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WIC1331

High Input Voltage Charger

Description

The WIC1331 is a cost-effective, fully integrated high input voltage single-cell Li-Ion battery charger. The charger uses a CC/CV charge profile required by Li-Ion battery. The charger accepts an input voltage up to 28V but is disabled when the input voltage exceeds the OVP threshold, typically 6.8V (WIC1331A) or 10.5V (WIC1331B), to prevent excessive power dissipation. The 28V rating eliminates the over- voltage protection circuit required in a low input voltage charger.

The charge current and the end-of-charge (EOC) current are programmable with external resistors. When the battery voltage is lower than typically 2.55V, the charger preconditions the battery with typically 18% of the programmed charge current. When the charge current reduces to the programmable EOC current level during the CV charge phase, an EOC indication is provided by $\overline{\text{CHG}}$ pin, which is an open-drain output. An internal thermal foldback function protects the charger from any thermal failure.

Two indication pins ($\overline{\text{PPR}}$ and $\overline{\text{CHG}}$) allow simple interface to a microprocessor or LEDs. When no adapter is attached or when disabled, the charger draws less than 1μA leakage current from the battery.

The WIC1331 is available in Green TDFN-3×3-8L, TDFN-2×3-8L, TDFN-2×2-8L and SOIC-8 (Exposed Pad) packages .

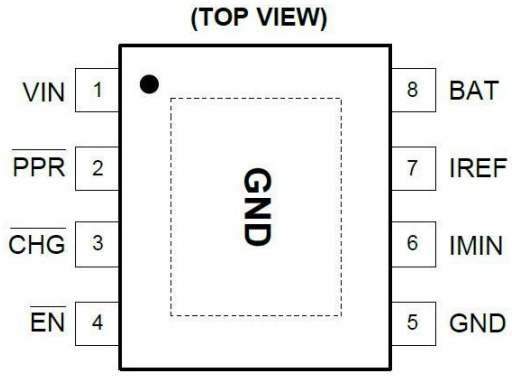
Features

- Complete Charger for Single-Cell Li-Ion or Polymer Batteries
- Integrated Pass Element and Current Sensor
- No External Blocking Diode Required
- Low Component Count and Cost
- Programmable Charge Current
- Maximum Charge Current 1.1A
- Programmable End-of-Charge Current
- Charge Current Thermal Foldback for Thermal Protection
- 2.55V Trickle Charge Threshold
- 6.8V Input Over-Voltage Protection for WIC1331A
- 10.5V Input Over-Voltage Protection for WIC1331B
- Power Presence and Charge Indications
- Less than 1μA Leakage Current off the Battery When No Input Power Attached or Charger Disabled
- Available in Green TDFN-3×3-8L, TDFN-2×3-8L,TDFN-2×2-8L and SOIC-8 (Exposed Pad) Packages

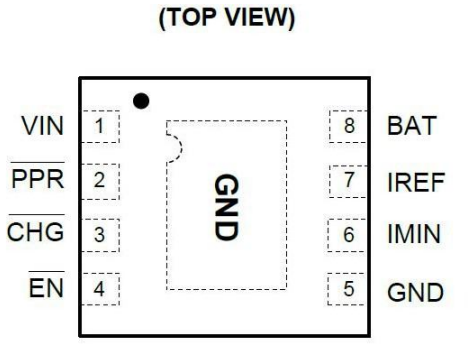
Applications

- Mobile Phones
- Blue-Tooth Devices
- PDAs
- MP3 Players
- Stand-Alone Chargers
- Other Handheld Devices

Pin Configuration



SOIC-8 (Exposed Pad)



TDFN-3×3-8L/TDFN-2×3-8L/TDFN-2×2-8L

Pin Function

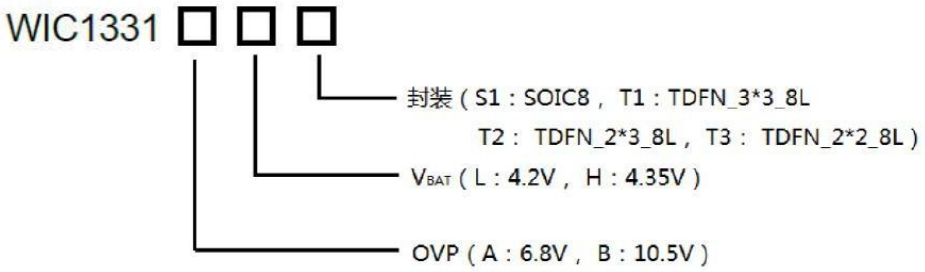
Pin	Name	Function
1	VIN	Power Input. The absolute maximum input voltage is 28V. A 1μF or larger value X5R ceramic capacitor is recommended to be placed very close to the input pin for decoupling purpose. Additional capacitance may be required to provide a stable input voltage.
2	$\overline{PPR}$	Open-drain Power Presence Indication. The open-drain MOSFET turns on when the input voltage is above the POR threshold but below the OVP threshold and off otherwise. This pin is capable to sink 15mA (MIN) current to drive an LED. The maximum voltage rating for this pin is 5.5V. This pin is independent on the EN pin input.
3	$\overline{CHG}$	Open-drain Charge Indication. This pin outputs a logic low when a charge cycle starts and turns to high impedance when the end-of-charge (EOC) condition is qualified. This pin is capable to sink 15mA (MIN) current to drive an LED. When the charger is disabled, the CHG pin outputs high impedance.
4	$\overline{EN}$	Enable Input. This is a logic input pin to disable or enable the charger. Drive to high to disable the charger. When this pin is driven to low or left floating, the charger is enabled. This pin has an internal 200kΩ pull-down resistor.
5、9	GND	System Ground.
6	IMIN	End-of-Charge (EOC) Current Programming Pin. Connect a resistor between this pin and the GND pin to set the EOC current. The EOC current I_{MIN} can be programmed by the following equation: $I_{MIN} = 9700/R_{IMIN}(mA)$ where R_{IMIN} is in kΩ.
7	IREF	Charge-Current Programming and Monitoring Pin. Connect a resistor between this pin and the GND pin to set the charge current limit determined by the following equation: $I_{REF} = 12150/R_{IREF}(mA)$ where R_{IREF} is in kΩ .
8	BAT	Charger Output Pin. Connect this pin to the battery. A 1μF or larger X5R ceramic capacitor is recommended for decoupling and stability purposes. When the EN pin is pulled to logic high, the BAT output is disabled.

Absolute Maximum Ratings

SYMBOL	Item	Rating	UNIT
V_{IN}	Input Voltage	-0.3 to 30	V
$V_{OTHERPIN}$	Other Pins	-0.3 to 6.0	V
P_D	Power Dissipation@T_A=25℃ ((SOIC-8)	1.111	W
T_J	Junction Temperature	150	ºC
T_{stg}	Storage Temperature Range	-65 to +150	ºC
T_L	Lead Temperature (Soldering,10sec)	260	ºC

Label Information

MODEL	V_{BAT}(V)	V_{OVP}(V)	PACKAGE DESCRIPTION	ORDER NUMBER
WIC1331	4.2V	6.8V	SOIC8	WIC1331ALS1
		6.8V	TDFN-3*3-8L	WIC1331ALT1
		6.8V	TDFN-2*3-8L	WIC1331ALT2
		6.8V	TDFN-2*2-8L	WIC1331ALT3
		10.5V	SOIC8	WIC1331BLS1
		10.5V	TDFN-3*3-8L	WIC1331BLT1
		10.5V	TDFN-2*3-8L	WIC1331BLT2
		10.5V	TDFN-2*2-8L	WIC1331BLT3
	4.35V	6.8V	SOIC8	WIC1331AHS1
		6.8V	TDFN-3*3-8L	WIC1331AHT1
		6.8V	TDFN-2*3-8L	WIC1331AHT2
		6.8V	TDFN-2*2-8L	WIC1331AHT3
		10.5V	SOIC8	WIC1331BHS1
		10.5V	TDFN-3*3-8L	WIC1331BHT1
		10.5V	TDFN-2*3-8L	WIC1331BHT2
		10.5V	TDFN-2*2-8L	WIC1331BHT3



Recommended Operating Conditions

Item	Range	Unit
Junction Temperature	-40~125	℃
Air Temperature	-40~85	℃

Electrical Characteristics

V_{IN} = 5V, R_{IMIN} = 243kΩ, T_A = +25℃, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
RECOMMENDED OPERATING CONDITIONS						
VIN	Maximum Supply Voltage				28	V
WIC1331A	Operating Supply Voltage		4.55		6.10	V
WIC1331B	Operating Supply Voltage		4.55		9.35	V
V_{POR_RISE}	POR Threshold	VIN Rising	3.21	3.95	4.55	V
V_{POR_FALL}	POR Threshold	VIN Falling	2.86	3.60	4.35	V
V_{OVP}-6.8	OVP threshold	V_{BAT}=4.3V，R_{IREF}=120 kΩ	6.1	6.8	7.26	V
V_{OVP}-10.5	OVP threshold	V_{BAT}=4.3V，R_{IREF}=120 kΩ	9.35	10.5	11.15	V
V_{OVPHYS}-6.8	OVP threshold Hysteresis		140	220	300	mV
V_{OVPHYS}-10.5	OVP threshold Hysteresis		245	340	430	
STANDBY CURRENT						
$I_{Q\_STANDBY}$	VIN Supply Current	V_{BATT}=4.5V，EN=High	--	200	275	uA
I_Q	VIN Supply Current	V_{BATT}=4.5V，EN=Low	--	270	320	uA
I_{BAT_SLEEP}	Sleep Model Leakage Current		--	1	5	uA
V_{BATT}	V_{BATT} Constant Voltage	0℃ to 85℃, I_{LOAD}=0mA	4.152	4.2	4.248	V
			4.305	4.35	4.395	V
T_{FOLD}	Over Current Foldback Threshold		--	115	--	℃
	PGB/CHGSB Leakage Current		20	--	--	mA
V_{PRE}	Preconditioning Charge Threshold Voltage	V_{BATT} Rising，R_{IREF}=120 kΩ	2.4	2.55	2.7	V
V_{PRE_HYS}	Preconditioning Voltage Hysteresis	V_{BATT} Falling，R_{IREF}=120 kΩ	20	100	190	mV
$R_{DS(ON)}$	ON Resistance	V_{BAT}=4.3V，R_{IREF}=10 kΩ，Charge Current=500mA	--	500		mΩ
V_{IREF}	IREF Pin Voltage	V_{BAT}=3.8V，R_{IREF}=120 kΩ		1.215		V
I_{REF}	Adjustable Charge Current Range	SOIC8	10	--	1100	mA
	Constant Charge Current	V_{BAT}=3.8V，R_{IREF}=24.3 kΩ	440	500	560	mA
$I_{REF\_ACCURACY}$	Constant Charge Current Accuracy	V_{BAT}=3.8V，I_{REF}>500mA		10		%
		V_{BAT}=3.8V,100mA≤I_{REF}≤500mA		15		%
		V_{BAT}=3.8V,10mA≤I_{REF}≤100mA		20		%
I_{TRK}	Trickle Charge Current	V_{BAT}=2.4V，R_{IREF}=24.3 kΩ	75	90	105	mA
$I_{TRK\_ACCURACY}$	Trickle Charge Current Accuracy	V_{BAT}=3.8V，I_{REF}>500mA		15		%
		V_{BAT}=3.8V,100mA≤I_{REF}≤500mA		20		%
		V_{BAT}=3.8V,10mA≤I_{REF}≤100mA		25		%
I_{MIN}	End-of-Charge Current	R_{IREF}=24.3kΩ, R_{IMIN}=243kΩ	35	40	45	mA
$I_{MIN\_ACCURACY}$	EOC Current Accuracy	$I_{MIN\_SETTING}$=2mA	0.5	2	3.5	mA
		$I_{MIN\_SETTING}$=5mA	3	5	7	mA
		$I_{MIN\_SETTING}$>10mA		10		%
	EOC Rising Threshold	R_{IREF}=24.3 kΩ	315	370	435	mA
	EN Pin Pull Down Resistance			200		kΩ
V_{IH}	EN Voltage Logic-High		1.5	--	--	V
V_{IL}	EN Voltage Logic-Low		--	--	0.4	

NOTES:

1. The 4.5V VBAT is selected so that the PPR output can be used as the indication for the offset comparator output indication. If the VBAT is lower than the POR threshold, no output pin can be used for indication.

2. The charge current can be affected by the thermal foldback function if the IC under the test setup cannot dissipate the heat.

Functional Description

Operation

The WIC1331 charges a Li-Ion battery using a CC/CV profile. The constant current I_{REF} is set with the external resistor R_{IREF} and the constant voltage is fixed at 4.2V/4.35V. If the battery voltage is below a typical 2.55V trickle charge threshold, the WIC1331 charges the battery with a trickle current until the battery voltage rises above the trickle charge threshold. When the battery voltage reaches 4.2V/4.35V, the charger enters a CV mode.Figure 3 shows the typical charge waveform after the power is on.

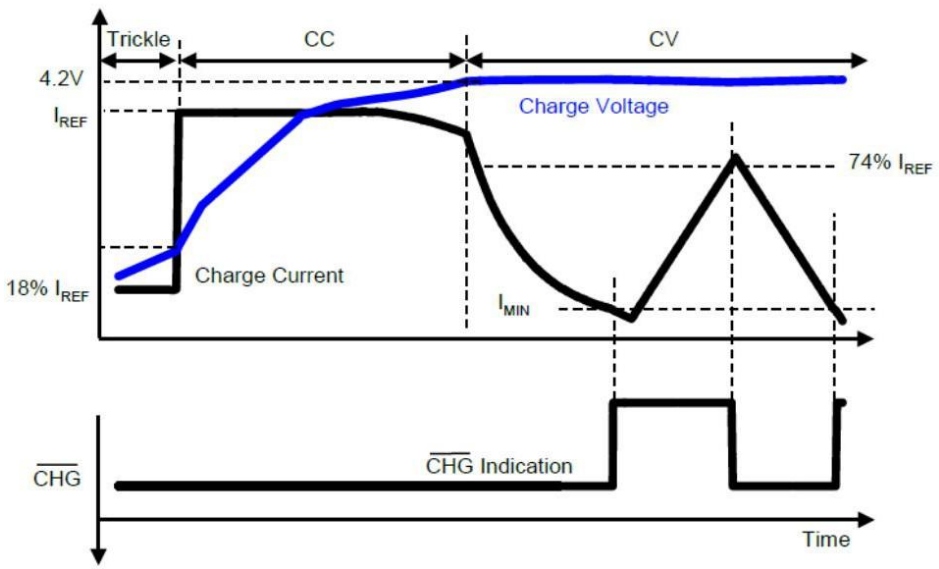


Figure 1.typical charge waveform

$\overline{PPR}$ Indication

The $\overline{PPR}$ pin is an open-drain output to indicate the presence of the AC adapter. Whenever the input voltage is higher than the $\overline{POR}$ threshold, the $\overline{PPR}$ pin turns on the internal open-drain MOSFET to indicate a logic low signal.

$\overline{CHG}$ Indication

The $\overline{CHG}$ is an open-drain output ,The MOSFET turns off when the EOC current is reached. The MOSFET turns on When the Charge Function is normal.

$\overline{EN}$ Input

$\overline{EN}$ is an active-low logic input to enable the charger. Drive the EN pin to low or leave it floating to enable the charger. This pin hasa 200kΩ internal pull-down resistor so when left floating, the input is equivalent to logic low.

Over Voltage Protection

The WIC1331 accepts an input voltage up to 28V but disables charging when the input voltage exceeds the OVP threshold, typically 6.8V for WIC1331A and 10.5V for WIC1331B, to protect against unqualified or faulty AC adapters.

Preconditioning Charge Current

If the battery voltage is below a typical 2.55V trickle charge threshold, the WIC1331 charges the battery with a trickle current of 18% of IREF until the battery voltage rises above the trickle charge threshold.

Constant Charge Current Model

Connect a resistor between IREF pin and the GND pin to set the charge current limit determined by the followingequation:

$$I_{REF} = 12150/R_{IREF}(mA)$$

where RIREF is in kΩ.

Constant Charge Voltage Model

Connect a resistor between this IMIN and the GND pin to set the EOC current. The EOC current IMIN can be programmed by the following equation:

$$I_{MIN} = 9700/R_{IMIN}(mA)$$

where R_{IMIN} is in kΩ.

After the EOC is reached, the charge current has to rise to typically 74% I_{REF} for the CHG pin to turn on again

Thermal Foldback

The thermal foldback function starts to reduce the charge current when the internal temperature reaches a typical value of +115℃.

Application Circuit

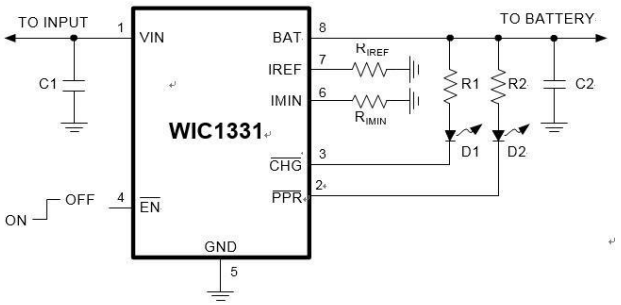


Figure 1. Typical Application Circuit Interfacing to Indication LEDs

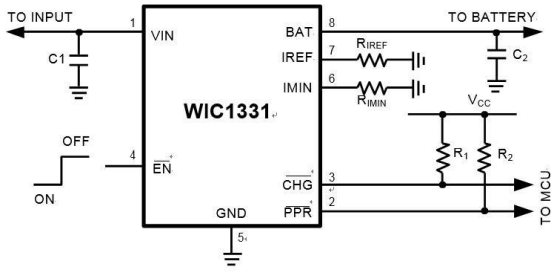
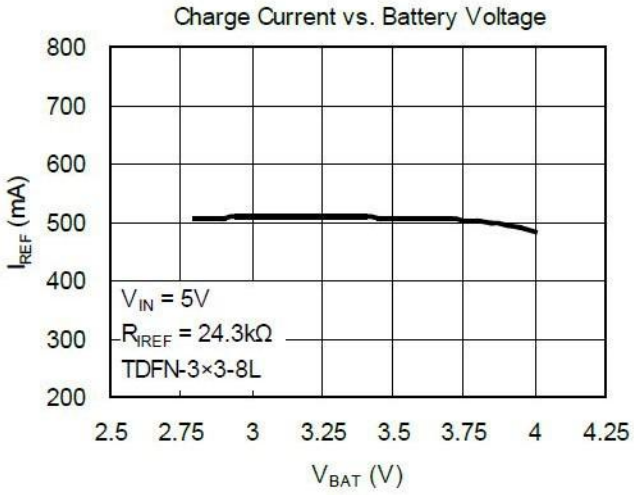
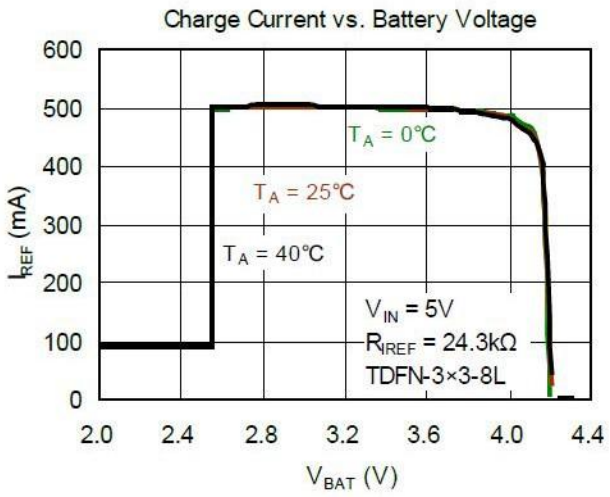
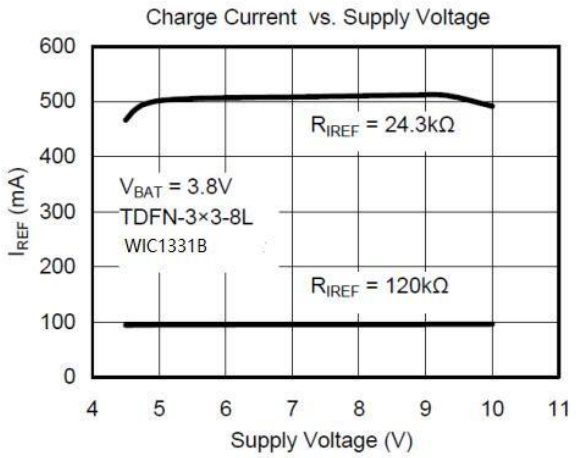


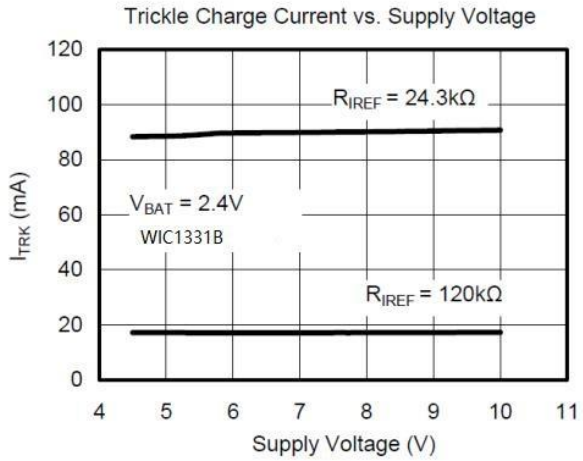
Figure 2. Typical Application Circuit with the Indication Signals Interfacing to an MCU

Typical Performance Characteristics

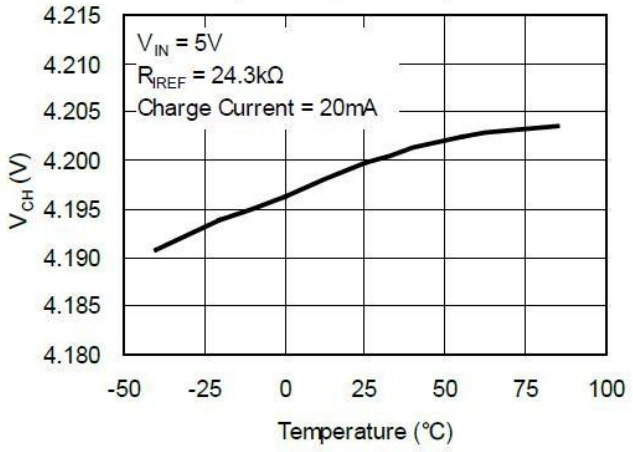




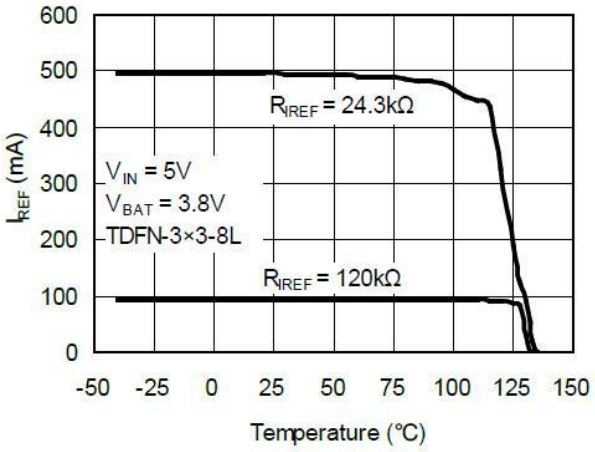




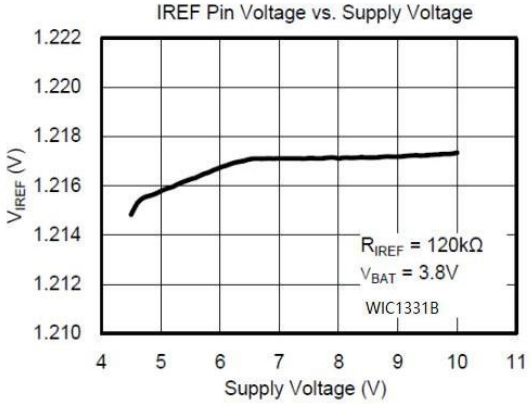
Output Voltage vs. Temperature



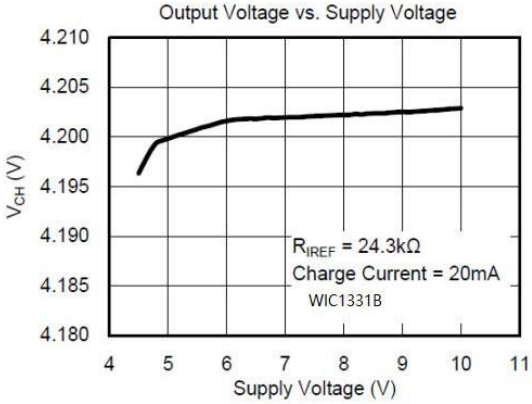
Charge Current vs. Temperature



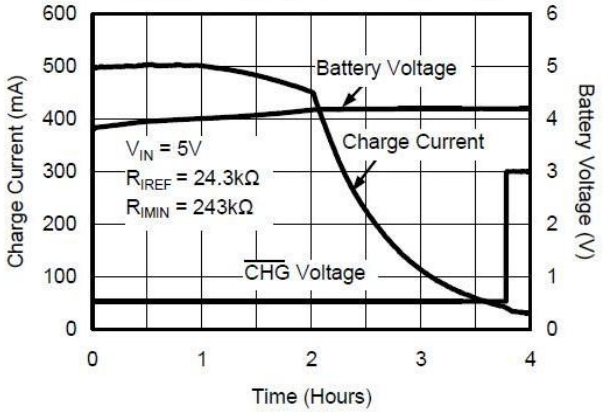
IREF Pin Voltage vs. Supply Voltage



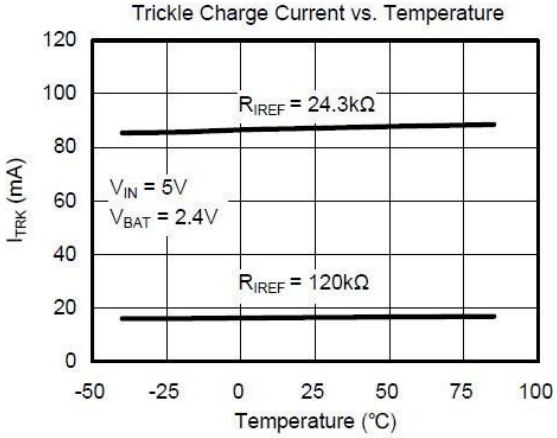
Output Voltage vs. Supply Voltage



Complete Charge Cycle (1500mAh Battery)

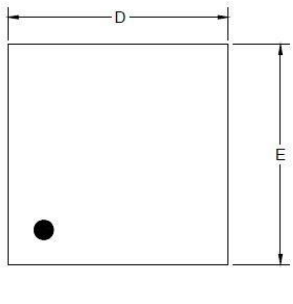


Trickle Charge Current vs. Temperature

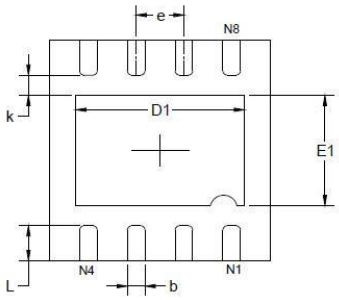


Package Information

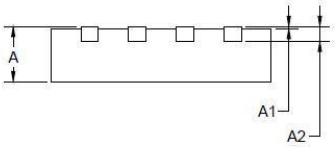
TDFN-3×3-8L



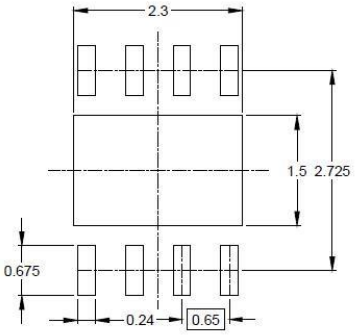
TOP VIEW



BOTTOM VIEW



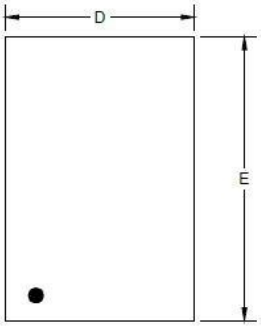
SIDE VIEW



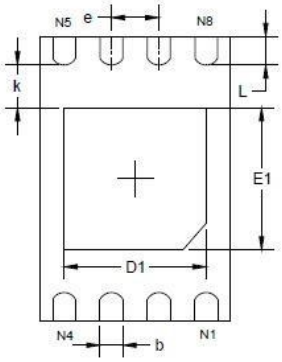
RECOMMENDED LAND PATTERN (Unit: mm)

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

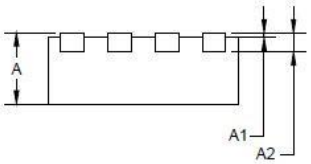
TDFN-2×3-8L



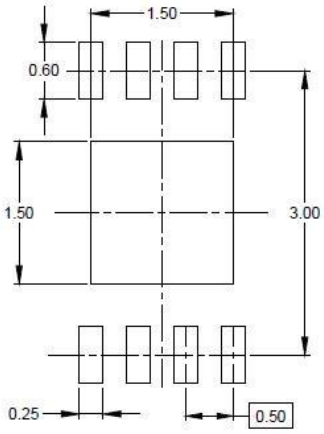
TOP VIEW



BOTTOM VIEW



SIDE VIEW



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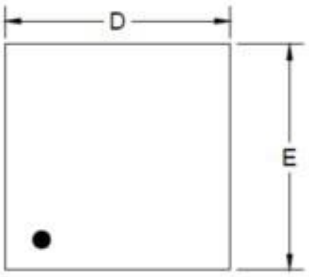
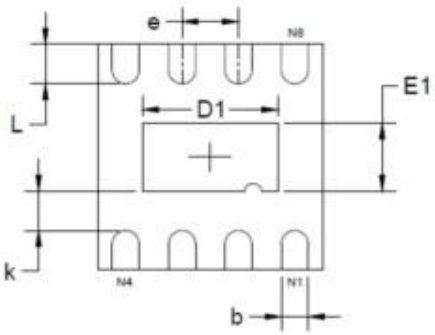
A2	0.203 REF		0.008 REF	
D	1.924	2.076	0.076	0.082
D1	1.400	1.600	0.055	0.063
E	2.924	3.076	0.115	0.121
E1	1.400	1.600	0.055	0.063
k	0.200 MIN		0.008 MIN	
b	0.200	0.300	0.008	0.012
e	0.500 TYP		0.020 TYP	
L	0.224	0.376	0.009	0.015

TDFN-2×2-8L

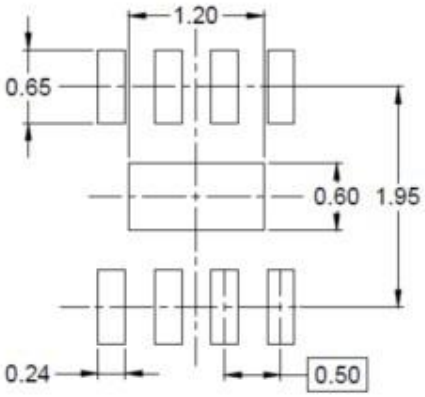


TOP VIEW



BOTTOM VIEW

SIDE VIEW



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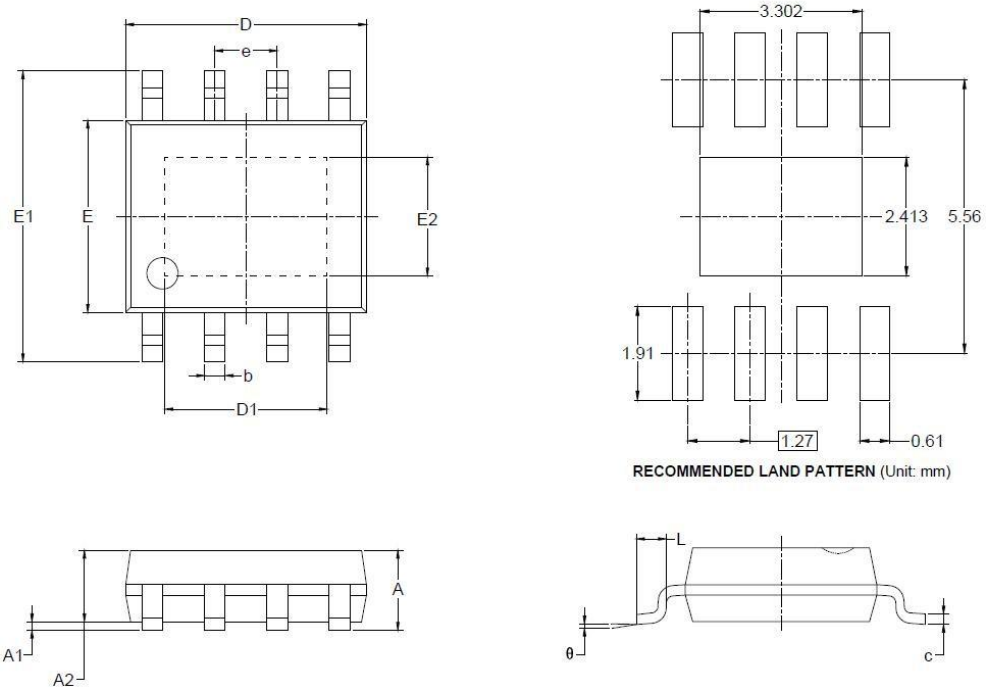
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
D	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.500	0.700	0.020	0.028
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.500 TYP		0.020 TYP	
L	0.250	0.450	0.010	0.018

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°

Contact Information

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