

Description

GM7230 of regulators provides all the active functions for a step-down (buck) switching regulator, and drives 3A load with excellent line and load regulation. GM7230's is available in fixed output voltages of 3.3V, 5V, 12V, and a versatile Adjustable output version.

These regulators are simple to use and require a minimum number of external components. 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 heatsink or even no heatsink.

GM7230 performs well with standard inductors from several manufacturers, and simplifying the design of switch-mode power supplies. GM7230 guarantees $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 15\%$ on the oscillator frequency.

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 thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. Available in standard 5-lead TO-220 package with several different lead bend options, and a 5-lead TO-263 surface mount package.

Features

- ◆ 3.3V, 5V, 12V and Adjustable output versions
- ◆ Adjustable version output voltage range 1.23V to 37V $\pm 4\%$ max over line and load conditions
- ◆ 3A output current
- ◆ Input voltage range up to 40V
- ◆ Requires only 4 external components
- ◆ High efficiency
- ◆ TTL shutdown capability, low power standby mode
- ◆ Low power standby mode, IQ typically 80 μA
- ◆ Thermal shutdown, current limit protection
- ◆ Uses standard inductors
- ◆ 150 kHz fixed frequency internal oscillator

Application

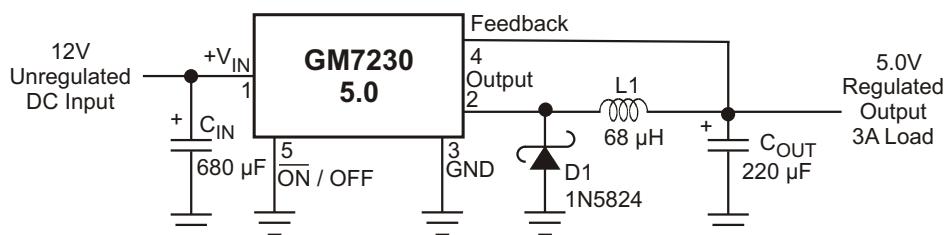
Pre-regulator for linear regulators

On-card/board switching regulators

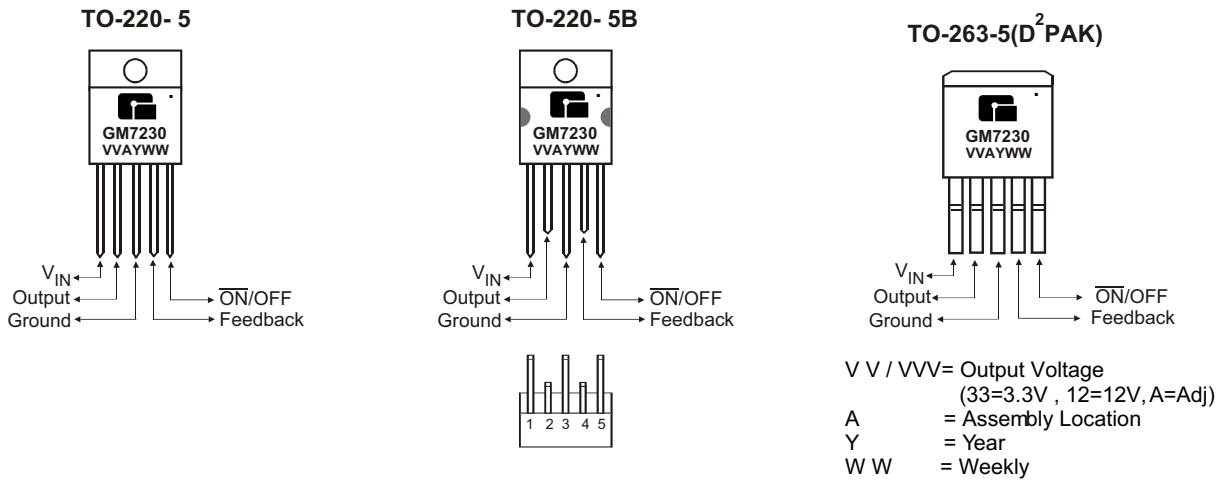
High-efficiency step-down buck regulator

Positive to negative converter (buck-boost)

TYPICAL APPLICATIONS



◆ MARKING INFORMATION & PIN CONFIGURATIONS



◆ ORDERING INFORMATION

| Ordering Number | Output Voltage | Package | Shipping |
|-----------------|----------------|-----------|------------------------|
| GM7230-ATB5T | A d j | TO-220-5 | 50 Units / Tube |
| GM7230-ATB5BT | A d j | TO-220-5B | 50 Units / Tube |
| GM7230-ATA5R | A d j | TO-263-5 | 800 Units/ Tape & Reel |
| GM7230-ATA5T | A d j | TO-263-5 | 50 Units / Tube |
| GM7230-3.3TB5T | 3.3 | TO-220-5 | 50 Units / Tube |
| GM7230-3.3TB5BT | 3.3 | TO-220-5B | 50 Units / Tube |
| GM7230-3.3TA5R | 3.3 | TO-263-5 | 800 Units/ Tape & Reel |
| GM7230-3.3TA5T | 3.3 | TO-263-5 | 50 Units / Tube |
| GM7230-5.0TB5T | 5.0 | TO-220-5 | 50 Units / Tube |
| GM7230-5.0TB5BT | 5.0 | TO-220-5B | 50 Units / Tube |
| GM7230-5.0TA5R | 5.0 | TO-263-5 | 800 Units/ Tape & Reel |
| GM7230-5.0TA5T | 5.0 | TO-263-5 | 50 Units / Tube |
| GM7230-12TB5T | 12 | TO-220-5 | 50 Units / Tube |
| GM7230-12TB5BT | 12 | TO-220-5B | 50 Units / Tube |
| GM7230-12TA5R | 12 | TO-263-5 | 800 Units/ Tape & Reel |
| GM7230-12TA5T | 12 | TO-263-5 | 50 Units / Tube |
| GM7230-15TB5T | 15 | TO-220-5 | 50 Units / Tube |
| GM7230-15TB5BT | 15 | TO-220-5B | 50 Units / Tube |
| GM7230-15TA5R | 15 | TO-263-5 | 800 Units/ Tape & Reel |
| GM7230-15TA5T | 15 | TO-263-5 | 50 Units / Tube |

* TB5B: Bent and Staggered Leads of TO-220 package

** For detail Ordering Number identification, please see last page.

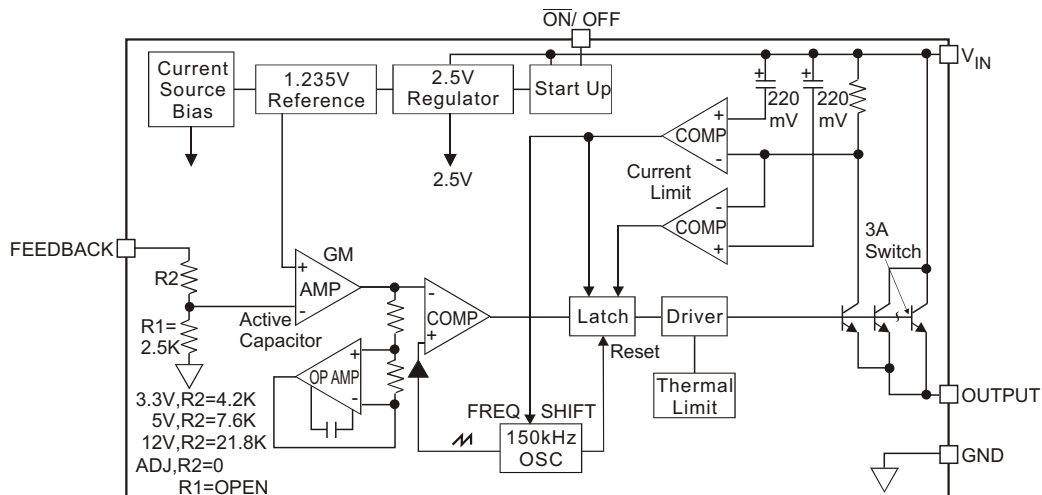
◆ ABSOLUTE MAXIMUM RATINGS

| Rating | Value | Unit |
|--|------------------------------|------|
| Maximum Supply Voltage | 45 | V |
| $\overline{\text{ON}}/\text{OFF}$ Pin Input Voltage/ Feed back pin voltage | $-0.3 \leq V \leq +25$ | V |
| Output Voltage to Ground (Steady State) | -1.0 | V |
| Power Dissipation | Internally Limited | - |
| Storage Temperature Range | -65 to + 150 | °C |
| Maximum Junction Temperature | +150 | °C |
| Operating Temperature Range | $-40 \leq T_J \leq 125$ | °C |
| Minimum ESD Rating (C=100pF, R=1.5k) | 2 | kV |
| Lead Temperature (Soldering, 10 sec.) | +260 | °C |
| Lead Temperature S Package Vapor Phase (60 secretary.) Infrared (10 secretary.) T Package (Soldering, 10 secretary.) Maximum Junction Temperature | +215 +245 +260 +150 | °C |

◆ OPERATING CONDITIONS

| Rating | Value | Unit |
|-------------------|-------------------------|------|
| Temperature Range | $45 \leq T_J \leq +125$ | °C |
| Supply Voltage | 4.5 to 40 | V |

◆ BLOCK DIAGRAM



◆ ELECTRICAL CHARACTERISTICS: GM7230-3.3

(Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|----------------|---|-----------|---------------------|-----|---------------------|------|
| Output Voltage | $4.75 \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ | V_{OUT} | 3.168/ 3.135 | 3.3 | 3.432/ 3.465 | V |
| Efficiency | $V_{IN} = 12\text{V}$, $I_{LOAD} = 3.0\text{A}$ | | - | 73 | - | % |

◆ ELECTRICAL CHARACTERISTICS: GM7230-5.0

(Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|----------------|--|-----------|---------------------|-----|---------------------|------|
| Output Voltage | $7\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ | V_{OUT} | 4.800/ 4.750 | 5.0 | 5.200/ 5.250 | V |
| Efficiency | $V_{IN} = 12\text{V}$, $I_{LOAD} = 3.0\text{A}$ | | - | 80 | - | % |

◆ ELECTRICAL CHARACTERISTICS: GM7230-12

(Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|----------------|---|-----------|---------------------|------|---------------------|------|
| Output Voltage | $15\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ | V_{OUT} | 11.52/ 11.40 | 12.0 | 12.48/ 12.60 | V |
| Efficiency | $V_{IN} = 25\text{V}$, $I_{LOAD} = 3.0\text{A}$ | | - | 90 | - | % |

◆ ELECTRICAL CHARACTERISTICS: GM7230-ADJ

(Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|------------------|---|-----------|---------------------|-------|---------------------|------|
| Feedback Voltage | $4.5\text{V} \leq V_{IN} \leq 40\text{V}$, $0.2\text{A} \leq I_{LOAD} \leq 3\text{A}$ $V_{OUT} = 3\text{V}$ | V_{OUT} | 1.193/ 1.180 | 1.230 | 1.267/ 1.280 | V |
| Efficiency | $V_{IN} = 12\text{V}$, $I_{LOAD} = 3\text{A}$, $V_{OUT} = 3\text{V}$ | | - | 73 | - | % |

◆ ELECTRICAL CHARACTERISTICS: All Output Voltage Versions

(Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, $V_{IN} = 12\text{V}$ for the 3.3V, 5.0V and ADJ version and $V_{IN} = 24\text{V}$ for 12V version. $I_{LOAD} = 500\text{ mA}$)

| Parameter | Conditions | Symbol | Min | Typ | Max | Unit |
|---|--|------------|------------------|------|------------------|--------------------|
| Feedback Bias Current | $V_{FB} = 1.3\text{V}$ (Adjustable Version Only) | I_b | - | 10 | 50 / 100 | nA |
| Oscillator Frequency | (Note 6) | f_o | 127/ 110 | 150 | 173 / 173 | kHz |
| Saturation Voltage | $I_{OUT} = 3\text{A}$ (Notes 7, 8) | V_{SAT} | - | 1.16 | 1.4 / 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} | 3.6 / 3.4 | 4.5 | 6.9 / 7.5 | A |
| Output Leakage Current | (Notes 7, 9, 10) Output = 0 V | I_L | - | - | 50 | μA |
| | (Notes 10) Output = -0.9V | | - | 2 | 30 | mA |
| Quiescent Current | (Note 9) | I_Q | - | 5 | 10 | mA |
| Standby Quiescent Current | $\overline{\text{ON}}$ /OFF Pin = 5V (OFF) (Note 10) | I_{STBY} | - | 80 | 200 / 250 | μA |
| Thermal Resistance | TO-220 or TO-263 Package, Junction to Case | JC | - | 2 | - | $^\circ\text{C/W}$ |
| | TO-220 Package, Junction to Ambient (Note 11) | JA | - | 50 | - | |
| | TO-263 Package, Junction to Ambient (Note 12) | JA | - | 50 | - | |
| | TO-263 Package, Junction to Ambient (Note 13) | JA | - | 30 | - | |
| | TO-263 Package, Junction to Ambient (Note 14) | JA | - | 20 | - | |
| $\overline{\text{ON}}$ /OFF Pin | Low (ON) | V_{IH} | - | 1.3 | 0.6 | V |
| Logic Input Level | High (OFF) | V_{IL} | 2.0 | 1.3 | - | V |
| $\overline{\text{ON}}$ /OFF Pin Input Current | $V_{LOGIC} = 2.5\text{V}$ (OFF) | I_H | - | 5 | 15 | μA |
| | $V_{LOGIC} = 0.5\text{V}$ (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 100 pF capacitor discharged through a 1.5k resistor 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, and 15V for the 12V version, to force the output transistor switch OFF.

Note 10: $V_{IN} = 40\text{V}$.

Note 11: Junction to ambient thermal resistance (no external heat sink) for the TO-220 package mounted vertically, with the leads soldered to a printed circuit board with (1 oz.) copper area of approximately 1 in².

Note 12: Junction to ambient thermal resistance with the TO-263 package tab soldered to a single printed circuit board with 0.5 in² of (1 oz.) copper area.

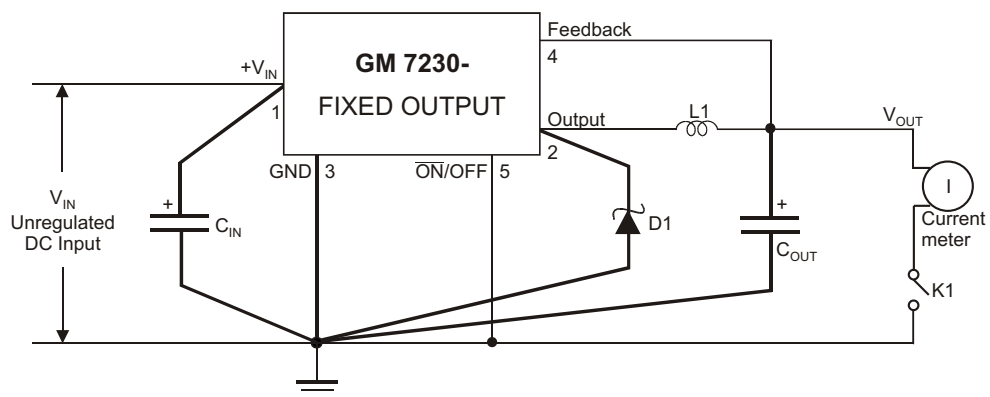
Note 13: Junction to ambient thermal resistance with the TO-263 package tab soldered to a single sided printed circuit board with 2.5 in² of (1 oz.) copper area.

Note 14: Junction to ambient thermal resistance with the TO-263 package tab soldered to a double sided printed circuit board with 3 in² of (1 oz.) copper area on GM7230 side of the board, and approximately 16 in² of copper on the other side of the p-c board.

◆ TEST CIRCUIT AND LAYOUT GUIDELINES

Careful layout is important with any switching regulator. 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 below should be kept as short as possible. Single-point grounding (as indicated in Figure 1) 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(a). Fixed Output Voltage Versions



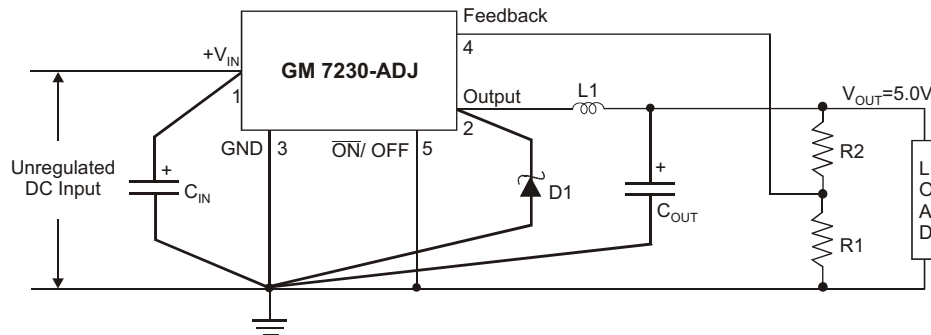
C_{IN} - 470 μ F, 50V, Aluminum Electrolytic

C_{OUT} - 220 μ F, 25V, Aluminum Electrolytic

D1 - 5A, 40V Schottky

L1 - 68 μ H, 3L Electronic Corp. TC-680M-3A-5026

Figure 1(b). Adjustable Output Voltage Versions



$$V_{OUT} = V_{REF} \left(1 + \frac{R2}{R1} \right)$$

$$R2 = R1 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$

where $V_{REF} = 1.23V$, $R1$ approximately $1k$, 1%

C_{IN} - 470 μF , 50V, Aluminum Electrolytic

C_{OUT} - 220 μF , 25V, Aluminum Electrolytic

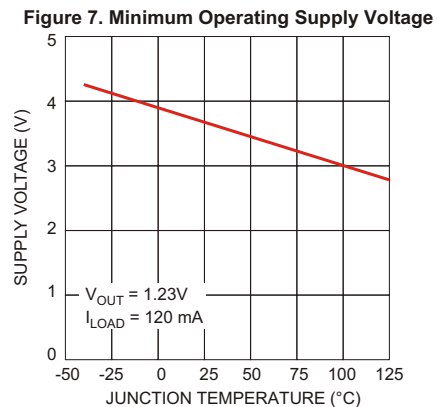
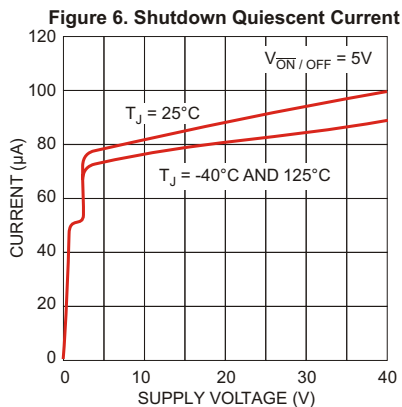
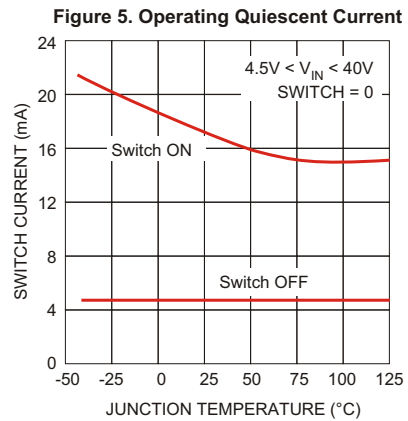
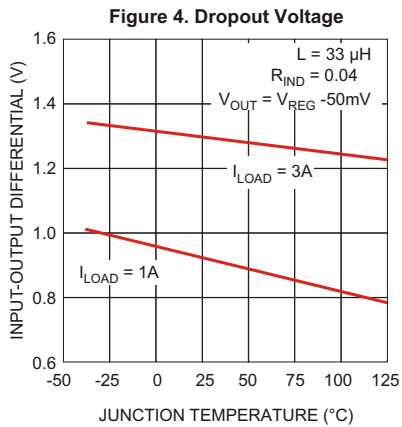
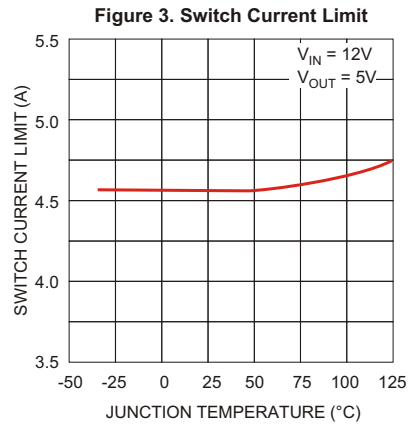
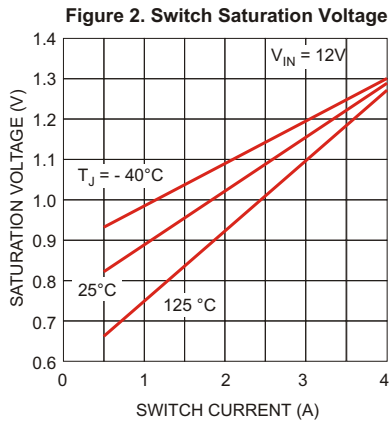
D1 - 5A, 40V Schottky

L1 - 68 μH , 3L Electronic Corp. TC-680M-3A-5026

R1 - 1k Ω , 1%

$V_{OUT} = 5V$, R2 = 3.06k Ω , 1%

◆ Typical Performance Characteristics



◆ Typical Performance Characteristics

Figure 8. $\overline{\text{ON}}$ / OFF Pin Current (Sinking)

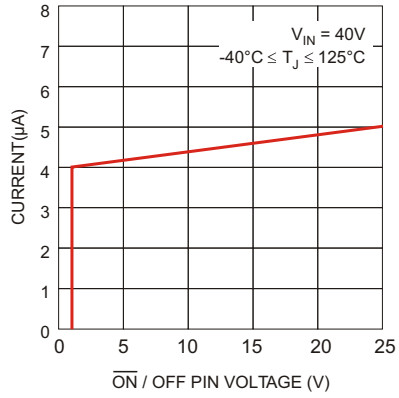
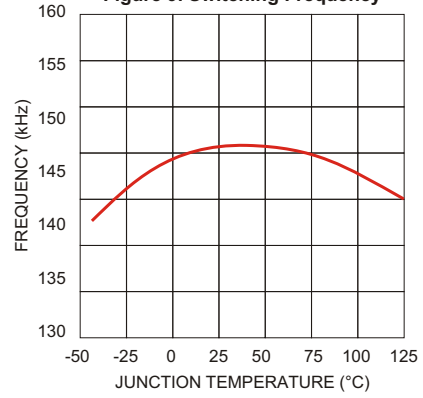


Figure 9. Switching Frequency



◆ Inductor Selection by Manufacturer's Part Number.

| Inductor Value | 3L Electronic Corp. |
|----------------|---------------------|
| 47 μ H | TC-470M-3A-5026 |
| 68 μ H | TC-680M-3A-5026 |
| 100 μ H | TC-101M-3A-5026 |
| 150 μ H | TC-151M-3A-8026 |
| 220 μ H | TC-221M-3A-8026 |
| 330 μ H | TC-331M-3A-8026 |
| 470 μ H | TC-471M-3A-8026 |
| 680 μ H | TC-681M-3A-8026 |
| 1000 μ H | TC-102M-3A-9426 |
| 1500 μ H | TC-152M-3A-9426 |

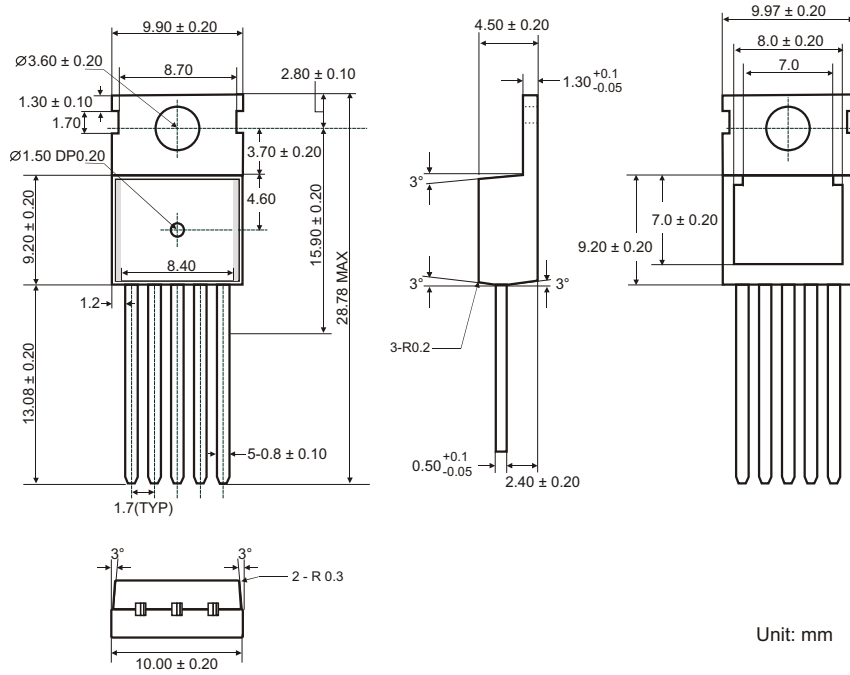
3L Electronic Corp., + 886(2) 86659999
 Website : www.3lcoil.com.tw

◆ Capacitor Selection by Manufacturer's Part Number

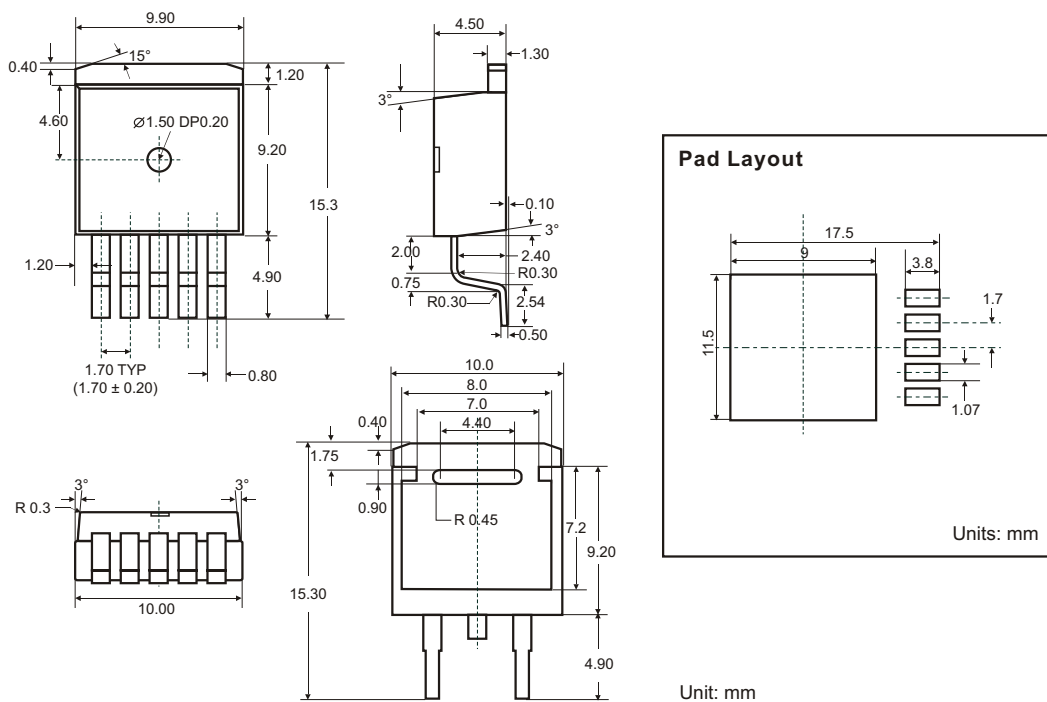
| Capacitor Value | Nippon Chemil - Con Corp. |
|-----------------|---------------------------|
| 100 μ F | KY50VB100-MH11 |
| 220 μ F | KY50VB220-MJ16 |
| 470 μ F | KY50VB470-MJ30 |
| 680 μ F | KY50VB680-MK30 |
| 1000 μ F | KY50VB1000-ML25 |

Nippon Chemi-Con Corp. , + 81(3)54367628
 Website : www.chemi-con.co.jp

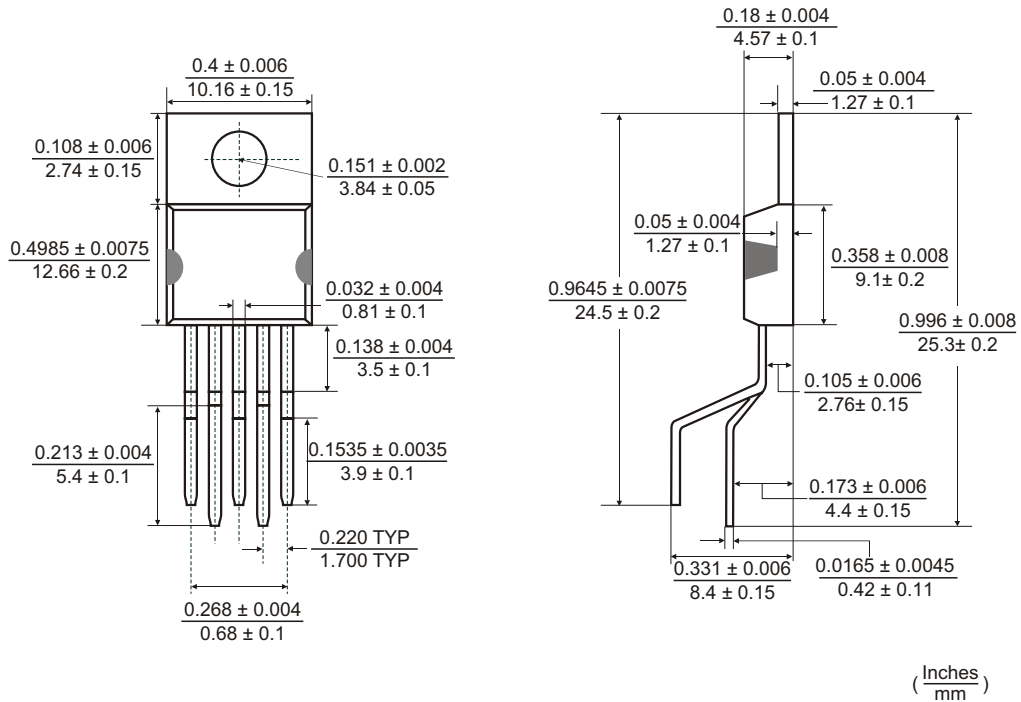
◆ TO-220-5 PACKAGE OUTLINE DIMENSIONS



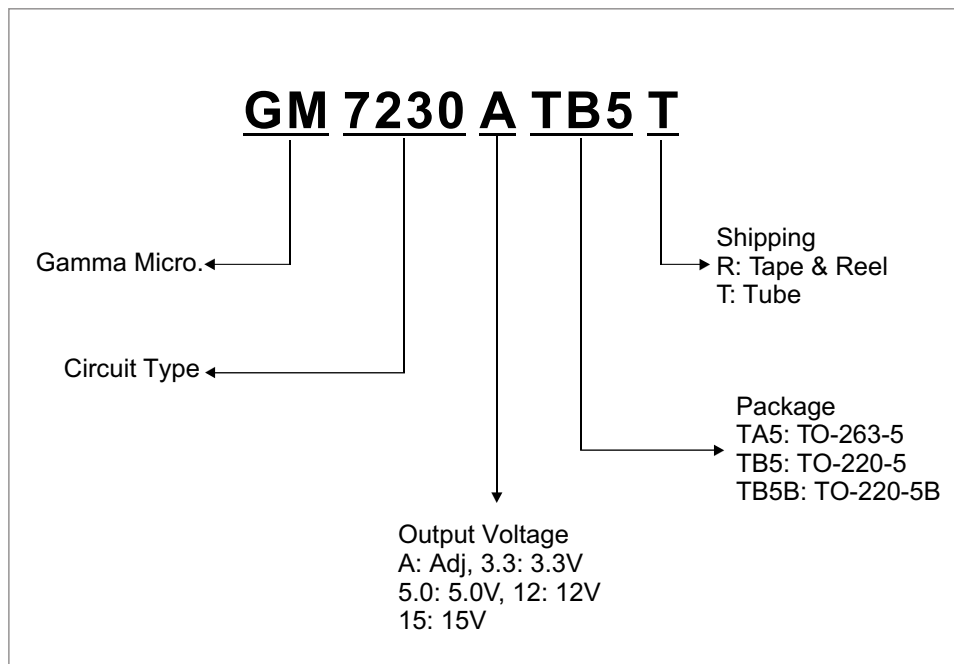
◆ TO-263-5 PACKAGE OUTLINE DIMENSIONS





◆ TO-220-5B PACKAGE OUTLINE DIMENSIONS



◆ ORDERING NUMBER



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