

# LM2578A/LM3578A Switching Regulator

## General Description

The LM2578A is a switching regulator which can easily be set up for such DC-to-DC voltage conversion circuits as the buck, boost, and inverting configurations. The LM2578A features a unique comparator input stage which not only has separate pins for both the inverting and non-inverting inputs, but also provides an internal 1.0V reference to each input, thereby simplifying circuit design and p.c. board layout. The output can switch up to 750 mA and has output pins for its collector and emitter to promote design flexibility. An external current limit terminal may be referenced to either the ground or the  $V_{in}$  terminal, depending upon the application. In addition, the LM2578A has an on board oscillator, which sets the switching frequency with a single external capacitor from <1 Hz to 100 kHz (typical).

The LM2578A is an improved version of the LM2578, offering higher maximum ratings for the total supply voltage and output transistor emitter and collector voltages.

## Features

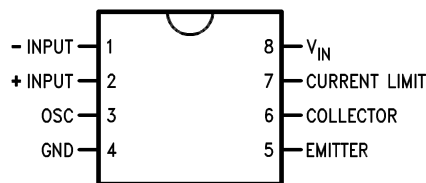
- Inverting and non-inverting feedback inputs
- 1.0V reference at inputs
- Operates from supply voltages of 2V to 40V
- Output current up to 750 mA, saturation less than 0.9V
- Current limit and thermal shut down
- Duty cycle up to 90%

## Applications

- Switching regulators in buck, boost, inverting, and single-ended transformer configurations
- Motor speed control
- Lamp flasher

## Connection Diagram and Ordering Information

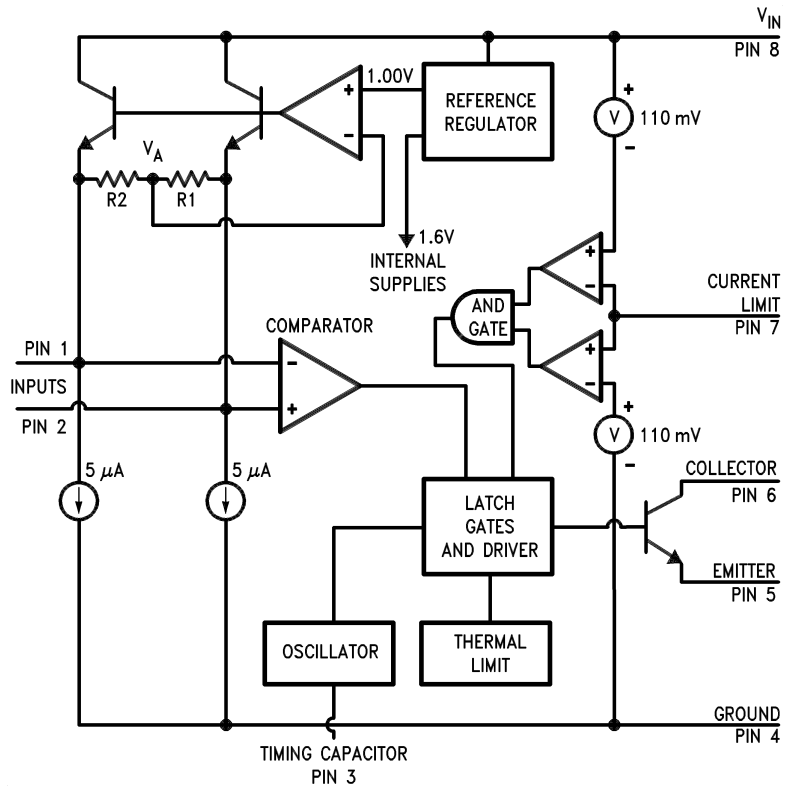
Dual-In-Line Package



00871129

Order Number LM3578AM, LM2578AN or LM3578AN  
See NS Package Number M08A or N08E

# Functional Diagram



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**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Total Supply Voltage	50V
Collector Output to Ground	-0.3V to +50V
Emitter Output to Ground (Note 2)	-1V to +50V
Power Dissipation (Note 3)	Internally limited
Output Current	750 mA
Storage Temperature	-65°C to +150°C
Lead Temperature	
(soldering, 10 seconds)	260°C
Maximum Junction Temperature	150°C

ESD Tolerance (Note 4)

2 kV

**Operating Ratings**

Ambient Temperature Range	
LM2578A	-40°C ≤ T <sub>A</sub> ≤ +85°C
LM3578A	0°C ≤ T <sub>A</sub> ≤ +70°C
Junction Temperature Range	
LM2578A	-40°C ≤ T <sub>J</sub> ≤ +125°C
LM3578A	0°C ≤ T <sub>J</sub> ≤ +125°C

**Electrical Characteristics**

These specifications apply for 2V ≤ V<sub>IN</sub> ≤ 40V (2.2V ≤ V<sub>IN</sub> ≤ 40V for T<sub>J</sub> ≤ -25°C), timing capacitor C<sub>T</sub> = 3900 pF, and 25% ≤ duty cycle ≤ 75%, unless otherwise specified. Values in standard typeface are for T<sub>J</sub> = 25°C; values in **boldface type** apply for operation over the specified operating junction temperature range.

Symbol	Parameter	Conditions	Typical (Note 5)	LM2578A/ LM3578A Limit (Note 6)	Units
<b>OSCILLATOR</b>					
f <sub>OSC</sub>	Frequency		20	24 16	kHz kHz (max) kHz (min)
Δf <sub>OSC</sub> /ΔT	Frequency Drift with Temperature		<b>-0.13</b>		%/°C
	Amplitude		550		mV <sub>p-p</sub>
<b>REFERENCE/COMPARATOR</b> (Note 7)					
V <sub>R</sub>	Input Reference Voltage	I <sub>1</sub> = I <sub>2</sub> = 0 mA and I <sub>1</sub> = I <sub>2</sub> = 1 mA ±1% (Note 8)	1.0	1.050/ <b>1.070</b> 0.950/ <b>0.930</b>	V V (max) V (min)
ΔV <sub>R</sub> /ΔV <sub>IN</sub>	Input Reference Voltage Line Regulation	I <sub>1</sub> = I <sub>2</sub> = 0 mA and I <sub>1</sub> = I <sub>2</sub> = 1 mA ±1% (Note 8)	0.003		%/V %/V (max)
I <sub>INV</sub>	Inverting Input Current	I <sub>1</sub> = I <sub>2</sub> = 0 mA, duty cycle = 25%	0.5		μA
	Level Shift Accuracy	Level Shift Current = 1 mA	1.0	10/ <b>13</b>	% % (max)
ΔV <sub>R</sub> /Δt	Input Reference Voltage Long Term Stability		100		ppm/1000h
<b>OUTPUT</b>					
V <sub>C</sub> (sat)	Collector Saturation Voltage	I <sub>C</sub> = 750 mA pulsed, Emitter grounded	0.7	0.90/ <b>1.2</b>	V V (max)
V <sub>E</sub> (sat)	Emitter Saturation Voltage	I <sub>O</sub> = 80 mA pulsed, V <sub>IN</sub> = V <sub>C</sub> = 40V	1.4	1.7/ <b>2.0</b>	V V (max)
I <sub>CES</sub>	Collector Leakage Current	V <sub>IN</sub> = V <sub>CE</sub> = 40V, Emitter grounded, Output OFF	0.1	200/ <b>250</b>	μA μA (max)
BV <sub>CEO(SUS)</sub>	Collector-Emitter Sustaining Voltage	I <sub>SUST</sub> = 0.2A (pulsed), V <sub>IN</sub> = 0	60	50	V V (min)
<b>CURRENT LIMIT</b>					
V <sub>CL</sub>	Sense Voltage Shutdown Level	Referred to V <sub>IN</sub> or Ground (Note 9)	110	80 160	mV mV (min) mV (max)

## Electrical Characteristics (Continued)

These specifications apply for  $2V \leq V_{IN} \leq 40V$  ( $2.2V \leq V_{IN} \leq 40V$  for  $T_J \leq -25^\circ C$ ), timing capacitor  $C_T = 3900$  pF, and  $25\% \leq$  duty cycle  $\leq 75\%$ , unless otherwise specified. Values in standard typeface are for  $T_J = 25^\circ C$ ; values in **boldface type** apply for operation over the specified operating junction temperature range.

Symbol	Parameter	Conditions	Typical (Note 5)	LM2578A/ LM3578A Limit (Note 6)	Units
<b>CURRENT LIMIT</b>					
$\Delta V_{CL}/\Delta T$	Sense Voltage Temperature Drift		<b>0.3</b>		%/ $^\circ C$
$I_{CL}$	Sense Bias Current	Referred to $V_{IN}$	4.0		$\mu A$
		Referred to ground	0.4		$\mu A$
<b>DEVICE POWER CONSUMPTION</b>					
$I_S$	Supply Current	Output OFF, $V_E = 0V$	2.0	<b>3.5/4.0</b>	mA mA (max)
		Output ON, $I_C = 750$ mA pulsed, $V_E = 0V$	14		mA

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions.

**Note 2:** For  $T_J \geq 100^\circ C$ , the Emitter pin voltage should not be driven more than 0.6V below ground (see Application Information).

**Note 3:** At elevated temperatures, devices must be derated based on package thermal resistance. The device in the 8-pin DIP must be derated at  $95^\circ C/W$ , junction to ambient. The device in the surface-mount package must be derated at  $150^\circ C/W$ , junction-to-ambient.

**Note 4:** Human body model, 1.5 k $\Omega$  in series with 100 pF.

**Note 5:** Typical values are for  $T_J = 25^\circ C$  and represent the most likely parametric norm.

**Note 6:** All limits guaranteed at room temperature (standard type face) and at temperature extremes (bold type face). Room temperature limits are 100% production tested. Limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate AOQL.

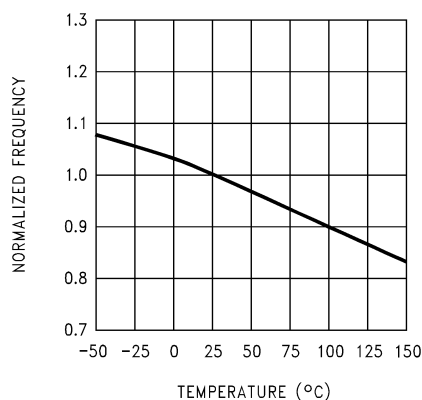
**Note 7:** Input terminals are protected from accidental shorts to ground but if external voltages higher than the reference voltage are applied, excessive current will flow and should be limited to less than 5 mA.

**Note 8:**  $I_1$  and  $I_2$  are the external sink currents at the inputs (refer to Test Circuit).

**Note 9:** Connection of a 10 k $\Omega$  resistor from pin 1 to pin 4 will drive the duty cycle to its maximum, typically 90%. Applying the minimum Current Limit Sense Voltage to pin 7 will not reduce the duty cycle to less than 50%. Applying the maximum Current Limit Sense Voltage to pin 7 is certain to reduce the duty cycle below 50%. Increasing this voltage by 15 mV may be required to reduce the duty cycle to 0%, when the Collector output swing is 40V or greater (see Ground-Referred Current Limit Sense Voltage typical curve).

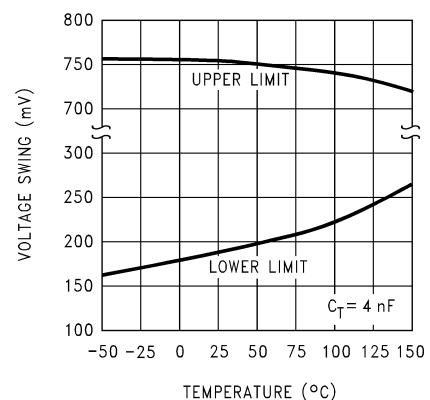
## Typical Performance Characteristics

**Oscillator Frequency Change with Temperature**



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**Oscillator Voltage Swing**



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