13-3087; Rev 0; 1/04

EVALUATION KIT AVAILABLE

Low-Cost, High-Reliability, 0.5V to 3.3V ORing MOSFET Controllers

General Description

Critical loads often employ parallel-connected power supplies with redundancy to enhance system reliability. The MAX8555/MAX8555A are highly integrated, inexpensive MOSFET controllers that provide isolation and redundant power capability in high-reliability systems. The MAX8555/MAX8555A are used in 0.5V to 3.3V systems, and have an internal charge pump to drive the gates of the N-channel pass elements to (V_{CS+} + 5V).

During startup, the MAX8555/MAX8555A monitor the voltage drop across the external MOSFETs. Once V_{CS+} approaches or exceeds the bus voltage (V_{CS-}), the MOSFETs are turned on. The MAX8555/MAX8555A feature a dual-purpose TIMER input. A single external resistor from TIMER to ground sets the turn-on speed of the external MOSFETs. Optionally, the TIMER input can be used as a logic enable input. Once the external MOSFET is turned on, these controllers monitor the load, protecting the bus against overvoltage, undervoltage, and reverse-current fault conditions. The MAX8555 is available with a 40mV reverse-current threshold, while the MAX8555A is available with a 20mV reverse-current threshold.

Overvoltage and undervoltage fault thresholds are adjustable and can be disabled. The current-limit trip points are set by the external MOSFETs' $R_{DS(ON)}$, reducing component count. An open-drain, logic-low fault output indicates if an overvoltage, undervoltage, or reverse-current fault occurs. The MAX8555 and the MAX8555A can shut down in response to a reverse-current fault condition as quickly as 200ns.

Both devices come in space-saving 10-pin µMAX or TDFN packages and are specified over the extended -40°C to +85°C temperature range.

Applications

Point-of-Load Supplies

Power-Supply Modules

Servers

Telecom Power Supplies

Rectifiers

Redundant Power Supplies in High-Availability Systems

Typical Operating Circuit appears at end of data sheet.

Features

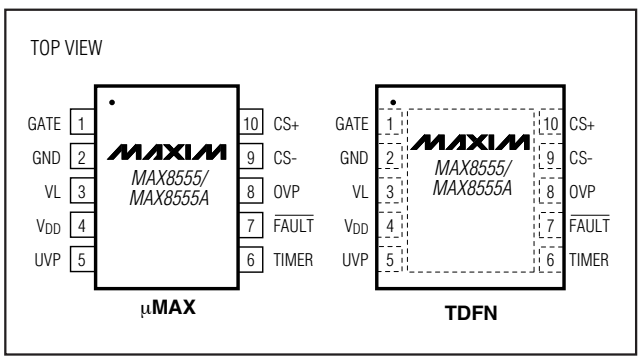
- **Simple, Integrated, and Inexpensive MOSFET Controllers**
- **ORing FET Drive for 0.5V to 3.3V**
- **Eliminate ORing Diode Power Dissipation**
- **Provide N+1 Redundant Supply Capability for Highly Reliable Systems**
- **Isolate Failed Short-Circuit Supply from Output BUS**
- **Respond to Reverse Short-Circuit Current in 200ns**
- **Adjustable Blank Time**
- **Programmable Soft-Start**
- **Logic Enable Input**
- **Adjustable Overvoltage and Undervoltage Trip Points**
- **Fault-Indicator Output**
- **Space-Saving Packages**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX8555ETB	-40°C to 85°C	10 TDFN 3mm x 3mm*	ACC
MAX8555EUB	-40°C to 85°C	10 µMAX	8555EUB
MAX8555AETB	-40°C to 85°C	10 TDFN 3mm x 3mm*	ADD
MAX8555AEUB	-40°C to 85°C	10 µMAX	8555AEUB

**Exposed paddle*

Pin Configurations



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Low-Cost, High-Reliability, 0.5V to 3.3V ORing MOSFET Controllers

ABSOLUTE MAXIMUM RATINGS

GATE to GND .....-0.3V to +12V
FAULT, VL to GND .....-0.3V to +6V
OVP, UVP, TIMER, CS+, CS- to GND .....-0.3V to +(V_{VL} + 0.3V)
V_{DD} to GND.....(V_{VL} - 0.3V) to +18V
Continuous Power Dissipation (T_A = +70°C)
10-Pin µMAX (derate 5.6mW/°C above +70°C) 444mW
10-Pin TDFN (derate 24.4mW/°C above +70°C) 1951mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°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_{DD} = 12V, V_{CS-} = 1.4V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.25V, R_{FAULT} = 50kΩ, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, **T_A = 0°C to +85°C**, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{DD} SUPPLY						
V_{DD} Input Voltage	V_{TIMER} = 2.5V	VL unconnected	8.00		13.25	V
		VL = V_{DD}	3.0		5.5	
V_{DD} Supply Current	VL unconnected, V_{TIMER} = 2.5V, V_{DD} = 13.25V			2.0	3.3	mA
	V_{DD} = V_{VL} = 5V, V_{TIMER} = 2.5V			0.04	0.2	
V_{DD} Shutdown Current	V_{TIMER} = 0V, V_{DD} = 13.25V				3.0	mA
V_{DD} Overvoltage Internal Threshold	Rising threshold		14.0	14.4	15.0	V
	Falling threshold		13.3	13.8	14.5	
VL SUPPLY						
VL Input Voltage	V_{DD} = V_{VL}		3.0		5.5	V
VL Supply Current	V_{DD} = V_{VL} = 5V, V_{TIMER} = 2.5V			1.8	3.0	mA
VL Current in Shutdown Mode	TIMER = GND, V_{DD} = V_{VL} = 5V			1.6	3.0	mA
VL Output Voltage	V_{DD} = 8V to 13.25V, I_{VL} = 0A		3.80	4.1	4.45	V
VL Undervoltage Lockout	VL = V_{DD}, rising threshold		2.78	2.82	2.90	V
	VL = V_{DD}, falling threshold		2.68	2.75	2.82	
CS INPUTS						
CS+, CS- Input Current	V_{TIMER} = 2.5V, V_{CS} = 3.0V			5.2		µA
Offset Input Current (CS+, CS-)	V_{CS} = 3.0V, Figure 4		-250		+250	nA
CS+/CS- Input Range	(Note 1)		0.5		V_{VL} - 0.5	V
CS Isolation	V_{CS+} = +3V, V_{CS-} = 0V, I_{CS-}			-0.5		µA
	V_{CS-} = +3V, V_{CS+} = 0V, I_{CS+}			-0.5		
CHARGE-PUMP VOLTAGE						
GATE Voltage, V_{GATE}	Measured from GATE to CS+	V_{DD} = 8V to 13.25V	5.0	5.25	5.5	V
		V_{DD} = V_{VL} = 5V				
Charge-Pump Switching Frequency	R_{TIMER} = 20kΩ			187		kHz
	R_{TIMER} = 125kΩ			450		
	R_{TIMER} = open			500		
	V_{TIMER} = 1.5V			550		

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 12V, V_{CS-} = 1.4V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.25V, R_{FAULT} = 50kΩ, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, **T_A = 0°C to +85°C**, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
TIMER						
TIMER Voltage			1.22	1.25	1.28	V
TIMER Maximum Source Current	V_{TIMER} = 1.0V		85	100	115	µA
TIMER High Input Current	V_{TIMER} = 1.5V			10	15	µA
TIMER Maximum Frequency Select Voltage Input Range	(Note 1)		1.5		V_{VL}	V
TIMER Logic High, V_{IH}	Charge pump enabled		1.0			V
TIMER Logic Low, V_{IL}	Charge pump disabled				0.5	V
FAULT						
Fault Output Low Voltage	$I_{\overline{FAULT}}$ = 10mA				0.2	V
Fault Sink Current	$V_{\overline{FAULT}}$ = 0.4V		15			mA
Fault Leakage Current	$V_{\overline{FAULT}}$ = 5.5V, T_A = +25°C				1	µA
GATE						
Gate-On Threshold	Measured from CS- to CS+	MAX8555	80	100	120	mV
		MAX8555A	35	50	65	
Gate-Drive Current	V_{GATE} = V_{CS+} = 2.5V	R_{TIMER} = open	17	25	33	µA
		R_{TIMER} = 25kΩ	8	12	16	
	V_{GATE} = V_{CS+} = 2.5V, V_{DD} = V_{VL} = 3V	R_{TIMER} = open		15		
		R_{TIMER} = 25kΩ		7.5		
	V_{GATE} = V_{CS+} = 2.5V, V_{DD} = V_{VL} = 5V	R_{TIMER} = open		30		
		R_{TIMER} = 25kΩ		15		
Gate Shutdown Delay	(Note 2)	V_{TIMER} falling		100	200	ns
		I_{REV} fault		60	150	
Gate Discharge Current	V_{GATE} = V_{CS+}= +5V			1000		mA
GATE Fall Time	Gate voltage fall from $\overline{FAULT}$ to V_{GATE} = V_{CS+}, R1 = 2Ω, Figure 3 or Figure 4			0.2		µs
CURRENT SENSE						
Reverse-Current Threshold	Measured from CS- to CS+	MAX8555	34	40	46	mV
		MAX8555A	16	20	24	
Startup I_{REV} Blank Time	TIMER = unconnected			4.1		ms
Forward-Current Threshold	Measured from CS+ to CS-		6	10	14	mV

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ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 12V, V_{CS-} = 1.4V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.25V, R_{FAULT} = 50kΩ, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, **T_A = 0°C to +85°C**, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
OVERVOLTAGE PROTECTION					
OVP Fault Threshold, V_{OVP}	OVP rising	0.49	0.5	0.51	V
	OVP falling		0.4		
OVP Bias Current	T_A = +25°C			0.1	µA
	T_A = +85°C		0.021		
UNDERVOLTAGE PROTECTION					
UVP Fault Threshold, V_{UVP}	UVP rising	0.488	0.5	0.512	V
	UVP falling		0.4		
UVP Bias Current	T_A = +25°C			0.1	µA
	T_A = +85°C		0.003		

ELECTRICAL CHARACTERISTICS

(V_{DD} = 12V, V_{CS-} = 1.4V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.25V, R_{FAULT} = 50kΩ, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{DD} SUPPLY						
V_{DD} Input Voltage	V_{TIMER} = 2.5V	VL unconnected	8.00		13.25	V
		VL = V_{DD}	3.0		5.5	
V_{DD} Supply Current	VL unconnected, V_{TIMER} = 2.5V, V_{DD} = 13.25V				3.3	mA
	V_{DD} = V_{VL} = 5V, V_{TIMER} = 2.5V				0.2	
V_{DD} Shutdown Current	V_{TIMER} = 0V, V_{DD} = 13.25V				3.0	mA
V_{DD} Overvoltage Internal Threshold	Rising threshold		14.0		15.0	V
	Falling threshold		13.3		14.5	
VL SUPPLY						
VL Input Voltage	V_{DD} = V_{VL}		3.0		5.5	V
VL Supply Current	V_{DD} = V_{VL} = 5V, V_{TIMER} = 2.5V				3.0	mA
VL Current in Shutdown Mode	TIMER = GND, V_{DD} = V_{VL}= 5V				3.0	mA
VL Output Voltage	V_{DD} = 8V to 13.25V, I_{VL} = 0A		3.80		4.45	V
VL Undervoltage Lockout	VL = V_{DD}, rising threshold		2.78		2.90	V
	VL = V_{DD}, falling threshold		2.68		2.82	
CS INPUTS						
Offset Input Current (CS+, CS-)	V_{CS} = 3.0V, Figure 4		-250		+250	nA
CS+/CS- Input Range	(Note 1)		0.5		V_{VL} - 0.5	V
CHARGE-PUMP VOLTAGE						
GATE Voltage, V_{GATE}	Measured from GATE to CS+	V_{DD} = 8V to 13.25V	5.0		5.5	V
		V_{DD} = V_{VL} = 5V				

ELECTRICAL CHARACTERISTICS (continued)

(V_{DD} = 12V, V_{CS-} = 1.4V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.25V, R_{FAULT} = 50kΩ, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 3)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
TIMER						
TIMER Voltage			1.22		1.28	V
TIMER Maximum Source Current	V_{TIMER} = 1.0V		85		115	µA
TIMER High Input Current	V_{TIMER} = 1.5V				15	µA
TIMER Maximum Frequency Select Voltage Input Range	(Note 1)		1.5		V_{VL}	V
TIMER Logic High, V_{IH}	Charge pump enabled		1.1			V
TIMER Logic Low, V_{IL}	Charge pump disabled				0.5	V
FAULT						
Fault Output Low Voltage	$I_{\overline{FAULT}}$ = 10mA				0.2	V
Fault Sink Current	$V_{\overline{FAULT}}$ = 0.4V		15			mA
GATE						
Gate-On Threshold	Measured from CS- to CS+	MAX8555	80		120	mV
		MAX8555A	35		65	
Gate-Drive Current	V_{GATE} = V_{CS+} = 2.5V	R_{TIMER} = open	17		33	µA
		R_{TIMER} = 25kΩ	8		16	
Gate Shutdown Delay		V_{TIMER} falling			200	ns
		I_{REV} fault			150	
CURRENT SENSE						
Reverse-Current Threshold	Measured from CS- to CS+	MAX8555	34		46	mV
		MAX8555A	16		24	
Forward-Current Threshold	Measured from CS+ to CS-		6		14	mV
OVERVOLTAGE PROTECTION						
OVP Fault Threshold, V_{OVP}	OVP rising		0.49		0.51	V
UNDERVOLTAGE PROTECTION						
UVP Fault Threshold, V_{UVP}	UVP rising		0.488		0.512	V

Note 1: Guaranteed by design. Not production tested.

Note 2: Gate shutdown delay is measured from reverse-current fault to the start of gate-voltage falling or from TIMER to the start of gate-voltage falling.

Note 3: Specifications to -40°C are guaranteed by design and not production tested.

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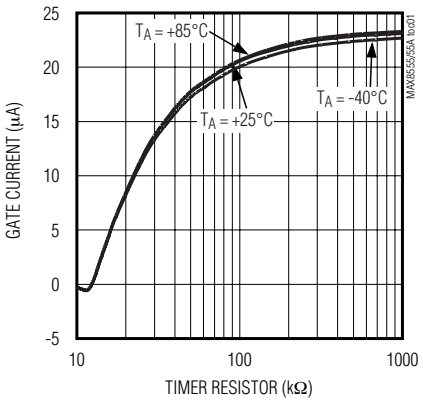
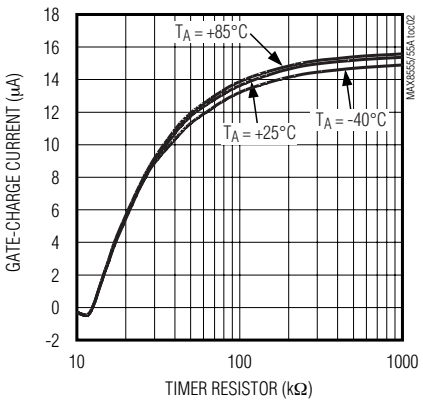
Typical Operating Characteristics

(V_{DD} = 12V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.4V, R_{FAULT} = 50kΩ to output bus, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, T_A = +25°C, R1 = 2Ω in Figure 3, MAX8555A, unless otherwise noted.)

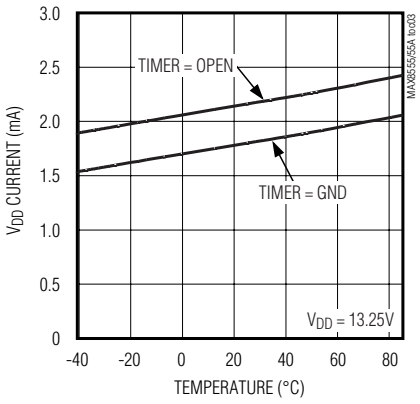
GATE-CHARGE CURRENT vs. TIMER RESISTOR (V_{DD} = 12V)



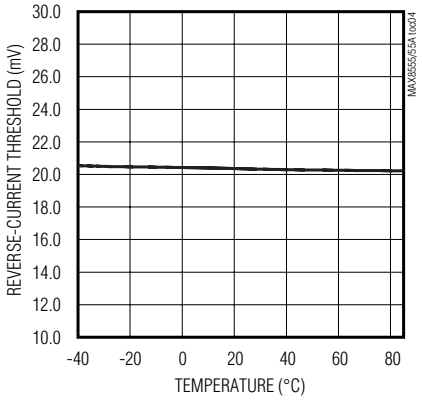
GATE-CHARGE CURRENT vs. TIMER RESISTOR (V_{DD} = V_{VL} = 3V)



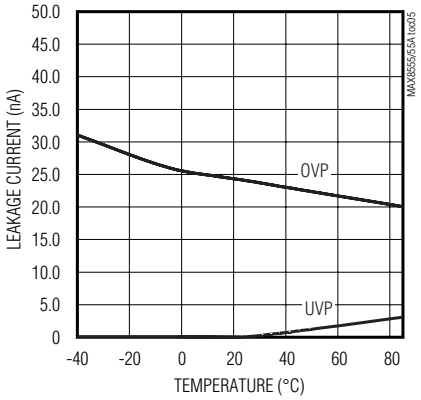
V_{DD} CURRENT vs. TEMPERATURE



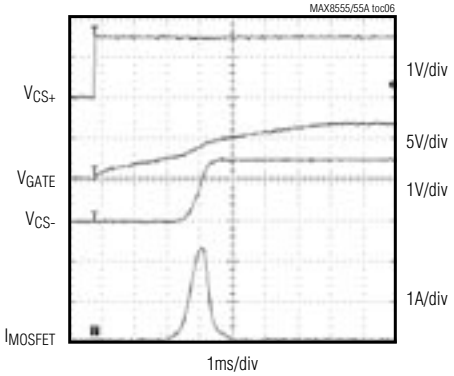
REVERSE-CURRENT THRESHOLD vs. TEMPERATURE



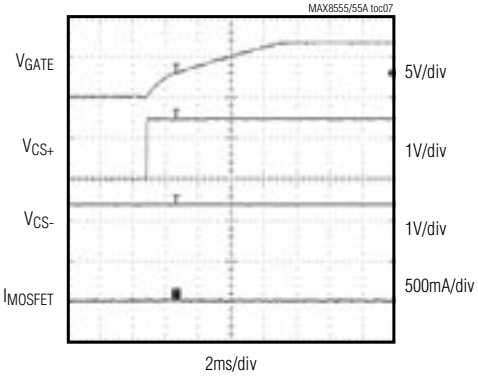
OVP AND UVP LEAKAGE CURRENT vs. TEMPERATURE



POWER-UP WAVEFORMS BUS VOLTAGE HIGH IMPEDANCE



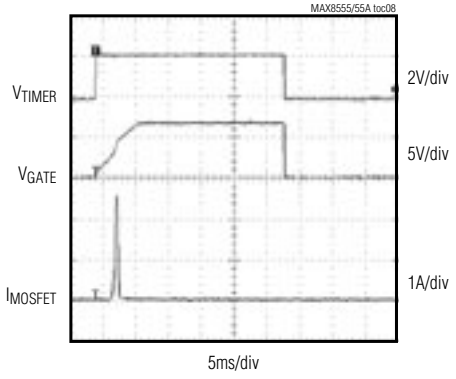
POWER-UP WAVEFORMS BUS VOLTAGE IS LIVE



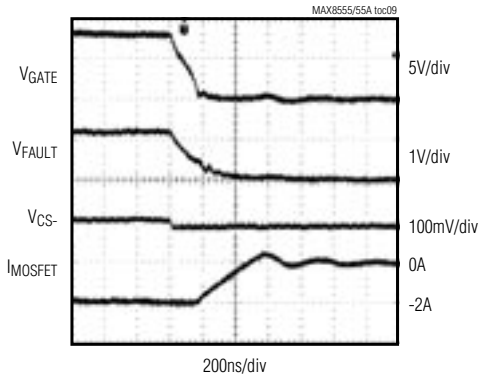
Typical Operating Characteristics (continued)

(V_{DD} = 12V, V_{CS+} = 1.5V, R_{TIMER} = 25kΩ, V_{UVP} = 1V, V_{OVP} = 0.4V, R_{FAULT} = 50kΩ to output bus, C_{VDD} = C_{GATE} = C_{VL} = 0.01µF, T_A = +25°C, R1 = 2Ω in Figure 3, MAX8555A, unless otherwise noted.)

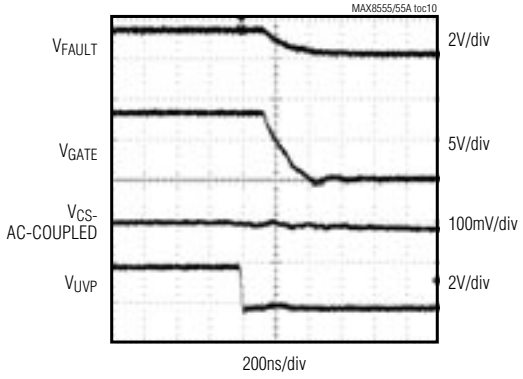
POWER-UP AND DOWN WAVEFORMS USING TIMER



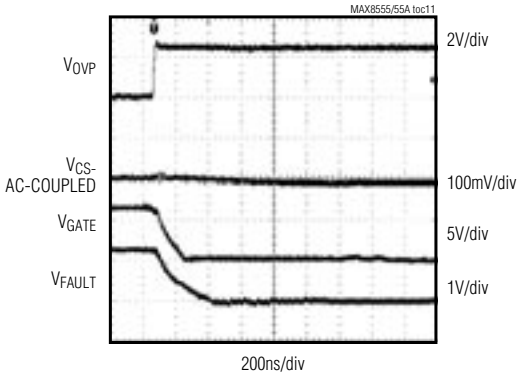
REVERSE-CURRENT SHUTDOWN WAVEFORMS



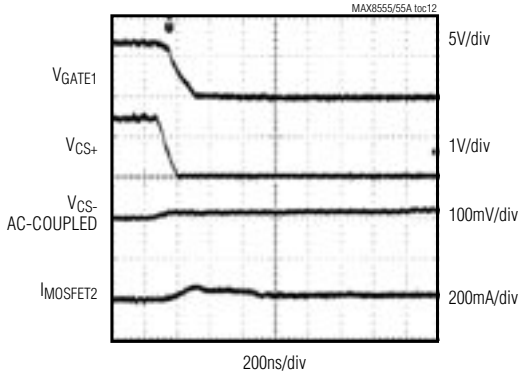
UVP SHUTDOWN WAVEFORMS



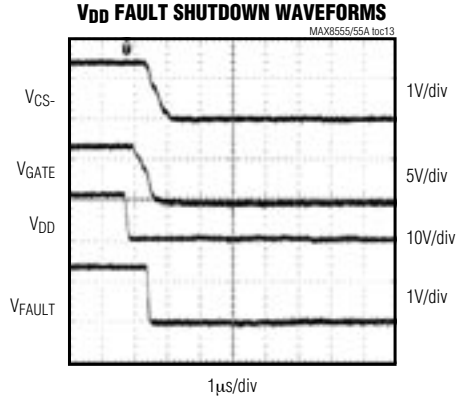
OVP SHUTDOWN WAVEFORMS



POWER-SUPPLY OUTPUT SHORT-CIRCUIT SHUTDOWN WAVEFORMS



V_{DD} FAULT SHUTDOWN WAVEFORMS



Low-Cost, High-Reliability, 0.5V to 3.3V ORing MOSFET Controllers

Pin Description

PIN	NAME	FUNCTION
1	GATE	Gate-Drive Output. Nominal GATE load is a 0.01µF capacitor to ground. Gate is discharged to GND in shutdown.
2	GND	Ground
3	VL	Low-Voltage Optional Input Power. Leave disconnected when V_{DD} = 8V to 13.25V, or connect V_{DD} to VL when V_{DD} = 3V to 5.5V. Bypass VL to GND with a 0.01µF capacitor.
4	V_{DD}	Power-Supply Input. Connect to an 8V to 13.25V supply or connect to VL when using a 3V to 5.5V supply. Bypass V_{DD} with a 0.01µF capacitor to ground.
5	UVP	Undervoltage-Protection Input. Connect UVP to the center of a resistor-divider from CS+ to GND. Connect UVP to VL to disable the undervoltage protection.
6	TIMER	Timer Input. Connect a resistor from TIMER to GND to select the charge-pump operating frequency. Drive TIMER low (< 0.5V) to disable the gate drive. Drive TIMER high (above 1.5V) for charge-pump operation at 550kHz.
7	$\overline{FAULT}$	Open-Drain Fault Output. $\overline{FAULT}$ is high impedance during normal operation and is pulled to GND when a fault condition occurs. Connect a pullup resistor of 10kΩ or higher value (50kΩ typ) to a voltage rail of 5.5V or lower.
8	OVP	Overvoltage-Protection Input. Connect OVP to the center of a resistor-divider from the output bus to GND. Connect OVP to GND to disable the overvoltage protection.
9	CS-	Current-Sensing Input. Connect CS- to the positive side of the system bus. Bypass with a 1000pF capacitor to GND.
10	CS+	Current-Sensing Input. Connect CS+ to the positive side of the input power. Bypass with a 1000pF capacitor to GND.

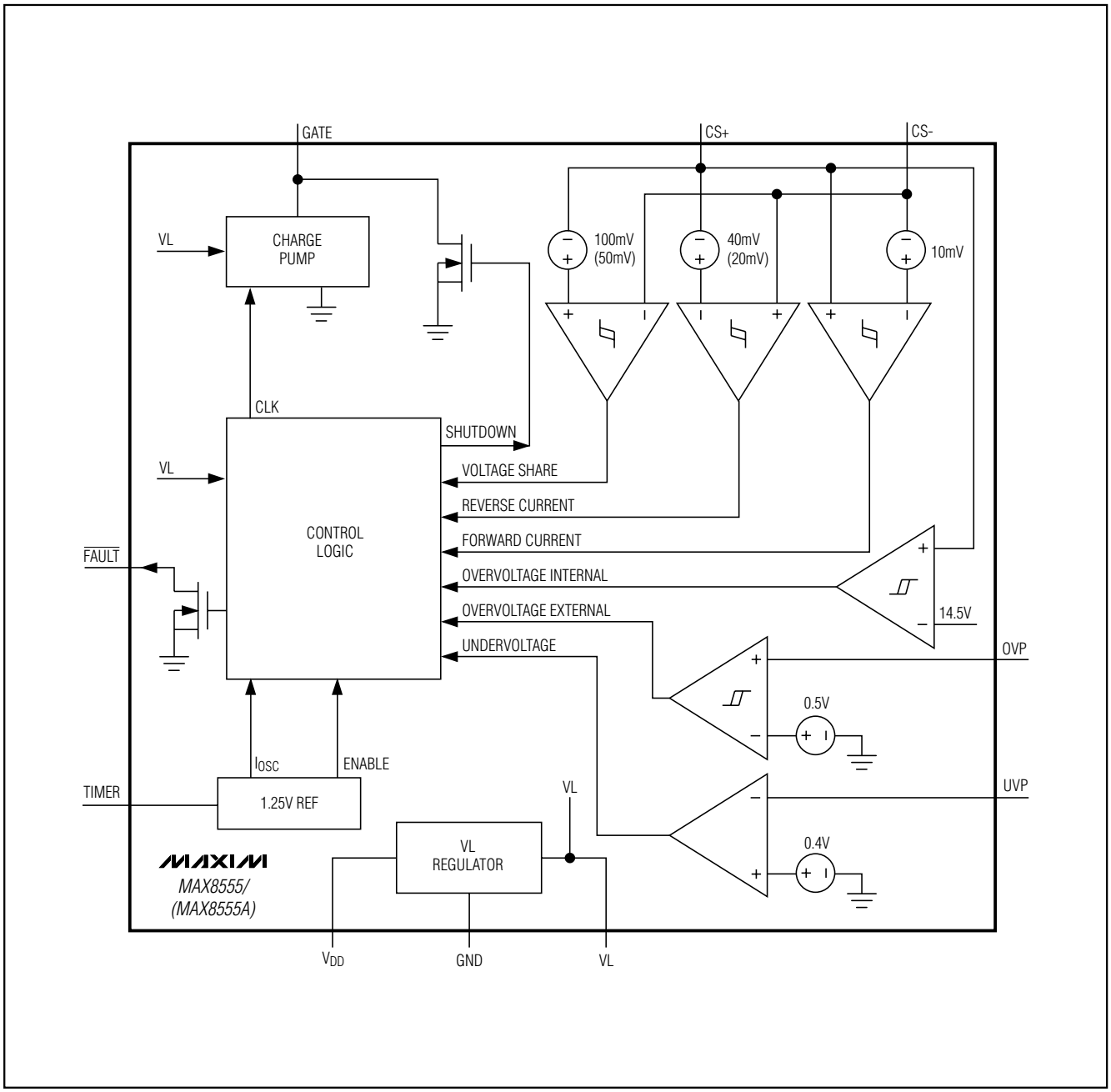
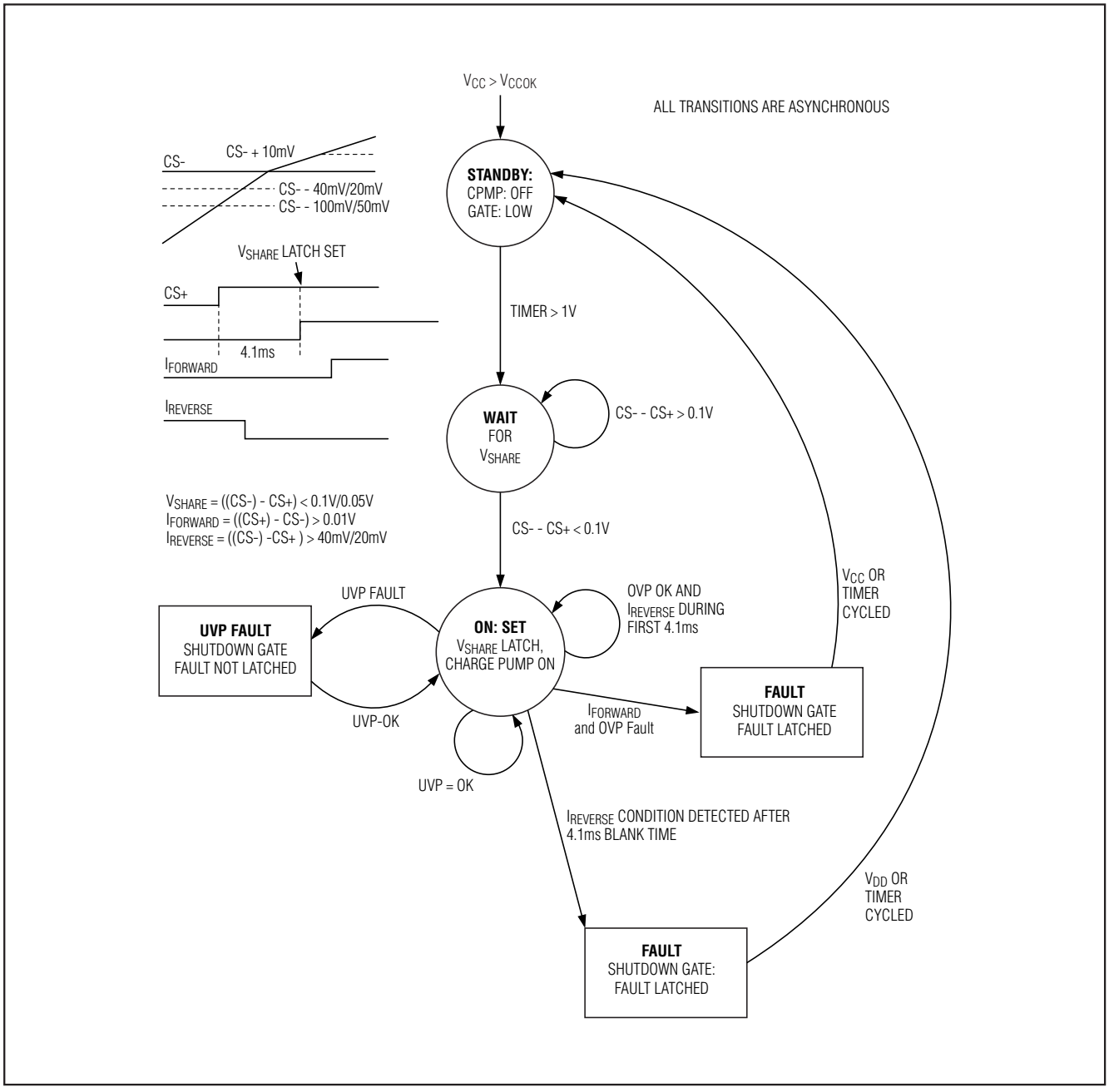


Figure 1. MAX8555/MAX8555A Functional Diagram

Low-Cost, High-Reliability, 0.5V to 3.3V ORing MOSFET Controllers

State Diagram