MICROCHIP®

5V TO ±10V VOLTAGE CONVERTER +B122+B124 REGULATED GaAs FET BIAS SUPPLY

FEATURES

- **Fixed – 4.1V or Adjustable – 0.5V to – 9V Output at 5mA**
- **4.5V to 10V Input Voltage Range**
- **Low Output Voltage Ripple**
  - **TCM850-852 .... 2mVp-p**
  - **TCM853 .... 1mVp-p**
- **100kHz Charge Pump Switching Frequency**
- **Optional External Synchronizing Clock Input (TCM852)**
- **Logic Level Shutdown Mode .... 0.5µA Typ. Temperature (TCM850/852/853)**
- **Low Cost, 8-Pin SOIC Package**

APPLICATIONS

- **Cellular Phones**
- **Negative Regulated Power Supplies**
- **LCD Bias Contrast Control**
- **Adjustable GaAs SET Bias**
- **Wireless Data Loggers**

GENERAL DESCRIPTION

The TCM850/1/2/3 combines an inverting charge pump and a low noise linear regulator in a single small outline package. They are ideal for biasing GaAS FETs in cellular telephone transmitter power amplifiers

All four devices accept a range of input voltages from 4.5V to 10.0V and have – 5mA output current capability. The TCM850/1/2 have both preset (– 4.1V) and variable (– 0.5V to –9.0V) output voltages that program with an external resistor divider. The TCM853 output voltage programs with an external positive control voltage. The TCM850/1/3 can be shutdown reducing quiescent current to less than 0.5µA (typ) over temperature, 2µA (typ) for the TCM851.

ORDERING INFORMATION

Part No.	Package	Temp. Range
TCM850COA	8-Pin SOIC	0°C to +70°C
TCM850EOA	8-Pin SOIC	– 40°C to +85°C
TCM851COA	8-Pin SOIC	0°C to +70°C
TCM851EOA	8-Pin SOIC	– 40°C to +85°C
TCM852COA	8-Pin SOIC	0°C to +70°C
TCM852EOA	8-Pin SOIC	– 40°C to +85°C
TCM853COA	8-Pin SOIC	0°C to +70°C
TCM853EOA	8-Pin SOIC	– 40°C to +85°C
TCM850EV	*Evaluation Kit for TCM850/1/2/3*	

FUNCTIONAL BLOCK DIAGRAM

Figure 1.

TCM850
TCM851
TCM852
TCM853

5V TO ±10V VOLTAGE CONVERTER
+B122+B124 REGULATED GaAs
FET BIAS SUPPLY
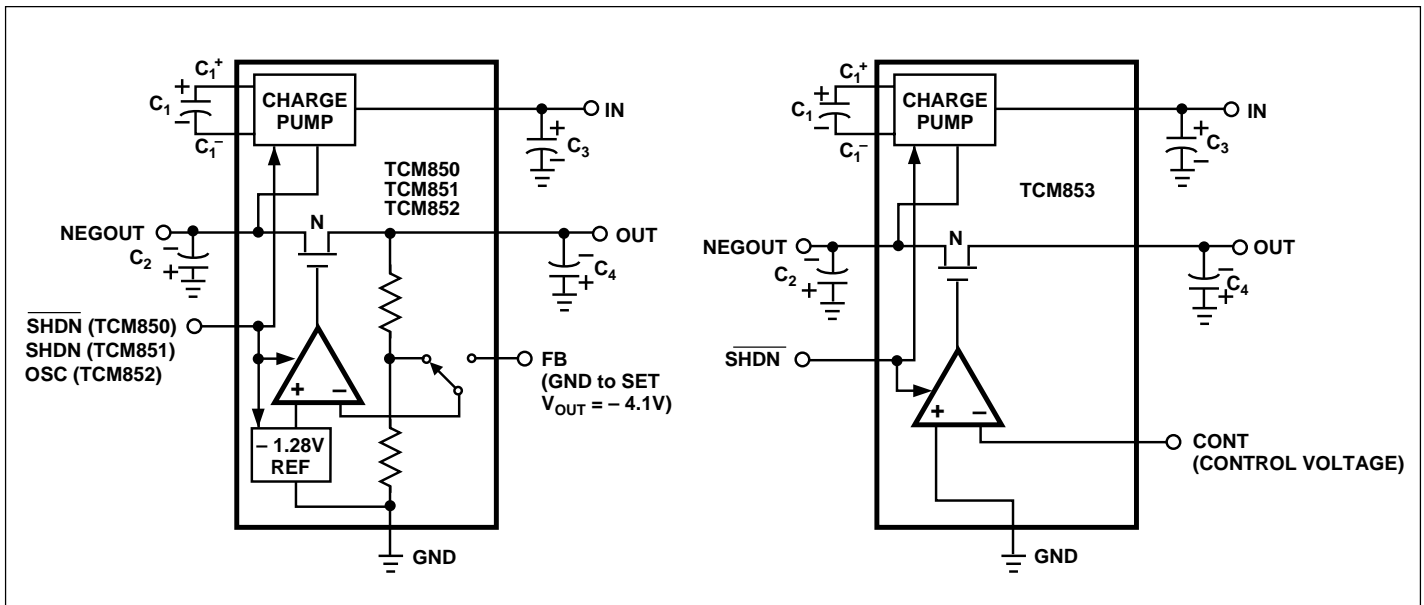
ABSOLUTE MAXIMUM RATINGS*

Supply Voltage (V_{IN} to GND) .... – 0.3V to +10.5V
V_{NEGOUT} to GND .... – 10.5V to 0.3V
V_{IN} to V_{NEGOUT} .... – 0.3 to 21V
$\overline{V_{OUT}}$ to GND** .... V_{NEGOUT} to 0.3V
$\overline{SHDN}$ or OSC (Pin 4) to GND .... – 0.3V to (V_{IN} + 0.3V)
Power Dissipation (TA ≤ 70°C)
    SOIC 470mW
Operating Temperature Range
    C Device .... 0°C to 70°C
    E Device .... – 40°C to +85°C
Storage Temperature Range .... – 65°C to +165°C
Lead Temperature (Soldering, 10 sec) .... +300°C

*This is a stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

**The output may be shorted to NEGOUT or GND if the package power dissipation is not exceeded. Typical short circuit current to GND is 50mA.

ELECTRICAL CHARACTERISTICS:

V_{IN} between +5V and +10V; V_{OUT} = – 4.1V; R_L = Open Circuit; T_A = T_{MIN} to T_{MAX} unless otherwise noted. A 100kHz, 50% duty cycle square wave between GND and V_{IN} is applied to the OSC pin of the TCM852.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Supply Voltage	Note 1	5	—	10	V
V_{OUT}	Output Voltage	TCM850-TCM852: V_{FB} = 0V (Note 3)	– 4.3	– 4.1	– 3.9	V
		TCM853: V_{CTRL} = 4.1V	– 4.2	—	– 4	
	Output Voltage Range			– 0.5 to – (V_{IN} –1)		V
V_{FBSET}	Set Voltage	TCM850-852: No Load	– 1.32	– 1.28	– 1.24	V
I_Q	Supply Current		—	2	3	mA
I_{SHUT}	Shutdown Supply Current	TCM850/853: V_{IN} = 10V, $\overline{SHDN}$ = 0V	—	0.5	—	μA
		TCM851: SHDN = 2V	—	2	—	
		TCM852: OSC Low	—	0.5	—	
	V_{OUT} Load Regulation	TCM850-TCM852: V_{FB} = 0V (Note 3)	—	4	8	mV/mA
		TCM853: V_{CTRL} = 4.1V	—	3	8	
	V_{OUT} Ripple	TCM850-TCM852	—	2	—	mVp-p
		TCM853	—	1	—	
f_{OSC}	Oscillator Frequency	TCM850-TCM853: T_A = 25°C (Note 2)	80	100	120	kHz
V_{IH}	Input High Voltage	Pin 4	2	—	—	V
V_{IL}	Input Low Voltage	Pin 4	—	—	0.5	V
I_{IN}	Input Current	Pin 4	—	—	±1	μA
C_{IN}	Input Capacitance	Pin 4	—	10	—	pF

NOTES:
  1. The supply voltage can drop to 4.5V, but the output is no longer guaranteed to sink 5mA at – 4.1V.
  2. The TCM852 will operate with a 50kHz to 250kHz square wave of 40% to 60% duty cycle. For best performance, use an 80kHz to 120kHz square wave with 50% duty cycle.
  3. I_{OUT} = 0mA or 5mA. Reference Figures 3 and 5.

5V TO ±10V VOLTAGE CONVERTER
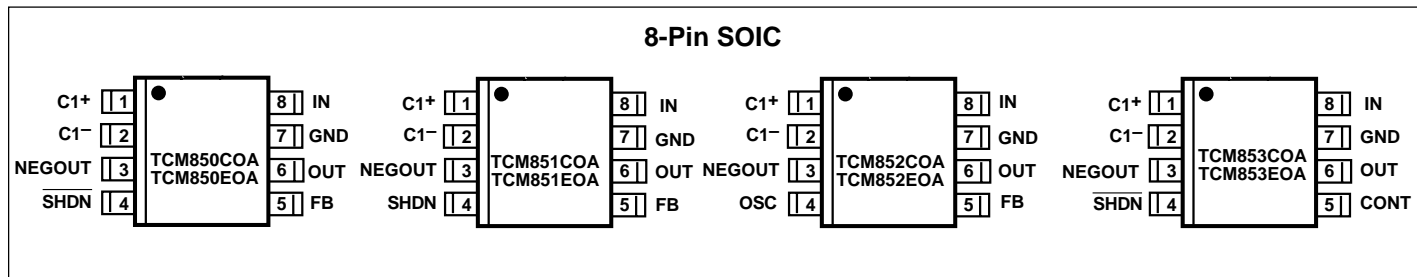# +B122+B124 REGULATED GaAs
FET BIAS SUPPLY

PIN CONFIGURATIONS

8-Pin SOIC

Figure 2.

PIN DESCRIPTION

Pin No (TCM850)	Pin No (TCM851)	Pin No (TCM852)	Pin No (TCM853)	Symbol	Description
1	1	1	1	C_1^+	C1 positive input terminal.
2	2	2	2	C_1^-	C1 negative input terminal.
3	3	3	3	NEGOUT	Negative (unregulated) output voltage.
4	—	—	4	$\overline{\text{SHDN}}$	Shutdown input (TTL active LOW).
—	4	—	—	SHDN	Shutdown input (TTL active HIGH).
—	—	4	—	OSC	External oscillator input.
5	5	5	—	FB	Feedback input. OUT is preset to – 4.1V when FB is grounded. OUT may be adjusted to other voltages by connecting a resistor divider as shown in Figure 4.
—	—	—	5	CONT	Control input. V_{OUT} is adjusted with a positive control voltage (0V to 10V) applied to this input through a resistive divider (Figure 5).
6	6	6	6	OUT	Output voltage terminal.
7	7	7	7	GND	Ground.
8	8	8	8	IN	Positive power supply input voltage (4.5V to 10V).

TCM850
TCM851
TCM852
TCM853

5V TO ±10V VOLTAGE CONVERTER
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DETAILED DEVICE DESCRIPTION

The voltage applied to V_{IN} is inverted by a capacitive charge pump (using commutating capacitor C1 and reservoir capacitor C2). The negative voltage at NEGOUT is then regulated by an internal linear regulator, the output of which is connected to the OUT pin (Figure 1). The most negative output voltage possible is the inverted input voltage (i.e. $-V_{IN}$) plus 1.0V (required by the post regulator). The linear regulator reduces combined output noise (charge pump ripple plus incoming supply noise) to 2mVp-p for the TCM850/1/2 and 1mVp-p for the TCM853.

APPLICATIONS INFORMATION

Setting the Output Voltage

The TCM850/1/2 operate in the fixed output voltage mode (OUT = −4.1V) when the FB input is grounded (Figure 3). The output voltage can be adjusted by connecting FB to the midpoint of a resistive voltage divider from OUT to GND (Figure 4). Care must be taken to allow a minimum of 1.0V across the linear regulator for proper regulation. The output voltage is calculated using the formula below (R2 should be chosen to be between 100kΩ and 400kΩ):

$$V_{OUT} = (-1.28)\left(1 + \frac{R2}{R1}\right)$$

Figure 4. TCM850/851/852 Adjustable Application

The relationship between output voltage and control voltage for the TCM853 (Figure 5) is given by:
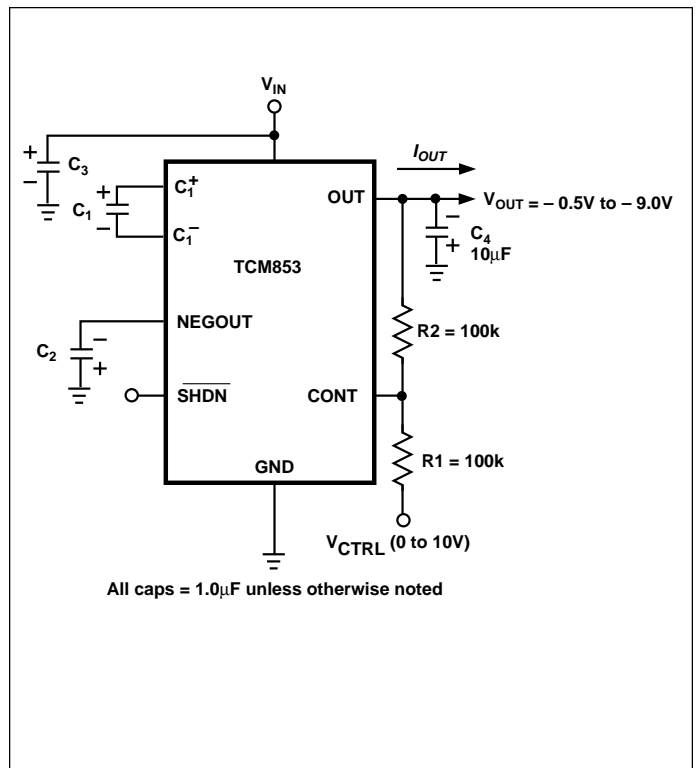
$$V_{OUT} = V_{CTRL} (-1.28)\left(\frac{R2}{R1}\right)$$

Figure 3. TCM850/851/852 Standard Application

Figure 5. TCM853 Standard Application Circuit

5V TO ±10V VOLTAGE CONVERTER
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TCM850
TCM851
TCM852
TCM853

Shutdown Mode

Shutdown inputs are provided to reduce TCM850/1/3 supply current during idle periods. When the shutdown input is in its active state, supply current over temperature is reduced to 0.5µA (typ) TCM850/2/3 and 2µA (typ) TCM851. All shutdown inputs are TTL level compatible: TCM850 and TCM853 both have active low inputs ($\overline{\text{SHDN}}$) while the TCM851 has an active high input. The TCM852 can be shutdown by setting the OSC input to a logic low level. The TCM852 exits the shutdown state when the clock signal is again restored.

Charge Pump Frequency Control

In applications where the charge pump switching frequency may cause interference or filtering problems, it is recommended the TCM852 be used. Switching frequency is determined by a 50kHz to 250kHz square wave signal applied to the OSC input. The signal applied to OSC can have a duty cycle between 40% and 60%. *Note: an external oscillator signal MUST be applied to the TCM852. The TCM852 does not have an on-board oscillator truebase.

Capacitors

Capacitors with low effective series resistance (ESR) should be used to maintain sufficient headroom across the linear post regulator. Recommended values for C1, C2, and C3 are 1µF, 0.8Ω ESR. The recommended value for C4 is 10µF, 0.2Ω. All capacitors should be either surface mount chip tantalum, or chip ceramic types.

Board Layout

The TCM850/1/2/3 typically finds use in applications where low output noise is important. To ensure good noise performance, please observe the following basic layout suggestions:

(1) Mount all components in the circuit as close together as possible.

(2) Keep trace lengths short; especially those to control inputs such as FB and CONT. This will reduce the effect of parasitic capacitance and inductance.

(3) Minimize ground impedance by employing a ground plane.
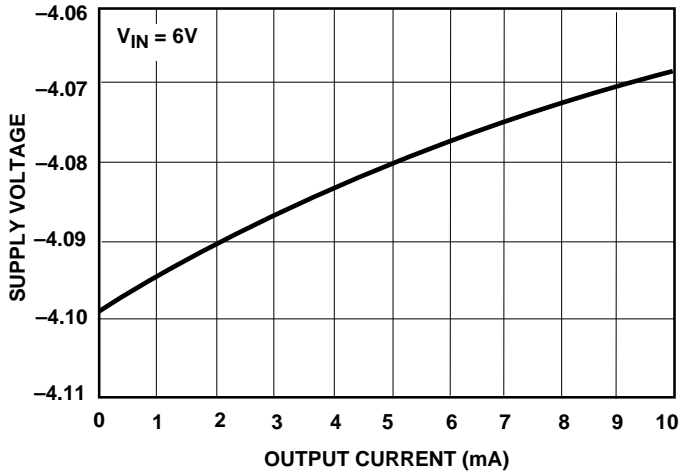
Noise and Ripple Measurement

The TCM850/1/2/3 charge pump switching action causes small ground voltage differences between the TCM850/1/2/3 circuit and the oscilloscope. These voltage differences cause ground currents in the probe wires inducing voltage spikes and result in erroneous readings. As a result, noise and ripple measurements should be made *directly* across output capacitor C4. Do not use the ground lead of the oscilloscope probe. Instead, remove the plastic cover from the probe tip and touch the probe ground ring directly to the negative side of C4. Tektronix chassis mount test jack (part number 131-0258) or a nail-type probe tip connect to the probe and minimize noise and ripple measurement error.

Evaluation Kit

Microchip Technology Inc. offers evaluation kit (TCM850EV) for the TCM850-853. A second evaluation kit (TC7660EV) evaluates several Microchip charge pumps including the TC7660, TC7660S, TC7662B, TC962, TC682. This kit also supports the TCM850 (but not the TCM851-853).
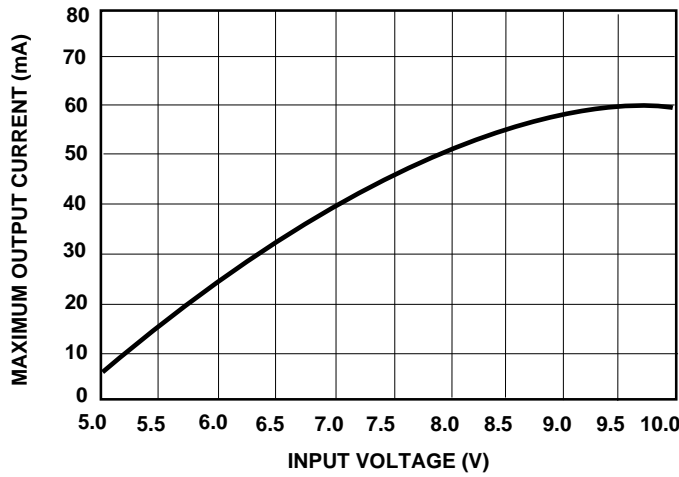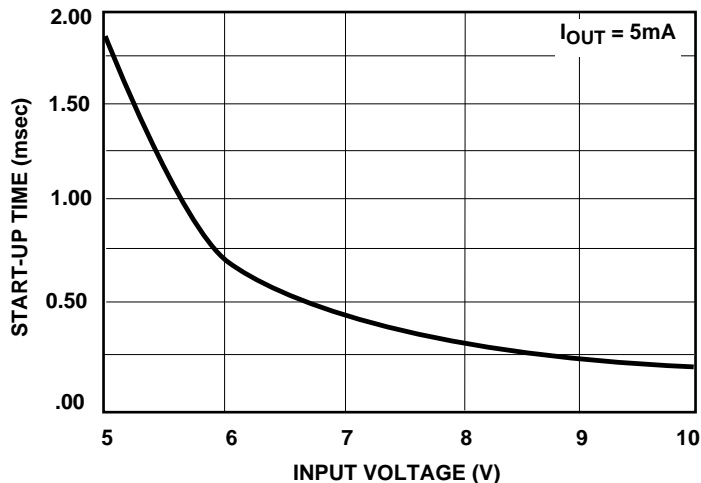
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TYPICAL CHARACTERISTICS

Output Voltage vs. Output Current

V_{IN} = 6V

SUPPLY VOLTAGE

OUTPUT CURRENT (mA)

Output Voltage vs. Input Voltage Over Temperature

I_{OUT} = 3mA

T_A = 85°C T_A = −40°C

T_A = 25°C

OUTPUT VOLTAGE
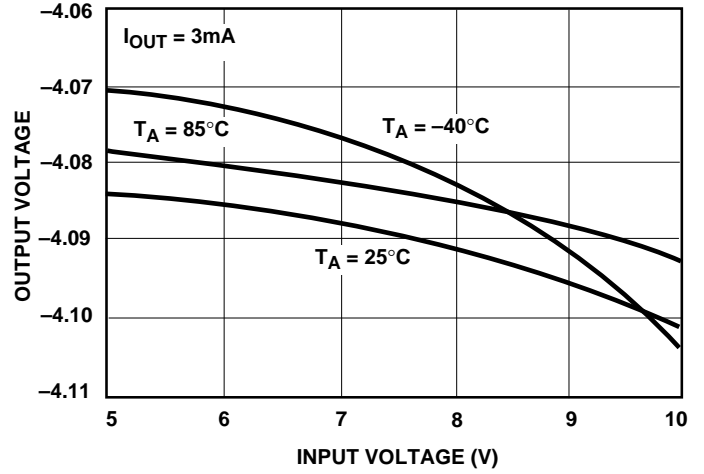
INPUT VOLTAGE (V)

Maximum Output Current vs. Input Voltage

MAXIMUM OUTPUT CURRENT (mA)

INPUT VOLTAGE (V)

No-Load Supply Current vs. Input Voltage

SUPPLY CURRENT (mA)
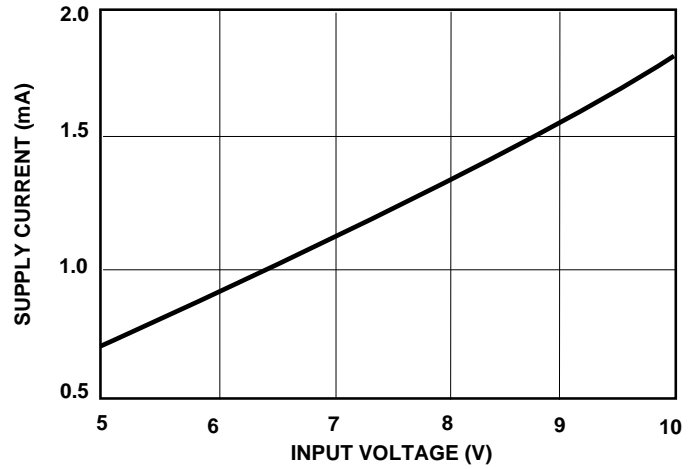
INPUT VOLTAGE (V)

Supply Current vs. Temperature

V_{IN} = 10V

SUPPLY CURRENT (mA)

TEMPERATURE (°C)
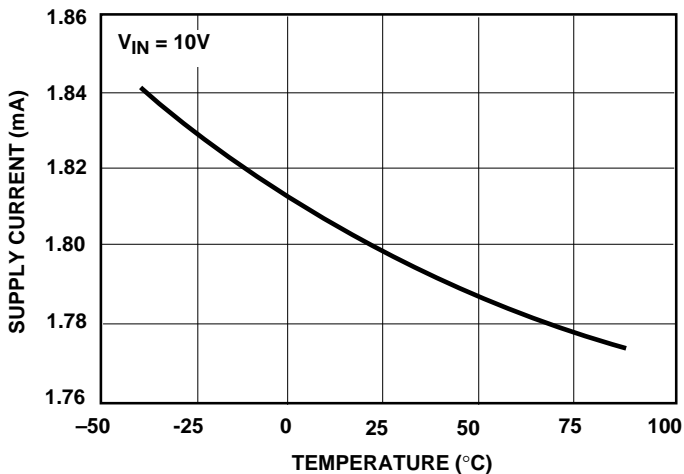
Efficiency vs. Load Current
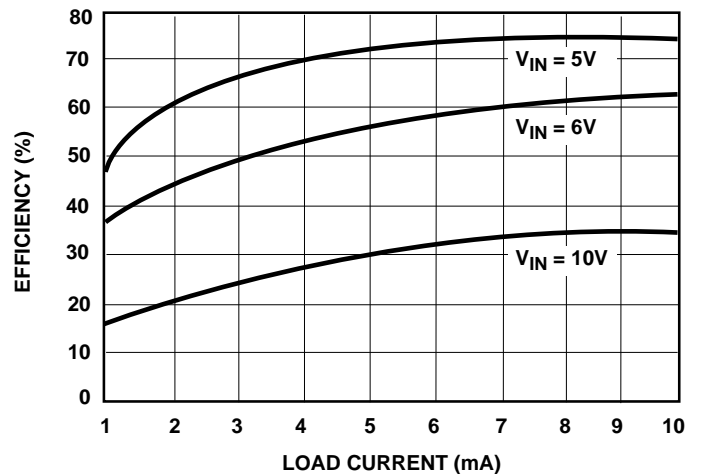
V_{IN} = 5V

V_{IN} = 6V

V_{IN} = 10V

EFFICIENCY (%)

LOAD CURRENT (mA)

TYPICAL CHARACTERISTICS (Cont.)

Start-Up Time vs. Input Voltage

$I_{OUT} = 5mA$

START-UP TIME (msec) vs. INPUT VOLTAGE (V)

PACKAGE DIMENSIONS

8-Pin SOIC

.157 (3.99)
.150 (3.81)

.244 (6.20)
.228 (5.79)

.050 (1.27) TYP.

.197 (5.00)
.189 (4.80)

.069 (1.75)
.053 (1.35)

.020 (0.51)
.013 (0.33)

.010 (0.25)
.004 (0.10)

8° MAX.

.010 (0.25)
.007 (0.18)

.050 (1.27)
.016 (0.40)
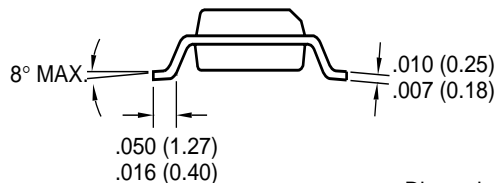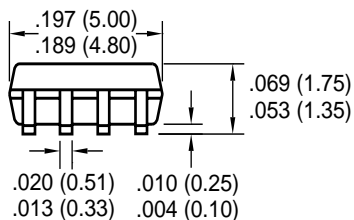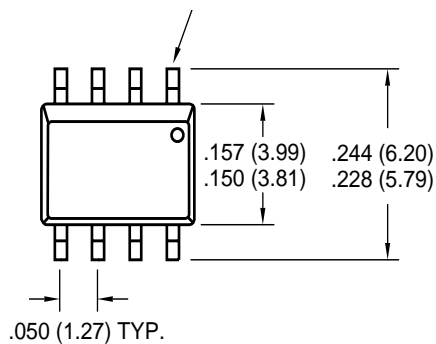
Dimensions: inches (mm)

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