# SGM41566
# Linear Regulation Battery Charger

## GENERAL DESCRIPTION

The SGM41566 is designed for charging low capacity battery cell with factory-programmable current programmable in the range of 50mA to 750mA from loosen regulated power source. The device features low drop-out constant-current constant-voltage charging, weak battery pre-charging, voltage fold-back safe retaining, floating charging protection and system start-up pre-charge, with NTC sensing protection.

The SGM41566 is available in a Green TDFN-2×2-8AL package. It operates in -40℃ to +125℃ junction temperature.

## FEATURES

- **Loosen Regulated Power Input**
- **Battery Voltages Option:**
  **25mV Raster in 3.5V to 4.8V Range**
- **Charging Current Option:**
  **50mA Raster in 50mA to 750mA Range**
- **5% to 25% Residual End-of-Charge Option**
- **Weak Battery Pre-Charge Option**
- **Voltage Fold-Back Safe Power Retaining**
- **NTC Temperature Sensing for Protection**
- **Floating Charging Protection**
- **Start-Up Charging for 12.5ms**
- **650ms Power Recycle Certification**
- **Full Charging Power-Up at Low Voltage**
- **Pre-Charging Power-Up at Normal Voltage**
- **Available in a Green TDFN-2×2-8AL Package**

## APPLICATIONS

Low Capacity Rechargeable Battery Powered Applications

## TYPICAL APPLICATION

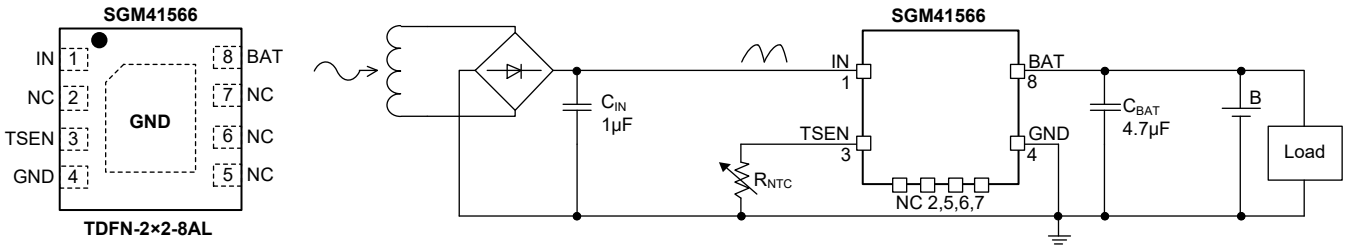



**Figure 1. Typical Application Circuit**

## PACKAGE/ORDERING INFORMATION

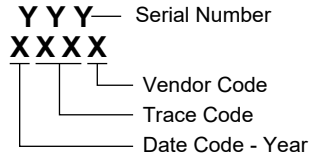
| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM41566-350C55 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-350C55XTDE8G/TR | MDV<br>XXXX | Tape and Reel, 3000 |
| SGM41566-360F41 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-360F41XTDE8G/TR | MDR<br>XXXX | Tape and Reel, 3000 |
| SGM41566-360N21 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-360N21XTDE8G/TR | 07B<br>XXXX | Tape and Reel, 3000 |
| SGM41566-365A33 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-365A33XTDE8G/TR | 074<br>XXXX | Tape and Reel, 3000 |
| SGM41566-365A41 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-365A41XTDE8G/TR | MDU<br>XXXX | Tape and Reel, 3000 |
| SGM41566-365O12 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-365O12XTDE8G/TR | MDW<br>XXXX | Tape and Reel, 3000 |
| SGM41566-365O22 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-365O22XTDE8G/TR | MDM<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405A14 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405A14XTDE8G/TR | MDT<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405A22 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405A22XTDE8G/TR | 04Z<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405A33 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405A33XTDE8G/TR | 051<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405A55 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405A55XTDE8G/TR | 054<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405D11 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405D11XTDE8G/TR | 04Y<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405D22 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405D22XTDE8G/TR | 050<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405D33 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405D33XTDE8G/TR | 052<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405D44 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405D44XTDE8G/TR | 053<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405L21 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405L21XTDE8G/TR | MDY<br>XXXX | Tape and Reel, 3000 |
| SGM41566-405N21 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-405N21XTDE8G/TR | 01Z<br>XXXX | Tape and Reel, 3000 |
| SGM41566-415J11 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-415J11XTDE8G/TR | 075<br>XXXX | Tape and Reel, 3000 |
| SGM41566-415L21 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-415L21XTDE8G/TR | MDX<br>XXXX | Tape and Reel, 3000 |
| SGM41566-420B04 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-420B04XTDE8G/TR | 076<br>XXXX | Tape and Reel, 3000 |
| SGM41566-420J04 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-420J04XTDE8G/TR | MDZ<br>XXXX | Tape and Reel, 3000 |
| SGM41566-420O22 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-420O22XTDE8G/TR | 077<br>XXXX | Tape and Reel, 3000 |
| SGM41566-435C33 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-435C33XTDE8G/TR | 078<br>XXXX | Tape and Reel, 3000 |

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM41566-440D11 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-440D11XTDE8G/TR | MDQ<br>XXXX | Tape and Reel, 3000 |
| SGM41566-440O22 | TDFN-2×2-8AL | -40℃ to +125℃ | SGM41566-440O22XTDE8G/TR | 079<br>XXXX | Tape and Reel, 3000 |

NOTE: Contact Factory if other charge voltage and/or charge current are desired.

## MARKING INFORMATION

NOTE: XXXX = Date Code, Trace 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

IN to GND ..... -0.3V to 28V
IN Clamp Current or Voltage (1) ..... 10mA or 28V
BAT to GND (When $V_{IN}$ > $V_{BAT}$) ..... -0.3V to 20V
BAT to GND (When $V_{IN}$ ≤ $V_{BAT}$) ..... -0.3V to 4.8V
TSEN to GND ..... -0.3V to 6V
TSEN Clamp Current or Voltage (1) ..... 0.3mA or 6V
Package Thermal Resistance
TDFN-2×2-8AL, $\theta_{JA}$ ..... 95℃/W
TDFN-2×2-8AL, $\theta_{JB}$ ..... 47℃/W
TDFN-2×2-8AL, $\theta_{JC(TOP)}$ ..... 84℃/W
TDFN-2×2-8AL, $\theta_{JC(BOT)}$ ..... 9℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM ..... 8000V
CDM ..... 1000V

## RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range ..... 2.9V to 19.5V
IN Clamp Current or Voltage (1) ..... 10mA or 19.5V
TSEN Clamp Current or Voltage (1) ..... 0.3mA or 5.5V
Input Effective Capacitance, $C_{IN}$ ..... 0.1μF to 12μF
Output Effective Capacitance, $C_{BAT}$ ..... 1μF to 12μF
Operating Junction Temperature Range ..... -40℃ to +125℃

NOTE:
1. The current limit and voltage limit are set for those values which applies onto the IN or TSEN pin current and voltage source for 10 minutes and should not cause any change to key operation parameters.

## 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

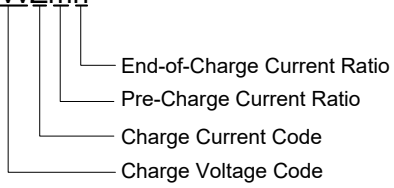
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

# SUFFIX CODE FOR CHARGE VOLTAGE AND CHARGE CURRENT

**Surfix:** vvvZmn

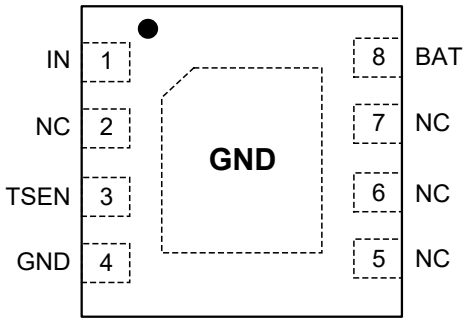



**Model: SGM41566-vvvZmn**

| Charge Voltage (Option Code "vvv") | | | | Charge Current (Option Code "Z") | | Pre-Charge Ratio (to Charge Current) (Option Code "m") | |
|---|---|---|---|---|---|---|---|
| **Code** | **Voltage (V)** | **Code** | **Voltage (V)** | **Code** | **Current (mA)** | **Code** | **Current Ratio (%)** |
| **350** | 3.500 | **438** | 4.375 | **A** | 50 | **0** | No pre-charge |
| **355** | 3.550 | **440** | 4.400 | **B** | 100 | **1** | 5 |
| **360** | 3.600 | **443** | 4.425 | **C** | 150 | **2** | 10 |
| **365** | 3.650 | **445** | 4.450 | **D** | 200 | **3** | 15 |
| **370** | 3.700 | **448** | 4.475 | **E** | 250 | **4** | 20 |
| **375** | 3.750 | **450** | 4.500 | **F** | 300 | **5** | 25 |
| **380** | 3.800 | **453** | 4.525 | **G** | 350 | **End-of-Charge Ratio (to Charge Current) (Option Code "n")** | |
| **385** | 3.850 | **455** | 4.550 | **H** | 400 | | |
| **390** | 3.900 | **458** | 4.575 | **I** | 450 | | |
| **395** | 3.950 | **460** | 4.600 | **J** | 500 | **Code** | **Current Ratio (%)** |
| **400** | 4.000 | **463** | 4.625 | **K** | 550 | **1** | 5 |
| **405** | 4.050 | **465** | 4.650 | **L** | 600 | **2** | 10 |
| **410** | 4.100 | **468** | 4.675 | **M** | 650 | **3** | 15 |
| **415** | 4.150 | **470** | 4.700 | **N** | 700 | **4** | 20 |
| **420** | 4.200 | **473** | 4.725 | **O** | 750 | **5** | 25 |
| **425** | 4.250 | **475** | 4.750 | | | | |
| **430** | 4.300 | **478** | 4.775 | | | | |
| **433** | 4.325 | **480** | 4.800 | | | | |
| **435** | 4.350 | | | | | | |

## PIN CONFIGURATION

(TOP VIEW)




TDFN-2×2-8AL

## PIN DESCRIPTION

| PIN | NAME | TYPE (1) | FUNCTION |
|---|---|---|---|
| 1 | IN | P | Charge Power Input, for Powering this Device and Feeding to the Charge Output. The capacitor with effective capacitance in the range of 0.1μF to 12μF is recommended. It should be placed close to this pin for decoupling. |
| 3 | TSEN | IO | Temperature Sensing and Enable Input. The external connection to this pin is checked, once power input voltage is in the effective range by feeding current (38.6μA) out of the pin. If the pin voltage is less than $V_{ENL}$ (102mV), it is considered as being grounded. The charging function is disabled while the feeding current is reduced to about 25.5μA. If the pin voltage is higher than $V_{ENH}$ (2.68V), charging function is enabled. If the pin voltage is between $V_{ENL}$ and $V_{ENH}$, it is considered that the NTC thermistor is connected, and the ground resistance is evaluated for temperature safe charging. In this case, charging is allowed, only when the pin voltage is within the range of hot threshold resistance related voltage $V_{HOT}$ to cold threshold related voltage $V_{COLD}$.<br>The feeding current biases the pin voltage to be higher than $V_{COLD}$ but less than $V_{ENH}$. If pin voltage in this range is found, it is considered to be excessive cold condition or NTC connection open, charge function is disabled. |
| 4 | GND | G | Ground of the Circuit. |
| 8 | BAT | O | Output to the Battery and/or System Load for Charging and/or Powering the System Load. The output decoupling capacitor with effective capacitance in the range of 1μF to 12μF is recommended. The pin sinks about 4μA if the pin voltage is higher than charging voltage, and the pin sinks about 1.5mA if output clamp is triggered. |
| 2, 5, 6, 7 | NC | NC | No Internal Connection. |
| Exposed Pad | GND | — | Exposed Pad. Exposed pad is internally connected to GND. Connect it to a large ground plane to maximize thermal dissipation. |

NOTE:
1. P = Power, IO = Input and Output, G = Ground, O = Output, NC = No Connection.

## ELECTRICAL CHARACTERISTICS

($V_{IN}$ = ($V_{CHG(NOM)}$ + 0.5V) or 5V (whichever is greater), $V_{TSEN}$ = 0.4V, $T_J$ = -40℃ to +125℃, typical values are at $T_J$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Voltage Range | $V_{IN}$ | | | 2.9 | | 19.5 | V |
| Charge Voltage Range | $V_{CHG}$ | $V_{CHG}$ option range | | 3.5 | | 4.8 | V |
| Charge Current Range | $I_{CHG}$ | $I_{CHG}$ option range | | 50 | | 750 | mA |
| Input Clamp Voltage | $V_{OV}$ | $I_{IN}$ = 10mA | | 20 | 21 | 22 | V |
| Input Clamp Current | $I_{OV}$ | $V_{IN}$ = 22V | | 18 | 26 | 33 | mA |
| Pass On-Resistance | $R_{ON}$ | $I_{IN}$ = 90% × $I_{CHG}$, $V_{BAT}$ = 3V, $I_{CHG}$ ≥ 200mA | | | 0.6 | 1.1 | Ω |
| BAT Leakage | $I_{STANDBY}$ | $V_{BAT}$ = 95% × $V_{CHG}$, IN floating, $T_J$ = -40℃ to +85℃ | | | 1 | 3 | μA |
| | | $V_{BAT}$ = 95% × $V_{CHG}$, $V_{TSEN}$ = 0V, $T_J$ = -40℃ to +85℃ | | | 1 | 8 | |
| | | $V_{BAT}$ = 95% × $V_{CHG}$, TSEN floating, $T_J$ = -40℃ to +85℃ | | | 2.4 | 8 | |
| Input Current | $I_Q$ | $V_{TSEN}$ = 0V, charging disabled | | | 66 | 95 | μA |
| | | $V_{TSEN}$ = 5V, charging terminated | | | 80 | 125 | |
| | | $V_{TSEN}$ = 0.4V, charging terminated | | | 125 | 180 | |
| In-Charging Current | $I_{GND}$ | $V_{BAT}$ = 90% × $V_{CHG}$, GND current during charge | | | 0.4% × $I_{BAT}$ | | mA |
| Under-Voltage Lockout Thresholds | $V_{UVLOr}$ | $V_{IN}$ rising | | 2.65 | 2.74 | 2.82 | V |
| | $V_{UVLOf}$ | $V_{IN}$ falling | | 2.33 | 2.42 | 2.50 | |
| IN-BAT Offset Voltage | $V_{OS}$ | $I_{IN}$ = 0.3mA to 80mA, $V_{BAT}$ = 90% × $V_{CHG}$ | | 35 | 80 | 120 | mV |
| IN-BAT Forward Threshold Voltage (1) | $V_{DH}$ | $V_{BAT}$ = 3V, $I_{CHG}$ ≤ 200mA, charge current rise to 95% × $I_{CHG}$ | | | 130 | 260 | mV |
| IN-BAT Reverse Threshold Voltage | $V_{DL}$ | | | | 22 | | mV |
| BAT Discharge Current | $I_{OV\_BAT}$ | $V_{BAT}$ = 104% × $V_{CHG}$ | | 1 | 1.5 | 2 | mA |
| BAT Activation Voltage Threshold | $V_{BAT\_ACT}$ | During the active charge time | | | 2.74 | | V |
| **Normal Charge, Charge Termination** | | | | | | | |
| Charge Voltage | $V_{CHG}$ | Option voltage raster step | | | 25 | | mV |
| Charge Voltage Accuracy | | $I_{BAT}$ = 1mA | $T_J$ = +25℃ | -20 | | 20 | mV |
| | | | $T_J$ = +2℃ to +43℃ | -25 | | 25 | |
| | | | $T_J$ = -40℃ to +85℃ | -32 | | 28 | |
| Floating Drop Ratio | $V_{FCHG}/V_{CHG}$ | Percentage drop to the $V_{CHG}$ | | 1.5 | 2 | 2.5 | % |
| Recharge Drop Ratio | $V_{RECHG}/V_{CHG}$ | Percentage drop to the $V_{CHG}$ | | 2.6 | 4 | 5.2 | % |
| Pre-Charge Voltage Ratio | $V_{PRECHG}/V_{CHG}$ | Percentage to the $V_{CHG}$ | | 62.5 | 65 | 67 | % |
| Charge Current | $I_{CHG}$ | Option current raster step | | | 50 | | mA |
| Charge Current Accuracy | | $V_{BAT}$ = 90% × $V_{CHG}$, $I_{CHG}$ < 150mA | $T_J$ = +25℃ | -8 | | 8 | % |
| | | | $T_J$ = -40℃ to +85℃ | -10 | | 10 | |
| | | $V_{BAT}$ = 90% × $V_{CHG}$, $I_{CHG}$ ≥ 150mA | $T_J$ = +25℃ | -5 | | 5 | % |
| | | | $T_J$ = -40℃ to +85℃ | -7 | | 7 | |

## ELECTRICAL CHARACTERISTICS (continued)

($V_{IN}$ = ($V_{CHG(NOM)}$ + 0.5V) or 5V (whichever is greater), $V_{TSEN}$ = 0.4V, $T_J$ = -40℃ to +125℃, typical values are at $T_J$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **Normal Charge, Charge Termination** | | | | | | | |
| Pre-Charge Current Ratio | $I_{PRE}/I_{CHG}$ | Percentage to the $I_{CHG}$, $T_J$ = -40℃ to +85℃ | Ratio = 5% | 2.8 | 5 | 7.2 | % |
| | | | Ratio = 10% | 7.0 | 10 | 13.0 | |
| | | | Ratio = 15% | 11.5 | 15 | 18.5 | |
| | | | Ratio = 20% | 15.5 | 20 | 24.5 | |
| | | | Ratio = 25% | 19.5 | 25 | 30.5 | |
| End-of-Charge Current Ratio | $I_{EOC}/I_{CHG}$ | Percentage to the $I_{CHG}$, $T_J$ = -40℃ to +85℃ | Ratio = 5% | 3.0 | 4.8 | 6.6 | % |
| | | | Ratio = 10% | 7.4 | 9.8 | 12.2 | |
| | | | Ratio = 15% | 11.2 | 14.8 | 18.4 | |
| | | | Ratio = 20% | 15.2 | 19.6 | 24.0 | |
| | | | Ratio = 25% | 19.0 | 24 | 29.0 | |
| **Timings for Charge-Recycle, Floating Charge, Charge Termination** | | | | | | | |
| Active Charging Time | $t_{ACT}$ | Charging with $I_{CHG}$ when starting from $V_{BAT}$ < $V_{BAT\_ACT}$ | | | 12.5 | | ms |
| Charging Recycle Time | $t_{HOLD}$ | The time holds previous charging state before recycle | | | 650 | | ms |
| Pre-Charge Voltage Deglitch Time (2) | $t_{D\_TRK}$ | $T_J$ = -40℃ to +85℃ | | 2.4 | 3.8 | 5.2 | ms |
| Floating Charge Time (2) | $t_{FLT}$ | Floating time for $t_{FLT}/2$ ~ $t_{FLT}$ for charge termination, $T_J$ = -40℃ to +85℃ | | 37 | 45 | 53 | min |
| Pre-Charge Safety Time (2) | $t_{SAFE}$ | $T_J$ = -40℃ to +85℃ | | 74 | 94 | 114 | min |
| **Operation Conditions and Limits** | | | | | | | |
| NTC Sensing Current | $I_{NTC\_EN}$ | $V_{TSEN}$ = $V_{HOT}$ to $V_{COLD}$ | | 37.2 | 38.6 | 40.2 | μA |
| | $I_{NTC\_DIS}$ | $V_{TSEN}$ = 0V | | 24.0 | 25.5 | 27.0 | |
| Equivalent Resistance | $R_{0.5℃}$ | Reference to the NCP15XH103F03RC (β3380) | | 26.74 | 27.37 | 28.00 | kΩ |
| | $R_{45℃}$ | | | 4.836 | 4.95 | 5.064 | |
| NTC Dismissal Threshold | $V_{ENH}$ | TSEN rising | | 2.54 | 2.68 | 2.85 | V |
| NTC Dismissal Threshold Hysteresis | $V_{ENHHYS}$ | TSEN falling | | | 30 | | mV |
| NTC Cold Threshold | $V_{COLD}$ | TSEN rising | | 1.035 | 1.057 | 1.080 | V |
| Cold Threshold Hysteresis | $V_{COLDHYS}$ | TSEN falling | | | 165 | | mV |
| NTC Hot Threshold | $V_{HOT}$ | TSEN falling | | 182 | 191 | 200 | mV |
| Hot Threshold Hysteresis | $V_{HOTHYS}$ | TSEN rising | | | 33 | | mV |
| Shutdown Threshold | $V_{ENL}$ | TSEN falling | | 92 | 102 | 112 | mV |
| Shutdown Threshold Hysteresis | $V_{ENLHYS}$ | TSEN rising | | | 15 | | mV |
| Thermal Fold-Back Threshold | $T_{FOLD}$ | | | | 145 | | ℃ |

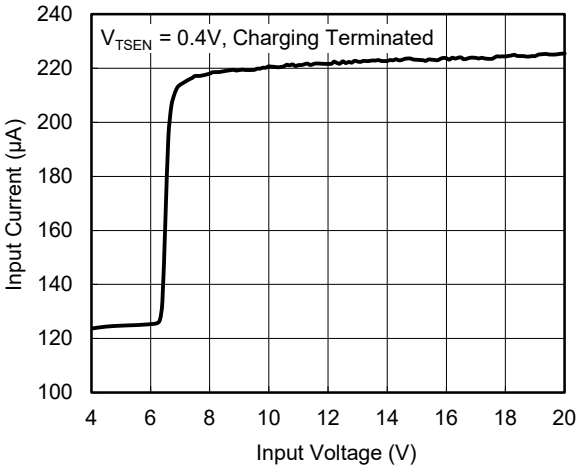
NOTES:

1. $V_{IN}$ - $V_{BAT}$ need more than 95% × $I_{CHG}$ × $R_{ON}$ when $I_{CHG}$ > 200mA.
2. Guaranteed by design and characterization. Not production tested.

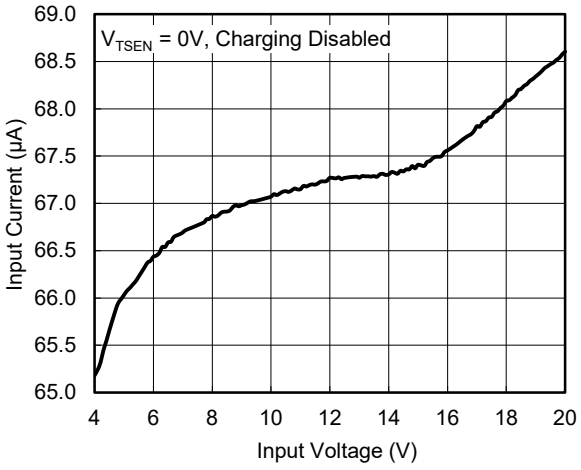
## TYPICAL PERFORMANCE CHARACTERISTICS

Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

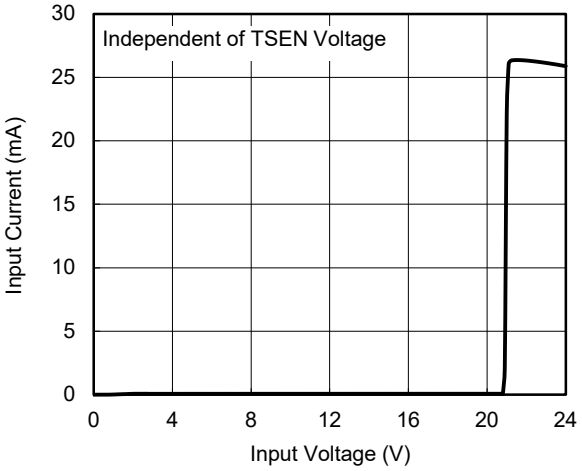
Input Current vs. Input Voltage



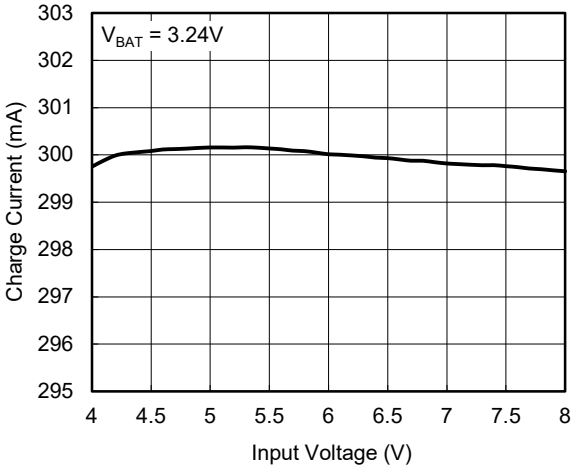

Input Current vs. Input Voltage



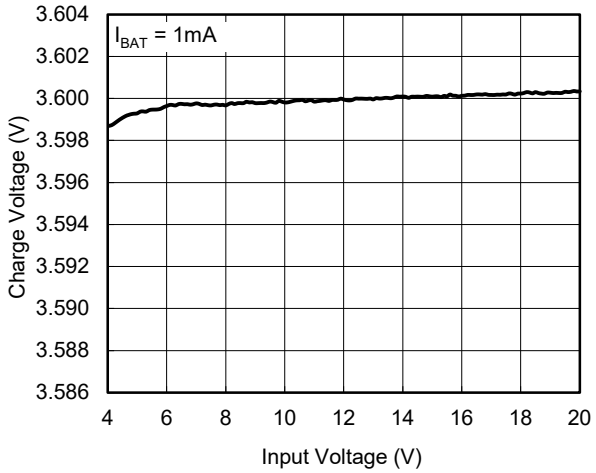

Input Current vs. Input Voltage



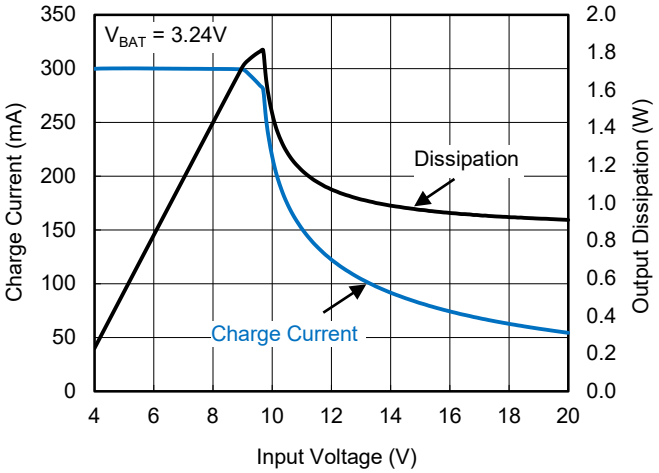

Charge Current vs. Input Voltage




Charge Voltage vs. Input Voltage



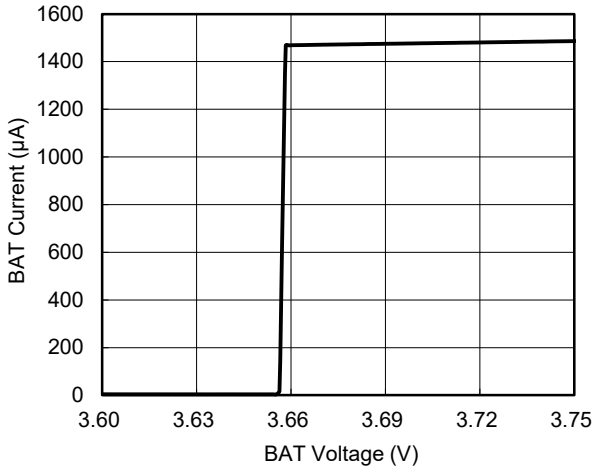

Charge Current and Dissipation vs. Input Voltage



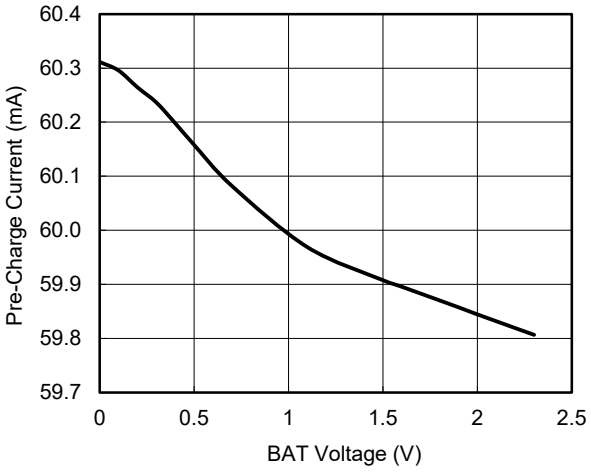
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

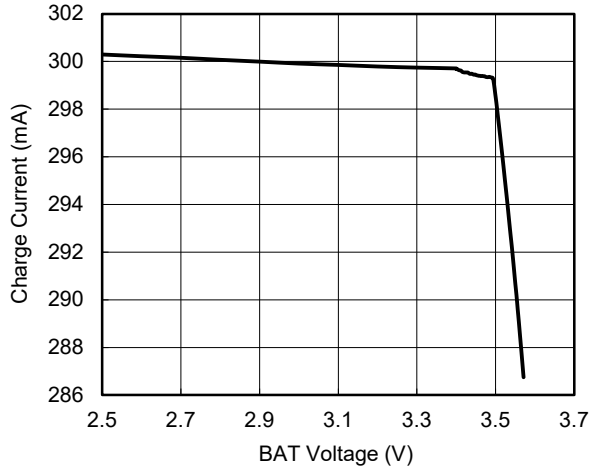
BAT Current vs. BAT Voltage



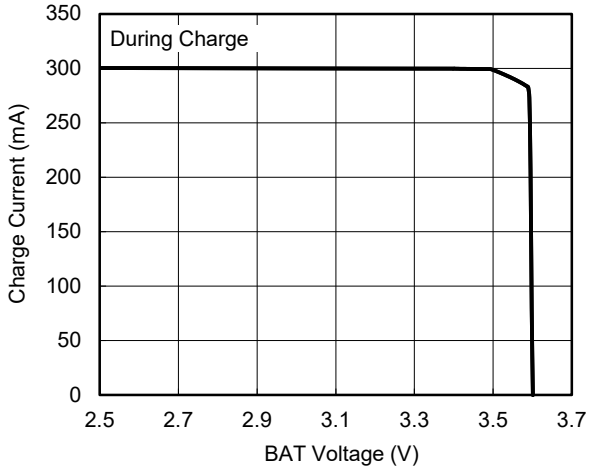

Pre-Charge Current vs. BAT Voltage



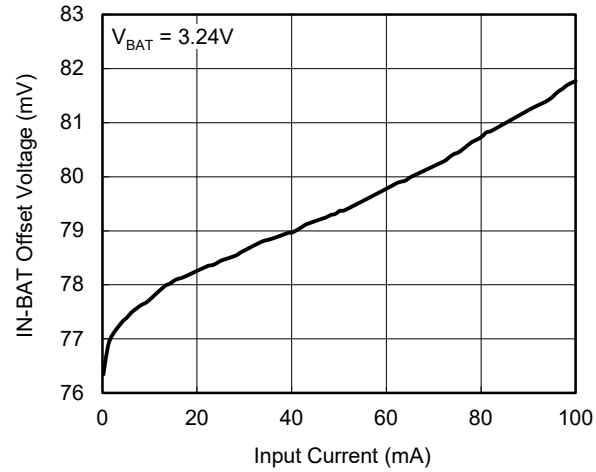

Charge Current vs. BAT Voltage



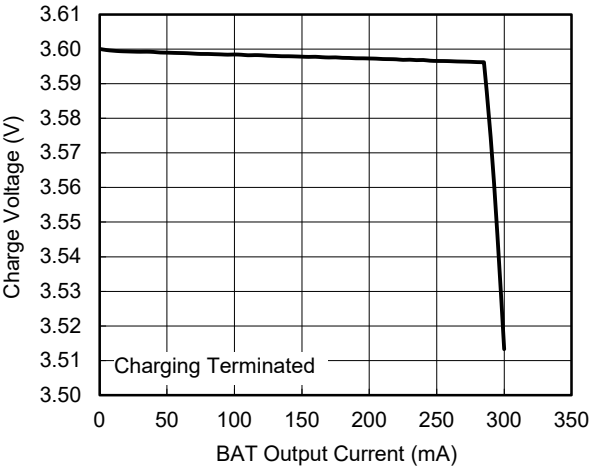

Charge Current vs. BAT Voltage




IN-BAT Offset Voltage vs. Input Current



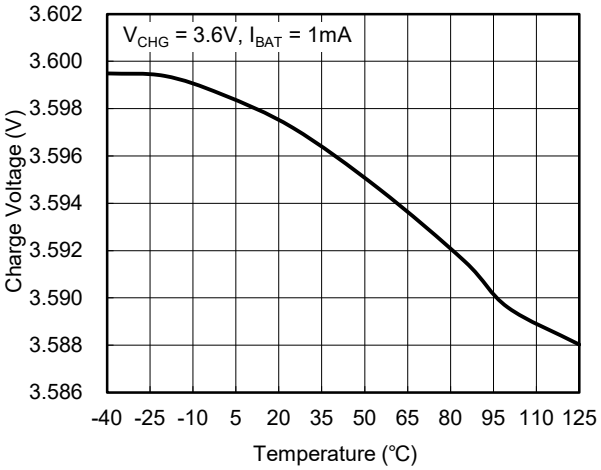

Charge Voltage vs. BAT Output Current



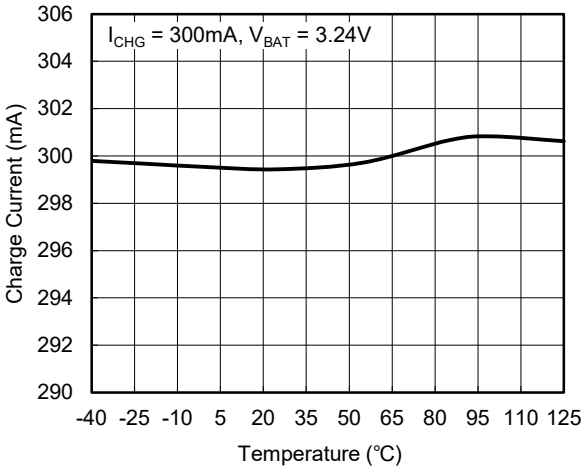
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

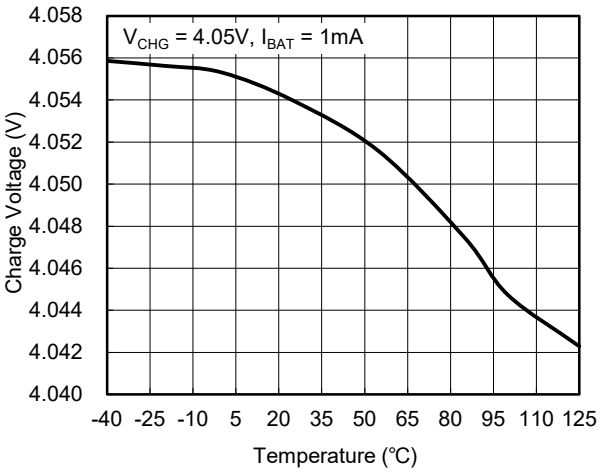
Charge Voltage vs. Temperature



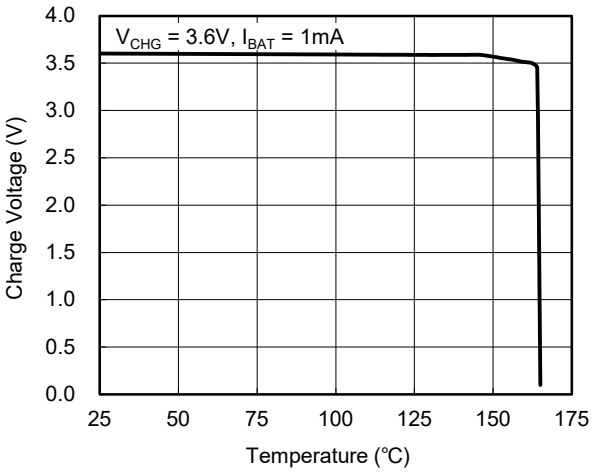

Charge Current vs. Temperature



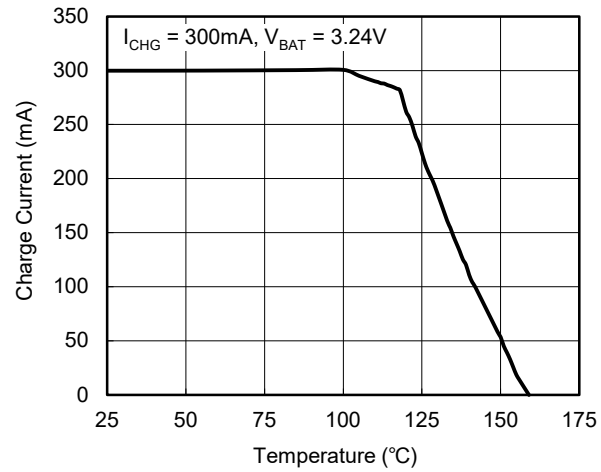

Charge Voltage vs. Temperature



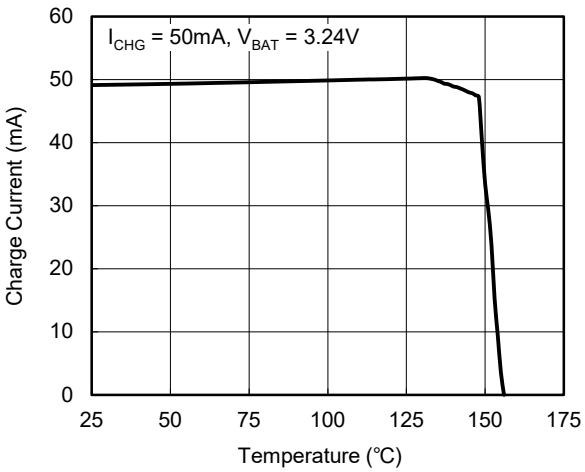

Charge Voltage vs. Temperature




Charge Current vs. Temperature



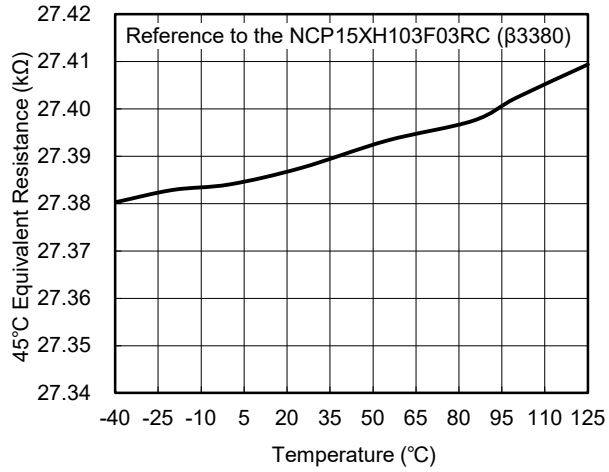

Charge Current vs. Temperature



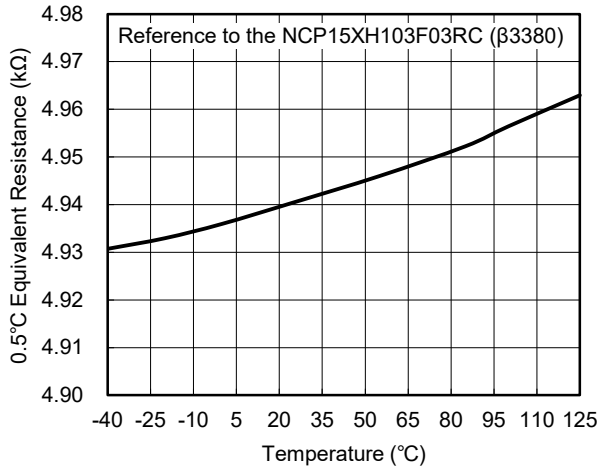
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

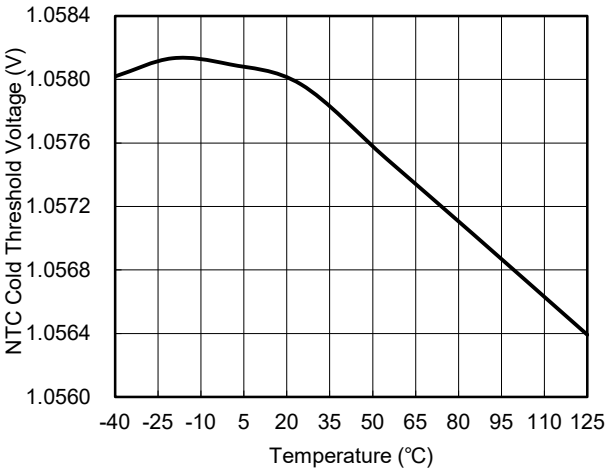
45℃ Equivalent Resistance vs. Temperature



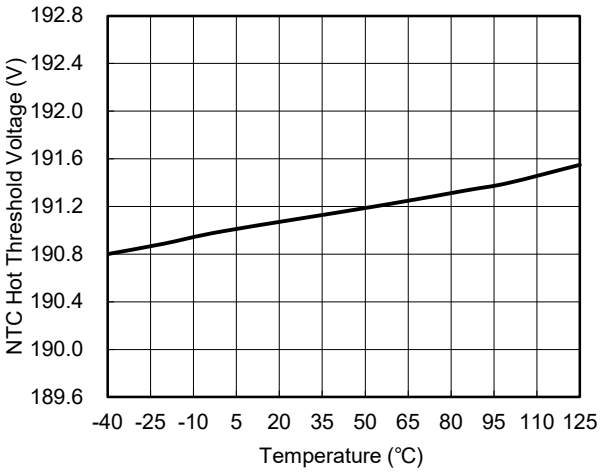

0.5℃ Equivalent Resistance vs. Temperature



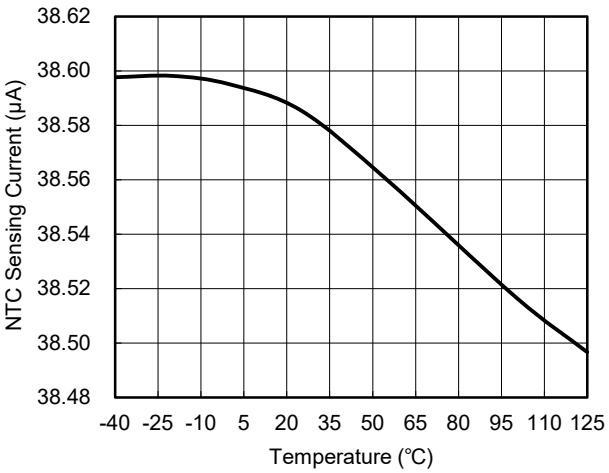

NTC Cold Threshold Voltage vs. Temperature



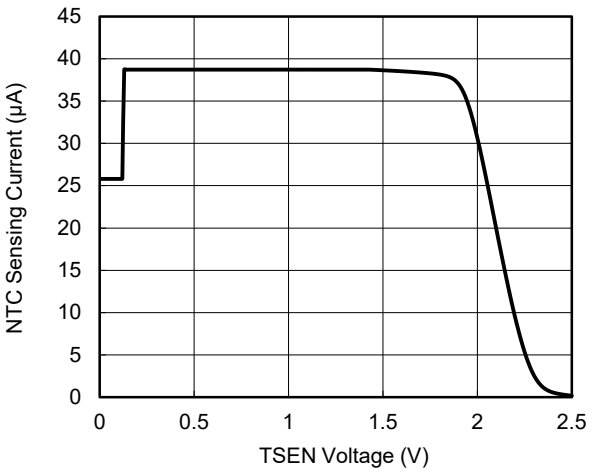

NTC Hot Threshold Voltage vs. Temperature




NTC Sensing Current vs. Temperature



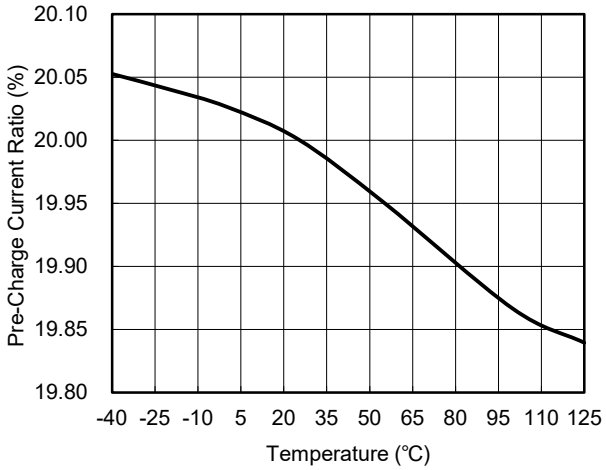

NTC Sensing Current vs. TSEN Voltage



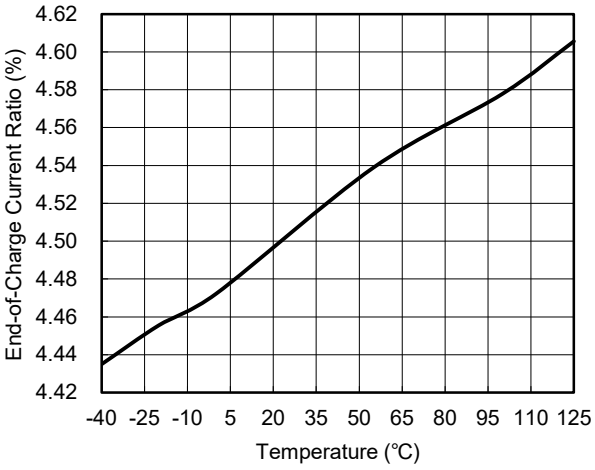
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

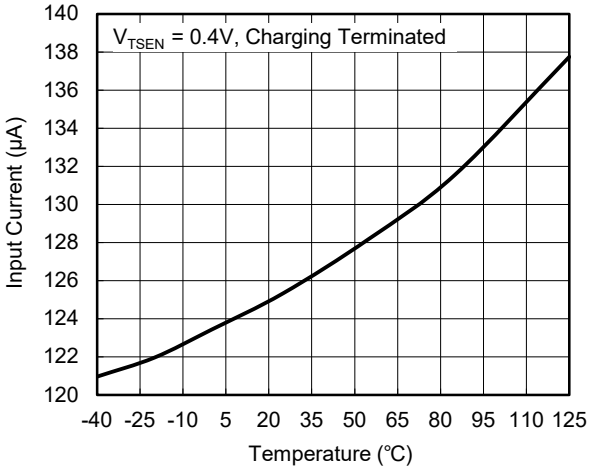
Pre-Charge Current Ratio vs. Temperature



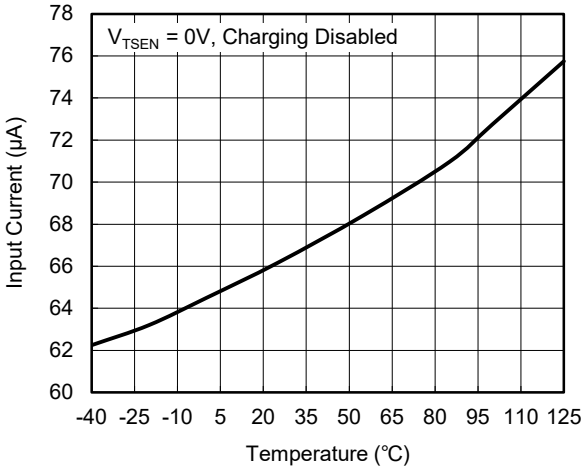

End-of-Charge Current Ratio vs. Temperature



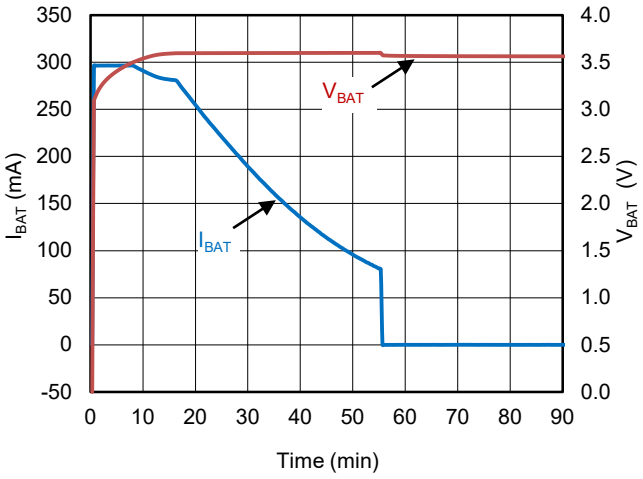

Input Current vs. Temperature



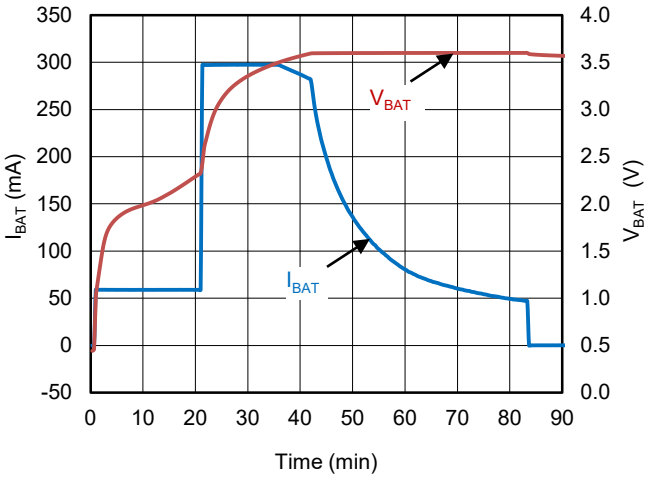

Input Current vs. Temperature




Charge Profile (with Protector)



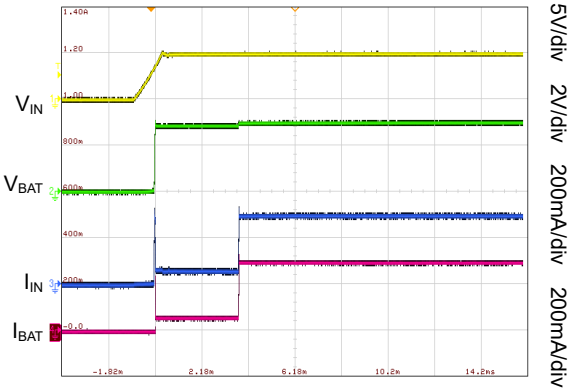

Charge Profile (without Protector)



## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

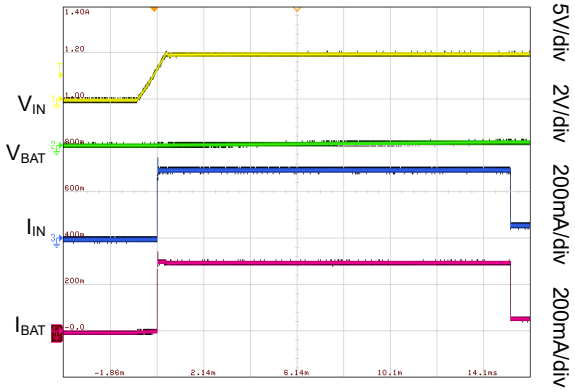
Measured by SGM41566-360F41, $V_{IN}$ = 5V, $V_{TSEN}$ = 0.4V, $T_J$ = +25℃, unless otherwise noted.

$V_{IN}$ Power-Up (with Protector)



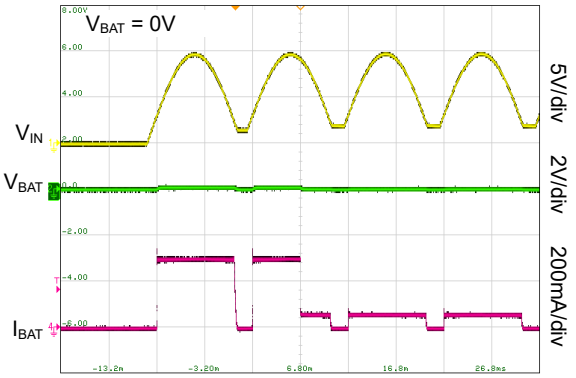

Time (2ms/div)

$V_{IN}$ Power-Up (without Protector)



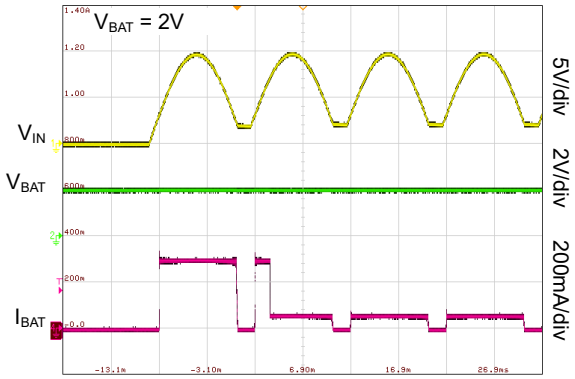

Time (2ms/div)

Rectified 50Hz Input Charging Waveforms



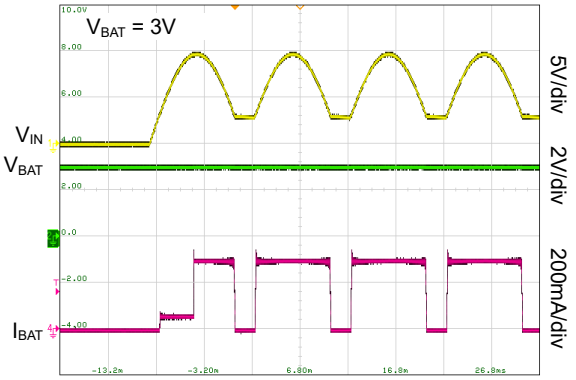

Time (5ms/div)

Rectified 50Hz Input Charging Waveforms



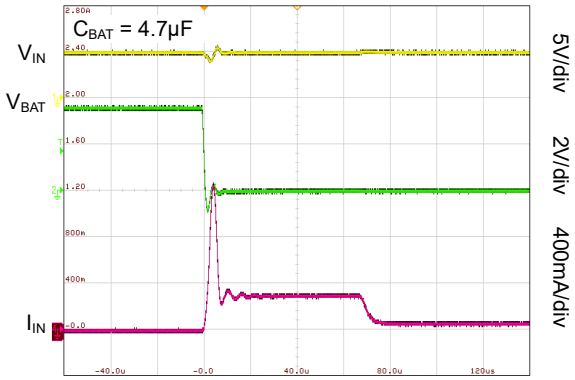

Time (5ms/div)

Rectified 50Hz Input Charging Waveforms




Time (5ms/div)

BAT Short




Time (20μs/div)

## CHARGE CYCLE DIAGRAM

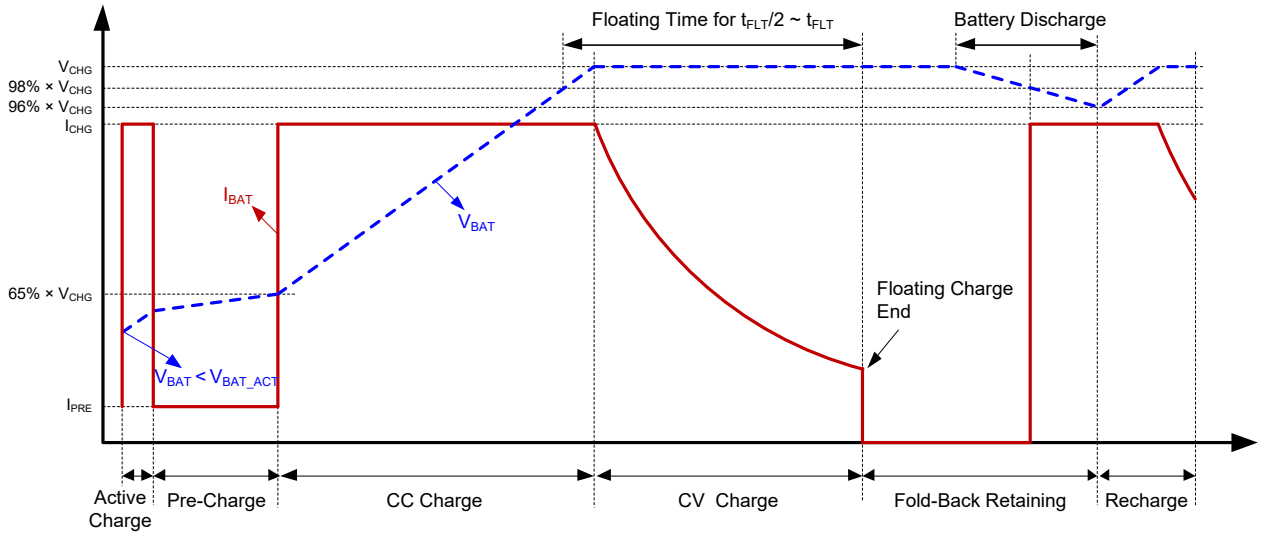



**Figure 2. Not-Time Scaled Illustrative Charge Profile (with Active Charge)**

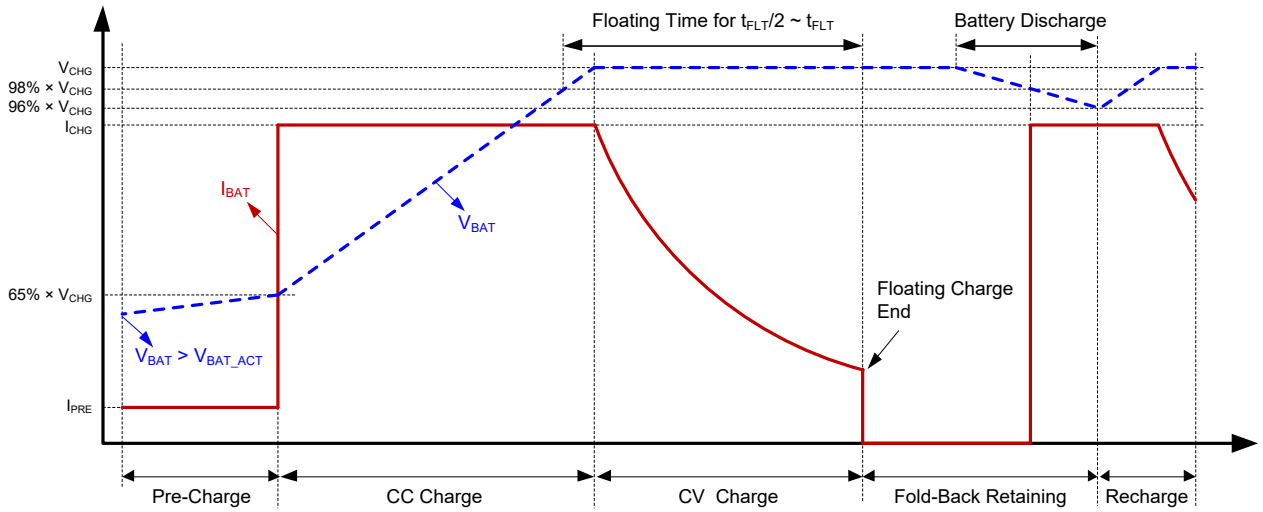



**Figure 3. Not-Time Scaled Illustrative Charge Profile (without Active Charge)**

## FUNCTIONAL BLOCK DIAGRAM

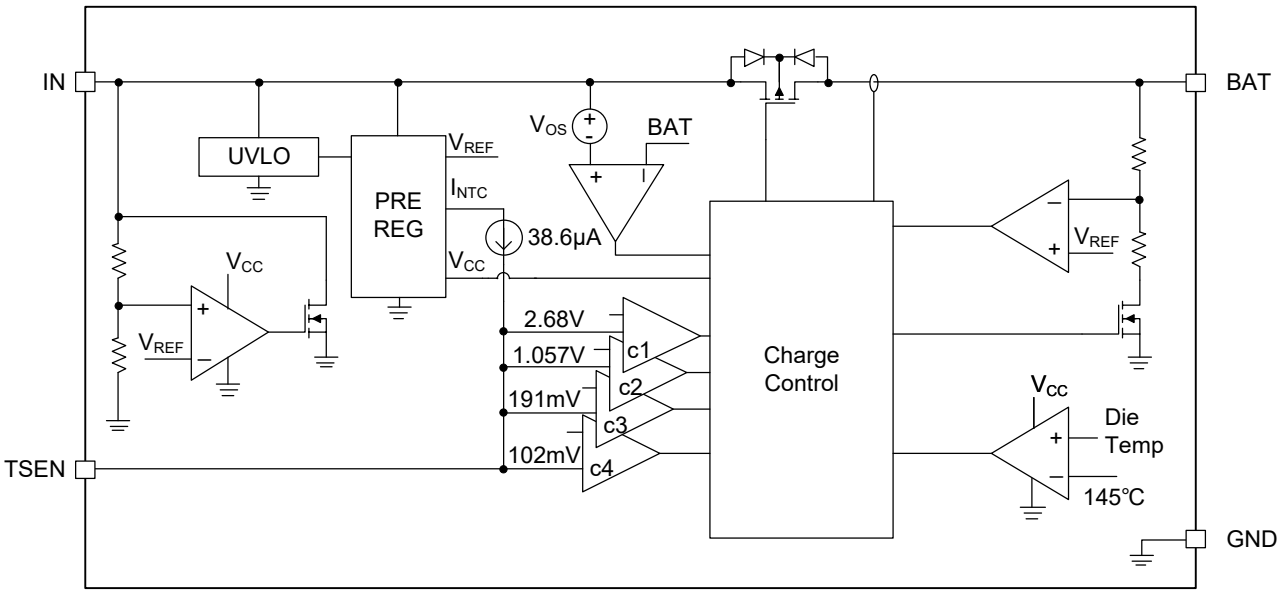



**Figure 4. Block Diagram**

# DETAILED DESCRIPTION

The SGM41566 is a constant-voltage and constant-current profile charge regulator with the input condition check. It features with input clamp, output clamp, die temperature regulation, NTC temperature-oriented protection and floating charging protection. As shown in Figure 1, there are only few external components desired. Figure 2 and Figure 3 show the illustrative charge profiles.

## System Start-Up Pre-Charge

When the input is applied and the BAT pin voltage is less than both the pre-charge threshold voltage and activation threshold voltage, the device outputs the constant normal charge current for $t_{ACT}$, which supplies for the system load to start up in no battery situation or the battery in protection off, before it turns into pre-charge where the output current may not be enough to start up the system.

## Wide Charge Available Input Range

Charging is kept when the input voltage is higher than the nominal input range, or when the supply cannot keep voltage and current stable. The charge current is regulated to prevent over-heating when the input voltage is at the higher range end, and it keeps conduction and maintains minimum forward drop-out when the input voltage is at the lower range end. It can charge from pulse train input such as half-sine wave of rectified AC and slow change source like solar cell photo-voltage, while it keeps charge state flags until the internal bias losses or the input stays low for long enough.

## Voltage Fold-Back Power Retaining

When the end-of-charge condition is certified, it lowers the output to the safe voltage $V_{FCHG}$, while keeping the current limit at the level of normal charge and retaining power to the load system. The design avoids frequent discharging and recharging cycling in the situation that charge supply is always attached.

## Minimum Floating Charge Time

When the charging current with high system load that sinks more than the residual end-of-charge current and the battery voltage stays higher than the floating charge voltage for over $t_{FLT}$ duration, the battery will stop charging and enter the end-of-charge fold-back power retaining state. As a weak source, it may also cause the current to fall to less than the residual end-of-charge current, and minimum floating charge time > $t_{FLT}/2$ is a part of condition for full-of-charge certification.

## Over-Temperature Charge Regulation

The device senses the die temperature. The thermal fold-back function starts to reduce the charge current when the internal temperature reaches the typical value of +145℃.

## BAT Over-Voltage Protection

When any leakage or transient pulls $V_{BAT}$ higher than 104% × $V_{CHG}$ in charge, the BAT sinks current with 1.5mA clamp current for protection.

## Full-of-Charge and Input Clamp

When the full-of-charge is certified, the input $I_{IN}$ drops low and the output voltage steps down from $V_{CHG}$ to $V_{FCHG}$. The sudden current changes the signals to the source side for turning into the full-of-charge state, and the source side can read the state by checking the output voltage or current. In case of wireless or contactless charging with high open load voltage, the device clamps its input voltage to about 21V with 26mA sinking.

## NTC Temperature Sensing and Enable

The TSEN sources current (38.6μA) is used to read ground resistance for temperature-oriented protection. A grounded NTC thermistor is connected to the TSEN pin for temperature sensing. Charging is allowed only when the temperature is in suitable range. When a β3380 $R_{25}$ 10kΩ NTC is used, the precise upper and lower thresholds are 45℃ and 0.5℃, respectively.

Pull the TSEN to ground to disable charge function, and pull the TSEN to high voltage > 2.68V to dismiss the temperature-oriented protection function, while enables charge.

## Pre-Charge Safety Time

To avoid further damage to bad battery or wrong system load, if the BAT pin voltage cannot reach 65% × $V_{CHG}$ for over $t_{SAFE}$ (94 minutes), the charging will be stopped. However, for the 50Hz rectified input voltage waveform, when the input voltage is lower than $V_{UVLOf}$, the SGM41566 has no such protection function.

This protection function is not available for the "No pre-charge" option.

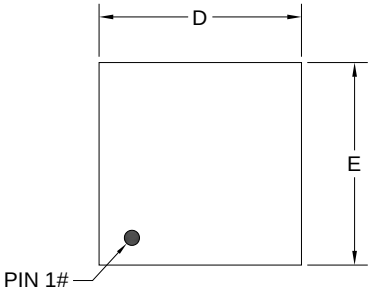
# REVISION HISTORY

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

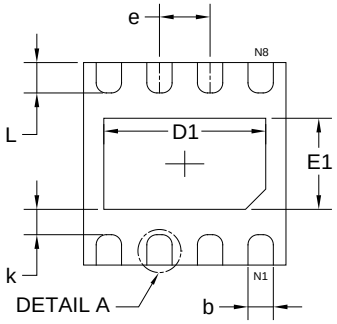
| Changes from Original (OCTOBER 2022) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

# PACKAGE OUTLINE DIMENSIONS

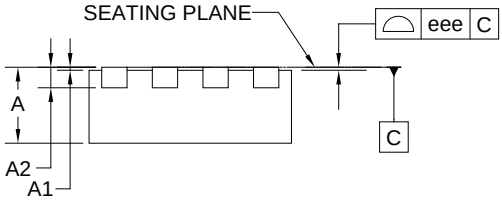
## TDFN-2×2-8AL



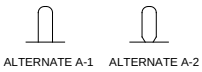

**TOP VIEW**



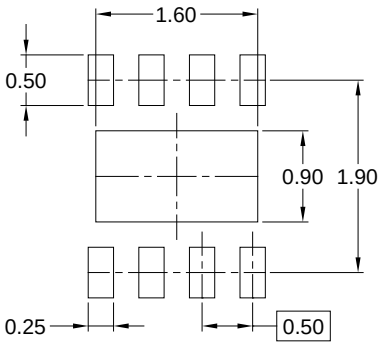

**BOTTOM VIEW**




**SIDE VIEW**




**DETAIL A**
ALTERNATE TERMINAL CONSTRUCTION



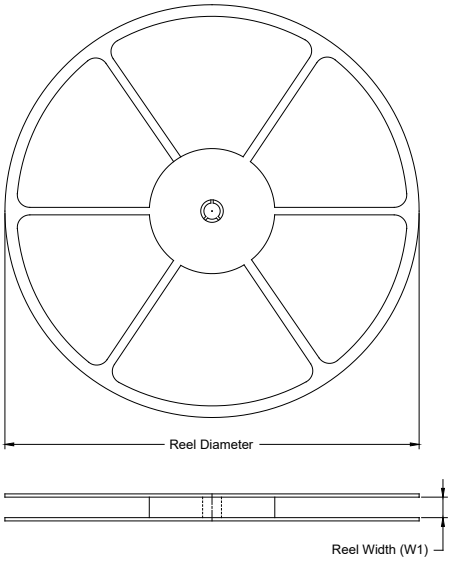

**RECOMMENDED LAND PATTERN** (Unit: mm)

| Symbol | Dimensions In Millimeters | | |
|---|---|---|---|
| | MIN | MOD | MAX |
| A | 0.700 | 0.750 | 0.800 |
| A1 | 0.000 | - | 0.050 |
| A2 | 0.203 REF | | |
| b | 0.200 | 0.250 | 0.300 |
| D | 1.900 | 2.000 | 2.100 |
| D1 | 1.450 | 1.600 | 1.700 |
| E | 1.900 | 2.000 | 2.100 |
| E1 | 0.750 | 0.900 | 1.000 |
| k | 0.150 | 0.250 | 0.350 |
| e | 0.450 | 0.500 | 0.550 |
| L | 0.200 | 0.300 | 0.400 |
| eee | 0.080 | | |

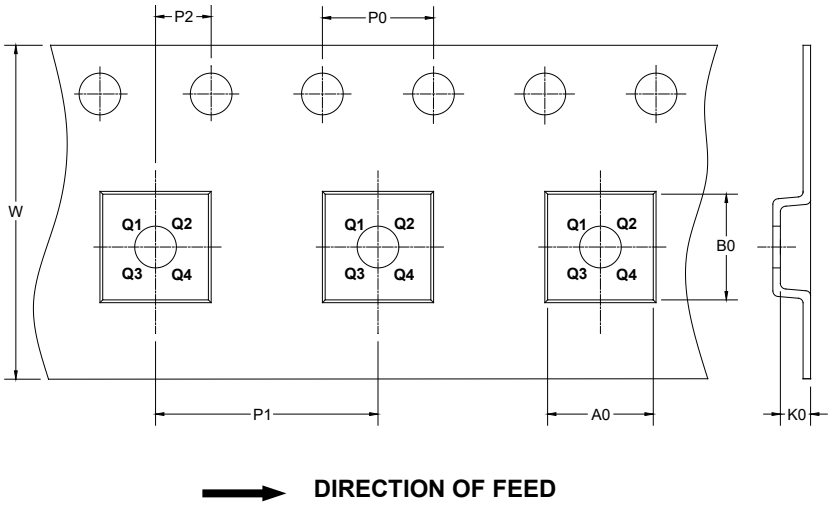
NOTE: This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



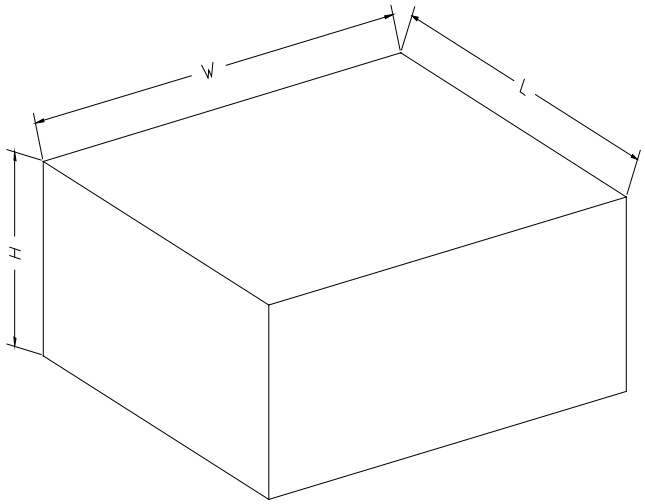

NOTE: The picture is only for reference. Please make the object as the standard.

## 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-2×2-8AL | 7″ | 9.5 | 2.30 | 2.30 | 1.10 | 4.0 | 4.0 | 2.0 | 8.0 | Q1 |

DD0001

## 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 |

DD0002