



# SGM40653/SGM40654/SGM40655 High-Current Over-Voltage Protector

## GENERAL DESCRIPTION

The SGM40653/4/5 are over-voltage protection devices designed to protect low voltage systems from damage with a high voltage supply up to +28V<sub>DC</sub>. The SGM40653/4/5 can withstand surges up to +120V without damage.

The integrated 62mΩ (TYP, CSP package)/73mΩ (TYP, TDFN package) R<sub>ON</sub> FET allow it to pass through 4.5A continuous current. The FET is turned off when the input voltage exceeds the over-voltage threshold which can be adjusted between 4V and 20V with optional external resistors.

If the OVLO input is set below the external OVLO select threshold, the SGM40653/4/5 automatically choose the internal trip thresholds that are preset to 15.39V/6.8V/5.81V (SGM40653/4/5) typically.

The open-drain  $\overline{ACOK}$  output indicates a stable power supply between minimum supply voltage and V<sub>OVLO</sub>. The SGM40653/4/5 also have enable control to reduce power consumption.

The SGM40653/4/5 are available in Green TDFN-3×3-12L and WLCSP-1.30×1.83-12B packages, and operate over an ambient temperature range of -40°C to +85°C.

## FEATURES

- **Wide Power Supply Voltage Range: 2.5V to 28V**
- **Integrated Switch On-Resistance:**
  - ◆ 62mΩ (TYP) (CSP Package)
  - ◆ 73mΩ (TYP) (TDFN Package)
- **Internal Over-Voltage Protection Thresholds:**
  - ◆ 15.39V (SGM40653)
  - ◆ 6.8V (SGM40654)
  - ◆ 5.81V (SGM40655)
- **Wide Adjustable OVLO Threshold Range: 4V to 20V**
- **Surge Immunity up to +120V**
- **Debounce Time: 18.5ms**
- **Soft-Start Function**
- **Enable Function**
- **Thermal Shutdown Protection**
- **-40°C to +85°C Operating Temperature Range**
- **Available in Green WLCSP-1.30×1.83-12B and TDFN-3×3-12L Packages**

## APPLICATIONS

Portable Internet Devices and Accessory  
Mobile Phones  
Tablet Computers

**PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM40653	WLCSP-1.30x1.83-12B	-40°C to +85°C	SGM40653YG/TR	XXXXX SZ0YG	Tape and Reel, 3000
SGM40654	WLCSP-1.30x1.83-12B	-40°C to +85°C	SGM40654YG/TR	XXXXX SXDYG	Tape and Reel, 3000
	TDFN-3x3-12L	-40°C to +85°C	SGM40654YTDF12G/TR	SGM 40654DF XXXXX	Tape and Reel, 4000
SGM40655	WLCSP-1.30x1.83-12B	-40°C to +85°C	SGM40655YG/TR	XXXXX SZ1YG	Tape and Reel, 3000
	TDFN-3x3-12L	-40°C to +85°C	SGM40655YTDF12G/TR	SGM 40655DF XXXXX	Tape and Reel, 4000

NOTE: XXXXX = Date Code and Vendor Code.

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

**ABSOLUTE MAXIMUM RATINGS**

Voltage Range (with Respect to GND)

IN ..... -0.3V to 28V  
 IN ..... +120V, 1.2/50µs, 2Ω surge <sup>(1)(2)</sup>  
 OUT ..... -0.3V to V<sub>IN</sub> + 0.3V  
 OVLO ..... -0.3V to 26.4V  
 $\overline{ACOK}$ ,  $\overline{EN}$  ..... -0.3V to 6V

Continuous IN, OUT Current <sup>(3)</sup>

WLCSP-1.30x1.83-12B Package ..... 4.5A  
 TDFN-3x3-12L Package ..... 4.5A

Peak IN, OUT Current (10ms), WLCSP Package ..... 8A

Package Thermal Resistance

TDFN-3x3-12L,  $\theta_{JA}$  ..... 85°C/W

Junction Temperature ..... +150°C

Storage Temperature Range ..... -65°C to +150°C

Lead Temperature (Soldering, 10s) ..... +260°C

ESD Susceptibility

HBM ..... 4000V

MM ..... 400V

CDM ..... 1000V

NOTES:

1. Surge pulse in compliance with IEC61000-4-5 specification.
2. Survives burst pulse up to +120V with 2Ω series resistance.
3. Continuous current limited by thermal design.

**RECOMMENDED OPERATING CONDITIONS**

Input Voltage Range ..... 2.5V to 28V

Operating Temperature Range ..... -40°C to +85°C

**OVERSTRESS CAUTION**

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

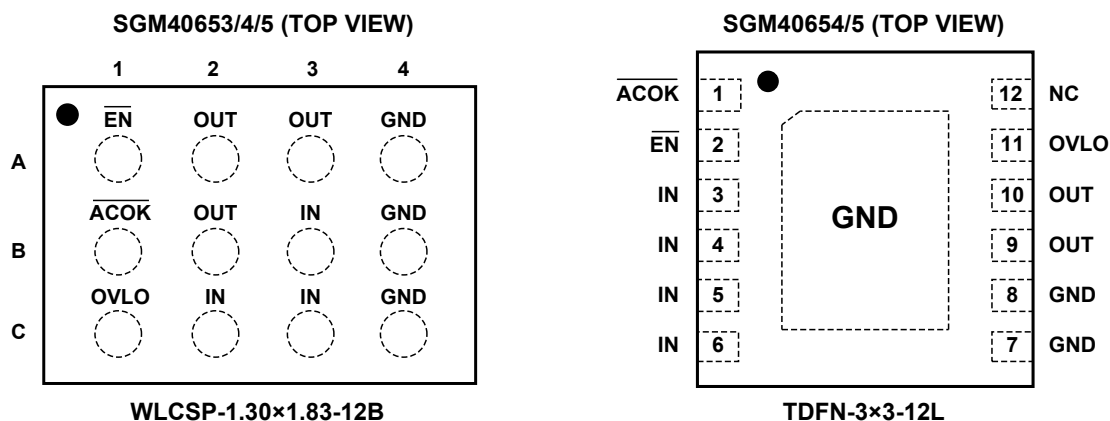
**ESD SENSITIVITY CAUTION**

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

**DISCLAIMER**

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

**PIN CONFIGURATIONS**



**PIN DESCRIPTION**

PIN		NAME	FUNCTION
WLCSP-1.30x1.83-12B	TDFN-3x3-12L		
A1	2	$\overline{EN}$	Enable Control Pin. When $\overline{EN}$ = "Low", chip is enabled; when $\overline{EN}$ = "High", chip is in disable status.
A2, A3, B2	9, 10	OUT	Output Voltage Pin.
A4, B4, C4	7, 8	GND	Ground.
B1	1	$\overline{ACOK}$	Open-Drain Flag Output Pin.
B3, C2, C3	3, 4, 5, 6	IN	Input Voltage Pin.
C1	11	OVLO	External OVLO Adjustment Pin.
-	12	NC	No Connection.

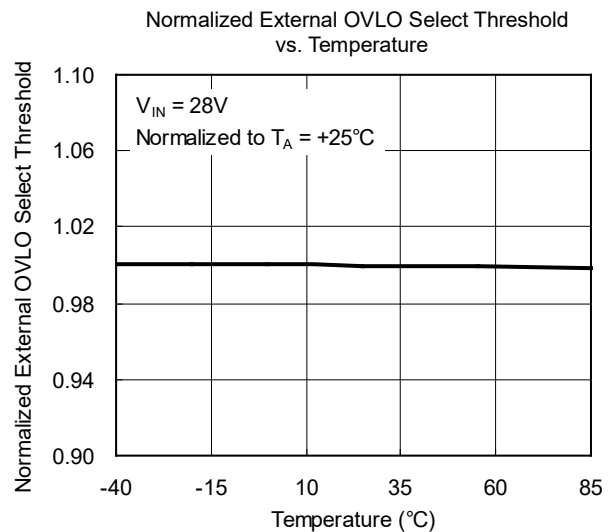
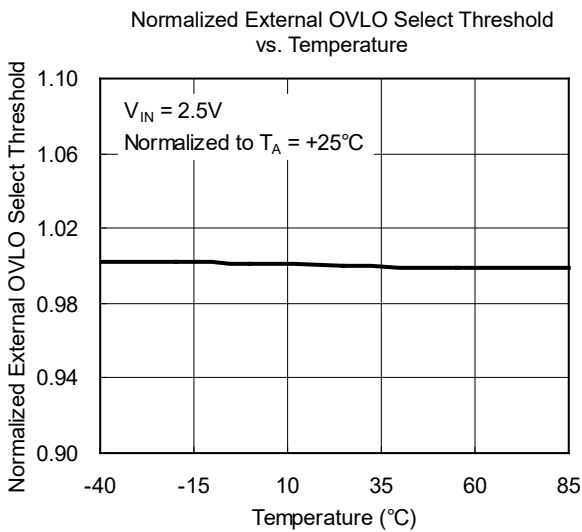
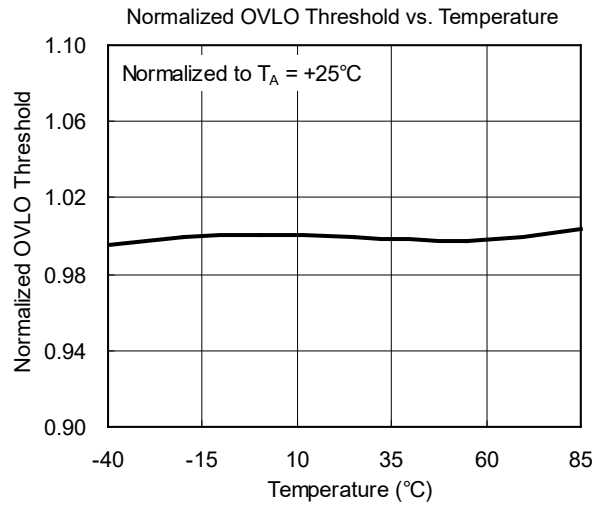
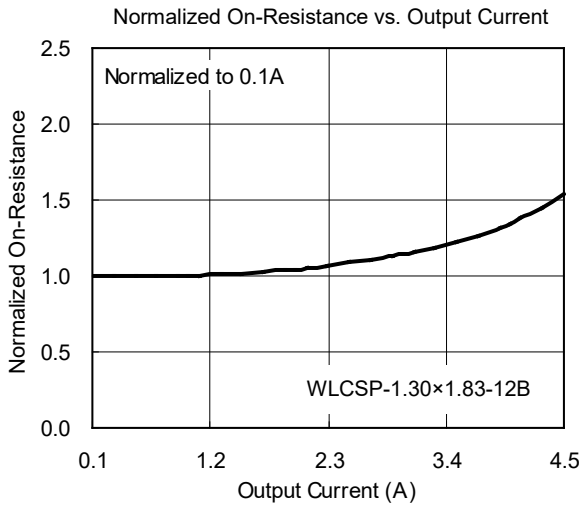
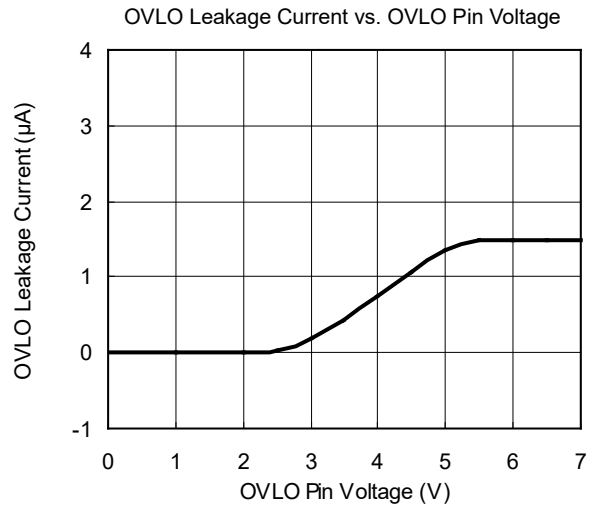
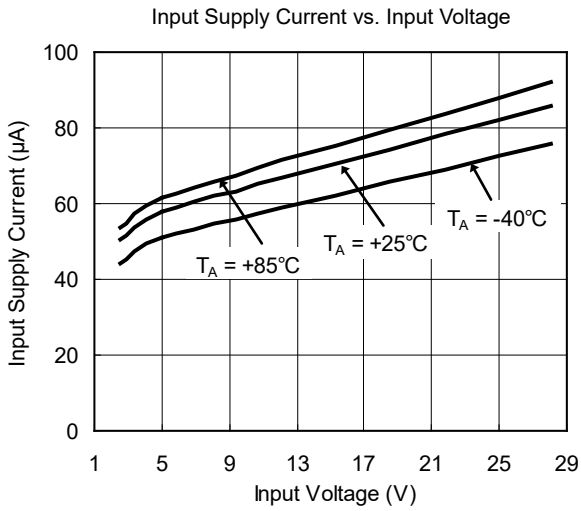
**ELECTRICAL CHARACTERISTICS**

( $V_{IN} = 2.5V$  to  $28V$ ,  $\overline{EN} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $T_A = -40^\circ C$  to  $+85^\circ C$ , typical values are at  $V_{IN} = 5V$ ,  $I_{IN} \leq 3A$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range	$V_{IN}$			2.5		28	V
Input Clamp Triggering Voltage	$V_{IN\_CLAMP}$	$I_{IN} = 10mA$ limited, $T_A = +25^\circ C$			28.6		V
Input Supply Current	$I_{IN}$	$V_{IN} = 5V$			56	85	$\mu A$
OVLO Supply Current	$I_{IN\_Q}$	$V_{OVLO} = 3V$ , $V_{IN} = 5V$ , $V_{OUT} = 0V$			56	85	$\mu A$
Shutdown Current	$I_{Q\_OFF}$	$V_{IN} = 5V$ , $\overline{EN} = 2V$				1	$\mu A$
Internal Over-Voltage Protection Threshold	$V_{IN\_OVLO}$	$V_{IN}$ rising	SGM40653	14.84	15.39	15.93	V
			SGM40654	6.59	6.8	7.01	
			SGM40655	5.64	5.81	5.98	
		$V_{IN}$ falling	SGM40653	14.45	15.07		
			SGM40654	6.43	6.66		
			SGM40655	5.50	5.69		
$V_{BG}$ Reference	$V_{BG}$			1.18	1.218	1.26	V
Adjustable OVLO Threshold Range				4		20	V
External OVLO Select Threshold	$V_{OVLO\_SELECT}$			0.22	0.26	0.30	V
Switch On-Resistance	$R_{ON}$	$V_{IN} = 5V$ , $I_{OUT} = 0.5A$ , $T_A = +25^\circ C$	WLCSP-1.30x1.83-12B		62	88	m $\Omega$
			TDFN-3x3-12L		73		
OUT Load Capacitance	$C_{OUT}$	$V_{IN} = 5V$				1000	$\mu F$
OVLO Input Leakage Current	$I_{OVLO}$	$V_{OVLO} = 1.3V$			10	100	nA
IN Leakage Voltage by OVLO	$V_{IN\_LEAK}$	$V_{OVLO} = 20V$ , $V_{IN} =$ unconnected, $R_{OVLO} = 1M\Omega$			0.01	0.20	V
Thermal Shutdown					138		$^\circ C$
Thermal Shutdown Hysteresis					30		$^\circ C$
<b>Digital Signal (<math>\overline{ACOK}</math>)</b>							
$\overline{ACOK}$ Output Low Voltage	$V_{OL}$	$V_{IO} = 3.3V$ , $I_{SINK} = 1mA$ , See Figure 1			0.26	0.43	V
$\overline{ACOK}$ Leakage Current	$I_{ACOK\_LEAK}$	$V_{IO} = 3.3V$ , $\overline{ACOK}$ deasserted, See Figure 1			0.01	1	$\mu A$
<b>Timing Characteristics</b>							
Debounce Time	$t_{DEB}$	Time from $V_{IN} > 2.5V$ to the time $V_{OUT}$ starts rising			18.5		ms
Soft-Start Time	$t_{SS}$	Time from $V_{IN} > 2.5V$ to soft-start off			37		ms
Switch Turn-On Time	$t_{ON}$	$V_{IN} = 5V$ , $R_L = 100\Omega$ , $C_{LOAD} = 100\mu F$ , $V_{OUT}$ from 10%, $V_{IN}$ to 90% $V_{IN}$			8		ms
Switch Turn-Off Time	$t_{OFF}$	$V_{IN} > V_{IN\_OVLO}$ to $V_{OUT} = 80\%$ of $V_{IN}$ , $R_L = 100\Omega$ , $V_{IN}$ rising at $2V/\mu s$			120		ns
<b><math>\overline{EN}</math> Logic Levels</b>							
Logic Low Input Voltage	$V_{IL}$					0.4	V
Logic High Input Voltage	$V_{IH}$	The rising rate of $\overline{EN}$ waveform that rises from 0.5V to 1.6V $> 2V/ms$		1.6			V
Input Low Current	$I_{IL}$	$V_{IN} = 5V$ , $\overline{EN} = 0V$				1	$\mu A$
Input High Current	$I_{IH}$	$V_{IN} = 5V$ , $\overline{EN} = 5V$				2	$\mu A$

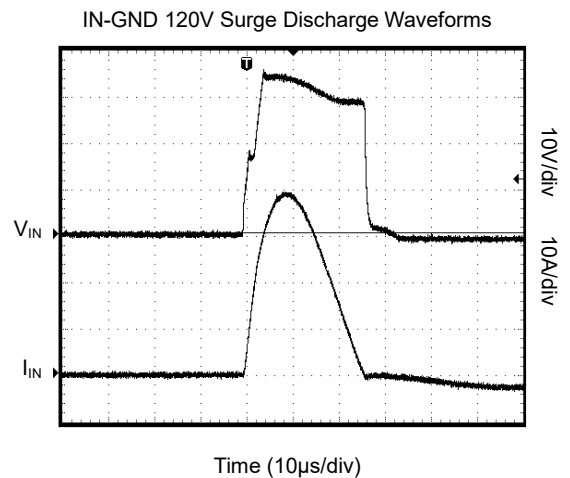
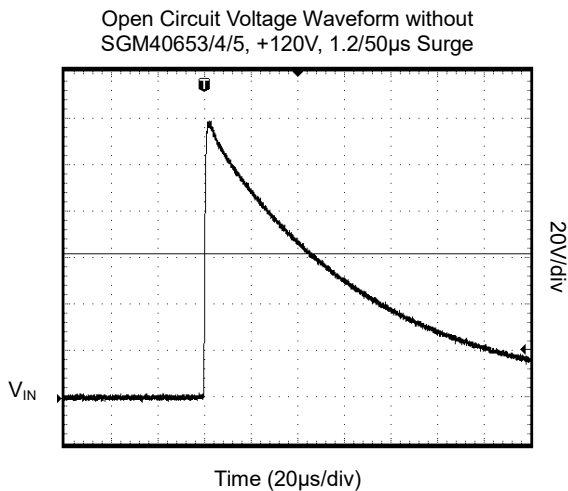
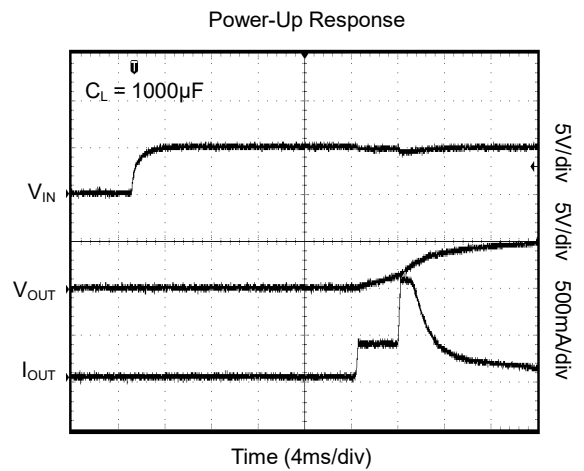
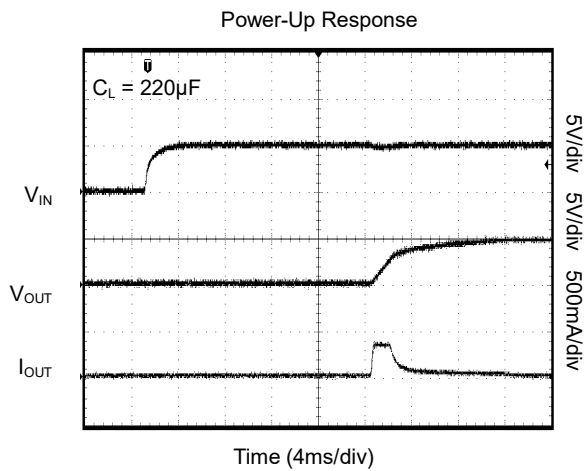
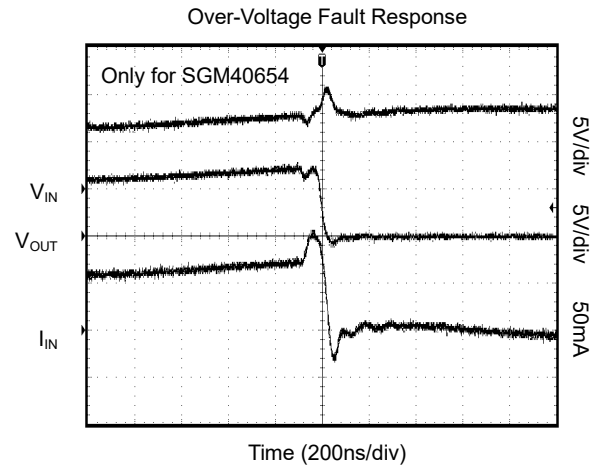
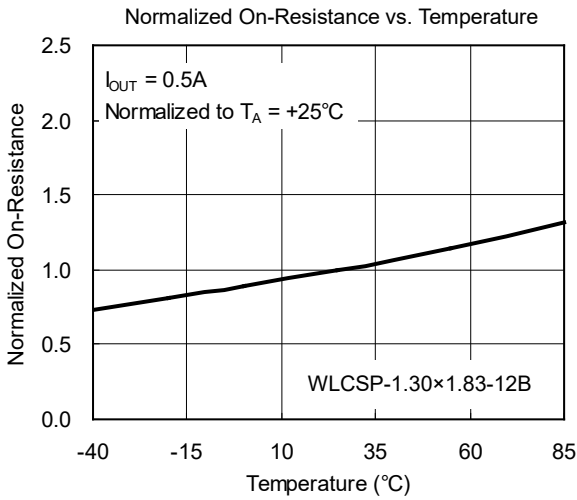
**TYPICAL PERFORMANCE CHARACTERISTICS**

$V_{IN} = 5V$ ,  $\overline{EN} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted.

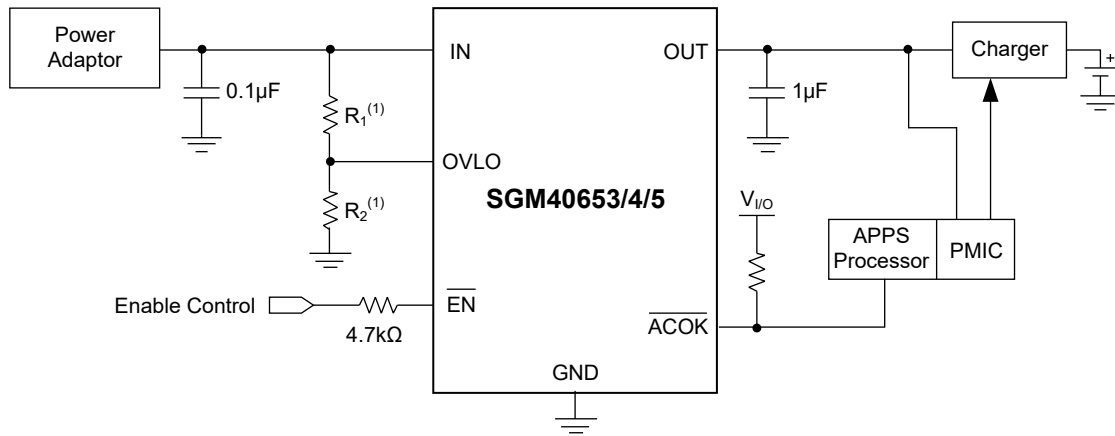


**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

$V_{IN} = 5V$ ,  $\overline{EN} = 0V$ ,  $C_{IN} = 0.1\mu F$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ , unless otherwise noted.



**TYPICAL APPLICATION**

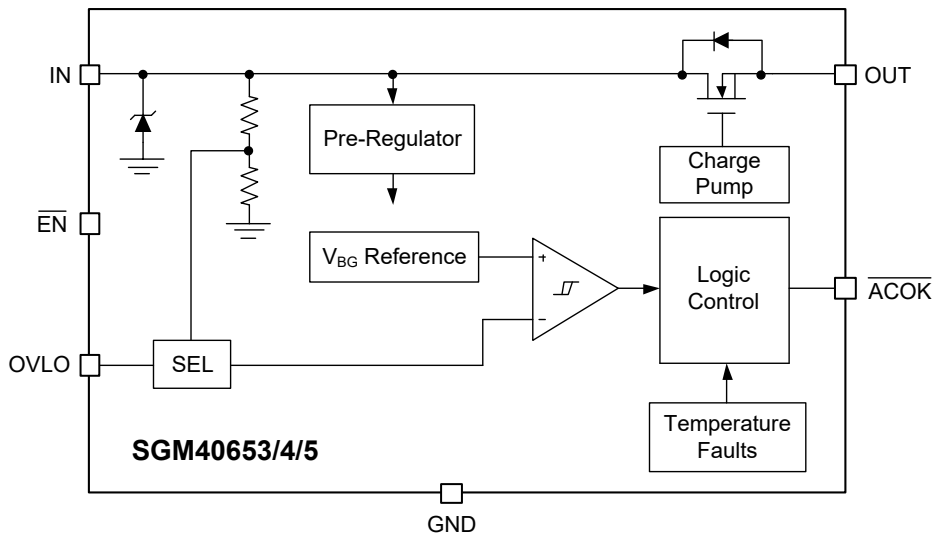


NOTE:

1.  $R_1$  and  $R_2$  are used only for adjustable OVLO, and otherwise, connect OVLO to GND.

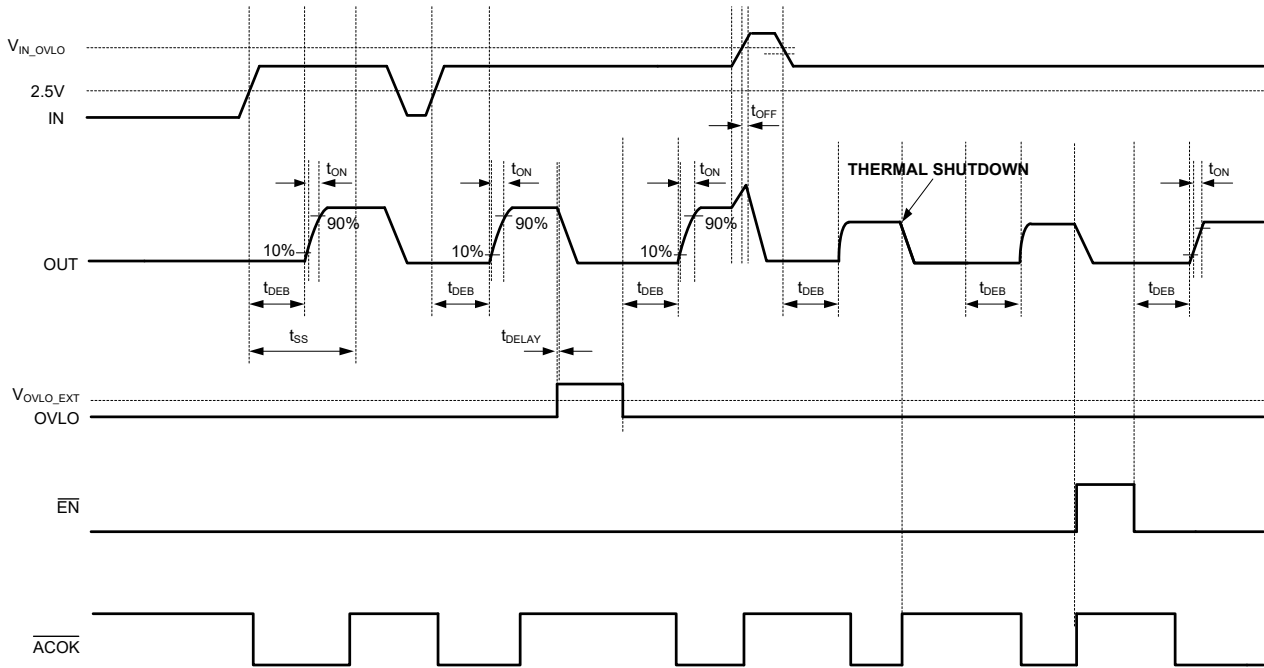
**Figure 1. Typical Application Circuit**

**FUNCTIONAL BLOCK DIAGRAM**



**Figure 2. Block Diagram**

**TIMING DIAGRAM**



NOTE: Waveforms are not to scale.

Figure 3. Timing Diagram

**SURGE UP TEST CIRCUIT**

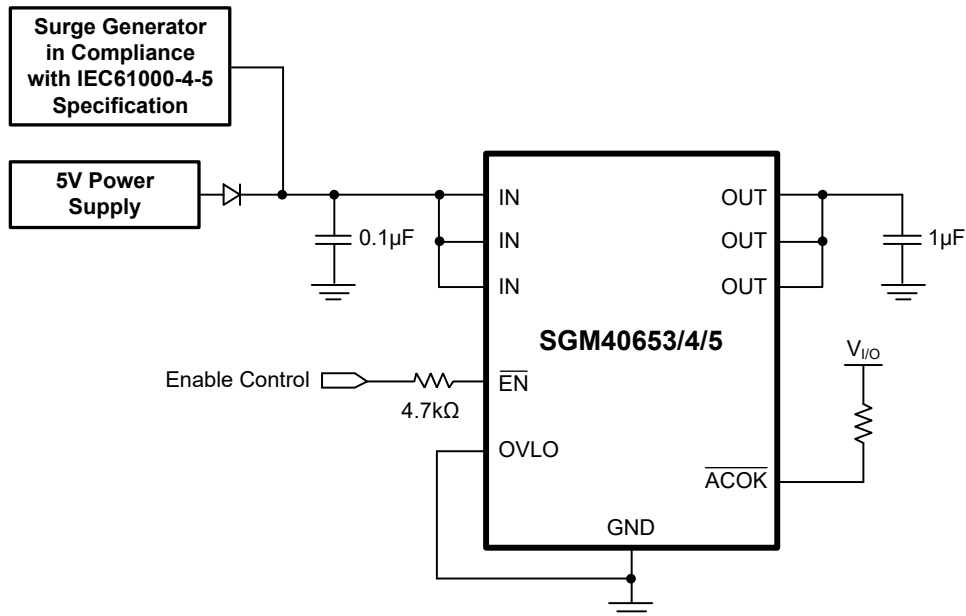


Figure 4. Surge Up Test Circuit



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## **REVISION HISTORY**

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### **DECEMBER 2017 – REV.B.2 to REV.B.3**

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Changed Pin Configurations section.....All

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### **AUGUST 2017 – REV.B.1 to REV.B.2**

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Changed Electrical Characteristics section ..... 4

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### **JUNE 2017 – REV.B to REV.B.1**

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Added package thermal resistance.....2

Changed Absolute Maximum Ratings section.....2

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### **APRIL 2017 – REV.A.4 to REV.B**

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Changed Package/Ordering Information section.....2

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### **JANUARY 2017 – REV.A.3 to REV.A.4**

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Changed Detailed Description section .....9

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### **JANUARY 2017 – REV.A.2 to REV.A.3**

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Changed Absolute Maximum Ratings section.....2

Changed Electrical Characteristics section ..... 4

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### **NOVEMBER 2016 – REV.A.1 to REV.A.2**

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Added TDFN-3×3-12L package.....All

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### **AUGUST 2016 – REV.A to REV.A.1**

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Changed Electrical Characteristics section ..... 4

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### **Changes from Original (FEBRUARY 2016) to REV.A**

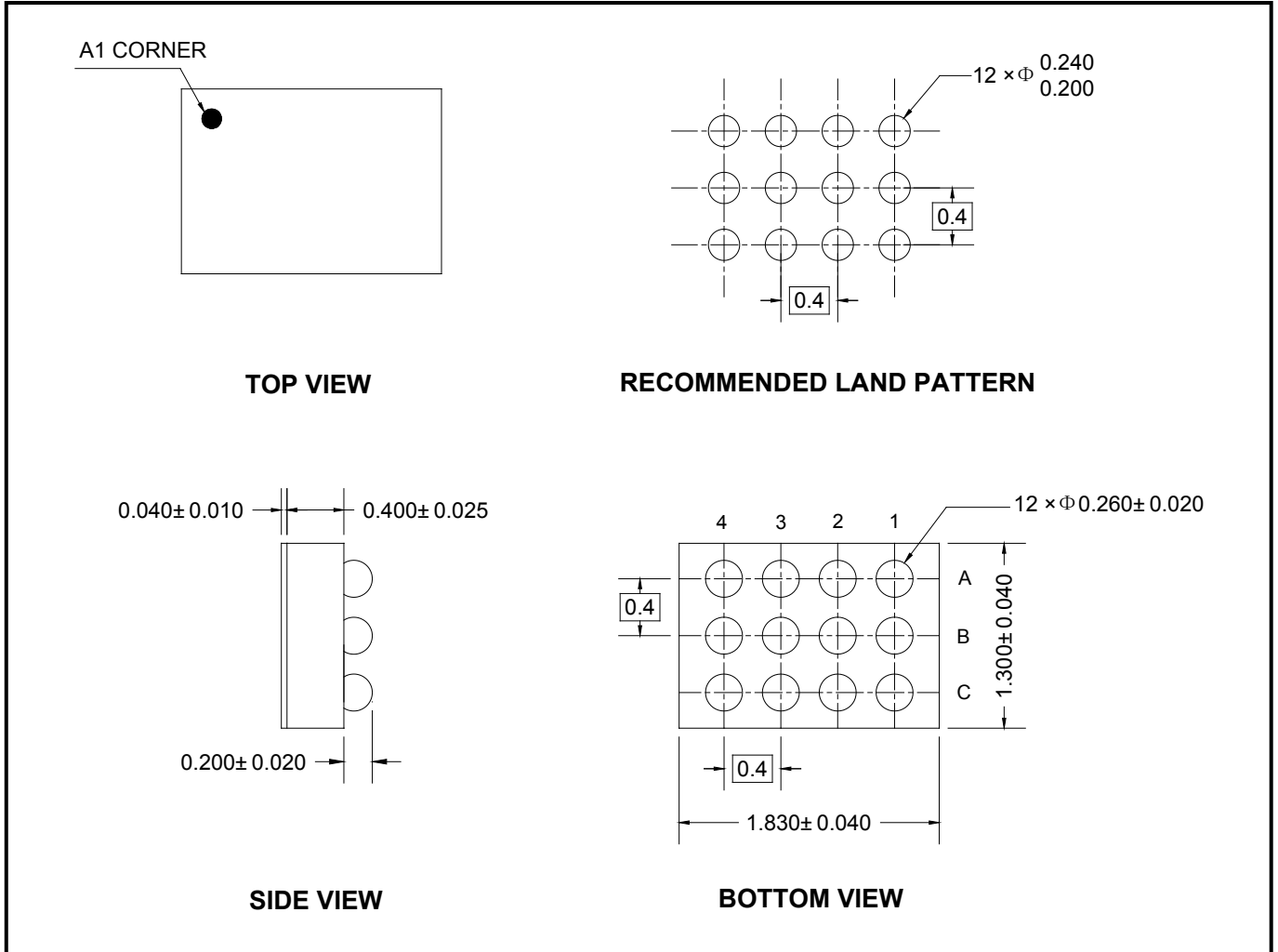
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Changed from product preview to production data.....All

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PACKAGE OUTLINE DIMENSIONS

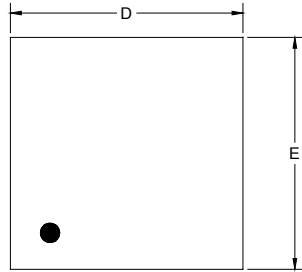
WLCSP-1.30×1.83-12B



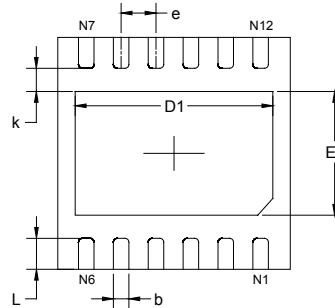
NOTE: All linear dimensions are in millimeters.

PACKAGE OUTLINE DIMENSIONS

TDFN-3x3-12L



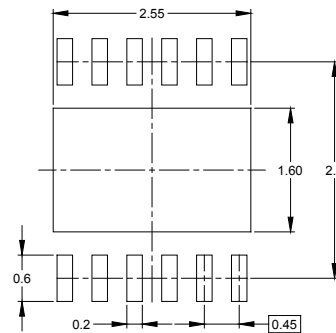
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	2.924	3.076	0.115	0.121
D1	2.450	2.650	0.096	0.104
E	2.924	3.076	0.115	0.121
E1	1.500	1.700	0.059	0.067
k	0.200 MIN		0.008 MIN	
b	0.150	0.250	0.006	0.010
e	0.450 TYP		0.018 TYP	
L	0.324	0.476	0.013	0.019

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
WLCSP-1.30×1.83-12B	7"	9.2	1.40	2.00	0.80	4.0	4.0	2.0	8.0	Q2
TDFN-3×3-12L	13"	12.4	3.30	3.30	1.10	4.0	8.0	2.0	12.0	Q1

D00001

# PACKAGE INFORMATION

## CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7" (Option)	368	227	224	8
7"	442	410	224	18
13"	386	280	370	5

DD0002