

GENERAL DESCRIPTION

The SGM4056 is a low cost battery charger with integrated high input voltage capability for single-cell Li-Ion or Li-polymer batteries. The SGM4056 has a CC/CV charge profile required for Li-Ion battery. The SGM4056 features the over-voltage protection (OVP) function. The OVP threshold is typically 6.8V (SGM4056-6.8) or 10.5V (SGM4056-10.5). The SGM4056 accepts a 26.5V maximum voltage for power input, when $V_{IN} > V_{OVP}$, the charger is disabled.

The SGM4056 has a charge indication feature. When the charger is disabled or the input is floating, the leakage current from the battery is $< 1\mu\text{A}$.

The SGM4056 is available in Green TDFN-3×3-8L, TDFN-2×3-8L, TDFN-2×2-8L and SOIC-8 (Exposed Pad) packages and is rated over the -40°C to +85°C temperature range.

FEATURES

- **Input Over-Voltage Protection Thresholds:**
 - ◆ 6.8V (TYP) for SGM4056-6.8
 - ◆ 10.5V (TYP) for SGM4056-10.5
- **Trickle Charge Threshold: 2.55V**
- **Power Input Voltage up to 26.5V**
- **Less Components and Low Cost**
- **Selectable Charge Current**
- **Selectable EOC Current**
- **Thermal Regulation Function**
- **Charging Status Indication**
- **1μA (MAX) Leakage Current when Charger Disabled or Input Floating**
- **Available in Green TDFN-3×3-8L, TDFN-2×3-8L, TDFN-2×2-8L and SOIC-8 (Exposed Pad) Packages**

APPLICATIONS

Handheld Devices
Smart Phones
Portable Internet Devices and Accessory
Standalone Chargers

PACKAGE/ORDERING INFORMATION

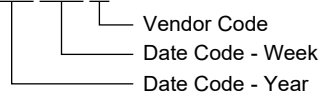
MODEL	V _{OVP} (V)	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDER NUMBER	PACKAGE MARKING	PACKING OPTION
SGM4056	6.8V	TDFN-3×3-8L	-40°C to +85°C	SGM4056-6.8YTDB8G/TR	SGM G9DB XXXXX	Tape and Reel, 3000
	6.8V	TDFN-2×3-8L	-40°C to +85°C	SGM4056-6.8YTDC8G/TR	SGB XXXX	Tape and Reel, 3000
	6.8V	TDFN-2×2-8L	-40°C to +85°C	SGM4056-6.8YTDE8G/TR	SG7 XXXX	Tape and Reel, 3000
	6.8V	SOIC-8 (Exposed Pad)	-40°C to +85°C	SGM4056-6.8YPS8G/TR	SGM 4056-6.8YPS8 XXXXX	Tape and Reel, 2500
	10.5V	TDFN-3×3-8L	-40°C to +85°C	SGM4056-10.5YTDB8G/TR	SGM GADB XXXXX	Tape and Reel, 3000
	10.5V	TDFN-2×3-8L	-40°C to +85°C	SGM4056-10.5YTDC8G/TR	SGC XXXX	Tape and Reel, 3000
	10.5V	TDFN-2×2-8L	-40°C to +85°C	SGM4056-10.5YTDE8G/TR	SG8 XXXX	Tape and Reel, 3000
	10.5V	SOIC-8 (Exposed Pad)	-40°C to +85°C	SGM4056-10.5YPS8G/TR	SGM 4056-10.5YPS8 XXXXX	Tape and Reel, 2500

MARKING INFORMATION

NOTE: XXXX = Date Code. XXXXXX = Date Code and Vendor Code.

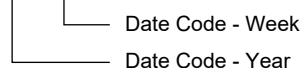
TDFN-3×3-8L/SOIC-8 (Exposed Pad)

XXXXX



TDFN-2×3-8L/TDFN-2×2-8L

YYY — Serial Number
XXXX



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)

VIN..... -0.3V to 30V

PPR, CHG, EN, IMIN, IREF, BAT..... -0.3V to 6V

Package Thermal Resistance

TDFN-3×3-8L, θ_{JA}..... 84°C/W

TDFN-2×3-8L, θ_{JA}..... 110°C/W

TDFN-2×2-8L, θ_{JA}..... 118°C/W

SOIC-8 (Exposed Pad), θ_{JA}..... 58°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..... 200V

CDM..... 1000V

RECOMMENDED OPERATING CONDITIONS

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.

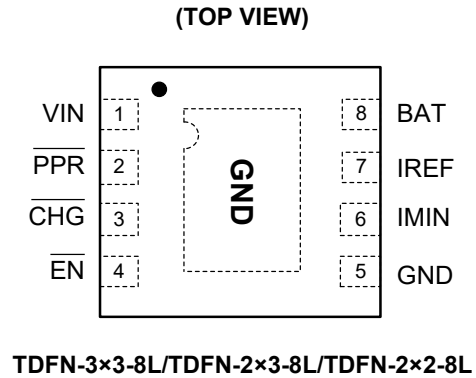
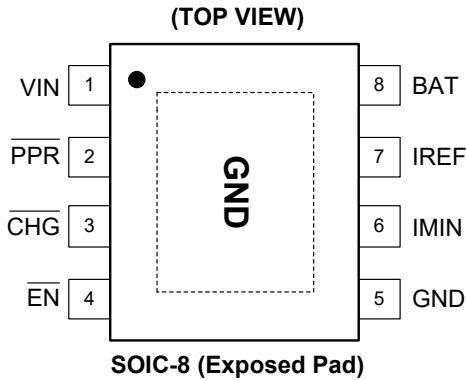
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. 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 very small parametric changes could cause the device not to meet its 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
1	VIN	Power Input Pin. It is recommended to use a 1µF (or larger value) X5R ceramic capacitor from VIN pin to ground to get good power supply decoupling. This ceramic capacitor should be placed as close as possible to VIN pin.
2	PPR	Open-Drain Power Presence Indication Pin. A low state indicates a good input voltage range ($V_{POR} < V_{IN} < V_{OVP}$), and is independent on the EN pin.
3	CHG	Open-Drain Charge Indication Pin. A low state indicates a charging state.
4	EN	Enable Input Pin. Active low. The pin is used to enable or disable the charger, and it has an internal 200kΩ pull-down resistor. When it goes high, the charger is disabled. When it goes low or left floating, the charger is enabled.
5	GND	Ground.
6	IMIN	End-of-Charge Current Selectable Pin. The EOC current is set by connecting a resistor between this pin and GND. The calculation formula of The EOC current I_{MIN} is as follows: $I_{MIN} \geq 10\text{mA}, I_{MIN} = \frac{10169}{R_{IMIN}} - 0.8 \text{ (mA)}$ $I_{MIN} < 10\text{mA}, I_{MIN} = \frac{9550}{R_{IMIN}} - 0.05 \text{ (mA)}$ Where, R_{IMIN} is in kΩ. The selectable range covers 5% (or 10mA, whichever is higher) to 50% of IREF.
7	IREF	Charge-Current Selectable Pin. Connect a resistor between IREF and GND pins to set the charge current limit according to the following formula: $I_{REF} \geq 100\text{mA}, I_{REF} = \frac{12230}{R_{IREF}} - 8 \text{ (mA)}$ $I_{REF} < 100\text{mA}, I_{REF} = \frac{11300}{R_{IREF}} - 0.9 \text{ (mA)}$ Where, R_{IREF} is in kΩ. The resistor should be placed as close to this pin as possible. When disabled, $V_{IREF} = 0V$.
8	BAT	Battery Positive Terminal Pin. It is recommended to connect a 1µF (or larger value) X5R ceramic capacitor. When the EN pin goes to high, the BAT output is disabled.
Exposed Pad	GND	Exposed Pad. Thermal pad is internally grounded and must be connected to the PCB GND plane.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, R_{IMIN} = 243kΩ, T_A = +25°C, unless otherwise noted.)

PARAMETER		SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Recommended Operating Conditions							
Maximum Supply Voltage						26.5	V
Operating Supply Voltage	SGM4056-6.8			4.55		6.10	V
	SGM4056-10.5			4.55		9.35	
Selectable Charge Current				100		900	mA
Power-On Reset							
Rising POR Threshold		V _{POR}	V _{BAT} = 3.0V, R _{IREF} = 120kΩ, use $\overline{\text{PPR}}$ pin to indicate the comparator output.	3.21	3.95	4.55	V
Falling POR Threshold		V _{POR}		2.86	3.60	4.35	V
VIN-BAT Offset Voltage							
Rising Edge		V _{OS}	V _{BAT} = 4.5V, R _{IREF} = 120kΩ, use $\overline{\text{PPR}}$ pin to indicate the comparator output. ⁽¹⁾		110	200	mV
Falling Edge		V _{OS}		5	60		mV
Over-Voltage Protection							
Over-Voltage Protection Threshold	SGM4056-6.8	V _{OVP}	V _{BAT} = 4.3V, R _{IREF} = 120kΩ, use $\overline{\text{PPR}}$ pin to indicate the comparator output.	6.10	6.80	7.26	V
	SGM4056-10.5			9.35	10.50	11.15	
OVP Threshold Hysteresis	SGM4056-6.8	V _{OVPHYS}		140	220	300	mV
	SGM4056-10.5			245	340	430	
Standby Current							
BAT Pin Sink Current		I _{STANDBY}	Charger disabled or the input is floating			1	μA
VIN Pin Supply Current		I _{VIN}	V _{BAT} = 4.3V, R _{IREF} = 24.3kΩ, charger disabled		200	275	μA
VIN Pin Supply Current		I _{VIN}	V _{BAT} = 4.3V, R _{IREF} = 24.3kΩ, charger enabled		270	320	μA
Voltage Regulation							
Output Voltage	V _{CH}	R _{IREF} = 24.3kΩ, 4.55V < V _{IN} < 6.10V, charge current = 20mA		4.152	4.2	4.248	V
		R _{IREF} = 24.3kΩ, 4.55V < V _{IN} < 9.35V, charge current = 20mA		4.152	4.2	4.248	
PMOS On-Resistance		R _{DS(ON)}	V _{BAT} = 3.8V, charge current = 500mA, R _{IREF} = 10kΩ		0.7		Ω
Charge Current ⁽²⁾							
IREF Pin Output Voltage		V _{IREF}	V _{BAT} = 3.8V, R _{IREF} = 120kΩ	1.162	1.215	1.262	V
Constant Charge Current		I _{REF}	R _{IREF} = 24.3kΩ, V _{BAT} = 2.8V to 3.8V	440	500	560	mA
Trickle Charge Current		I _{TRK}	R _{IREF} = 24.3kΩ, V _{BAT} = 2.4V	55	90	135	mA
End-of-Charge Current		I _{MIN}	R _{IREF} = 24.3kΩ	20	40	75	mA
EOC Rising Threshold			R _{IREF} = 24.3kΩ	315	370	435	mA
Pre-conditioning Charge Threshold							
Pre-conditioning Charge Threshold Voltage		V _{MIN}	R _{IREF} = 24.3kΩ	2.46	2.55	2.65	V
Pre-conditioning Voltage Hysteresis		V _{MINHYS}	R _{IREF} = 24.3kΩ	20	100	190	mV

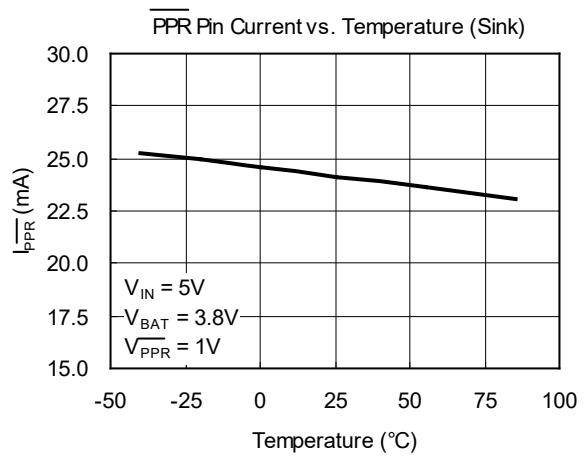
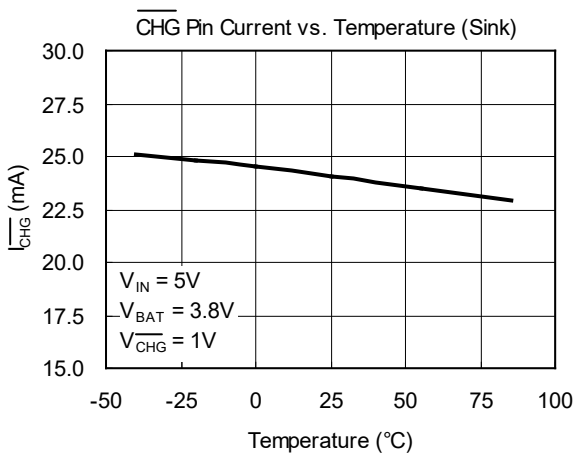
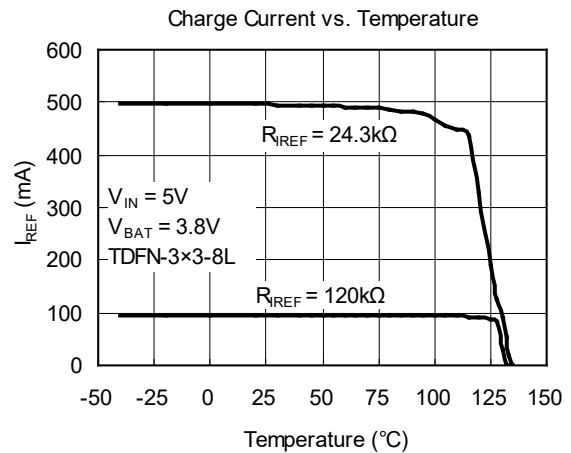
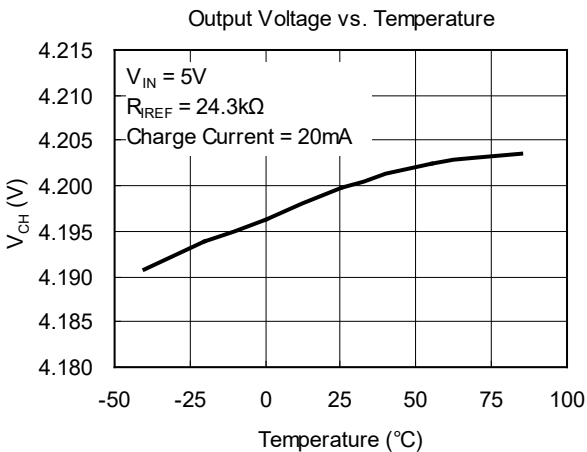
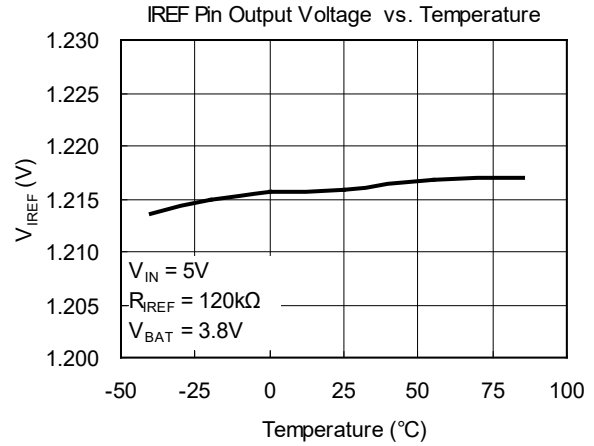
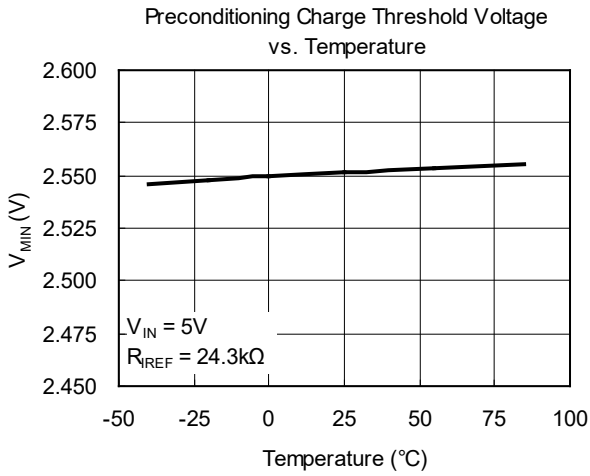
NOTES:

- By selecting 4.5V V_{BAT}, the $\overline{\text{PPR}}$ output can be used as the indication for the offset comparator output indication. If the V_{BAT} is below the POR threshold, no output pins are available to indicate.
- If the integrated circuit under the test unit cannot dissipate heat, the charge current will be affected by the thermal regulation function.

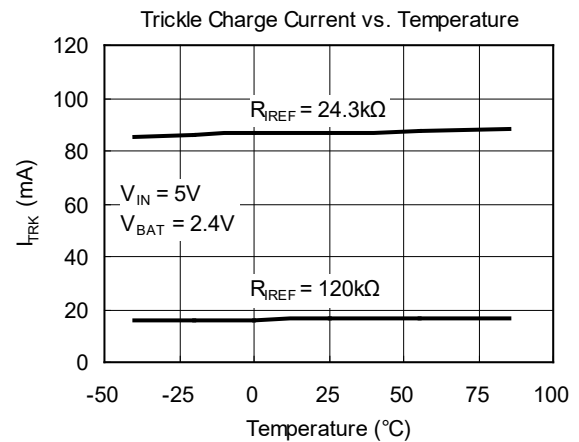
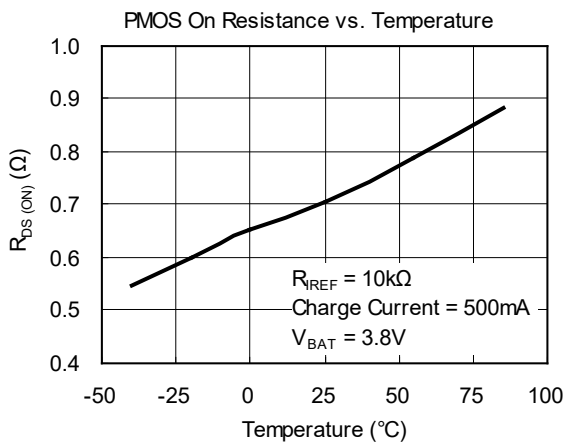
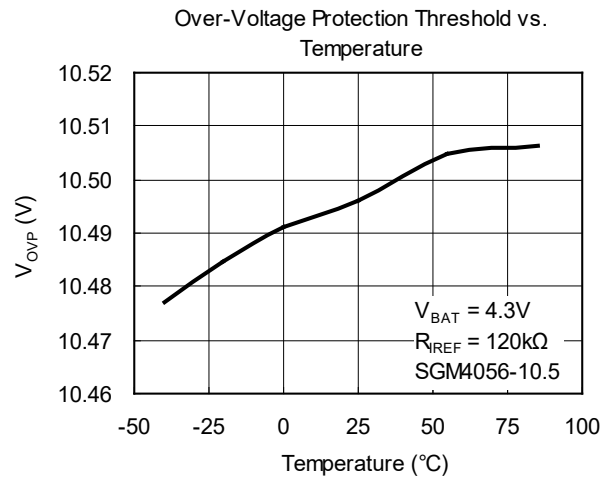
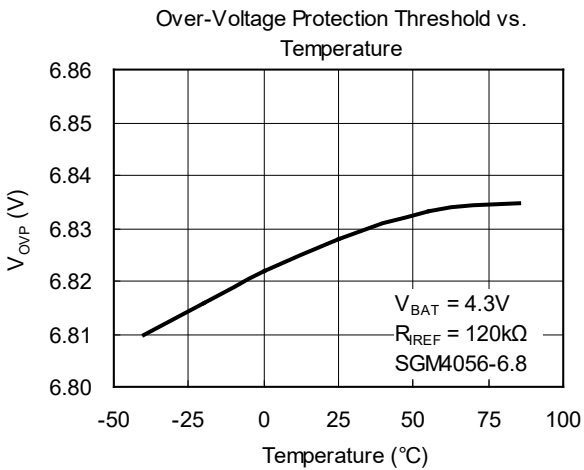
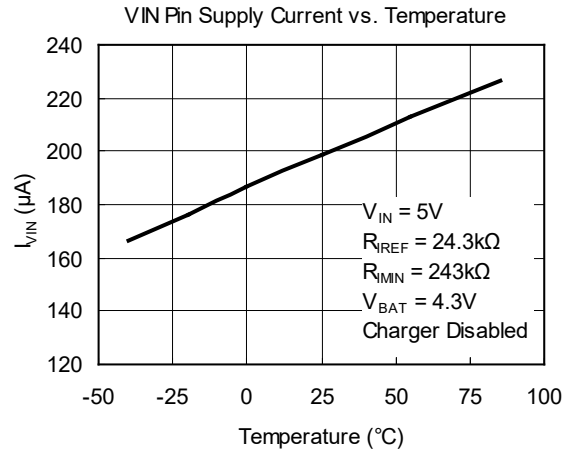
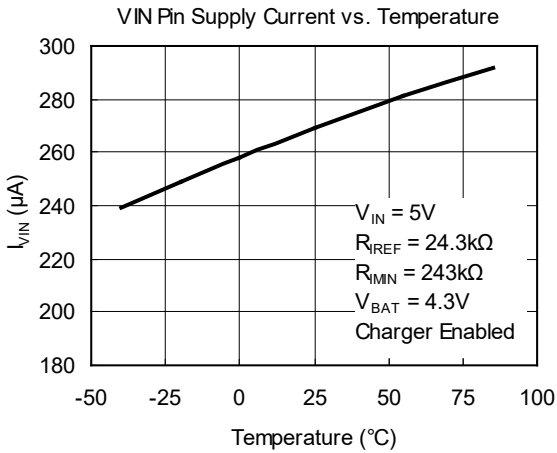
ELECTRICAL CHARACTERISTICS (continued)(V_{IN} = 5V, R_{IMIN} = 243kΩ, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Internal Temperature Monitoring						
Thermal Regulation Threshold	T _{REG}			115		°C
Logic Input and Outputs						
$\overline{\text{EN}}$ Pin Logic Input High			1.5			V
$\overline{\text{EN}}$ Pin Logic Input Low					0.8	V
$\overline{\text{EN}}$ Pin Internal Pull-Down Resistance			150	200	250	kΩ
$\overline{\text{CHG}}$ Sink Current when LOW		Pin voltage = 1V	15	24		mA
$\overline{\text{CHG}}$ Leakage Current when High Impedance		V _{$\overline{\text{CHG}}$} = 5.5V			4.5	μA
$\overline{\text{PPR}}$ Sink Current when LOW		Pin voltage = 1V	15	24		mA
$\overline{\text{PPR}}$ Leakage Current when High Impedance		V _{$\overline{\text{PPR}}$} = 5.5V			4.5	μA

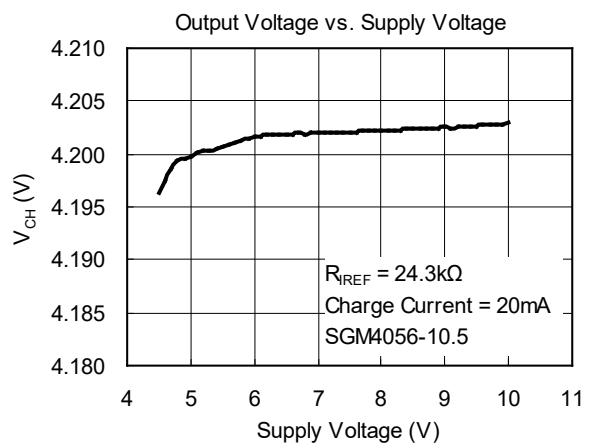
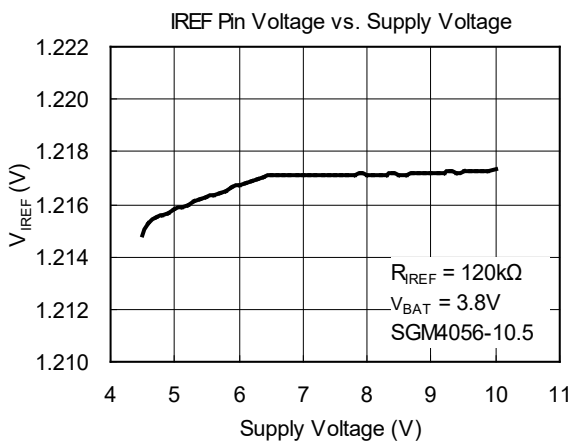
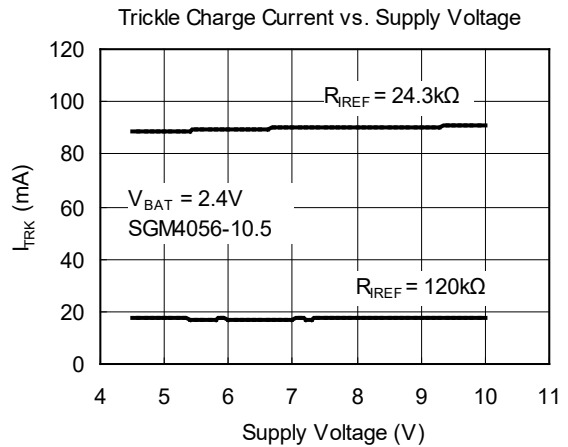
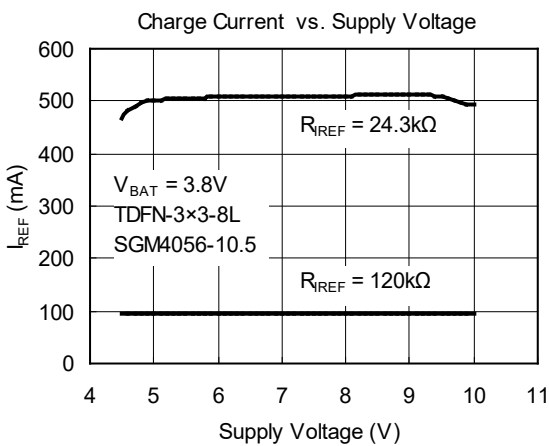
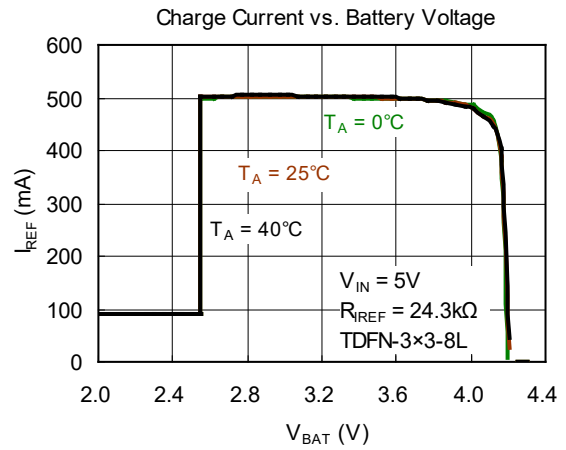
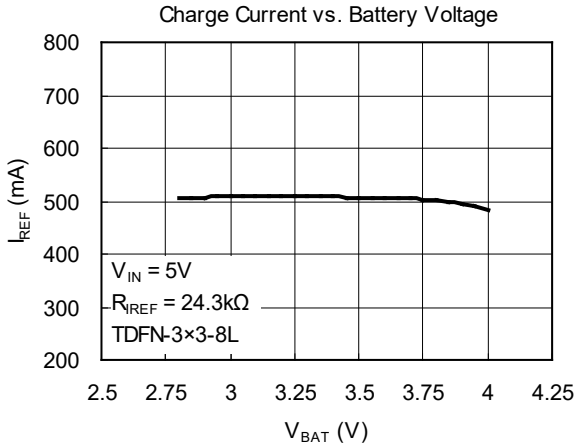
TYPICAL PERFORMANCE CHARACTERISTICS



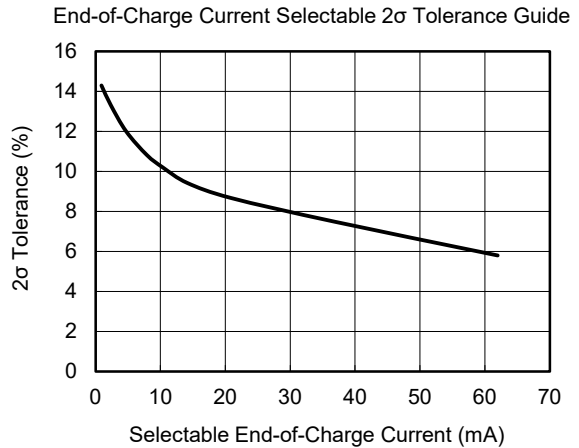
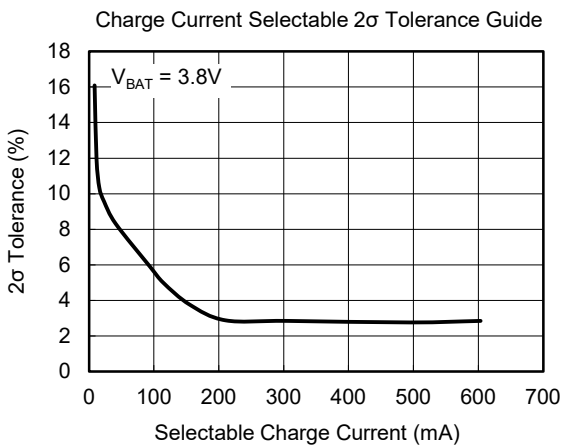
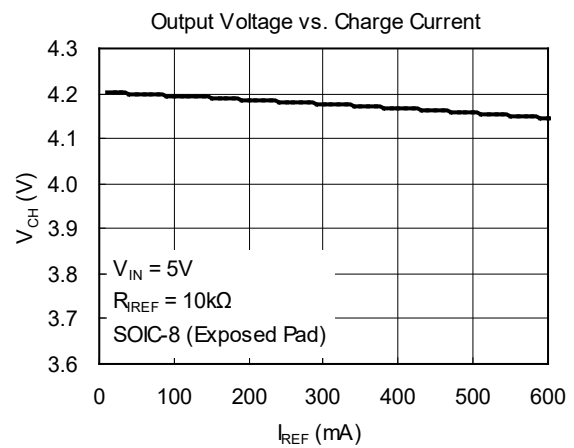
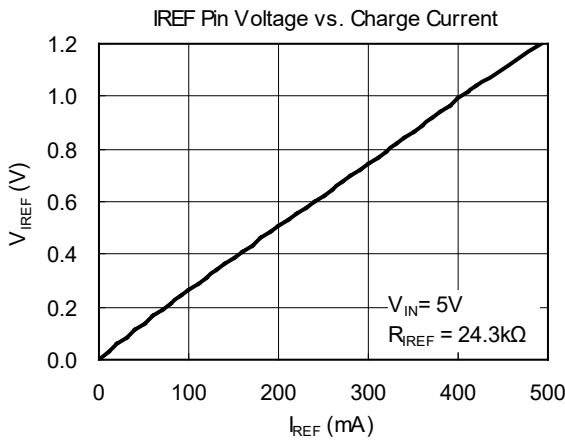
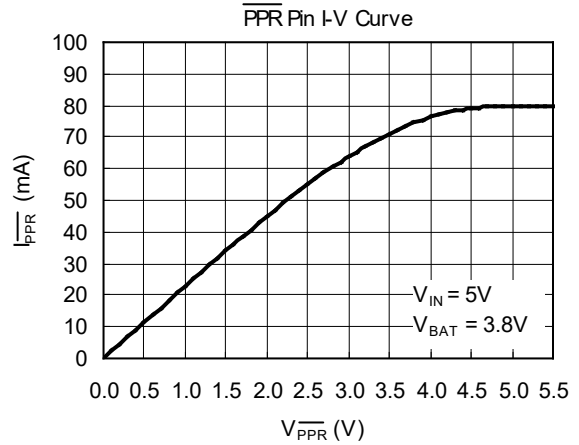
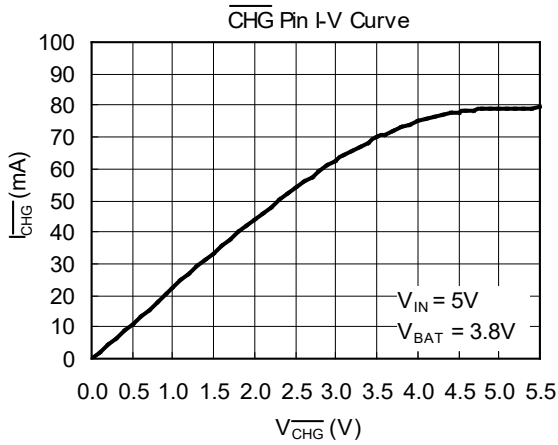
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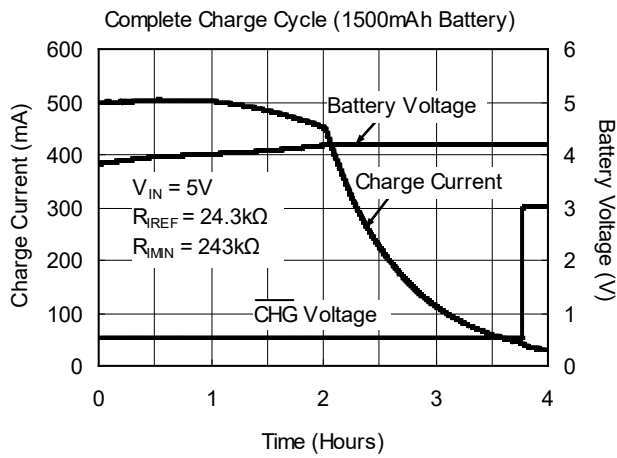
TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL PERFORMANCE CHARACTERISTICS (continued)



TYPICAL APPLICATION CIRCUITS

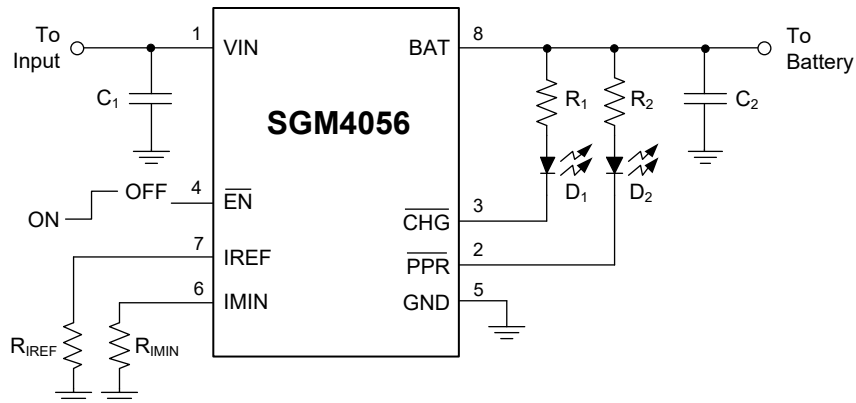


Figure 1. Typical Application Circuit Interfacing to Indication LEDs

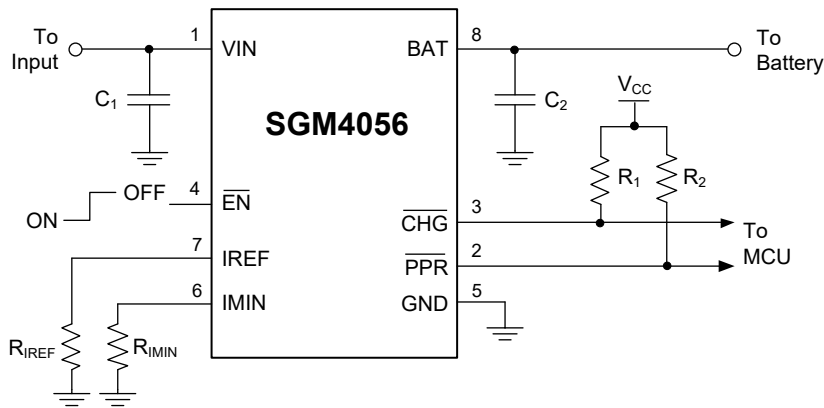


Figure 2. Typical Application Circuit with the Indication Signals Interfacing to an MCU

Table 1. Component Description for Typical Application Circuits

Component	Description
C ₁	1μF X5R ceramic cap.
C ₂	1μF X5R ceramic cap.
R _{IREF}	24.3kΩ, 1%, for 500mA charge current.
R _{IMIN}	243kΩ, 1%, for 40mA EOC current.
R ₁ , R ₂	300Ω, 5%, for Figure 1. 100kΩ, 5%, for Figure 2.
D ₁ , D ₂	LEDs for indication, for Figure 1.

TYPICAL APPLICATION CIRCUITS (continued)

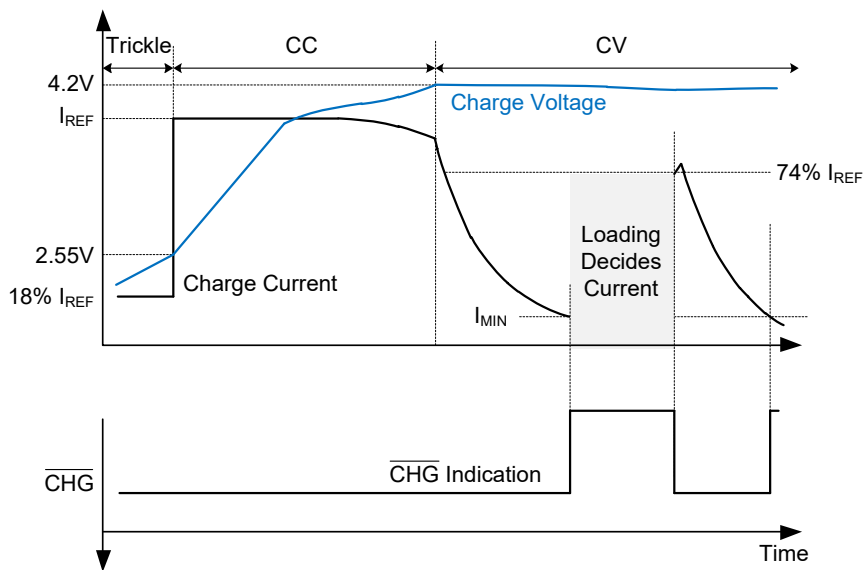


Figure 3. Illustrative Charge Profile (Not Scale in Time)

REVISION HISTORY

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

JUNE 2022 – REV.B to REV.B.1

Update General Description section	1
Update Typical Application Circuits section.....	13

AUGUST 2018 – REV.A.4 to REV.B

Update Pin Description section.....	4
Update Typical Performance Characteristics section	11

OCTOBER 2017 – REV.A.3 to REV.A.4

Changed Electrical Characteristics section	5
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MAY 2017 – REV.A.2 to REV.A.3

Changed Absolute Maximum Ratings section	2
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MAY 2015 – REV.A.1 to REV.A.2

Changed Pin Description section.....	3
Added Typical Performance Characteristics section	10

NOVEMBER 2014 – REV.A to REV.A.1

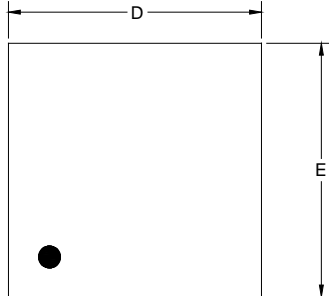
Changed Electrical Characteristics section	4
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Changes from Original (JANUARY 2013) to REV.A

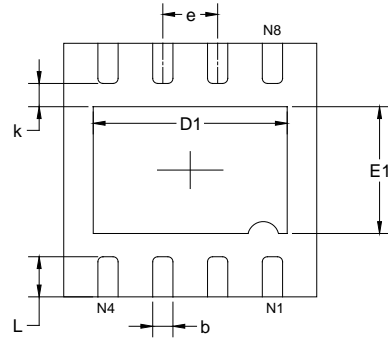
Changed from product preview to production data.....	All
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PACKAGE OUTLINE DIMENSIONS

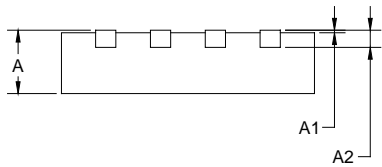
TDFN-3x3-8L



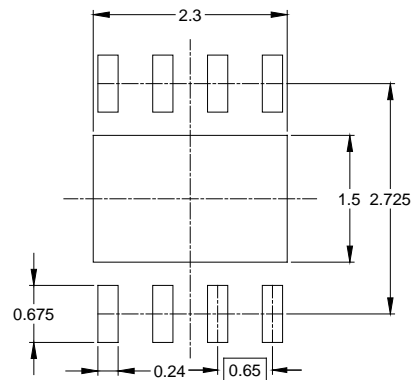
TOP VIEW



BOTTOM VIEW



SIDE VIEW



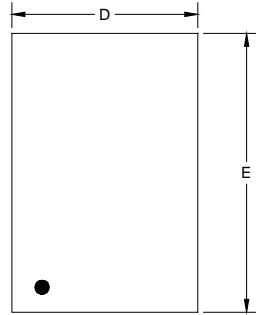
RECOMMENDED LAND PATTERN (Unit: mm)

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	2.900	3.100	0.114	0.122
D1	2.200	2.400	0.087	0.094
E	2.900	3.100	0.114	0.122
E1	1.400	1.600	0.055	0.063
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.650 TYP		0.026 TYP	
L	0.375	0.575	0.015	0.023

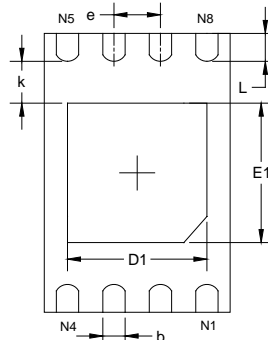
NOTE: This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

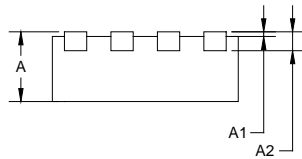
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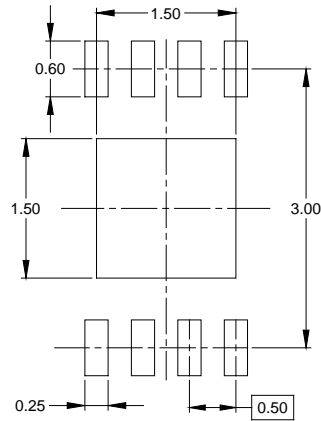
TOP VIEW



BOTTOM VIEW



SIDE VIEW



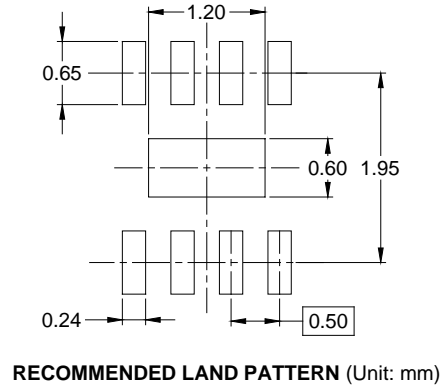
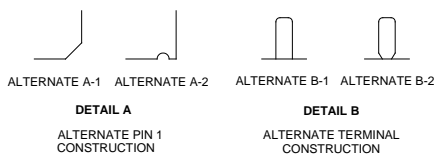
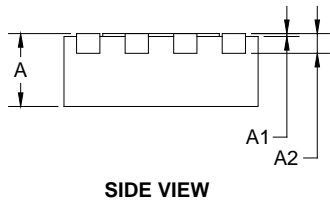
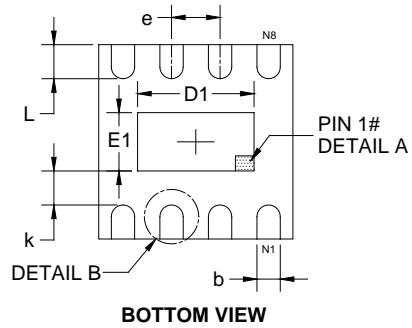
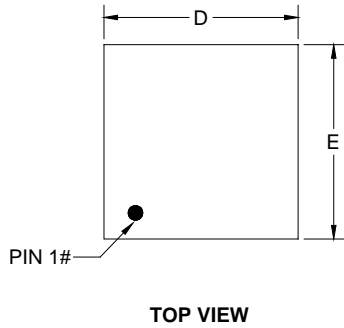
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.924	2.076	0.076	0.082
D1	1.400	1.600	0.055	0.063
E	2.924	3.076	0.115	0.121
E1	1.400	1.600	0.055	0.063
k	0.200 MIN		0.008 MIN	
b	0.200	0.300	0.008	0.012
e	0.500 TYP		0.020 TYP	
L	0.224	0.376	0.009	0.015

NOTE: This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

TDFN-2x2-8L

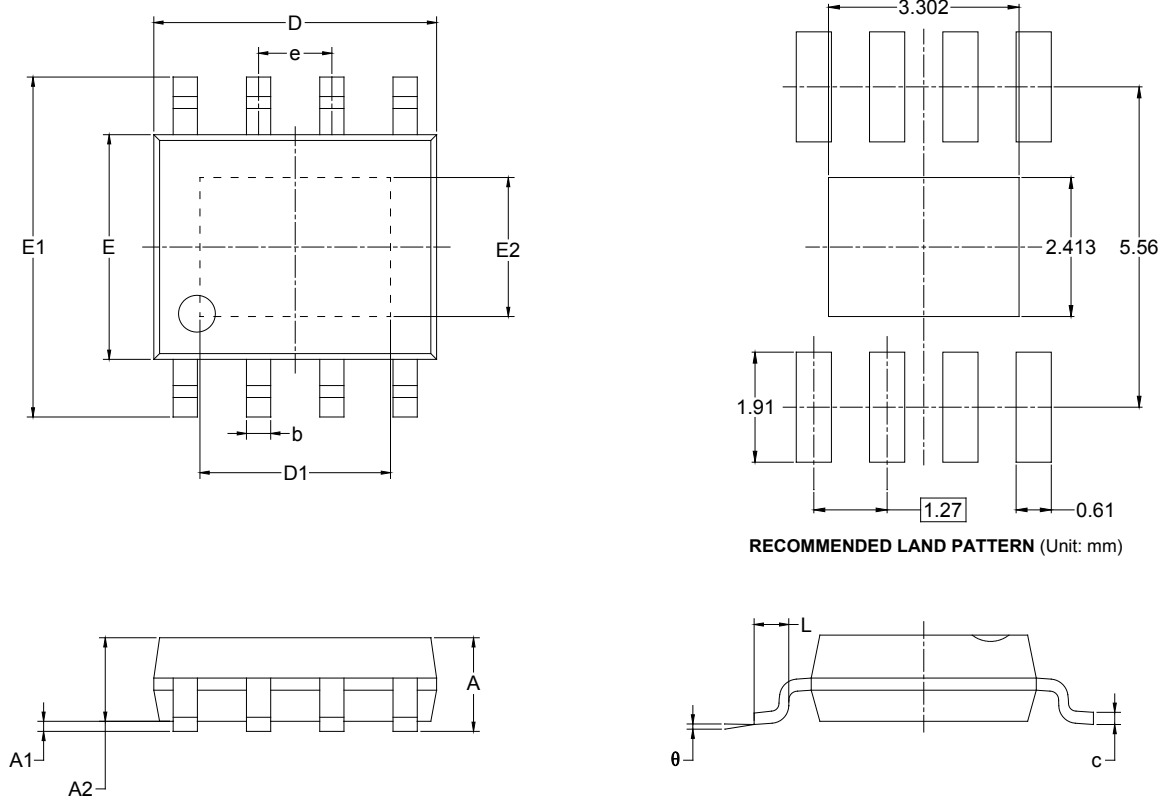


Symbol	Dimensions In Millimeters		
	MIN	MOD	MAX
A	0.700	0.750	0.800
A1	0.000	-	0.050
A2	0.203 REF		
D	1.900	2.000	2.100
E	1.900	2.000	2.100
D1	1.100	1.200	1.300
E1	0.500	0.600	0.700
b	0.180	-	0.300
e	0.500 TYP		
k	0.200 MIN		
L	0.250	0.350	0.450

NOTE: This drawing is subject to change without notice.

PACKAGE OUTLINE DIMENSIONS

SOIC-8 (Exposed Pad)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.700		0.067
A1	0.000	0.100	0.000	0.004
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

PACKAGE INFORMATION

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
TDFN-3×3-8L	13"	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	Q1
TDFN-2×3-8L	7"	9.5	2.30	3.30	1.10	4.0	4.0	2.0	8.0	Q2
TDFN-2×2-8L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
SOIC-8 (Exposed Pad)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1

DD0001

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