

Single-Port, 40W, IEEE 802.3af/at PSE Controller with Integrated MOSFET

General Description

The MAX5971A is a single-port, power-sourcing equipment (PSE) power controller designed for use in IEEE® 802.3af/at-compliant PSE. This device provides powered device (PD) discovery, classification, current limit, and DC and AC load-disconnect detections. The MAX5971A operates automatically without the need for any software programming and features an integrated power MOSFET and sense resistor. The device also supports new Class 5 and 2-event classification for detection and classification of high-power PDs. The MAX5971A provides up to 40W to a single port (Class 5 enabled) and still provides high-capacitance detection for legacy PDs.

The MAX5971A provides input undervoltage lockout (UVLO), input overvoltage lockout, overtemperature detection, output voltage slew-rate limit during startup, and LED status indication.

The MAX5971A is available in a space-saving, 28-pin TQFN (5mm x 5mm) power package, and is rated for the extended (-40°C to +85°C) temperature range.

Applications

Single-Port PSE End-Point Applications
 Single-Port PSE Power Injectors (Midspan Applications)
 Switches/Routers
 Industrial Automation Equipment
 Wireless LAN Access Point/WiMAX™ Base Station

Features

- ◆ IEEE 802.3af/at Compliant
- ◆ Up to 40W for Single-Port PSE Applications
- ◆ Integrated 0.5Ω Power MOSFET and Sense Resistor
- ◆ PD Detection and Classification
- ◆ Programmable Current Limit for Class 5 PDs
- ◆ High-Capacitance Detection for Legacy Devices
- ◆ Supports Both DC and AC Load Removal Detections
- ◆ Current Foldback and Duty Cycle-Controlled Current Limit
- ◆ LED Indicator for Port Status
- ◆ Direct Fast-Shutdown Control Capability
- ◆ Space-Saving, 28-Pin TQFN (5mm x 5mm) Package

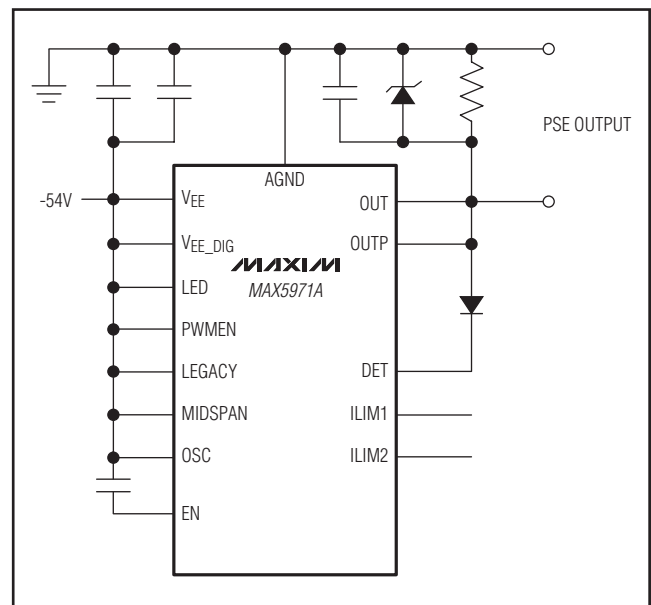
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX5971AETI+	-40°C to +85°C	28 TQFN-EP*

+Denotes a lead(Pb)-free/RoHS-compliant package.

*EP = Exposed pad.

Typical Operating Circuit



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ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to V_{EE}, unless otherwise noted.)

AGND, DET, LED	-0.3V to +80V
OUT	-0.3V to (V _{AGND} + 0.3V)
OUTP	-6V to (V _{AGND} + 0.3V)
VEE_DIG	-0.3V to +0.3V
OSC	-0.3V to +6V
EN, PWMEN, MIDSPAN, LEGACY, ILIM1, ILIM2	-0.3V to +4V
Maximum Current Into LED	40mA
Maximum Current Into OUT	Internally regulated
Continuous Power Dissipation (T _A = +70°C)	
28-Pin TQFN (derate 34.5mW/°C above +70°C)	2758mW

Package Thermal Resistance (Note 1)

θ _{JA}	29°C/W
θ _{JC}	2°C/W
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C
Soldering Temperature (reflow)	+260°C

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maxim-ic.com/thermal-tutorial.

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_{AGND} - V_{EE} = 32V to 60V, T_A = -40°C to +85°C, all voltages are referenced to V_{EE}, unless otherwise noted. Typical values are at V_{AGND} - V_{EE} = +54V, T_A = +25°C. Currents are positive when entering the pin and negative otherwise.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
POWER SUPPLIES							
Operating Voltage Range	V _{AGND}	V _{AGND} - V _{EE}	32		60	V	
Supply Current	I _{EE}	V _{OUT} = V _{EE} , all logic inputs unconnected, measured at AGND in power mode		2.5	4	mA	
CURRENT LIMIT							
Current Limit	I _{LIM}	Maximum I _{LOAD} allowed during current-limit conditions, V _{OUT} = 0V (Note 3)	Class 0, 1, 2, 3	400	420	441	mA
			Class 4	684	720	756	
			Class 5 if ILIM1 = V _{EE} , ILIM2 = unconnected	807	850	893	
			Class 5 if ILIM1 = unconnected, ILIM2 = V _{EE}	855	900	945	
			Class 5 if ILIM1 = V _{EE} , ILIM2 = V _{EE}	902	950	998	
Foldback Initial OUT Voltage	V _{FLBK_ST}	V _{AGND} - V _{OUT} below which the current limit starts folding back		27		V	
Foldback Final OUT Voltage	V _{FLBK_END}	V _{AGND} - V _{OUT} below which the current limit reaches I _{TH_FB}		10		V	
Minimum Foldback Current Limit Threshold	I _{TH_FB}	V _{OUT} = V _{AGND}		166		mA	

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ELECTRICAL CHARACTERISTICS (continued)

(V_{AGND} - V_{EE} = 32V to 60V, T_A = -40°C to +85°C, all voltages are referenced to V_{EE}, unless otherwise noted. Typical values are at V_{AGND} - V_{EE} = +54V, T_A = +25°C. Currents are positive when entering the pin and negative otherwise.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
OVERCURRENT							
Overcurrent Threshold	I _{CUT}	Overcurrent threshold allowed for t ≤ t _{FAULT} , V _{OUT} = 0V (Note 3)	Class 0, 1, 2, 3	351	370	389	mA
			Class 4	602	634	666	
			Class 5 if ILIM1 = V _{EE} , ILIM2 = unconnected	710	748	785	
			Class 5 if ILIM1 = unconnected, ILIM2 = V _{EE}	752	792	832	
			Class 5 if ILIM1 = V _{EE} , ILIM2 = V _{EE}	794	836	878	
INTERNAL POWER							
DMOS On-Resistance	R _{DS(ON)}	Measured from OUT to V _{EE} , I _{OUT} = 100mA	T _A = +25°C	0.5	0.9	Ω	
			T _A = +85°C	0.6	1.3		
Power-Off OUT Leakage Current	I _{OUT_LEAK}	V _{EN} = V _{EE} , V _{OUT} = V _{AGND}			10	μA	
SUPPLY MONITORS							
V _{EE} Undervoltage Lockout	V _{EE_UVLO}	V _{AGND} - V _{EE} , V _{AGND} increasing		28.5		V	
V _{EE} Undervoltage Lockout Hysteresis	V _{EE_UVLOH}	Port is shutdown if: V _{AGND} - V _{EE} < V _{EE_UVLO} - V _{EE_UVLOH}		3		V	
V _{EE} Overvoltage Lockout	V _{EE_OV}	V _{AGND} - V _{EE} > V _{EE_OV} , V _{AGND} increasing		62.5		V	
V _{EE} Overvoltage Lockout Hysteresis	V _{EE_OVH}			1		V	
Thermal Shutdown Threshold	T _{SHD}	Port is shutdown and device resets if the junction temperature exceeds this limit, temperature increasing		150		°C	
Thermal Shutdown Hysteresis	T _{SHDH}	Temperature decreasing		20		°C	
OUTPUT MONITOR							
OUT Input Current	I _{BOUT}	V _{OUT} = V _{AGND} , probing phases			6	μA	
Idle Pullup Current at OUT	I _{DIS}	OUTP discharge current, detection and classification off, port shutdown, V _{OUTP} = V _{AGND} - 2.8V	200		265	μA	
Short to V _{EE} Detection Threshold	DCN _{TH}	V _{OUT} - V _{EE} , V _{OUT} decreasing, enabled during detection	1.5	2.0	2.5	V	
Short to V _{EE} Detection Threshold Hysteresis	DCN _{HY}			220		mV	
LOAD DISCONNECT							
DC Load-Disconnect Threshold	I _{DC_{TH}}	Minimum load current allowed before disconnect (DC disconnect active), V _{OUT} = 0V	5	7.5	10	mA	
AC Load-Disconnect Threshold	I _{ACTH}	Current into DET, for I _{DET} < I _{ACTH} the port powers off (AC disconnect active)	115	130	145	μA	

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ELECTRICAL CHARACTERISTICS (continued)

(V_{AGND} - V_{EE} = 32V to 60V, T_A = -40°C to +85°C, all voltages are referenced to V_{EE}, unless otherwise noted. Typical values are at V_{AGND} - V_{EE} = +54V, T_A = +25°C. Currents are positive when entering the pin and negative otherwise.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
Triangular Wave Peak-to-Peak Voltage Amplitude	AMP _{TRW}	Measured at DET, referred to AGND	3.85	4	4.2	V	
OSC Pullup/Pulldown Currents	I _{OSC}	Measured at OSC	26	32	39	μA	
ACD_EN Threshold	V _{ACD_EN}	V _{OSC} - V _{EE} > V _{ACD_EN} to activate AC disconnect	270	330	380	mV	
Load Disconnect Timer	t _{DISC}	Time from I _{RSENSE} < I _{DCTH} (DC disconnect active) or I _{DET} < I _{ACTH} (AC disconnect active) to gate shutdown	300		400	ms	
DETECTION							
Detection Probe Voltage (First Phase)	V _{DPH1}	V _{AGND} - V _{DET} during the first detection phase	3.8	4	4.2	V	
Detection Probe Voltage (Second Phase)	V _{DPH2}	V _{AGND} - V _{DET} during the second detection phase	9	9.3	9.6	V	
Current-Limit Protection	I _{DLIM}	V _{DET} = V _{AGND} during detection, measure current through DET	1.50	1.75	2.00	mA	
Short-Circuit Threshold	V _{DCP}	If V _{AGND} - V _{OUT} < V _{DCP} after the first detection phase a short circuit to AGND is detected.		1		V	
Open-Circuit Threshold	I _{D_OPEN}	First point measurement current threshold for open condition		20		μA	
Resistor Detection Window	R _{DOK}	(Note 4)	19		26.5	kΩ	
Resistor Rejection Window	R _{DBAD}	Detection rejects lower values			15.5	kΩ	
		Detection rejects higher values	32				
CLASSIFICATION							
Classification Probe Voltage	V _{CL}	V _{AGND} - V _{DET} during classification	16		20	V	
Current-Limit Protection	I _{CILIM}	V _{DET} = V _{AGND} , during classification measure current through DET	65		80	mA	
Classification Current Thresholds	I _{CL}	Classification current thresholds between classes	Class 0, Class 1	5.5	6.5	7.5	mA
			Class 1, Class 2	13.0	14.5	16.0	
			Class 2, Class 3	21	23	25	
			Class 3, Class 4	31	33	35	
			Class 4 upper limit (Note 5)	45	48	51	
Mark Event Voltage	V _{MARK}	V _{AGND} - V _{DET} during mark event	8		10	V	
Mark Event Current Limit	I _{MARK_LIM}	V _{DET} = V _{AGND} , during mark event measure current through DET	55		80	mA	

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ELECTRICAL CHARACTERISTICS (continued)

(V_{AGND} - V_{EE} = 32V to 60V, T_A = -40°C to +85°C, all voltages are referenced to V_{EE}, unless otherwise noted. Typical values are at V_{AGND} - V_{EE} = +54V, T_A = +25°C. Currents are positive when entering the pin and negative otherwise.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DIGITAL INPUTS/OUTPUTS (Voltages referenced to V_{EE})						
Digital Input Low	V _{IL}				0.8	V
Digital Input High	V _{IH}		2.4			V
Internal Input Pullup Current	I _{PU}	Pullup current to internal digital supply to set default values	3	5	7	μA
LED Output Low Voltage	V _{LED_LOW}	I _{LED} = 10mA, PWM disabled, port power-on			0.8	V
LED Output Leakage	I _{LED_LEAK}	PWM disabled, shutdown mode, V _{LED} = 60V			10	μA
PWM Frequency				25		kHz
PWM Duty Cycle				6.25		%
TIMING						
Startup Time	t _{START}	Time during which a current limit set to 420mA is allowed, starts when power is turned on	50	60	70	ms
Fault Time	t _{FAULT}	Maximum allowed time for an overcurrent condition set by I _{CUT} after startup	50	60	70	ms
Detection Reset Time	t _{ME}	Time allowed for the port voltage to reset before detection starts		80	90	ms
Detection Time	t _{DET}	Maximum time allowed before detection is completed			330	ms
Midspan Mode Detection Delay	t _{DMID}		2	2.2	2.4	s
Classification Time	t _{CLASS}	Time allowed for classification		19	23	ms
Mark Event Time		Time allowed for mark event	7	9	11	ms
V _{EEUVLO} Turn-On Delay	t _{DLY}	Time V _{AGND} must be above the V _{EEUVLO} thresholds before the device operates		5.2		ms
Restart Timer	t _{RESTART}	Time the device waits before turning on after an overcurrent fault		16 x t _{FAULT}		ms

Note 2: This device is production tested at T_A = +25°C. Limits at T_A = -40°C and +85°C are guaranteed by design.

Note 3: If I_{LIM1} and I_{LIM2} are both unconnected, Class 5 detection is disabled. See the *Class 5 PD Classification* section and Table 3 for details and settings.

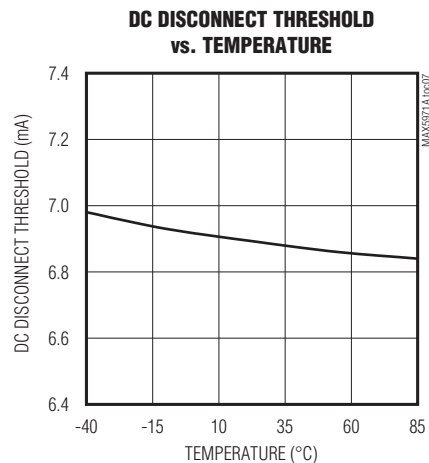
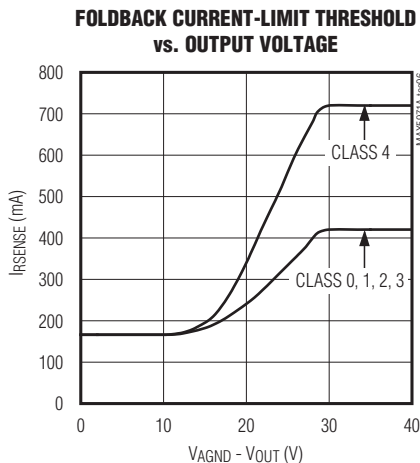
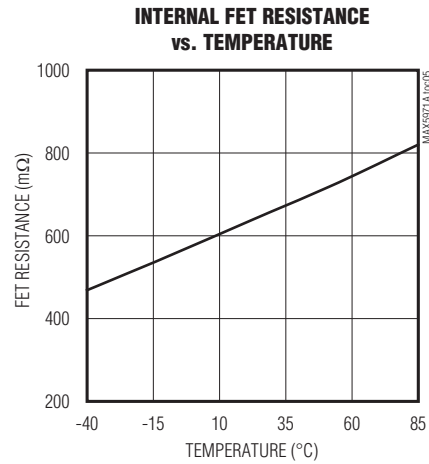
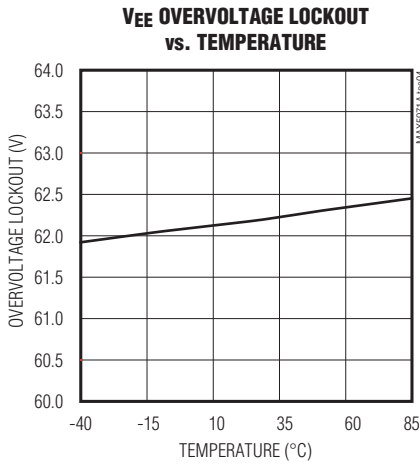
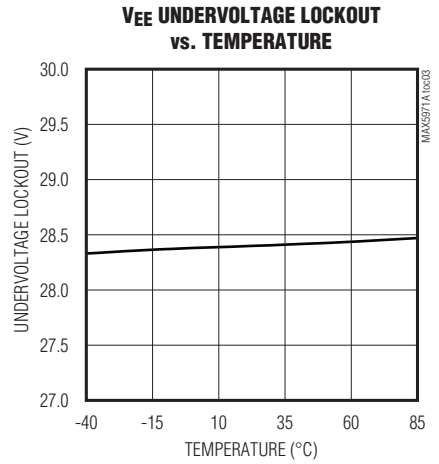
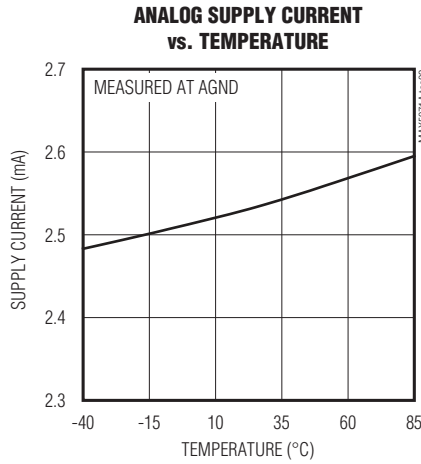
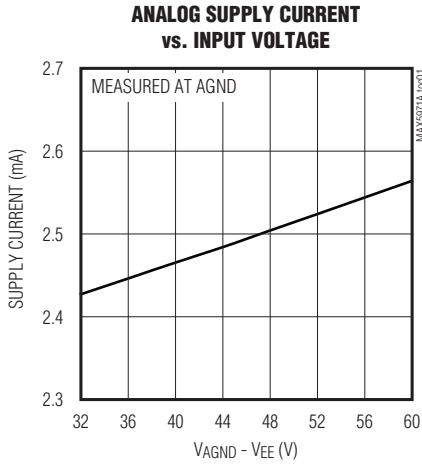
Note 4: $R_{DOK} = (V_{OUT2} - V_{OUT1}) / (I_{DET2} - I_{DET1})$. V_{OUT1}, V_{OUT2}, I_{DET2}, and I_{DET1} represent the voltage at OUT and the current at DET during phase 1 and 2 of the detection, respectively.

Note 5: If Class 5 is enabled, this is the classification current thresholds from Class 4 to Class 5.

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Typical Operating Characteristics

($T_A = +25^\circ\text{C}$, unless otherwise noted.)



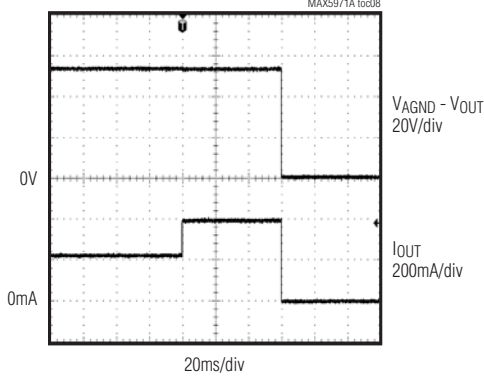
Single-Port, 40W, IEEE 802.3af/802.3at PSE Controller with Integrated MOSFET

Typical Operating Characteristics (continued)

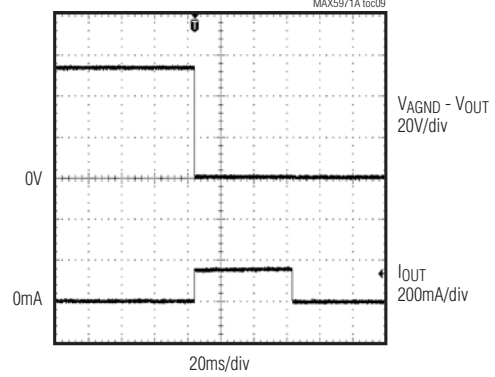
($T_A = +25^\circ\text{C}$, unless otherwise noted.)

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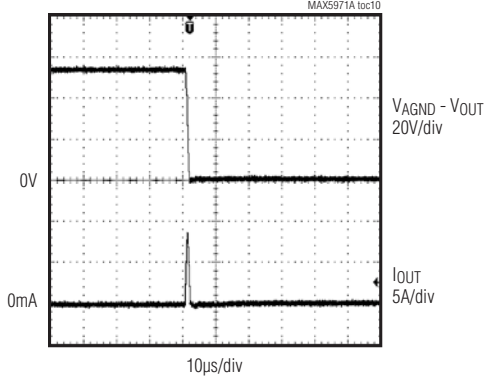
OVERCURRENT TIMEOUT (240Ω TO 138Ω)



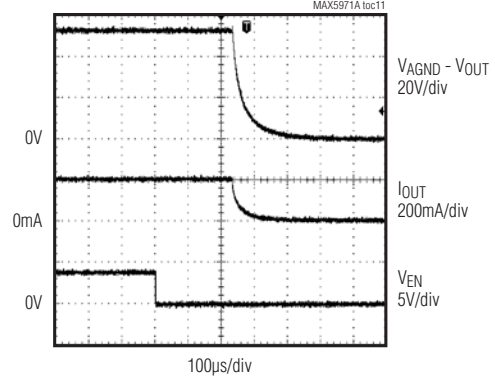
SHORT-CIRCUIT RESPONSE TIME



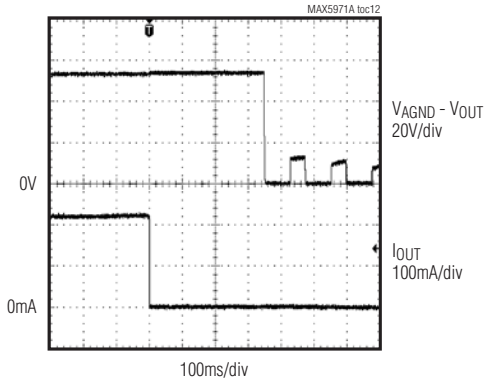
SHORT-CIRCUIT TRANSIENT RESPONSE



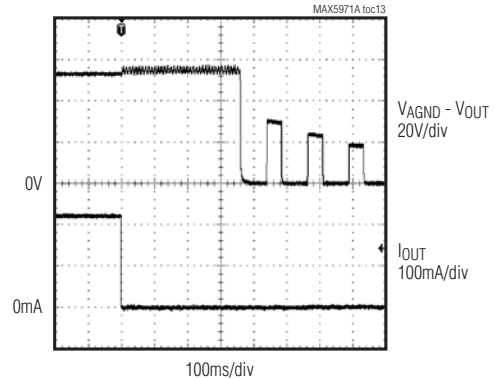
EN TO OUT TURN-OFF DELAY



ZERO-CURRENT DETECTION WAVEFORM WITH DC DISCONNECT ENABLED



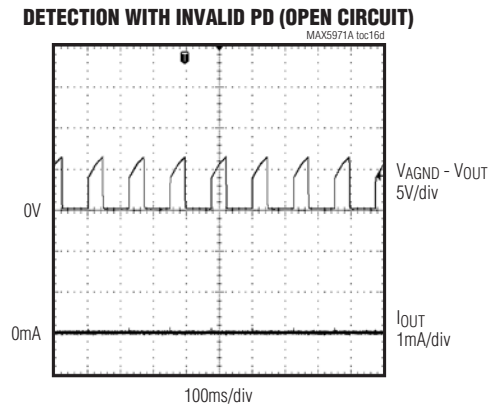
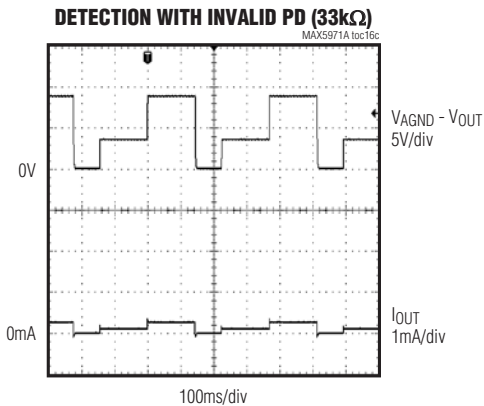
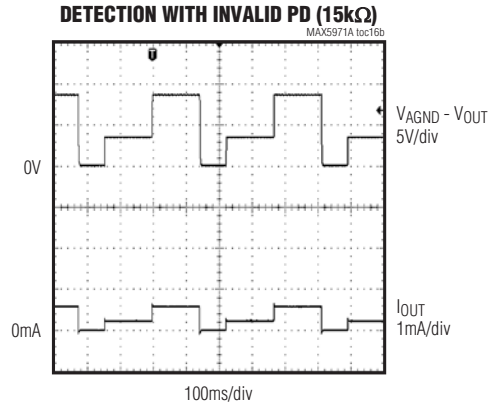
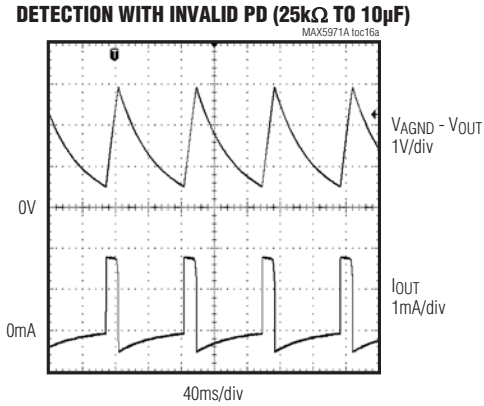
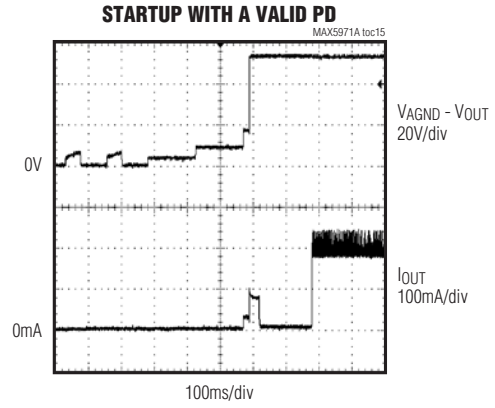
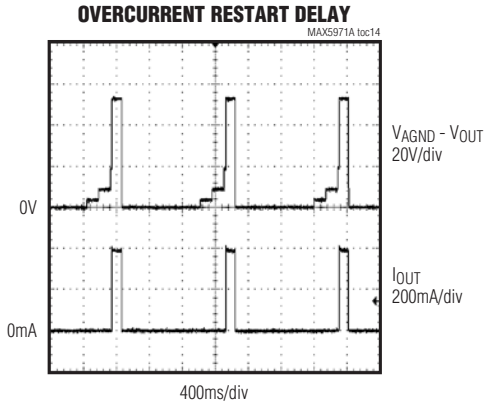
ZERO-CURRENT DETECTION WAVEFORM WITH AC DISCONNECT ENABLED



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Typical Operating Characteristics (continued)

($T_A = +25^\circ\text{C}$, unless otherwise noted.)



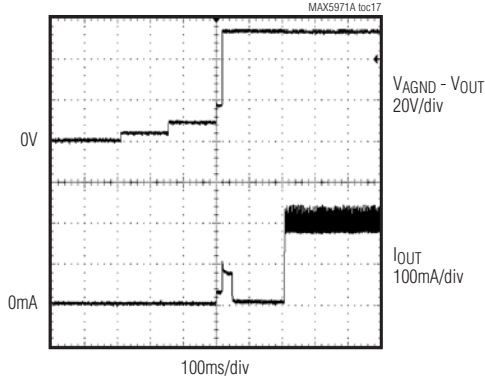
Single-Port, 40W, IEEE 802.3af/802.3at PSE Controller with Integrated MOSFET

Typical Operating Characteristics (continued)

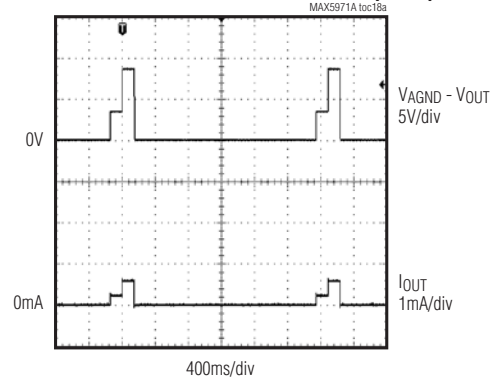
($T_A = +25^\circ\text{C}$, unless otherwise noted.)

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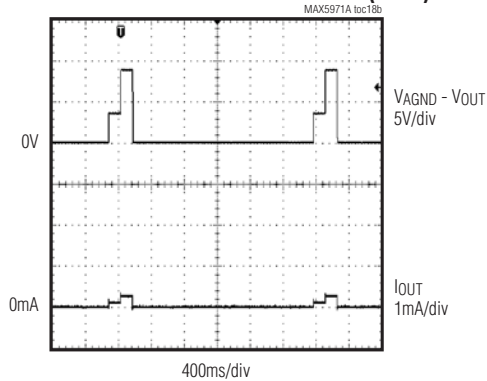
STARTUP IN MIDSPAN WITH A VALID PD



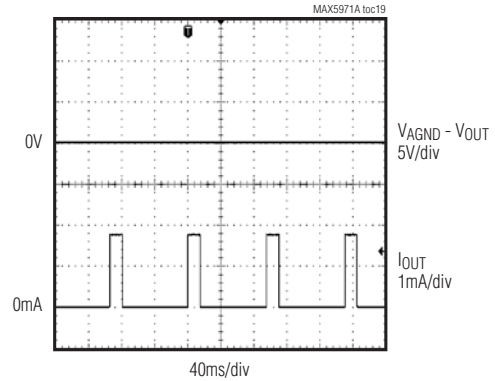
DETECTION IN MIDSPAN WITH INVALID PD (15k Ω)



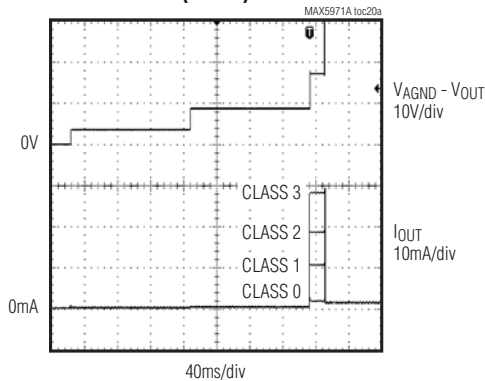
DETECTION IN MIDSPAN WITH INVALID PD (33k Ω)



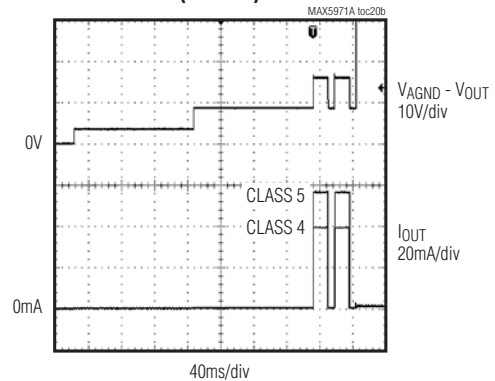
DETECTION IN OUTPUT SHORTED TO AGND



**CLASSIFICATION WITH DIFFERENT PD CLASSES
(0 TO 3)**



**CLASSIFICATION WITH DIFFERENT PD CLASSES
(4 AND 5)**

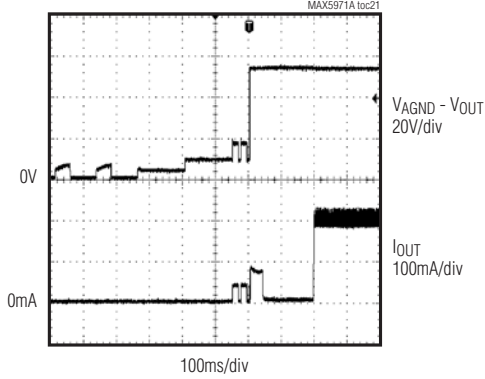


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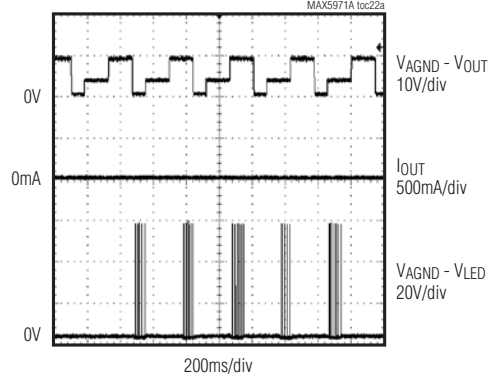
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

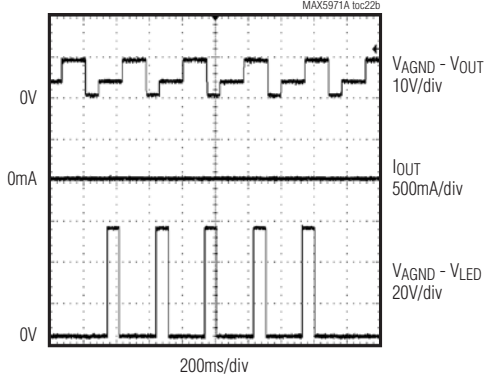
STARTUP USING 2-EVENT CLASSIFICATION WITH A VALID PD



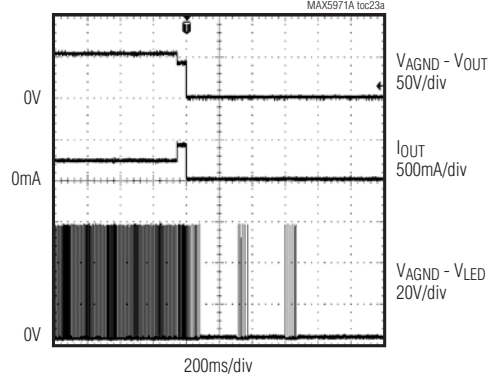
LED DETECTION FAULT WITH PWM ENABLED



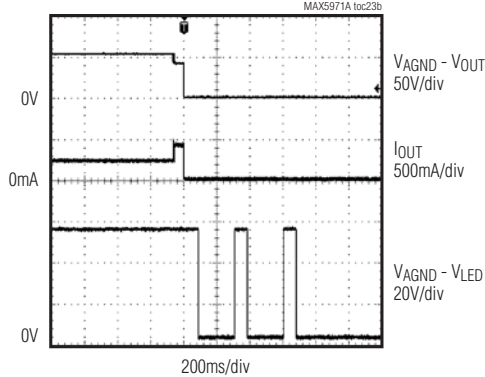
LED DETECTION FAULT WITH PWM DISABLED



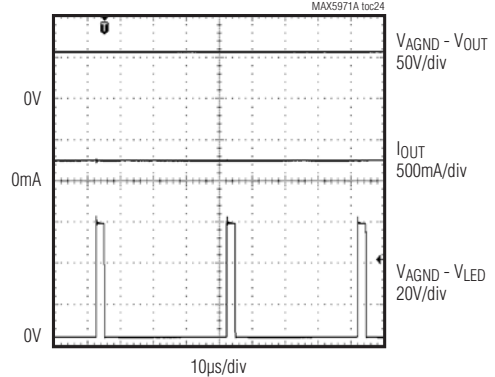
LED OVERCURRENT FAULT WITH PWM ENABLED



LED OVERCURRENT FAULT WITH PWM DISABLED



LED PWM TIMING AND DUTY CYCLE



分销商库存信息:		
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MAXIM		
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MAX5971AETI+	MAX5971AETI+T	
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