GM66300 Series

3.0A ULTRA LOW DROPOUT VOLTAGE REGULATORS

Description

The GM66300, GM66301 and GM66302 are 3.0A, low dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. Utilizing proprietary Super beta PNP pass element, the GM66300/1/2 offers extremely low dropout (typically 400mV at 3.0A) and low ground current (typically 36mA at 3.0A).

The GM66300/1/2 is ideal for PC add-in cards that need to convert from standard 3.3V to 2.5V or 2.5V to 1.8V. A guaranteed maximum dropout voltage of 500mV over all operating conditions allows the GM66300/1/2 to provide 2.5V from a supply as low as 3V, and 1.8V from a supply as low as 2.5V. The GM66300/1/2 also has fast transient response for heavy switching applications. The device requires only 47µF of output capacitance to maintain stability and achieve fast transient response.

The GM66300/1/2 is fully protected with over current limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The GM66301 offers a TTL-logic compatible enable pin and an error flag that indicates under voltage and over current conditions. Offered in fixed voltages, the GM66300/1 comes in the TO-220 and TO-263 packages and is an ideal upgrade to older, NPN-based linear voltage regulators.

The GM66302 is adjustable version, with On/Off feature.

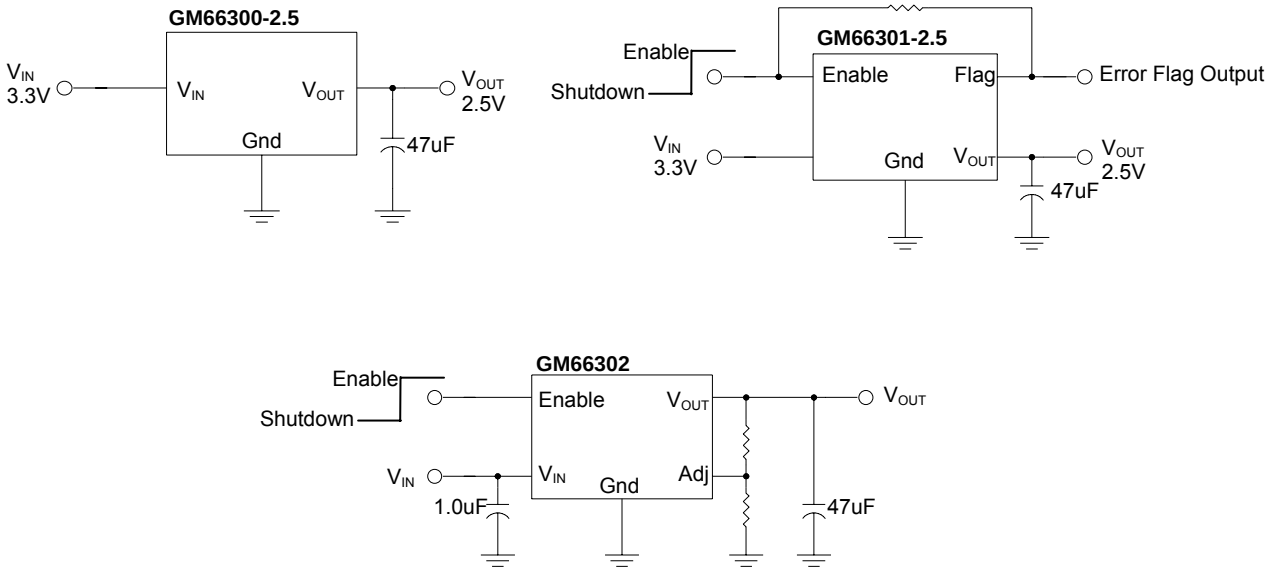
Features

- **3.0A minimum guaranteed output current**
- **500mV maximum dropout voltage over temperature, which is ideal for 3.0V to 2.5V conversion and 2.5V to 1.8V conversion.**
- **1% initial accuracy**
- **Low ground current**
- **Current limiting and Thermal shutdown**
- **Reversed-battery protection**
- **Reversed-leakage protection**
- **Fast transient response**
- **Error flag output (GM66301 only)**
- **Adjustable version (GM66302 only)**

Application

- **PC Add-in Cards**
- **High Efficiency Linear Power Supplies**
- **Multi-media and PC Processor Supplies**
- **Low Voltage Microcontrollers**
- **Automotive Electronics**

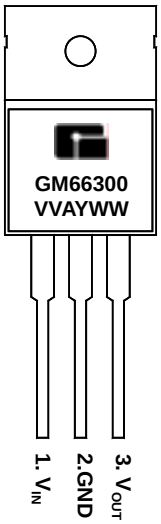
Typical Application Circuits



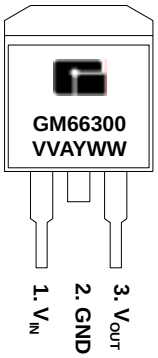
Marking Information and Pin Configurations (Top View)

GM66300 (Pb Free)

TO 220



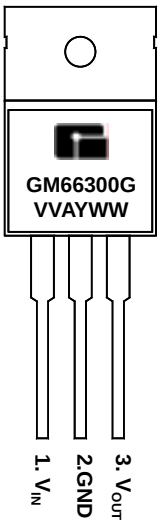
TO 263
(D^2-PAK)



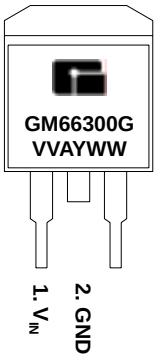
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

GM66300 (Green Product)

TO 220



TO 263
(D^2-PAK)

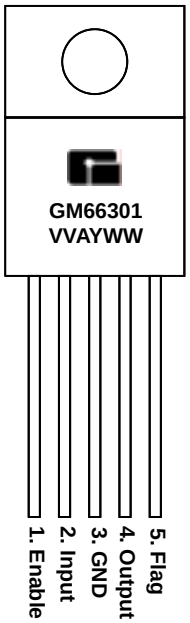


G: Green Product
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

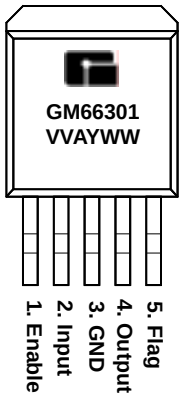
Marking Information and Pin Configurations (Top View)

GM66301 (Pb Free)

5L TO 220



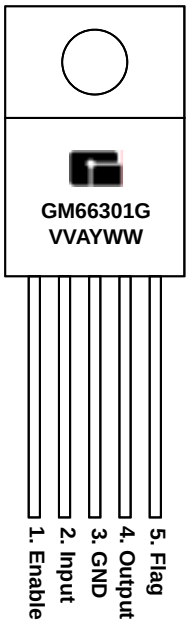
5L TO 263



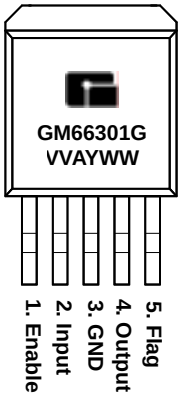
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

GM66301 (Green Product)

5L TO 220



5L TO 263

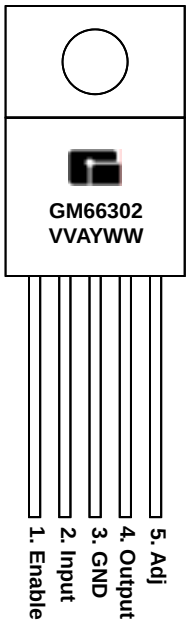


G: Green Product
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

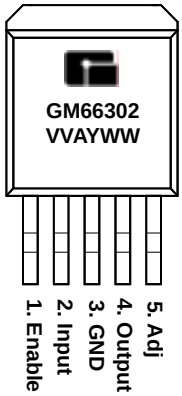
Marking Information and Pin Configurations (Top View)

GM66302 (Pb Free)

5L TO 220



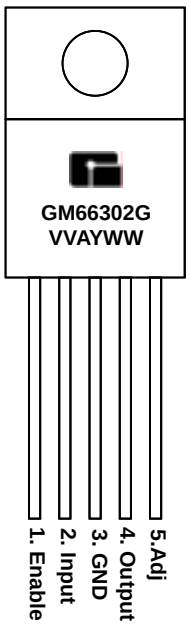
5L TO 263



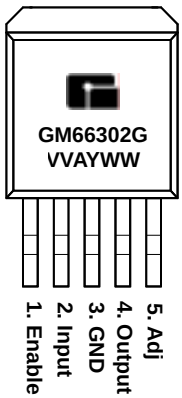
VV: Voltage suffix (15 = 1.5V, 50 = 5.0V…A = Adj)
A: Assembly / Test site code
Y: Year
WW: Week

GM66302 (Green Product)

5L TO 220



5L TO 263



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

Ordering Number	Output Voltage	Package	Shipping
GM66300			
GM66300-1.8TA3T	1.8V	TO-263	50 Units/Tube
GM66300-1.8TA3R	1.8V	TO-263	800 Units / Reel
GM66300-1.8TB3T	1.8V	TO-220	50 Units/Tube
GM66300-2.5TA3T	2.5V	TO-263	50 Units/Tube
GM66300-2.5TA3R	2.5V	TO-263	800 Units / Reel
GM66300-2.5TB3T	2.5V	TO-220	50 Units/Tube
GM66300-3.3TA3T	3.3V	TO-263	50 Units/Tube
GM66300-3.3TA3R	3.3V	TO-263	800 Units / Reel
GM66300-3.3TB3T	3.3V	TO-220	50 Units/Tube
GM66300-5.0TA3T	5.0V	TO-263	50 Units/Tube
GM66300-5.0TA3R	5.0V	TO-263	800 Units / Reel
GM66300-5.0TB3T	5.0V	TO-220	50 Units/Tube

Ordering Information – Green Product

Ordering Number	Output Voltage	Package	Shipping
GM66300			
GM66300-1.8TA3TG	1.8V	TO-263	50 Units/Tube
GM66300-1.8TA3RG	1.8V	TO-263	800 Units / Reel
GM66300-1.8TB3TG	1.8V	TO-220	50 Units/Tube
GM66300-2.5TA3TG	2.5V	TO-263	50 Units/Tube
GM66300-2.5TA3RG	2.5V	TO-263	800 Units / Reel
GM66300-2.5TB3TG	2.5V	TO-220	50 Units/Tube
GM66300-3.3TA3TG	3.3V	TO-263	50 Units/Tube
GM66300-3.3TA3RG	3.3V	TO-263	800 Units / Reel
GM66300-3.3TB3TG	3.3V	TO-220	50 Units/Tube
GM66300-5.0TA3TG	5.0V	TO-263	50 Units/Tube
GM66300-5.0TA3RG	5.0V	TO-263	800 Units / Reel
GM66300-5.0TB3TG	5.0V	TO-220	50 Units/Tube

Ordering Information – Pb Free

Ordering Number	Output Voltage	Package	Shipping
GM66301			
GM66301-1.8TA5T	1.8V	5L-TO-263	50 Units/Tube
GM66301-1.8TA5R	1.8V	5L-TO-263	800 Units / Reel
GM66301-1.8TB5T	1.8V	5L-TO-220	50 Units/Tube
GM66301-2.5TA5T	2.5V	5L-TO-263	50 Units/Tube
GM66301-2.5TA5R	2.5V	5L-TO-263	800 Units / Reel
GM66301-2.5TB5T	2.5V	5L-TO-220	50 Units/Tube
GM66301-3.3TA5T	3.3V	5L-TO-263	50 Units/Tube
GM66301-3.3TA5R	3.3V	5L-TO-263	800 Units / Reel
GM66301-3.3TB5T	3.3V	5L-TO-220	50 Units/Tube
GM66301-5.0TA5T	5.0V	5L-TO-263	50 Units/Tube
GM66301-5.0TA5R	5.0V	5L-TO-263	800 Units / Reel
GM66301-5.0TB5T	5.0V	5L-TO-220	50 Units/Tube

Ordering Information – Green Product

Ordering Number	Output Voltage	Package	Shipping
GM66301			
GM66301-1.8TA5TG	1.8V	TO-263-5	50 Units/Tube
GM66301-1.8TA5RG	1.8V	TO-263-5	800 Units / Reel
GM66301-1.8TB5TG	1.8V	TO-220-5	50 Units/Tube
GM66301-2.5TA5TG	2.5V	TO-263-5	50 Units/Tube
GM66301-2.5TA5RG	2.5V	TO-263-5	800 Units / Reel
GM66301-2.5TB5TG	2.5V	TO-220-5	50 Units/Tube
GM66301-3.3TA5TG	3.3V	TO-263-5	50 Units/Tube
GM66301-3.3TA5RG	3.3V	TO-263-5	800 Units / Reel
GM66301-3.3TB5TG	3.3V	TO-220-5	50 Units/Tube
GM66301-5.0TA5TG	5.0V	TO-263-5	50 Units/Tube
GM66301-5.0TA5RG	5.0V	TO-263-5	800 Units / Reel
GM66301-5.0TB5TG	5.0V	TO-220-5	50 Units/Tube

Ordering Information – Pb Free

Ordering Number	Output Voltage	Package	Shipping
GM66302			
GM66302TA5T	Adj	TO-263-5	50 Units/Tube
GM66302TA5R	Adj	TO-263-5	800 Units / Reel
GM66302TB5T	Adj	TO-220-5	50 Units/Tube

Ordering Information – Green Product

Ordering Number	Output Voltage	Package	Shipping
GM66302			
GM66302TA5TG	Adj	TO-263-5	50 Units/Tube
GM66302TA5RG	Adj	TO-263-5	800 Units / Reel
GM66302TB5TG	Adj	TO-220-5	50 Units/Tube

Absolute Maximum Ratings

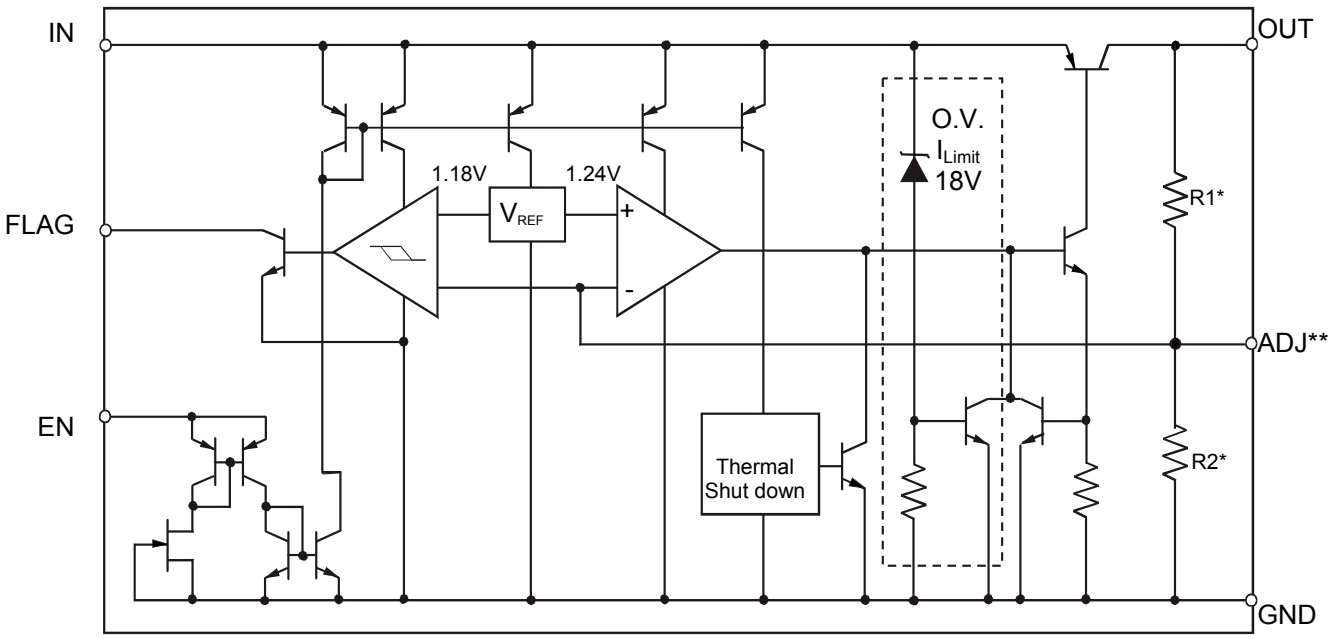
Parameter	Symbol	Value	Unit
Power Dissipation	P_D	Internally Limited	W
Input Power Supply Voltage (Note 1)	V_{IN}	-20 to +20	V
Enable Pin Voltage	V_{EN}	+20	V
Storage Temperature Range	T_{STG}	- 65 to 150	℃
Lead Temperature (Soldering, 5 sec)		+ 260	℃

Note 1: Maximum positive supply voltage of 60V must be of limited duration (<100msec) and duty cycle (< 1%). The maximum continuous supply voltage is 26V.

Operating Ratings

Parameter	Symbol	Value	Unit
Maximum Operating Input Voltage	V_{IN}	2.5 - 16	V
Operating Junction Temperature	T_J	-40 to +125	℃

Block Diagram



* Feedback network in fixed versions only
** Adjustable version only

Electrical Characteristics:

Unless otherwise specified: T_J = 25°C, Bold values are guaranteed across the full operating temperature range.

Parameter	Condition		Symbol	Min	Typ	Max	Unit
Output Voltage	I_O = 10mA		V_{OUT}	-1		1	%
	10mA ≤ I_O ≤ 3.0A, V_{OUT} + 1V ≤ V_{IN} ≤ 8V			**-2**		**2**	
Line Regulation	I_O = 10mA, V_{OUT} + 1V ≤ V_{IN} ≤ 8V		ΔV_{OI}		0.06	0.5	%
Load Regulation	V_{IN} = V_{OUT} + 1V, 10mA ≤ I_O ≤ 3A		ΔV_{OL}		0.2	1.0	%
Output Temperature Coefficient	(Note 5)		$\Delta V_{OUT}/\Delta T$		20	100	ppm/℃
Dropout Voltage (Note 6, Note 9)	ΔV_{OUT} = -1%	I_O = 100mA	V_{DO}		65	**200**	mV
		I_O = 750A			185		
		I_O = 1.5A			250		
		I_O = 3.0A			385	**550**	
Ground Current (Note 7)	I_O = 750mA, V_{IN} = V_{OUT} + 1V		I_{GND}		10	**20**	mA
	I_O = 1.5A, V_{IN} = V_{OUT} + 1V				17		
	I_O = 1.5A, V_{IN} = V_{OUT} + 1V				45		
Ground Pin Current at Dropout	V_{IN} = 0.5V less than specified V_{OUT}, I_O = 10mA		I_{GNDDO}		6		mA
Current Limit	V_{OUT} = 0V, V_{IN} = V_{OUT} + 1V		I_{CL}		4.5		A
Enable Input GM66301/GM66302							
Input Logic Voltage	Low (Off)					**0.8**	V
	High (On)			**2.5**			
Enable Pin Input Current	V_{EN} = 2.5V		I_{EN}		15	30	μA
						75	
	V_{EN} = 0.8V					2	
						4	
Regulator Output Current in Shutdown	(Note 8)		I_{OSD}		10		μA
						20	
Flag Output (GM66301)							
Output Leakage Current	V_{OH} = 16V		$I_{FLG(leak)}$		0.01	1	μA
						2	
Output Low Voltage	V_{IN} = 2.5V, I_{OL} = 250μA, Note 9		$V_{FLG(do)}$		220	300	mV
						400	
Low Threshold	% of V_{OUT}		V_{FLG}	93			%
High Threshold	% of V_{OUT}					99.2	
Hysteresis					1		

Note 1. Exceeding the absolute maximum ratings may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. Devices are ESD sensitive. Handing precautions recommended.

Note 4. $P_{D(max)}=(T_{J(max)}-T_A)+\theta_{JA}$, where θJA depends upon the printed circuit layout. See “Applications Information”.

Note 5. Output voltage temperature coefficient is .VOUT(worst case)+(TJ(max)- TJ(min)) where TJ(max) is +125°C and TJ(min) is -40°C.

Note 6. VDO=VIN-VOUT when VOUT decreases to 99% of its nominal output voltage with VIN=VOUT+1V. For output voltages below 2.5V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.5V. Minimum input operating voltage is 2.5V.

Note 7. IGND is the quiescent current. IIN=IGND+IOUT.

Note 8. VEN 0.8V, VIN 8V, and VOUT=0V.

Note 9. For 1.8V device, VIN=2.5V.

Typical Application Circuits

The GM66300/01/02 is a high performance, low dropout voltage regulator suitable for moderate to high-current voltage regulator applications. Its 500mV dropout voltage at full load makes it especially valuable in battery-powered systems and a high-efficiency noise filter in post-regulator applications.

Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low VCE saturation voltage. A trade-off for the low dropout voltage is a varying base drive requirement. Super beta PNP process reduces this drive requirement to only 2% to 5% of the load current.

The GM66300/01/02 regulator is fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear, output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device (and load) survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

- ### Thermal design

  Linear regulators are simple to use. The most complicated design parameters to consider are thermal characteristics.

  Thermal design requires four application-specific parameters:

  · Maximum ambient temperature (T_A)

  · Output Current (I_{OUT})

  · Output Voltage (V_{OUT})

  · Input Voltage (V_{IN})

  · Ground Current (I_{GND})

  Calculate the power dissipation of the regulator from these numbers and the device parameters from this datasheet, where the ground current is taken from data sheet

  $$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

  The heat sink thermal resistance is determined by:

  $$\theta_{JA} = \frac{T_{J(max)} - T_A}{P_D} - (\theta_{JC} + \theta_{CS})$$

  where $T_{J(max)} \leq 125°C$ and θ_{CS} is between 0°C and 2°C/W.

  The heat sink may by significantly reduced in applications where the minimum input voltage is known and is large compared with the dropout voltage. Use a series input resistor to drop excessive voltage and distribute the heat between this resistor and the regulator. The low dropout properties of Super βeta PNP regulators allow significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 1.0μF is needed directly between the input and regulator ground. Refer to *Application Note 9* for further details and examples on thermal design and heat sink specification.

- ### Output Capacitor

  The GM66300/1/2 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The GM66300/1/2 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 47μF or greater, the output capacitor should have less than 1. of ESR. This will improve transient response as well as promote stability. Ultra-low ESR capacitors, such as ceramic chip capacitors may promote instability. These very low ESR levels may cause an oscillation and/or underdamped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytics can also be used, as long as the ESR of the capacitor is ≤1Ω. The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

- ## Input Capacitor

An input capacitor of 1μF or greater is recommended when the device is more than 4 inches away from the bulk as supply capacitance, or when the supply is a battery. Small, surfacemount, ceramic chip capacitors can be used for the bypassing. Larger values will help to improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

- ## Transient Repsonse and 3.3V to 2.5V and 2.5V to 1.8V Conversions

The GM66300/1/2 has excellent transient response to variations in input voltage and load current. The device has been designed to respond quickly to load current variations and input voltage variations. Large output capacitors are not required to obtain this performance. A standard 47μF output capacitor, preferably tantalum, is all that is required. Larger values help to improve performance even further. By virtue of its low-dropout voltage, this device does not saturate into dropout as readily as similar NPN-based designs.

When converting from 3.3V to 2.5V or 2.5V to 1.8V, the NPN-based regulators are already operating in dropout, with typical dropout requirements of 1.2V or greater. To convert down to 2.5V without operating in dropout, NPN-based regulators require an input voltage of 3.7V at the very least. TheGM66300/1/2 regulator will provide excellent performance with an input as low as 3.0V or 2.5V. This gives the PNP-based regulators a distinct advantage over older, NPN-based linear regulators.

- ## Minimum Load Current

The MIC39300/1/2 regulator is specified between finite loads. If the output current is too small, leakage dominate

and the output voltage rises. A 10mA minimum load current is necessary for proper regulation.

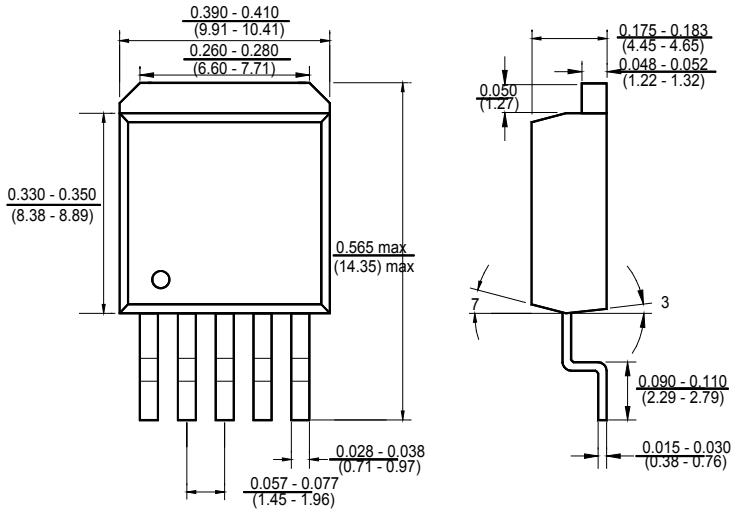
- ## Error Flag

The GM66301 version features an error flag circuit which monitors the output voltage and signals an error condition when the voltage drops 5% below the nominal output voltage. The error flag is an open-collector output that can sink 10mA during a fault condition. Low output voltage can be caused by a number of problems, including an over current fault (device in current limit) or low input voltage. The flag is inoperative during over temperature shutdown. When the error flag is not used, it is best to leave it open. The flag pin can be tied directly to pin 4, the output pin.

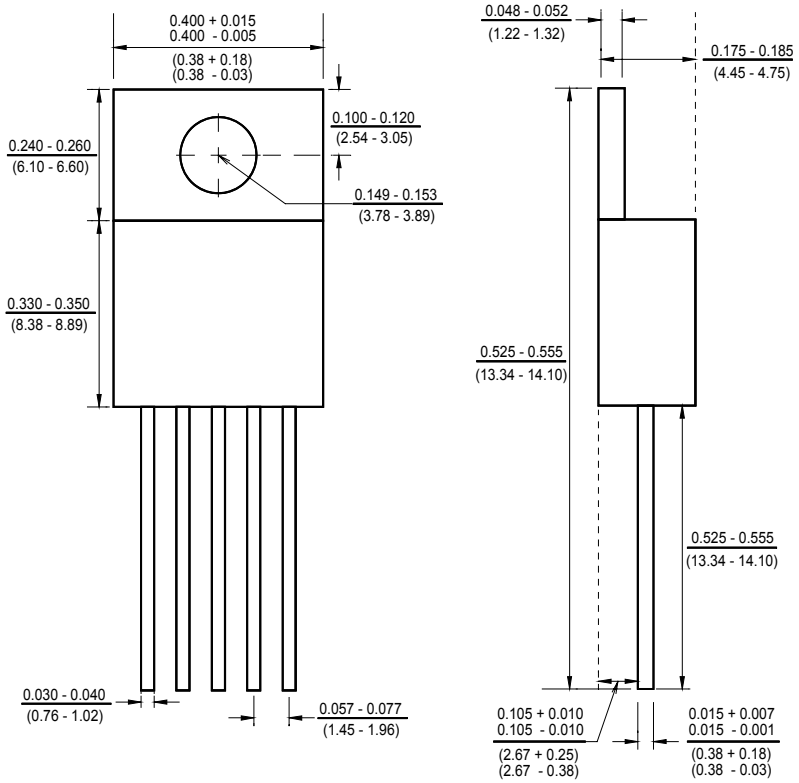
- ## Enable Input

The GM66301/2 version features an enable input for on/off control of the device. Its shutdown state draws “zero” current (only microamperes of leakage). The enable input is TTL/CMOS compatible for simple logic interface, but can be connected to up to 20V. When enabled, it draws approximately 15μA.

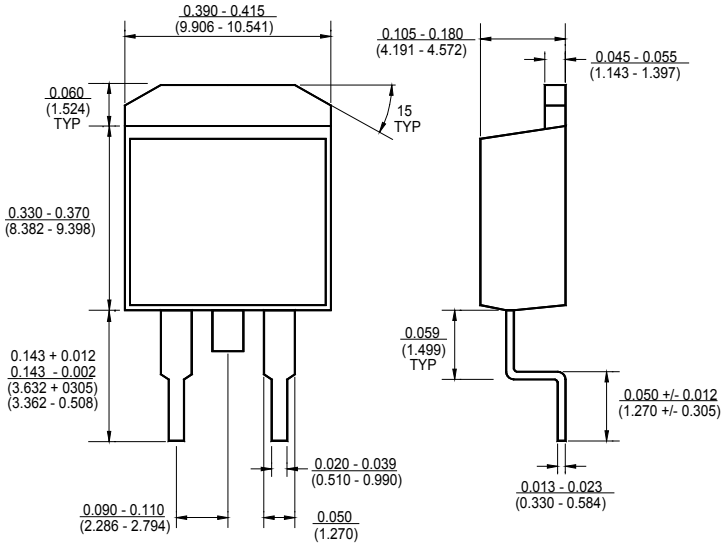
Package Outline Dimensions – TO-263-5



Package Outline Dimensions – TO-220-5



Package Outline Dimensions – TO263



Ordering Number

GM	66300	-1.5	TA3	R	G
APM Gamma Micro	Circuit Type	Output Voltage 1.8 = 1.8V 2.5 = 2.5V 3.3 = 3.3V 5.0 = 5.0V	Package Type TA3: TO263 TB3: TO220	Shipping Type R:Taping& Reel T: Tube	Blank: Pb-free G:Green

GM	66301	-1.5	TA5	R	G
APM Gamma Micro	Circuit Type	Output Voltage 1.8 = 1.8V 2.5 = 2.5V 3.3 = 3.3V 5.0 = 5.0V	Package Type TA5: TO263-5 TB5: TO220-5	Shipping Type R:Taping& Reel T:Tube	Blank: Pb-free G:Green

GM	66302	-A	TA5	R	G
APM Gamma Micro	Circuit Type	Output Voltage Adj	Package Type TA3: TO263-5 TB3: TO220-5	Shipping Type R:Taping& Reel T:Tube	Blank: Pb-free G:Green