



High-Efficiency, Quad-Output, Main Power-Supply Controllers for Notebook Computers

General Description

The MAX8732A/MAX8733A/MAX8734A dual step-down, switch-mode power-supply (SMPS) controllers generate logic-supply voltages in battery-powered systems. The MAX8732A/MAX8733A/MAX8734A include two pulse-width modulation (PWM) controllers, adjustable from 2V to 5.5V or fixed at 5V and 3.3V. These devices feature two linear regulators providing 5V and 3.3V always-on outputs. Each linear regulator provides up to 100mA output current with automatic linear-regulator bootstrapping to the main SMPS outputs. The MAX8732A/MAX8733A/MAX8734A include on-board power-up sequencing, a power-good (PGOOD) output, digital soft-start, and internal soft-stop output discharge that prevents negative voltages on shutdown. Additionally, the outputs are high impedance when V_{CC} falls below its UVLO set point while the outputs are enabled.

Maxim's proprietary Quick-PWM™ quick-response, constant on-time PWM control scheme operates without sense resistors and provides 100ns response to load transients while maintaining a relatively constant switching frequency. The unique ultrasonic pulse-skipping mode maintains the switching frequency above 25kHz, which eliminates noise in audio applications. Other features include pulse skipping, which maximizes efficiency in light-load applications, and fixed-frequency PWM mode, which reduces RF interference in sensitive applications.

The MAX8732A features a 200kHz/5V and 300kHz/3.3V SMPS for highest efficiency, while the MAX8733A features a 400kHz/5V and 500kHz/3.3V SMPS for "thin and light" applications. The MAX8734A provides a pin-selectable switching frequency, allowing either 200kHz/300kHz or 400kHz/500kHz operation of the 5V/3.3V SMPSs, respectively. The MAX8732A/MAX8733A/MAX8734A are available in 28-pin QSOP packages and operate over the extended temperature range (-40°C to +85°C).

The MAX8732A/MAX8733A/MAX8734A are pin-for-pin upgrades to the MAX1777/MAX1977/MAX1999. The MAX1999 evaluation kit (EV kit) can be used to evaluate the MAX8732A/MAX8733A/MAX8734A.

Applications

Notebook and Subnotebook Computers
PDAs and Mobile Communication Devices
3- and 4-Cell Li+ Battery-Powered Devices

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Features

- ◆ No Current-Sense Resistor Needed (MAX8734A)
- ◆ Accurate Current Sense with Current-Sense Resistor (MAX8732A/MAX8733A)
- ◆ 1.5% Output Voltage Accuracy
- ◆ 3.3V and 5V 100mA Bootstrapped Linear Regulators
- ◆ Internal Soft-Start and Soft-Stop Output Discharge
- ◆ Quick-PWM with 100ns Load Step Response
- ◆ 3.3V and 5V Fixed or Adjustable Outputs (Dual Mode™)
- ◆ 4.5V to 24V Input Voltage Range
- ◆ Enhanced Ultrasonic Pulse-Skipping Mode (25kHz min)
- ◆ Power-Good (PGOOD) Signal
- ◆ Overvoltage Protection Enable/Disable

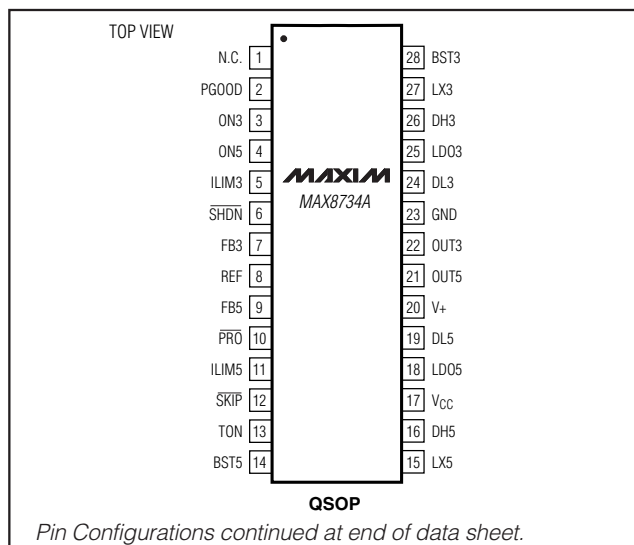
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	5V/3.3V SWITCHING FREQUENCY (kHz)
MAX8732AEEI+	-40°C to +85°C	28 QSOP	200/300
MAX8732AEEI	-40°C to +85°C	28 QSOP	200/300
MAX8733AEEI+	-40°C to +85°C	28 QSOP	400/500
MAX8733AEEI	-40°C to +85°C	28 QSOP	400/500

Ordering Information continued at end of data sheet.

+Denotes lead-free package.

Pin Configurations



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ABSOLUTE MAXIMUM RATINGS

V+, $\overline{\text{SHDN}}$ to GND -0.3V to +25V
 BST_ to GND -0.3V to +30V
 LX_ to BST_ -6V to +0.3V
 CS_ to GND (MAX8732A/MAX8733A only) -2V to +6V
 VCC, LDO5, LDO3, OUT3, OUT5, ON3, ON5, REF,
 FB3, FB5, $\overline{\text{SKIP}}$, $\overline{\text{PRO}}$, PGOOD to GND -0.3V to +6V
 DH3 to LX3 -0.3V to (VBST3 + 0.3V)
 DH5 to LX5 -0.3V to (VBST5 + 0.3V)
 ILIM3, ILIM5 to GND -0.3V to (VCC + 0.3V)
 DL3, DL5 to GND -0.3V to (VLDO5 + 0.3V)
 TON to GND (MAX8734A only) -0.3V to +6V

LDO3, LDO5, REF Short Circuit to GND Momentary
 LDO3 Current (internal regulator) Continuous +100mA
 LDO3 Current (switched over to OUT3) Continuous +200mA
 LDO5 Current (internal regulator) Continuous +100mA
 LDO5 Current (switched over to OUT5) Continuous +200mA
 Continuous Power Dissipation ($T_A = +70^\circ\text{C}$)
 28-Pin QSOP (derate 10.8mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$) 860mW
 Operating Temperature Range -40°C to $+85^\circ\text{C}$
 Junction Temperature $+150^\circ\text{C}$
 Storage Temperature Range -65°C to $+150^\circ\text{C}$
 Lead Temperature (soldering, 10s) $+300^\circ\text{C}$

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

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12\text{V}$, $\text{ON3} = \text{ON5} = V_{\text{CC}}$, $V_{\overline{\text{SHDN}}} = 5\text{V}$, $T_A = 0^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted. Typical values are at $T_A = +25^\circ\text{C}$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
MAIN SMPS CONTROLLERS					
V+ Input Voltage Range	LDO5 in regulation	6		24	V
	$V_+ = \text{LDO5}$, $V_{\text{OUT5}} < 4.43\text{V}$	4.5		5.5	
3.3V Output Voltage in Fixed Mode	$V_+ = 6\text{V}$ to 24V , $\text{FB3} = \text{GND}$, $V_{\overline{\text{SKIP}}} = 5\text{V}$	3.285	3.330	3.375	V
5V Output Voltage in Fixed Mode	$V_+ = 6\text{V}$ to 24V , $\text{FB5} = \text{GND}$, $V_{\overline{\text{SKIP}}} = 5\text{V}$, MAX8732A/MAX8734A ($\text{TON} = V_{\text{CC}}$)	4.975	5.050	5.125	V
	$V_+ = 7\text{V}$ to 24V , $\text{FB5} = \text{GND}$, $V_{\overline{\text{SKIP}}} = 5\text{V}$, MAX8733A/MAX8734A ($\text{TON} = \text{GND}$)				
Output Voltage in Adjustable Mode	$V_+ = 6\text{V}$ to 24V , either SMPS	1.975	2.00	2.025	V
Output Voltage Adjust Range	Either SMPS	2.0		5.5	V
FB3, FB5 Adjustable-Mode Threshold Voltage	Dual-Mode comparator	0.1		0.2	V
DC Load Regulation	Either SMPS, $V_{\overline{\text{SKIP}}} = 5\text{V}$, 0 to 5A		-0.1		%
	Either SMPS, $\overline{\text{SKIP}} = \text{GND}$, 0 to 5A		-1.5		
	Either SMPS, $V_{\overline{\text{SKIP}}} = 2\text{V}$, 0 to 5A		-1.7		
Line Regulation	Either SMPS, $6\text{V} < V_+ < 24\text{V}$		0.005		%/V
Current-Limit Threshold (Positive, Default)	$\text{ILIM}_- = V_{\text{CC}}$, GND - CS_ (MAX8732A/MAX8733A), GND - LX_ (MAX8734A)	93	100	107	mV
Current-Limit Threshold (Positive, Adjustable)	GND - CS_ (MAX8732A/MAX8733A), GND - LX_ (MAX8734A)	$V_{\text{ILIM}_-} = 0.5\text{V}$	40	50	mV
		$V_{\text{ILIM}_-} = 1\text{V}$	93	100	
		$V_{\text{ILIM}_-} = 2\text{V}$	185	200	
Zero-Current Threshold	$\overline{\text{SKIP}} = \text{GND}$, $\text{ILIM}_- = V_{\text{CC}}$, GND - CS_ (MAX8732A/MAX8733A), GND - LX_ (MAX8734A)		3		mV
Current-Limit Threshold (Negative, Default)	$\overline{\text{SKIP}} = \text{ILIM}_- = V_{\text{CC}}$, GND - CS_ (MAX8732A/MAX8733A), GND - LX_ (MAX8734A)		-120		mV
Soft-Start Ramp Time	Zero to full limit		1.7		ms

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ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12V$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5V$, $T_A = 0^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS	
Operating Frequency	MAX8732A or MAX8734A (V _{TON} = 5V), SKIP = V _{CC}	5V SMPS	200			kHz	
		3.3V SMPS	300				
	MAX8733A or MAX8734A (V _{TON} = 0), SKIP = V _{CC}	5V SMPS	400				
		3.3V SMPS	500				
	SKIP = REF		25	36			
On-Time Pulse Width	MAX8732A or MAX8734A (V _{TON} = 5V)	V _{OUT5} = 5.05V	1.895	2.105	2.315	μs	
		V _{OUT3} = 3.33V	0.833	0.925	1.017		
	MAX8733A or MAX8734A (V _{TON} = 0)	V _{OUT5} = 5.05V	0.895	1.052	1.209		
		V _{OUT3} = 3.33V	0.475	0.555	0.635		
Minimum Off-Time			250	300	350	ns	
Maximum Duty Cycle	MAX8732A or MAX8734A (V _{TON} = 5V)	V _{OUT5} = 5.05V	94			%	
		V _{OUT3} = 3.33V	91				
	MAX8733A or MAX8734A (V _{TON} = 0)	V _{OUT5} = 5.05V	88				
		V _{OUT3} = 3.33V	85				
INTERNAL REGULATOR AND REFERENCE							
LDO5 Output Voltage	ON3 = ON5 = GND, 6V < V+ < 24V, 0 < I _{LDO5} < 100mA		4.90	5.00	5.10	V	
LDO5 Short-Circuit Current	LDO5 = GND		190			mA	
LDO5 Undervoltage-Lockout Fault Threshold	Falling edge of LDO5, hysteresis = 1%		3.7	4.0	4.3	V	
LDO5 Bootstrap Switch Threshold	Falling edge of OUT5, rising edge at OUT5 regulation point		4.43	4.56	4.69	V	
LDO5 Bootstrap Switch Resistance	LDO5 to OUT5, V _{OUT5} = 5V		1.4			3.2	Ω
LDO3 Output Voltage	ON3 = ON5 = GND, 6V < V+ < 24V, 0 < I _{LDO3} < 100mA		3.28	3.35	3.42	V	
LDO3 Short-Circuit Current	LDO3 = GND		180			mA	
LDO3 Bootstrap Switch Threshold	Falling edge of OUT3, rising edge at OUT3 regulation point		2.80	2.91	3.02	V	
LDO3 Bootstrap Switch Resistance	LDO3 to OUT3, V _{OUT3} = 3.2V		1.5			3.5	Ω
REF Output Voltage	No external load		1.980	2.000	2.020	V	
REF Load Regulation	0 < I _{LOAD} < 50μA		10			mV	
REF Sink Current	REF in regulation		10			μA	
V+ Operating Supply Current	LDO5 switched over to OUT5, 5V SMPS		25			50	μA
V+ Standby Supply Current	V+ = 6V to 24V, both SMPSs off, includes I _{SHDN}		150			250	μA
V+ Shutdown Supply Current	V+ = 4.5V to 24V		6			15	μA
Quiescent Power Consumption	Both SMPSs on, FB3 = FB5 = $\overline{\text{SKIP}}$ = GND, V _{OUT3} = 3.5V, V _{OUT5} = 5.3V		3			4.5	mW
FAULT DETECTION							
Overvoltage Trip Threshold	FB3 or FB5 with respect to nominal regulation point		+8	+11	+14	%	

MAX8732A/MAX8733A/MAX8734A

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ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12V$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5V$, $T_A = 0^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Overvoltage Fault Propagation Delay	FB3 or FB5 delay with 50mV overdrive		10		μs
PGOOD Threshold	FB3 or FB5 with respect to nominal output, falling edge, typical hysteresis = 1%	-12	-9.5	-7	%
PGOOD Propagation Delay	Falling edge, 50mV overdrive		10		μs
PGOOD Output Low Voltage	$I_{SINK} = 4mA$			0.3	V
PGOOD Leakage Current	High state, forced to 5.5V			1	μA
Thermal-Shutdown Threshold			+160		$^\circ C$
Output Undervoltage Shutdown Threshold	FB3 or FB5 with respect to nominal output voltage	65	70	75	%
Output Undervoltage Shutdown Blanking Time	From ON_+ signal	10	22	35	ms
INPUTS AND OUTPUTS					
Feedback Input Leakage Current	$V_{FB3} = V_{FB5} = 2.2V$	-200	+40	+200	nA
$\overline{PRO}$ Input Voltage	Low level			0.6	V
	High level	1.5			
$\overline{SKIP}$ Input Voltage	Low level			0.8	V
	Float level	1.7		2.3	
	High level	2.4			
TON Input Voltage	Low level			0.8	V
	High level	2.4			
ON3, ON5 Input Voltage	Clear fault level/SMPS off level			0.8	V
	Delay start level	1.7		2.3	
	SMPS on level	2.4			
Input Leakage Current	$V_{\overline{PRO}}$ or $V_{TON} = 0$ or 5V	-1		+1	μA
	$V_{ON_+} = 0$ or 5V	-2		+2	
	$V_{\overline{SKIP}} = 0$ or 5V	-1		+1	
	$V_{SHDN} = 0$ or 24V	-1		+1	
	$V_{CS_+} = 0$ or 5V	-2		+2	
	$V_{ILIM3}, V_{ILIM5} = 0$ or 2V	-0.2		+0.2	
$\overline{SHDN}$ Input Trip Level	Rising edge	1.2	1.6	2.0	V
	Falling edge	0.96	1.00	1.04	
DH_ Gate-Driver Sink/Source Current	DH3, DH5 forced to 2V		2		A
DL_ Gate-Driver Source Current	DL3 (source), DL5 (source), forced to 2V		1.7		A
DL_ Gate-Driver Sink Current	DL3 (sink), DL5 (sink), forced to 2V		3.3		A
DH_ Gate-Driver On-Resistance	BST - LX_ forced to 5V		1.5	4.0	Ω
DL_ Gate-Driver On-Resistance	DL_, high state (pullup)		2.2	5.0	Ω
	DL_, low state (pulldown)		0.6	1.5	

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MAX8732A/MAX8733A/MAX8734A

ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12V$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5V$, $T_A = 0^\circ C$ to $+85^\circ C$, unless otherwise noted. Typical values are at $T_A = +25^\circ C$.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
OUT3, OUT5 Discharge-Mode On-Resistance			12	40	Ω
OUT3, OUT5 Discharge-Mode Synchronous Rectifier Turn-On Level		0.2	0.3	0.4	V

ELECTRICAL CHARACTERISTICS

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12V$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5V$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
MAIN SMPS CONTROLLERS					
V+ Input Voltage Range	LDO5 in regulation	6		24	V
	$V_+ = LDO5$, $V_{OUT5} < 4.41V$	4.5		5.5	
3.3V Output Voltage in Fixed Mode	$V_+ = 6V$ to $24V$, $FB3 = GND$, $V_{SKIP} = 5V$	3.27		3.39	V
5V Output Voltage in Fixed Mode	$V_+ = 6V$ to $24V$, $FB5 = GND$, $V_{SKIP} = 5V$, MAX8732A/MAX8734A ($T_{ON} = V_{CC}$)	4.95		5.15	V
	$V_+ = 7V$ to $24V$, $FB5 = GND$, $V_{SKIP} = 5V$, MAX8733A/MAX8734A ($T_{ON} = GND$)				
Output Voltage in Adjustable Mode	$V_+ = 6V$ to $24V$, either SMPS	1.97		2.03	V
Output Voltage Adjust Range	Either SMPS	2.0		5.5	V
FB3, FB5 Adjustable-Mode Threshold Voltage	Dual-Mode comparator	0.1		0.2	V
Current-Limit Threshold (Positive, Default)	$ILIM_+ = V_{CC}$, $GND - CS_+$ (MAX8732A/MAX8733A), $GND - LX_+$ (MAX8734A)	90		110	mV
Current-Limit Threshold (Positive, Adjustable)	$GND - CS_+$ (MAX8732A/MAX8733A), $GND - LX_+$ (MAX8734A)	$V_{ILIM_+} = 0.5V$	40	60	mV
		$V_{ILIM_+} = 1V$	90	110	
		$V_{ILIM_+} = 2V$	180	220	
On-Time Pulse Width	MAX8732A or MAX8734A ($V_{TON} = 5V$)	$V_{OUT5} = 5.05V$	1.895	2.315	μs
		$V_{OUT3} = 3.33V$	0.833	1.017	
	MAX8733A or MAX8734A ($V_{TON} = 0$)	$V_{OUT5} = 5.05V$	0.895	1.209	
		$V_{OUT3} = 3.33V$	0.475	0.635	
Minimum Off-Time		200		400	ns
INTERNAL REGULATOR AND REFERENCE					
LDO5 Output Voltage	$ON3 = ON5 = GND$, $6V < V_+ < 24V$, $0 < I_{LDO5} < 100mA$	4.90		5.10	V
LDO5 Undervoltage-Lockout Fault Threshold	Falling edge of LDO5, hysteresis = 1%	3.7		4.3	V

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ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12.0\text{V}$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5\text{V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LDO5 Bootstrap Switch Threshold	Falling edge of OUT5, rising edge at OUT5 regulation point	4.43		4.69	V
LDO5 Bootstrap Switch Resistance	LDO5 to OUT5, $V_{OUT5} = 5\text{V}$			3.2	Ω
LDO3 Output Voltage	$ON3 = ON5 = \text{GND}$, $6\text{V} < V_+ < 24\text{V}$, $0 < I_{LDO3} < 100\text{mA}$	3.27		3.43	V
LDO3 Bootstrap Switch Threshold	Falling edge of OUT3, rising edge at OUT3 regulation point	2.80		3.02	V
LDO3 Bootstrap Switch Resistance	LDO3 to OUT3, $V_{OUT3} = 3.2\text{V}$			3.5	Ω
REF Output Voltage	No external load	1.975		2.025	V
REF Load Regulation	$0 < I_{LOAD} < 50\mu\text{A}$			10	mV
REF Sink Current	REF in regulation	10			μA
V_+ Operating Supply Current	LDO5 switched over to OUT5, 5V SMPS			50	μA
V_+ Standby Supply Current	$V_+ = 6\text{V}$ to 24V , both SMPSs off, includes I_{SHDN}			300	μA
V_+ Shutdown Supply Current	$V_+ = 4.5\text{V}$ to 24V			15	μA
Quiescent Power Consumption	Both SMPSs on, $FB3 = FB5 = \overline{\text{SKIP}} = \text{GND}$, $V_{OUT3} = 3.5\text{V}$, $V_{OUT5} = 5.3\text{V}$			4.5	mW
FAULT DETECTION					
Overvoltage Trip Threshold	FB3 or FB5 with respect to nominal regulation point	+8		+14	%
PGOOD Threshold	FB3 or FB5 with respect to nominal output, falling edge, typical hysteresis = 1%	-12		-7	%
PGOOD Output Low Voltage	$I_{SINK} = 4\text{mA}$			0.3	V
PGOOD Leakage Current	High state, forced to 5.5V			1	μA
Output Undervoltage Shutdown Threshold	FB3 or FB5 with respect to nominal output voltage	65		75	%
Output Undervoltage Shutdown Blanking Time	From ON_+ signal	10		40	ms
INPUTS AND OUTPUTS					
Feedback Input Leakage Current	$V_{FB3} = V_{FB5} = 2.2\text{V}$	-200		+200	nA
$\overline{\text{PRO}}$ Input Voltage	Low level			0.6	V
	High level	1.5			
$\overline{\text{SKIP}}$ Input Voltage	Low level			0.8	V
	Float level	1.7		2.3	
	High level	2.4			
TON Input Voltage	Low level			0.8	V
	High level	2.4			

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ELECTRICAL CHARACTERISTICS (continued)

(Circuit of Figure 1 and Figure 2, no load on LDO5, LDO3, OUT3, OUT5, and REF, $V_+ = 12.0\text{V}$, $ON3 = ON5 = V_{CC}$, $V_{SHDN} = 5\text{V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
ON3, ON5 Input Voltage	Clear fault level/SMPS off level			0.8	V
	Delay start level	1.7		2.3	
	SMPS on level	2.4			
Input Leakage Current	V_{PRO} or $V_{TON} = 0$ or 5V	-1		+1	μA
	$V_{ON} = 0$ or 5V	-1		+1	
	$V_{SKIP} = 0$ or 5V	-2		+2	
	$V_{SHDN} = 0$ or 24V	-1		+1	
	$V_{CS} = 0$ or 5V	-2		+2	
	V_{ILIM3} , $V_{ILIM5} = 0$ or 2V	-0.2		+0.2	
$\overline{\text{SHDN}}$ Input Trip Level	Rising edge	1.2		2.0	V
	Falling edge	0.96		1.04	
DH_ Gate-Driver On-Resistance	BST - LX_ forced to 5V			4.0	Ω
DL_ Gate-Driver On-Resistance	DL_, high state (pullup)			5.0	Ω
	DL_, low state (pulldown)			1.5	
OUT3, OUT5 Discharge-Mode On-Resistance				40	Ω
OUT3, OUT5 Discharge-Mode Synchronous Rectifier Turn-On Level		0.2		0.4	V

Note 1: Specifications to -40°C are guaranteed by design, not production tested.

MAX8732A/MAX8733A/MAX8734A