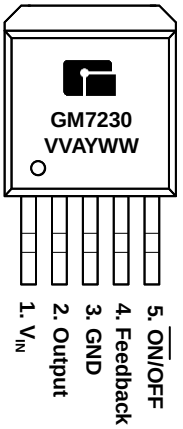
**TO-220-5**




**TO-220B-5**



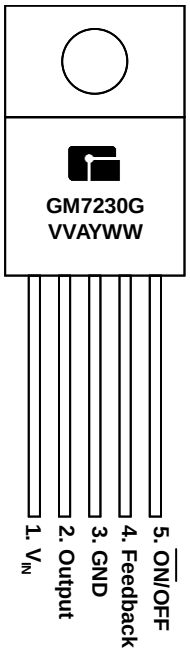

**TO-263-5**



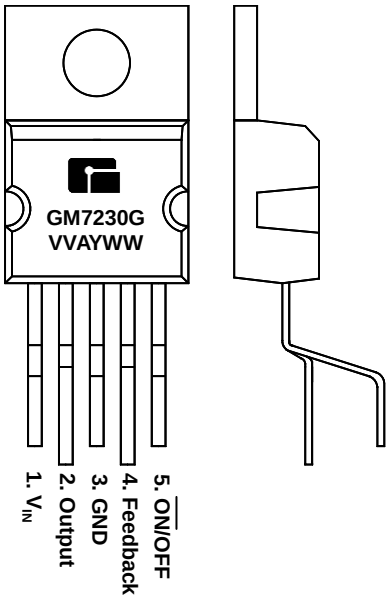

G: Green Product
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

## Marking Information and Pin Configurations – Green Products (Top View)

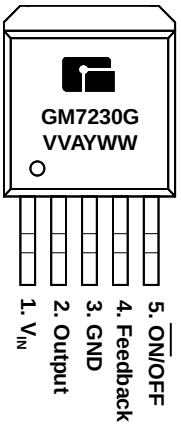
**TO-220-5**




**TO-220B-5**




**TO-263-5**




G: Green Product
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

## Ordering Information – Pb Free Products

| Ordering Number | Output Voltage | Package | Shipping |
|---|---|---|---|
| GM7230-ATA5T | Adj | TO-263-5 | 50 Units / Tube |
| GM7230-ATA5R | | TO-263-5 | 800 Units / Reel |
| GM7230-ATB5T | | TO-220-5 | 50 Units / Tube |
| GM7230-ATB5BT | | TO-220-5B | 50 Units / Tube |
| GM7230-3.3TA5T | 3.3 | TO-263-5 | 50 Units / Tube |
| GM7230-3.3TA5R | | TO-263-5 | 800 Units / Reel |
| GM7230-3.3TB5T | | TO-220-5 | 50 Units / Tube |
| GM7230-3.3TB5BT | | TO-220-5B | 50 Units / Tube |
| GM7230-5.0TA5T | 5.0 | TO-263-5 | 50 Units / Tube |
| GM7230-5.0TA5R | | TO-263-5 | 800 Units / Reel |
| GM7230-5.0TB5T | | TO-220-5 | 50 Units / Tube |
| GM7230-12TB5BT | | TO-220-5B | 50 Units / Tube |
| GM7230-12TA5T | 12 | TO-263-5 | 50 Units / Tube |
| GM7230-12TA5R | | TO-263-5 | 800 Units / Reel |
| GM7230-12TB5T | | TO-220-5 | 50 Units / Tube |
| GM7230-12TB5BT | | TO-220-5B | 50 Units / Tube |

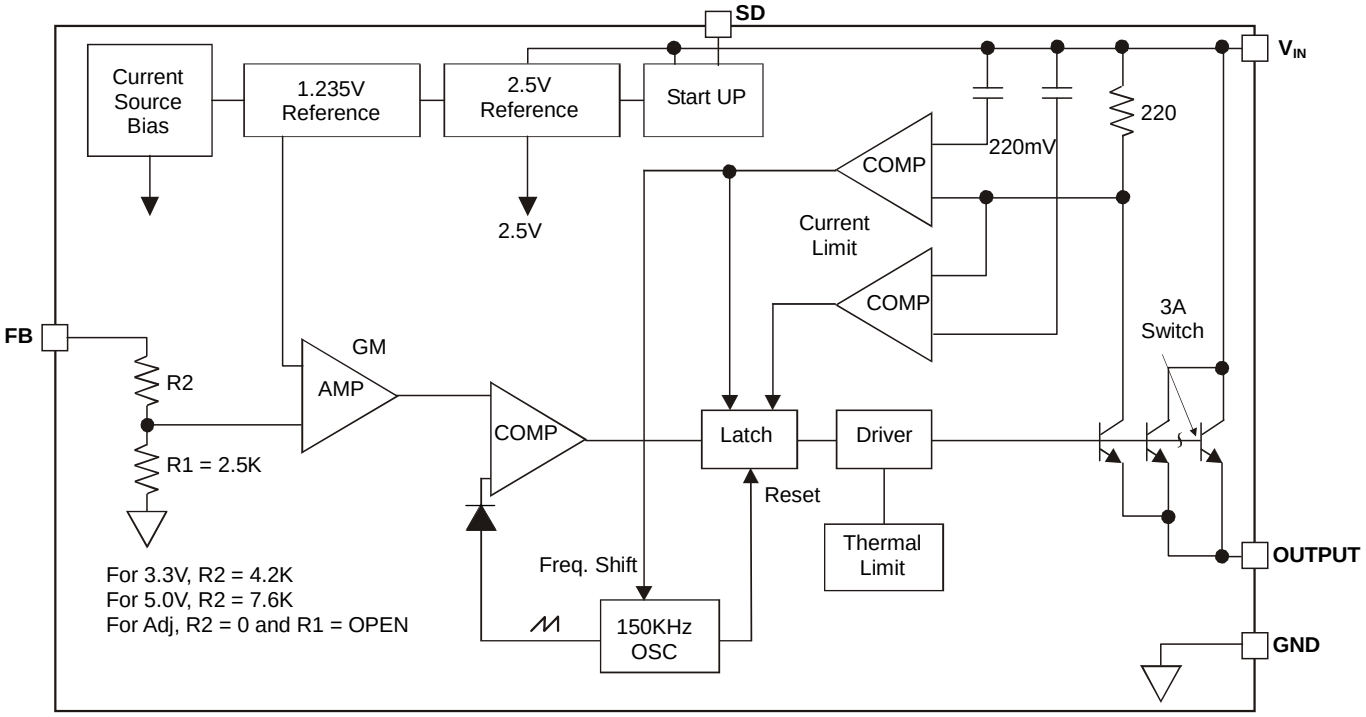
## Ordering Information – Green Products

| Ordering Number | Output Voltage | Package | Shipping |
|---|---|---|---|
| GM7230-ATA5TG | Adj | TO-263-5 | 50 Units / Tube |
| GM7230-ATA5RG | | TO-263-5 | 800 Units / Reel |
| GM7230-ATB5TG | | TO-220-5 | 50 Units / Tube |
| GM7230-ATB5BTG | | TO-220-5B | 50 Units / Tube |
| GM7230-3.3TA5TG | 3.3 | TO-263-5 | 50 Units / Tube |
| GM7230-3.3TA5RG | | TO-263-5 | 800 Units / Reel |
| GM7230-3.3TB5TG | | TO-220-5 | 50 Units / Tube |
| GM7230-3.3TB5BTG | | TO-220-5B | 50 Units / Tube |
| GM7230-5.0TA5TG | 5.0 | TO-263-5 | 50 Units / Tube |
| GM7230-5.0TA5RG | | TO-263-5 | 800 Units / Reel |
| GM7230-5.0TB5TG | | TO-220-5 | 50 Units / Tube |
| GM7230-12TB5BTG | | TO-220-5B | 50 Units / Tube |
| GM7230-12TA5TG | 12 | TO-263-5 | 50 Units / Tube |
| GM7230-12TA5RG | | TO-263-5 | 800 Units / Reel |
| GM7230-12TB5TG | | TO-220-5 | 50 Units / Tube |
| GM7230-12TB5BTG | | TO-220-5B | 50 Units / Tube |

## Absolute Maximum Ratings (Note 1)

| Rating | Value | Unit |
|---|---|---|
| Maximum Supply Voltage | 45 | V |
| SD Pin Input Voltage / Feed Back Pin Voltage | -0.3 + $V_{IN}$ + 0.3 | V |
| Output Voltage to Ground (Steady State) | -0.3 + $V_{IN}$ + 0.3 | V |
| Power Dissipation | Internally Limited | - |
| Thermal Resistance – Junction to Ambient ($\theta_{JA}$)<br>** 2 square inch of FR-4, double sided, 1oz. minimum copper weight, is recommended | 36 | ℃/W |
| Storage Temperature Range | - 65 to 150 | ℃ |
| Maximum Junction Temperature | + 150 | ℃ |
| Operating Temperature Range | - 40 to 125 | ℃ |
| Minimum EDS Rating (Note 2) | 2 | kV |
| Lead Temperature (Soldering, 10 sec) | + 260 | ℃ |

## Block Diagram



## Electrical Characteristics: GM7230-ADJ

(Specifications with standard type face are for T = 25°C, and those with bold face type apply over full Operating Temperature rage)

| Parameter | Condition | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $4.5V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$, $V_{OUT} = 3V$ | $V_{OUT}$ | 1.193<br>**1.180** | 1.230 | 1.267<br>**1.280** | V |
| Efficiency | $V_{IN}$ =12V, $I_{LOAD}$=2.0A, $V_{OUT}$ = 3V | η | | 73 | | % |

## Electrical Characteristics: GM7230-3.3

(Specifications with standard type face are for T = 25°C, and those with bold face type apply over full Operating Temperature rage)

| Parameter | Condition | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $4.75V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$ | $V_{OUT}$ | 3.168<br>**3.135** | 3.300 | 3.432<br>**3.465** | V |
| Efficiency | $V_{IN}$ =12V, $I_{LOAD}$=2.0A | η | | 73 | | % |

## Electrical Characteristics: GM7230-5.0

(Specifications with standard type face are for T = 25°C, and those with bold face type apply over full Operating Temperature rage)

| Parameter | Condition | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $7V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$ | $V_{OUT}$ | 4.800<br>**4.7500** | 5.000 | 5.200<br>**5.250** | V |
| Efficiency | $V_{IN}$ =12V, $I_{LOAD}$=2.0A | η | | 80 | | % |

## Electrical Characteristics: GM7230-12

(Specifications with standard type face are for T = 25°C, and those with bold face type apply over full Operating Temperature rage)

| Parameter | Condition | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage | $15V \le V_{IN} \le 40V$, $0.5A \le I_{LOAD} \le 3A$ | $V_{OUT}$ | 11.52<br>**11.40** | 12.00 | 12.48<br>**12.60** | V |
| Efficiency | $V_{IN}$ =15V, $I_{LOAD}$=3.0A | η | | 88 | | % |

## Electrical Characteristics: All Output Voltage Versions

(Specifications with standard type face are for $T_J$ = 25°C, and those with bold face type apply over full Operating Temperature rage. Unless otherwise specified, $V_{IN}$ = 12V for 3.3V, 5V, and Adjustable version, and $V_{IN}$ = 24V for 12V version, $I_{LOAD}$ = 500mA)

| Parameter | Condition | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Feedback Bias Current | $V_{FB}$ =1.3V (Adjustable Version Only) | $I_b$ | - | 10 | 50<br>**100** | nA |
| Oscillator Frequency | (Note 6) | $f_o$ | 127<br>**110** | 150 | 173<br>**173** | kHz |
| Saturation Voltage | $I_{OUT}$ = 3A (Notes 7, 8) | $V_{SAT}$ | - | 1.16 | 1.4<br>**1.5** | V |
| Max Duty Cycle (ON) | (Note 8) | DC | | 100 | **-** | % |
| Min Duty Cycle (OFF) | (Note 9) | DC | | 0 | | % |
| Current Limit | Peak Current (Notes 7, 8) | $I_{CL}$ | 3.4 | | | A |
| Output Leakage Current | Output =0V (Notes 7, 9, 10) | $I_L$ | - | - | 100 | µA |
| | Output = -0.9V (Note 10) | | - | 2 | **-** | mA |
| Quiescent Current | (Note 9) | $I_Q$ | - | 5 | - | mA |
| Standby Quiescent Current | SD Pin = 5V (OFF), Note 10 | $I_{STBY}$ | - | 70 | 200 | µA |
| SD Pin Logic Input Level | Low (ON) | $V_{IH}$ | - | 1.3 | 0.6 | V |
| | High (OFF) | $V_{IL}$ | 2.0 | 1.3 | - | |
| SD Pin Input Current | $V_{LOGIC}$ = 2.5V (OFF) | $I_H$ | | 5 | 15 | µA |
| | $V_{LOGIC}$ = 0.5V (ON) | $I_L$ | | 0.02 | 5 | µA |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

**Note 2:** The human body model is a 100pF capacitor discharged through a 1.5KΩresistor into each pin.

**Note 3:** Typical numbers are at 25°C and represent the most likely norm.

**Note 4:** All limits guaranteed at room temperature (standard type face) and at temperature extremes (bold type face). All room temperature limits are 100% production tested. All limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

**Note 5:** External components such as the catch diode, inductor, input and output capacitors, and voltage programming resistors can affect switching regulator system performance. When the GM7230 is used as shown in the Figure 1 test circuit, system performance will be as shown in system parameters section of Electrical Characteristics.

**Note 6:** The switching frequency is reduced when the second stage current limit is activated.

**Note 7:** No diode, inductor or capacitor connected to output pin.

**Note 8:** Feedback pin removed from output and connected to 0V to force the output transistor switch ON.

**Note 9:** Feedback pin removed from output and connected to 12V for the 3.3V, 5V, and the ADJ. version.

## Test Circuit and Layout Guidelines

Careful layout is important with any switching regulators. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. To minimize inductance and ground loops, the lengths of the leads indicated by heavy lines in Figure 1&2 below should be kept as short as possible. Single point grounding (as indicated or ground plane construction should be used for best results. When using the Adjustable version, place the programming resistors as close as possible to GM7230, to keep the sensitive feedback wiring short.

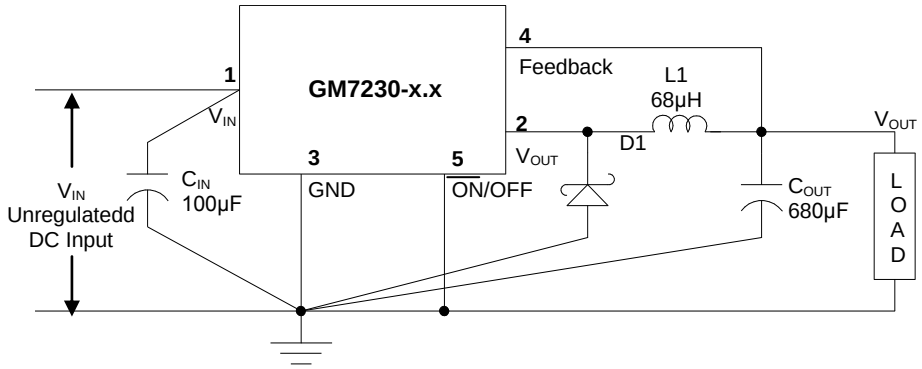



**Figure 1 Fixed Ouput Votlage Versions**

$C_{IN}$ = 470μF, Aluminum Electrolytic
$C_{OUT}$ = 220μF, 25V, Aluminum Electrolytic
D1 = Schottky, 5A/40V
L1 = 68μH

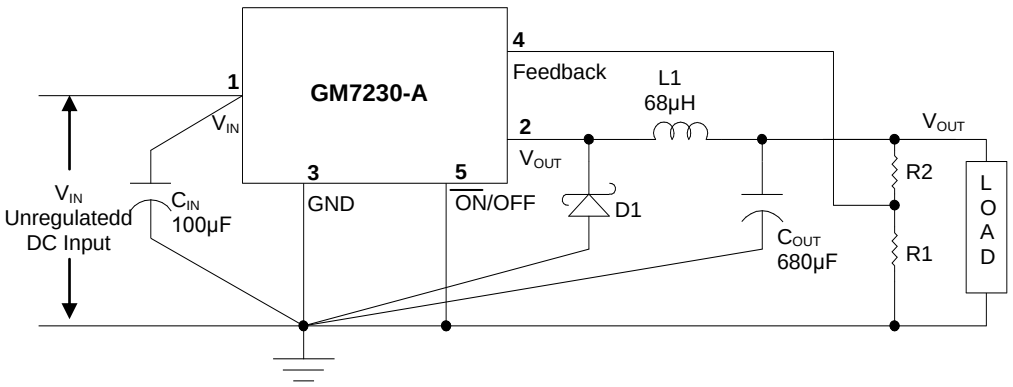



**Figure 2 Adjustable Ouput Votlage Versions**

$C_{IN}$ = 470μF, Aluminum Electrolytic
$C_{OUT}$ = 220μF, 25V, Aluminum Electrolytic
D1 = Schottky, 5A/40V
L1 = 68μH

$V_{OUT} = V_{REF} (1 + R2/R1)$

## Typical Performance Characteristics

Figure 3. Switch Saturation Voltage

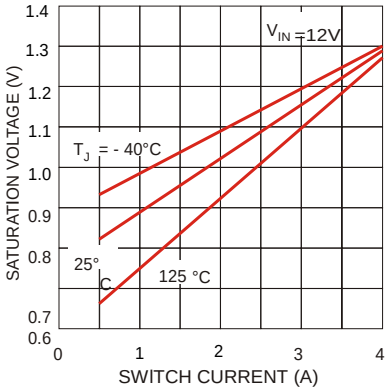



Figure 4. Switch Current Limit

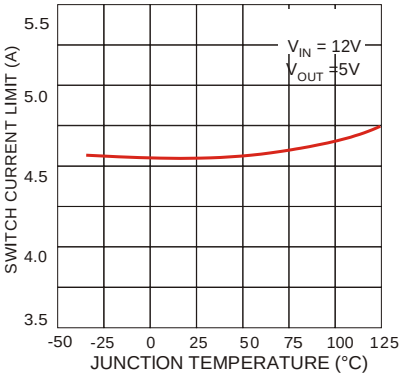



Figure 5. Dropout Voltage

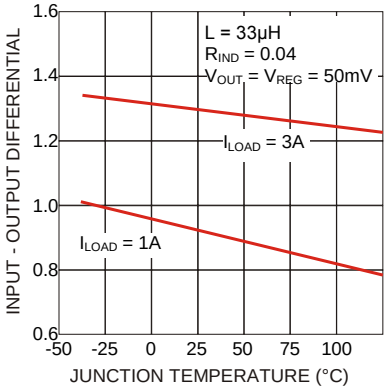



Figure 6. Operating Quiescent Current

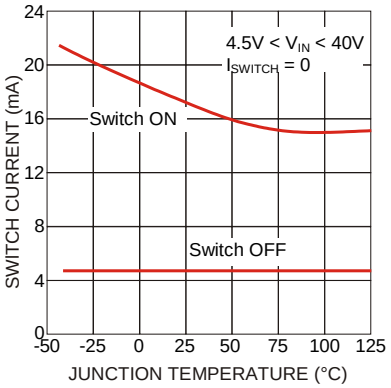



Figure 7. Shutdown Quiescent Current

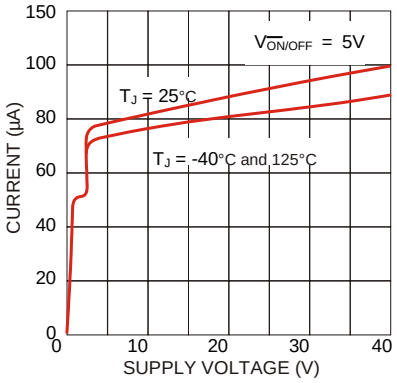



Figure 8. Minimum Operating Supply Voltage

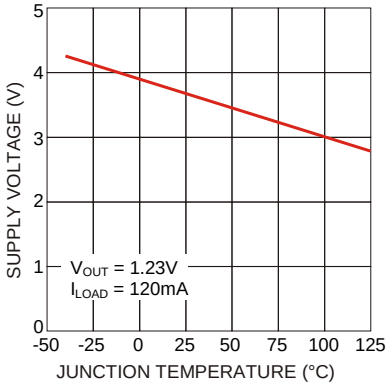



Figure 9. SD Pin Current (Sinking)

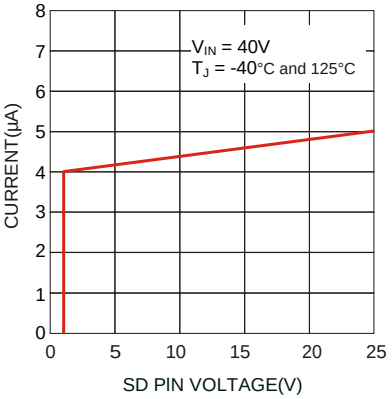
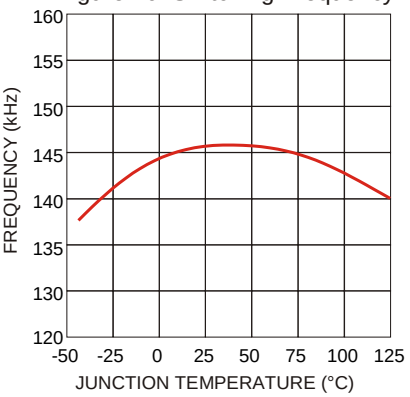
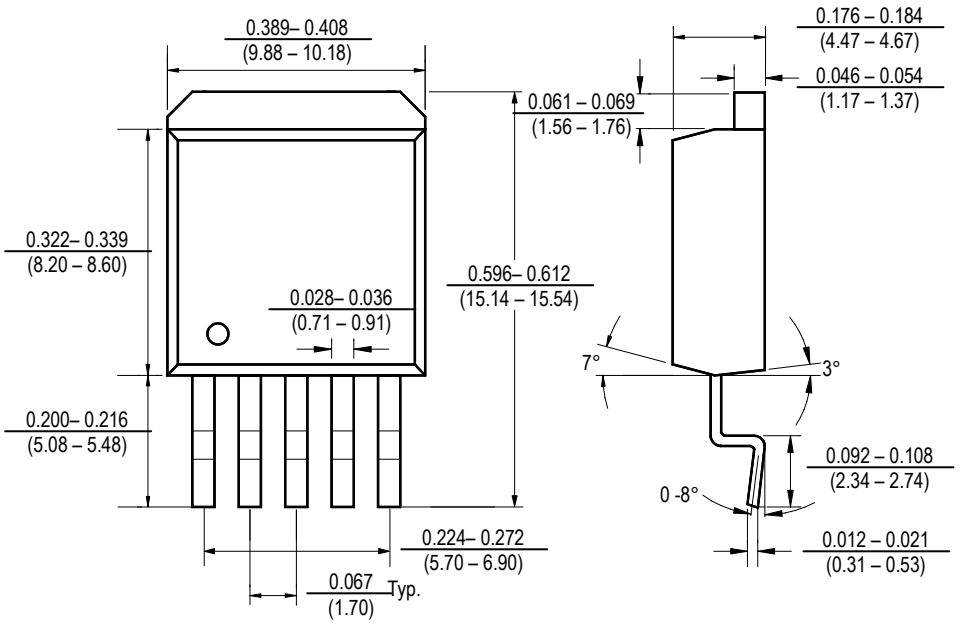


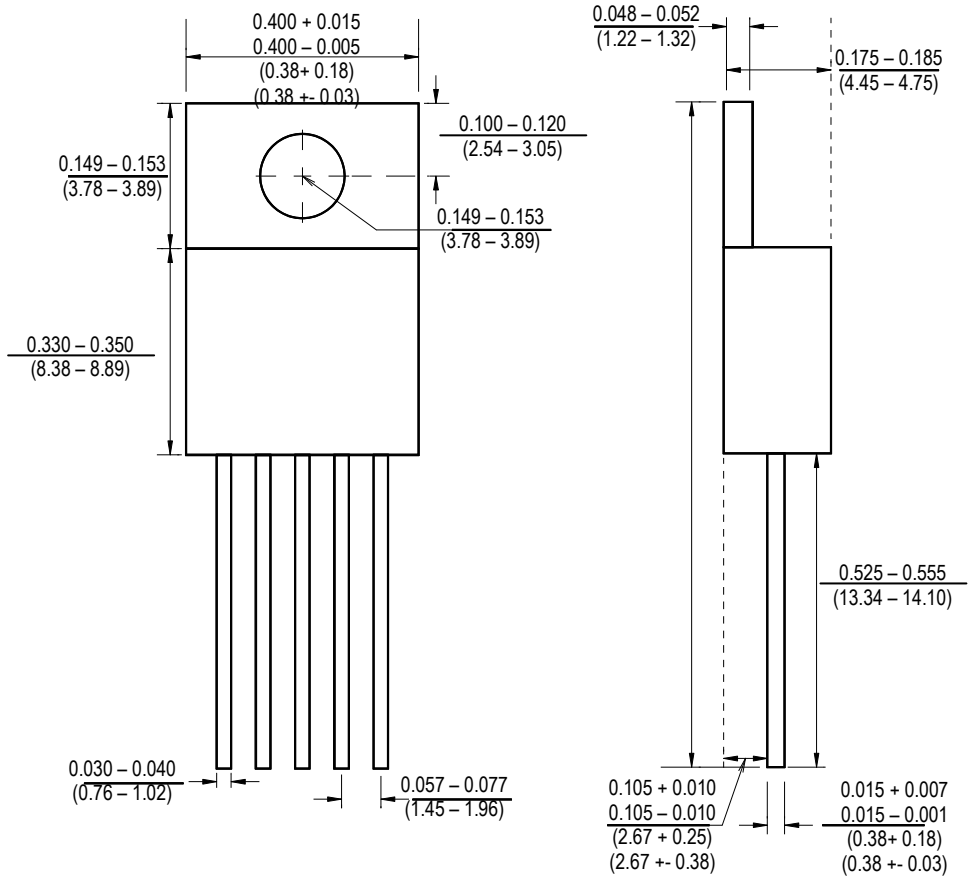

Figure 10. Switching Frequency



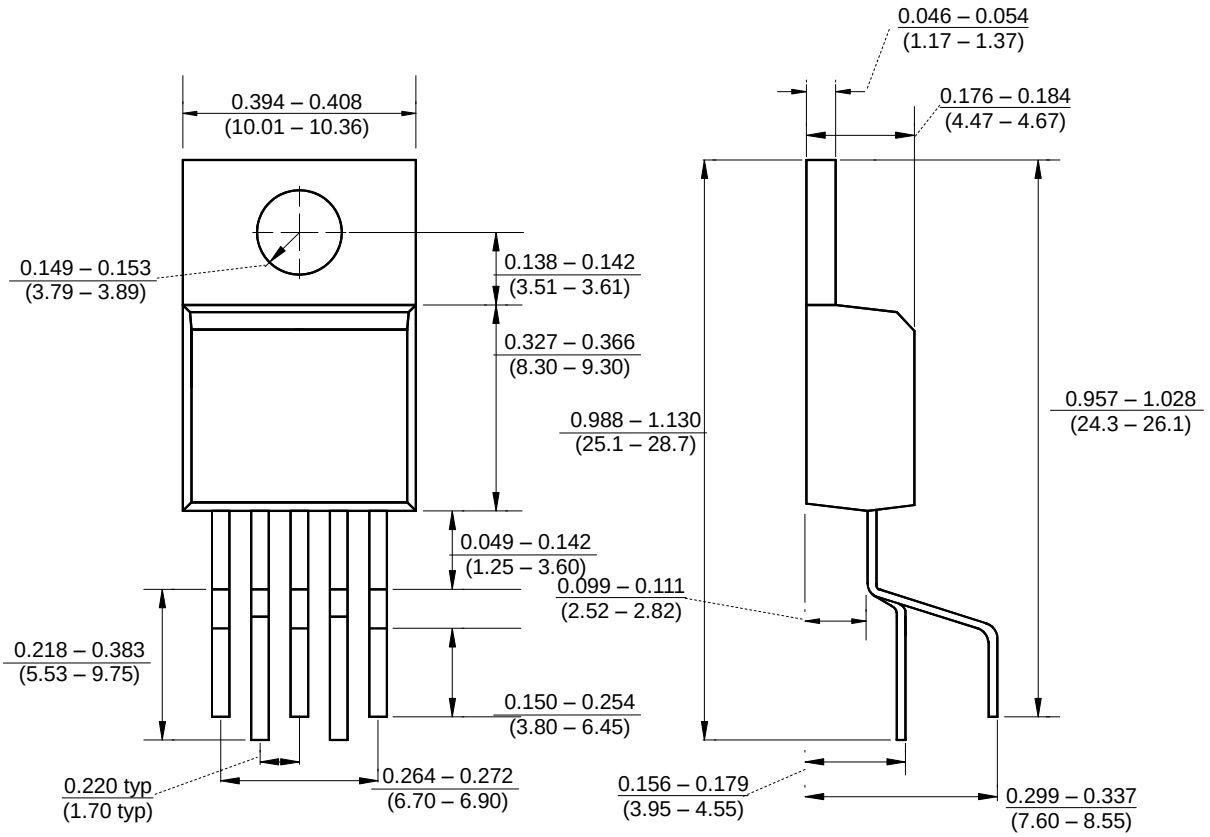
## Package Outline Dimensions – TO-263-5




## Package Outline Dimensions – TO-220-5



## Package Outline Dimensions – TO-220B-5




**Inches**
**(mm)**

## Ordering Number

| GM | 7230 | A | TA5 | R | G |
|---|---|---|---|---|---|
| APM Gamma Micro | Circuit Type | Output Voltage | Package Type | Shipping Type | |
| | | A: Adj<br>3.3 = 3.3V<br>5.0 = 5.0V<br>12 = 12.0V | TA5: TO263-5<br>TB5: TO-220-5<br>TB5B: TO-220B-5 | R: Taping & Reel<br>T: Tube | Blank: Pb-Free<br>G: Green |

Note:

**Pb-free products:**

- RoHS compliant and compatible with the current require-ments of IPC/JEDEC J-STD-020.
- Suitable for use in Pb-free soldering processes with 100% matte tin (Sn) plating.

**Green products:**

- Lead-free (RoHS compliant)
- Halogen free(Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight)

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