



## 5V/3.3V/3V 5A Step-Down, PWM, Switch-Mode DC-DC Regulators

### General Description

The MAX787/MAX788/MAX789 are monolithic, bipolar, pulse-width modulation (PWM), switch-mode, step-down DC-DC regulators. Each is rated at 5A. Very few external components are needed for standard operation because the power switch, oscillator, feedback, and control circuitry are all on-chip. Employing a classic buck topology, these regulators perform high-current step-down functions.

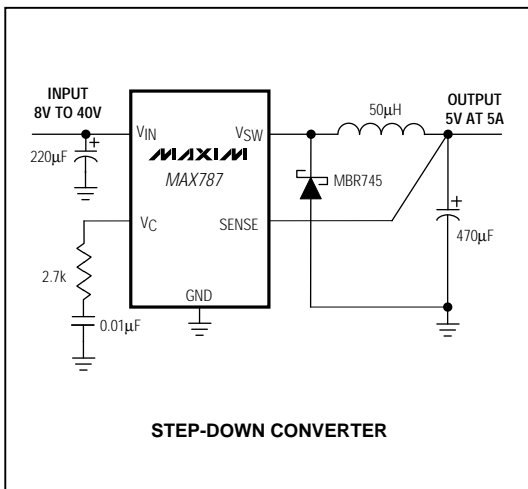
The MAX787/MAX788/MAX789 have excellent dynamic and transient response characteristics, while featuring cycle-by-cycle current limiting to protect against overcurrent faults and short-circuit output faults. They also have a wide 8V to 40V input range.

Each regulator is available in a 5-pin TO-220 package. These devices have a preset 100kHz oscillator frequency and a preset current limit of 6.5A. See the MAX724/MAX726 data sheet for more applications information.

### Applications

- Distributed Power from High-Voltage Buses
- High-Current, High-Voltage Step-Down
- Multiple-Output Buck Converter

### Typical Operating Circuit



### Features

- ◆ **Input Range: Up to 40V**
- ◆ **5A On-Chip Power Switch**
- ◆ **Fixed Outputs: 5V (MAX787)  
3.3V (MAX788)  
3V (MAX789)**
- ◆ **100kHz Switching Frequency**
- ◆ **Excellent Dynamic Characteristics**
- ◆ **Few External Components**
- ◆ **8.5mA Quiescent Current**
- ◆ **TO-220 Package**

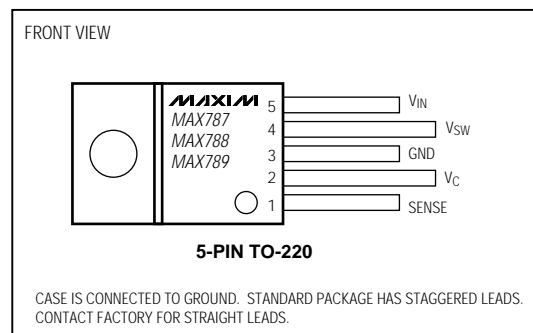
### Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX787CCK	0°C to +70°C	5 TO-220
MAX787ECK	-40°C to +85°C	5 TO-220
MAX788CCK	0°C to +70°C	5 TO-220
MAX788ECK	-40°C to +85°C	5 TO-220
MAX789CCK	0°C to +70°C	5 TO-220
MAX789ECK	-40°C to +85°C	5 TO-220

### Product Selection Guide

PART	V <sub>OUT</sub> (V)	I <sub>OUT</sub> MAX (A)
MAX724	Adjustable	5
MAX726	Adjustable	2
MAX727	5	2
MAX728	3.3	2
MAX729	3	2
MAX787	5	5
MAX788	3.3	5
MAX789	3	5

### Pin Configuration



MAX787/MAX788/MAX789

## 5V/3.3V/3V 5A Step-Down, PWM, Switch-Mode DC-DC Regulators

### ABSOLUTE MAXIMUM RATINGS

Input Voltage	45V	Junction Temperature Ranges	
Switch Voltage with Respect to Input Voltage	50V	MAX78_CCK	0°C to +125°C
Switch Voltage with Respect to GND Pin ( $V_{SW}$ negative) (Note 1)	35V	MAX78_ECK	-40°C to +125°C
SENSE Pin Voltage	-0.3V, +10V	Storage Temperature Range	-65°C to +160°C
Operating Temperature Ranges		Lead Temperature (soldering, 10sec)	+300°C
MAX78_CCK	0°C to +70°C		
MAX78_ECK	-40°C to +85°C		

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond 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.

### ELECTRICAL CHARACTERISTICS

( $V_{IN} = 25V$ ,  $T_J = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Supply Voltage Range			8.0		40.0	V
Switch-On Voltage (Note 1)	$I_{SW} = 1A$	$T_J \geq 0^\circ C$			1.85	V
		$T_J < 0^\circ C$			2.10	
	$I_{SW} = 5A$	$T_J \geq 0^\circ C$			2.30	
		$T_J < 0^\circ C$			2.50	
Switch-Off Leakage	$V_{IN} \leq 25V$ , $V_{SW} = 0V$	$T_J = +25^\circ C$		5	300	$\mu A$
	$V_{IN} = 40V$ , $V_{SW} = 0V$	$T_J = +25^\circ C$		10	500	
Supply Current (Note 3)	$V_{IN} \leq 40V$ , $V_{SENSE} = 5.5V$			8.5	11	mA
Minimum Supply Voltage	Normal Mode			7.3	8.0	V
	Start-Up Mode (Note 4)	$T_J \geq 0^\circ C$		3.5	4.8	
		$T_J < 0^\circ C$		3.5	5.0	
Switch-Current Limit (Note 5)			5.5	6.5	8.5	A
Maximum Duty Cycle			85	90		%
Switching Frequency						kHz
	$V_{OUT} = V_{SENSE} = 0V$ (Note 5)	$T_J = +25^\circ C$	90	100	110	
Switching Frequency Line Regulation						%V
	$8V \leq V_{IN} \leq 40V$			0.03	0.10	
Error-Amplifier Voltage Gain	$1V \leq V_C \leq 4V$	$T_J = +25^\circ C$		2000		V/V
Error-Amplifier Transconductance			3000	5000	9000	$\mu mho$
Error-Amplifier Source Current	$V_{SENSE} = V_{OUT} - 10\%$	$T_J = +25^\circ C$	100	140	225	$\mu A$
Error-Amplifier Sink Current	$V_{SENSE} = V_{OUT} + 10\%$	$T_J = +25^\circ C$	0.6	1.0	1.7	mA

## 5V/3.3V/3V 5A Step-Down, PWM, Switch-Mode DC-DC Regulators

### ELECTRICAL CHARACTERISTICS (continued)

( $V_{IN} = 25V$ ,  $T_j = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
SENSE Voltage	$V_C = 2V$	MAX787	4.85	5.00	5.15	V
		MAX788	3.20	3.30	3.40	
		MAX789	2.90	3.00	3.10	
SENSE Pin Divider Resistance	$T_j = +25^\circ C$	MAX787	3.0	5.0	8.0	k $\Omega$
		MAX788	2.5	4.2	7.0	
		MAX789	2.2	3.8	6.5	
Output Voltage Tolerance	$V_{OUT}$ (nominal) = 5V (MAX787), 3.3V (MAX788), or 3V (MAX789); all conditions of input voltage, output voltage, and load current	$T_j = +25^\circ C$		$\pm 0.5$	$\pm 2.0$	%
		$T_j = T_{MIN}$ to $T_{MAX}$		$\pm 1.0$	$\pm 3.0$	
Output Voltage Line Regulation	$8V \leq V_{IN} \leq 40V$			0.005	0.020	%/V
$V_C$ Voltage	0% duty cycle	$T_j = +25^\circ C$		1.5		V
$V_C$ Voltage Temperature Coefficient	0% duty cycle	$T_j = T_{MIN}$ to $T_{MAX}$		-4		mV/ $^\circ C$
Thermal Resistance Junction to Case (Note 6)					2.5	$^\circ C/W$

**Note 1:** Do not exceed switch-to-input voltage limitation.

**Note 2:** For switch currents between 1A and 5A, maximum switch-on voltage can be calculated via linear interpolation.

**Note 3:** By setting the SENSE pin to 5.5V, the  $V_C$  pin is forced to its low clamp level and the switch duty cycle is forced to zero, approximating the zero load condition.

**Note 4:** For proper regulation, total voltage from  $V_{IN}$  to GND must be  $\geq 8V$  after start-up.

**Note 5:** To avoid extremely short switch-on times, the switch frequency is internally scaled down when  $V_{SENSE}$  is less than 2.6V (MAX787), 2.0V (MAX788), or 1.8V (MAX789). Switch-current limit is tested with  $V_{SENSE}$  adjusted to give a 1 $\mu s$  minimum switch-on time.

**Note 6:** Guaranteed, not production tested.

### Pin Description

PIN	NAME	FUNCTION
1	SENSE	SENSE Input is the internal error amplifier's input, and should be directly connected to $V_{OUT}$ . SENSE also aids current limiting by reducing oscillator frequency when $V_{OUT}$ is low.
2	$V_C$	Error-Amplifier Output. A series RC network connected to this pin compensates the MAX787/MAX788/MAX789. Output swing is limited to about 5.8V in the positive direction and -0.7V in the negative direction. $V_C$ can also synchronize the MAX787/MAX788/MAX789 to an external TTL clock in the 115kHz to 170kHz range. See MAX724/MAX726 data sheet.
3	GND	Ground requires a short, low-noise connection to ensure good load regulation. The internal reference is referred to GND, so errors at this pin are multiplied by the error amplifier.
4	$V_{SW}$	Internal Power Switch Output. The switch output can swing 35V below ground and is rated for 5A.
5	$V_{IN}$	$V_{IN}$ supplies power to the internal circuitry and also connects to the collector of the internal power switch. $V_{IN}$ must be bypassed with a low-ESR capacitor, typically 200 $\mu F$ or 220 $\mu F$ .

# 5V/3.3V/3V 2A Step-Down, PWM, Switch-Mode DC-DC Regulators

## Package Information

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.140	0.190	3.56	4.82
B	0.015	0.040	0.38	1.01
C1	0.014	0.022	0.41	0.50
D	0.560	0.650	14.23	16.51
E	0.380	0.420	9.66	10.66
e	0.067 BSC		1.70 BSC	
F	0.045	0.055	1.14	1.39
H1	0.230	0.270	5.85	6.85
J1	0.080	0.115	2.04	2.92
J2	0.170	0.185	4.32	4.70
J3	0.327	0.335	8.31	8.51
L	0.170	0.200	4.32	5.08
L1	0.260	0.340	6.60	8.64
L2	0.700	0.720	17.78	18.29
φP	0.139	0.161	3.54	4.08
Q	0.100	0.120	2.54	3.04

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**5-PIN TO-220  
(STAGGERED LEAD)  
PACKAGE**

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.140	0.190	3.56	4.82
B	0.015	0.040	0.38	1.01
C1	0.014	0.022	0.41	0.50
D	0.560	0.650	14.23	16.51
E	0.380	0.420	9.66	10.66
e	0.067 BSC		1.70 BSC	
F	0.045	0.055	1.14	1.39
H1	0.230	0.270	5.85	6.85
J1	0.080	0.115	2.04	2.92
L	0.500	0.580	12.70	14.73
φP	0.139	0.161	3.54	4.08
Q	0.100	0.120	2.54	3.04

21-4737-

**5-PIN TO-220  
(STRAIGHT LEAD)  
PACKAGE**

CONTACT FACTORY FOR AVAILABILITY

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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