DIO5518CST5

750 mA, Single Li-ion Battery Charger

Description

The DIO5518CST5 is a complete constant-current / constant-voltage linear charger for single-cell lithium-ion batteries. No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. Thermal feedback regulates the charge current to limit the die temperature during high power operation or in high ambient temperature. The charge voltage is fixed at 4.35 V and the charge current can be programmed externally with a single resistor.

The DIO5518CST5 automatically terminates the charge cycle when the charge current drops to one tenth of the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the DIO5518CST5 automatically enters a low current state, dropping the battery drain current to less than 0.5 μA. The DIO5518CST5 can be put into shutdown mode, reducing supply current to 40 μA (typ.).

The DIO5518CST5 is available in a small package with SOT23-5. Standard product is Pb-free.

Features

- Programmable charge current up to 750 mA
- Over-temperature protection
- Undervoltage lockout protection
- Overvoltage lockout protection
- Reverse current protection between BAT and GND pins
- Automatic recharge threshold: 4.2 V (typ.)
- Charge status output pin
- 2.6 V trickle charge threshold
- Soft-start limits inrush current

Applications

- Wireless phones
- MP3/MP4 players
- Bluetooth devices

Ordering Information

Part No.	Top Marking	RoHS	T_A	Package	
DIO5518CST5	W51C	Green	-40 to 85°C	SOT23-5	Tape & Reel, 3000

If you encounter any issue in the process of using the device, please contact our customer service at marketing@dioo.com or phone us at (+86)-21-62116882. If you have any improvement suggestions regarding the datasheet, we encourage you to contact our technical writing team at docs@dioo.com. Your feedback is invaluable for us to provide a better user experience.

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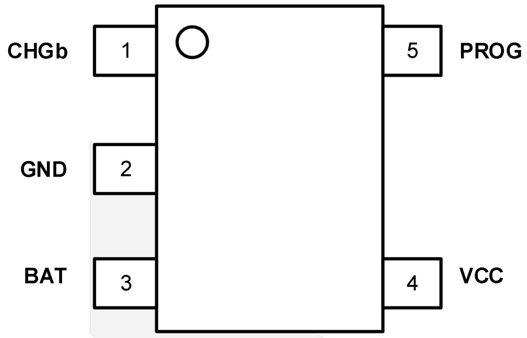


SOT23-5
Top View

Pin No.	Name	Description
1	CHGb	Open-drain charge status output. When the battery is charging, the CHGb pin is pulled low. When the charge cycle is completed or VCC is removed, the CHGb is forced high impedance.
2	GND	Ground.
3	BAT	Charge current output. Provides charge current to the battery and regulates the final float voltage to 4.35 V.
4	VCC	Power supply.
5	PROG	Charge current setting. The pin monitors charge current and controls shutdown. The charging current is given by $I_{BAT} = (1/R_{PROG}) \times 1000$. The chip will be shutdown when the PROG pin is floating.

2. Absolute Maximum Ratings

Exceeding the maximum ratings listed under Absolute Maximum Ratings when designing is likely to damage the device permanently. Do not design to the maximum limits because long-time exposure to them might impact the device's reliability. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Ratings	Unit
V_{CC}	Supply voltage	-0.3 ~ 10	V
V_{PROG}	PROG voltage	-0.3 ~ V_{CC}	V
V_{BAT}	BAT voltage	-0.3 ~ 10	V
V_{CHGb}	CHGb voltage	-0.3 ~ V_{CC}	V
I_{BAT}	BAT pin current	750	mA
P_D	Power dissipation	0.6	W
T_J	Junction temperature	150	°C
T_A	Operation temperature	-45 ~ 85	°C
T_{STG}	Storage temperature	-65 ~ 125	°C
T_L	Lead temperature (soldering 10 s)	260	°C

3. Recommended Operating Condition

Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

Symbol	Parameter	Ratings	Unit
V_{CC}	Input supply voltage	4.65 to 5.5	V
T_A	Operating temperature range	-40 to 85	°C

4. ESD Ratings

When a statically-charged person or object touches an electrostatic discharge sensitive device, the electrostatic charge might be drained through sensitive circuitry in the device. If the electrostatic discharge possesses sufficient energy, damage might occur to the device due to localized overheating.

Model	Condition	Value	Unit
Human-body model	ANSI/ESDA/JEDEC JS-001	±6000	V

5. Thermal Considerations

The thermal resistance determines the heat insulation property of a material. The higher the thermal resistance is, the lower the heat loss. Accumulation of heat energy degrades the performance of semiconductor components.

Symbol	Metric	Value	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance	140	°C/W

6. Electrical Characteristics

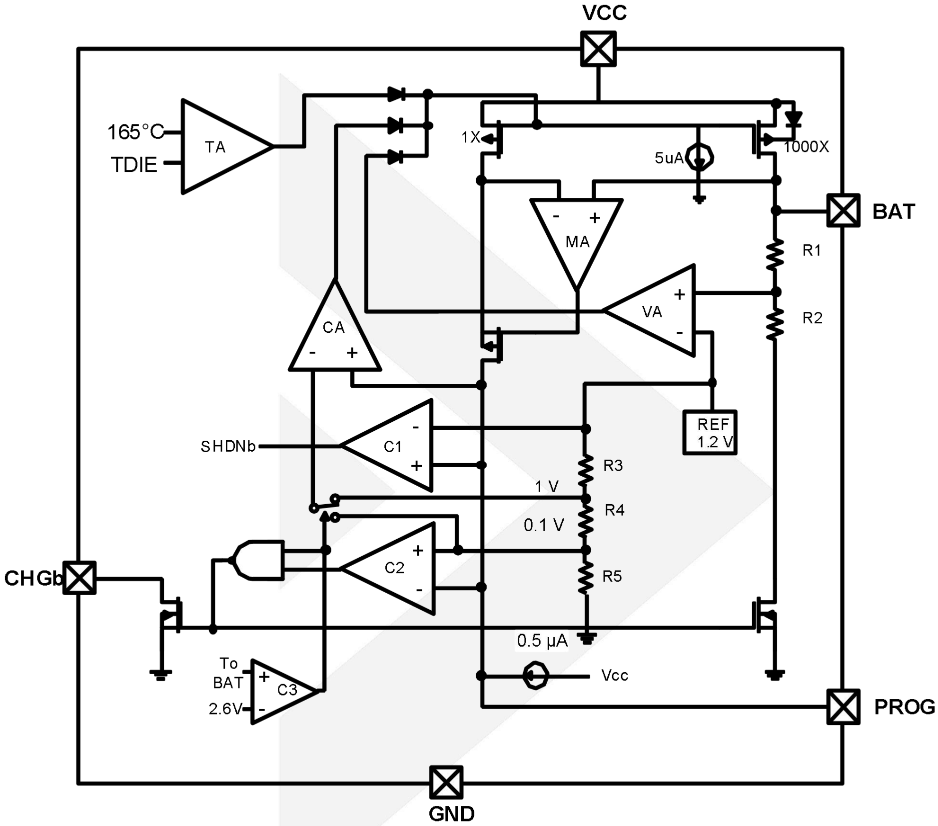
The values are obtained under these conditions unless otherwise specified: V_{CC} = 5 V, T_A = 25°C

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{SOLYCHRG}$	Charge mode supply current	R_{PROG} = 10 kΩ		250	2000	μA
		R_{PROG} = 20 kΩ		200	2000	μA
$I_{BATCHRG}$	Charge mode battery current	R_{PROG} = 10 kΩ	90	100	110	mA
		R_{PROG} = 20 kΩ	44	49	54	mA
		R_{PROG} = 30 kΩ	25	28.5	32	mA
$V_{PROGCHRG}$	PROG pin voltage	R_{PROG} = 10 kΩ	0.97	1.04	1.11	V
		R_{PROG} = 20 kΩ	0.97	1.04	1.11	V
$I_{SPLYSTBY}$	Standby mode supply current	Charge terminated		136	500	μA
$I_{BATSTBY}$	Standby mode battery current	Charge terminated	0	-2.5	-6	μA
$I_{SPLYASD}$	Shutdown mode supply current	V_{CC} < V_{BAT}	20	42	90	μA
I_{BATASD}	Shutdown mode BAT pin current	V_{CC} < V_{BAT}		±0.05	±1	μA
$I_{SPLYUVLO}$	UVLO mode supply current	V_{CC} < V_{UV}	20	42	90	μA
$I_{BATUVLO}$	UVLO mode BAT pin current	V_{CC} < V_{UV}		±0.05	±1	μA
$I_{SPLYOVLO}$	OVLO mode supply current	V_{CC} > V_{OV}		40		μA
$I_{BATOVLO}$	OVLO mode BAT pin current	V_{CC} > V_{OV}		±0.05	±1	μA
$I_{SPLYSHUT}$	Shutdown mode supply current	R_{PROG} not connected	20	42	70	μA
$I_{BATSHUT}$	Shutdown mode BAT pin current	R_{PROG} not connected		±0.05	±1	μA
I_{BATMSD}	Manual shutdown BAT pin current	V_{PROG} = 1.3 V		±0.05	±1	μA
$I_{BATSLEEP}$	Sleep mode BAT pin current	V_{CC} = 0 V		±0.05	±1	μA
$I_{Charge\_terminated}$	100mA /10 mA charger terminated	R_{PROG} = 10 kΩ		10		μA
$V_{Charge\_terminated}$		R_{PROG} = 10 kΩ		0.1		V
V_{FLOAT}	Float Voltage		4.31	4.35	4.39	V
I_{TRIKL}	Trickle charge current	R_{PROG} = 10 kΩ		10		mA
V_{TRIKL}	Trickle charge voltage threshold	R_{PROG} = 10 kΩ	2.5	2.6	2.7	V
$V_{TRIKL, HYS}$	Trickle charge voltage hysteresis	R_{PROG} = 10 kΩ		100		mV
V_{UVLO}	UVLO threshold	From V_{CC} low to high	3.7	3.9	4.1	V

$V_{UVLO, HYS}$	UVLO hysteresis			250		mV
V_{OVLO}	OVLO threshold	From V_{CC} low to high		6.2		V
V_{OVP_Hys}	OVLO hysteresis			180		mV
V_{MSD}	Manual shutdown threshold voltage	PROG pin rising		1.25		V
		PROG pin falling		1.0	1.35	V
V_{ASD}	Vcc-V_{BAT} lockout threshold voltage	V_{CC} from low to high		120		mV
		V_{CC} from high to low	5	50		mV
ΔV_{RECHRG}	Auto recharge battery voltage		100	150	200	mV
V_{CHGb}	CHGb pin output low voltage	I_{CHGb} = 5 mA		0.3	0.6	V
T_{LIM}	Junction temperature in CT Mode			165		°C
R_{ON}	Power FET on-resistance			250		mΩ
T_{SS}	Soft-start time	R_{PROG} = 2 kΩ		50		μs
T_{RECHRG}	Recharge comparator filter time			2		ms
T_{TERM}	Termination comparator filter time			1		ms
I_{PROG}	PROG pin pull-up current		0.35	0.5	0.75	μA

Note: Specifications subject to change without notice.

7. Block Diagram



8. Function Description

The DIO5518CST5 is a single-cell lithium-ion battery charger using a constant-current / constant-voltage algorithm. It can deliver up to 750 mA of charge current with a final float voltage accuracy of ±1%. The DIO5518CST5 includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required; thus, the basic charger circuit requires only two external components. Furthermore, the DIO5518CST5 is capable of operating from a USB power source.

8.1. Normal charge cycle

A charge cycle begins when the voltage at the V_{CC} pin rises above the UVLO threshold level and a 1% program resistor is connected from the PROG pin to ground or when a battery is connected to the charger output. If the BAT pin is less than 2.6 V, the charger enters trickle charge mode. In this mode, the DIO5518CST5 supplies approximately one tenth of the programmed charge current to bring the battery voltage up to a safe level for full current charging.

When the BAT pin voltage rises above 2.6 V, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage, the DIO5518CST5 enters constant-voltage mode and the charge current begins to decrease. The charge cycle ends when the PROG voltage is less than 100 mV.

8.2. Programming charge current

The charge current is programmed by using a single resistor from the PROG pin to ground. The battery charge current of constant current mode is 1000 times the current out of the PROG pin. The program resistor and the charge current of constant current are calculated by using Equation 1:

$$I_{CHRG} = \left(\frac{1V}{R_{PROG}} \right) \times 1000 \qquad (1)$$

8.3. Charge termination

A charge cycle is terminated when the charge current falls to one tenth of the programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the PROG pin. When the PROG pin voltage falls below 100 mV for longer than T_{TERM} (typically 1 ms), charging is terminated. The charge current is latched off and the DIO5518CST5 enters standby mode, where the input supply current drops to 136 μA. (Note: CC/10 termination is disabled in trickle charging mode and thermal limiting mode).

When charging, transient loads on the BAT pin can cause the PROG pin to fall below 100 mV for short periods of time before the DC charge current has dropped to one tenth of the programmed value. The 1 ms filter time (T_{TERM}) on the termination comparator ensures that transient loads of this nature do not result in premature charge cycle termination. As soon as the average charge current drops below one tenth of the programmed value, the DIO5518CST5 terminates the charge cycle and ceases to provide any current through the BAT pin and the chip will be put into standby mode. In this state, all loads on the BAT pin must be supplied by the battery.

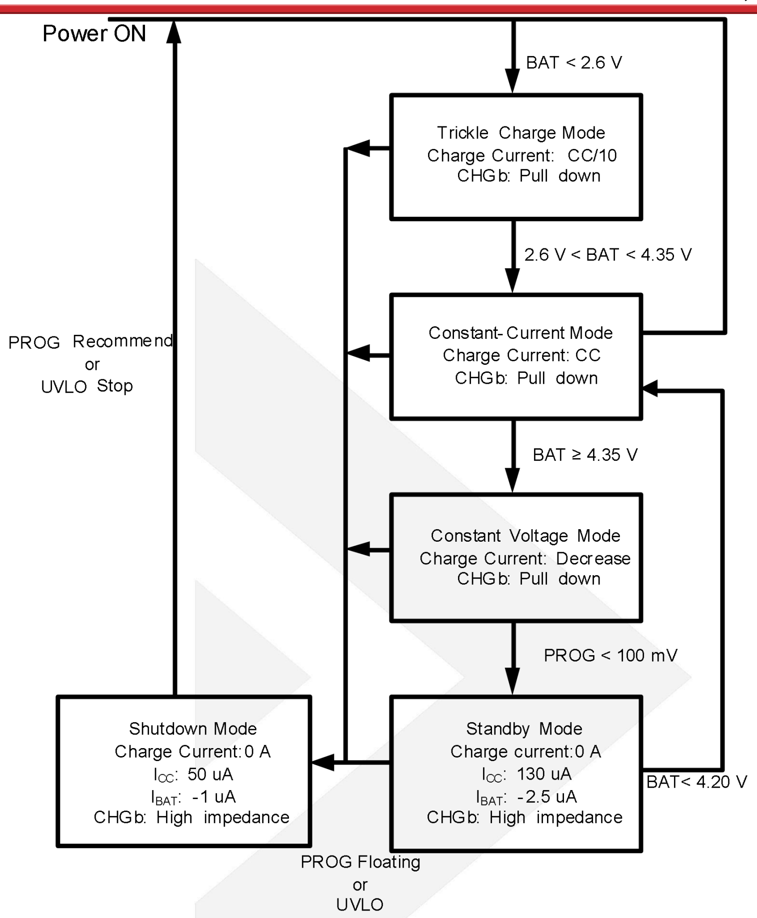


Figure 1. State diagram of a typical charge cycle

The DIO5518CST5 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.2 V recharge threshold (V_{RECHRG}), another charge cycle begins and current is once again supplied to the battery. The state diagram of a typical charge cycle is shown as Figure 1.

8.4. Charge status indicator

The charge status output indicator is an open-drain circuit.The indicator has two different states: pull-down (~10 mA), and high impedance.The pull-down state indicates that the DIO5518CST5 is in a charge cycle. High impedance indicates that the charge cycle is completed. The CHGb also can be used to detect the charge states by a microprocessor with a pull-up resistor.

8.5. Thermal limiting

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 165°C. This feature protects the DIO5518CST5 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk damaging the DIO5518CST5. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

8.6. Undervoltage lockout (UVLO)

An internal undervoltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{CC} rises above the undervoltage lockout threshold. The UVLO circuit has a built-in hysteresis of 250 mV. Furthermore, to protect against reverse current in the power MOSFET, the UVLO circuit keeps the charger in shutdown mode if V_{CC} falls to within 50 mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until V_{CC} rises 120 mV above the battery voltage.

8.7. Overvoltage lockout (OVLO)

An internal overvoltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{CC} rises above the overvoltage lockout threshold. The OVLO circuit has a built-in hysteresis of 180 mV. Furthermore, to protect against reverse current in the power MOSFET, the OVLO circuit keeps the charger in shutdown mode if V_{CC} falls to within 50 mV of the battery voltage. If the OVLO comparator is tripped, the charger will not come out of shutdown mode until V_{CC} rises 120 mV above the battery voltage.

8.8. Manual shutdown

At any point in the charge cycle, the DIO5518CST5 can be put into shutdown mode by removing R_{PROG} thus floating the PROG pin. This reduces the battery drain current to less than 1 μA and the supply current to less than 50 μA. A new charge cycle can be initiated by reconnecting the program resistor.

The CHGb pin is in a high impedance state if the DIO5518CST5 is in manual shutdown mode or in the undervoltage lockout mode: either V_{CC} is within 120 mV of the BAT pin voltage or insufficient voltage is applied to the V_{CC} pin.

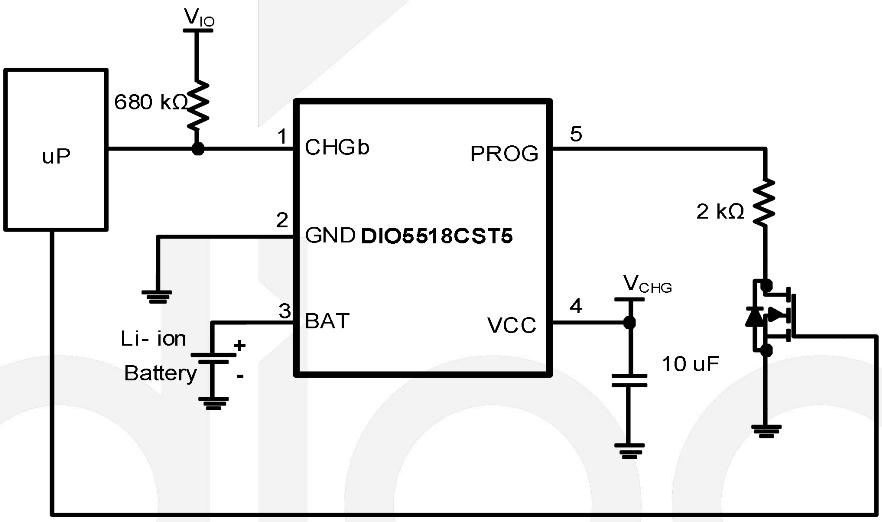


Figure 2. Manual shutdown mode application circuit

8.9. Automatic recharge

As soon as the charge cycle is terminated, the DIO5518CST5 continuously monitors the voltage on the BAT pin by using a comparator with a 2 ms filter time (T_{RECHRG}). A charge cycle restarts when the battery voltage falls below 4.35 V (typ.) (which corresponds to approximately 80% to 90% battery capacity). This ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations. The CHGb output enters a pull-down state during recharge cycles.

9. Application Information

Important notice: Validation and testing are the most reliable ways to confirm system functionality. The application information is not part of the specification and is for reference purposes only.

9.1. Stability considerations

The constant-voltage mode feedback loop is stable without an output capacitor provided a battery is connected to the charger output. With no battery present, an output capacitor is recommended to reduce ripple voltage. When using high value, low ESR ceramic capacitors, add a 1 Ω resistor in series with the capacitor. No series resistor is needed if tantalum capacitors are used.

In constant-current mode, the PROG pin is in the feedback loop, not the battery. The constant-current mode stability is affected by the impedance at the PROG pin. With no additional capacitance on the PROG pin, the charger is stable with program resistor values as high as 50 kΩ. However, additional capacitance on this node reduces the maximum allowed program resistor thus it should be avoided.

9.2. Thermal limit

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 165°C. This feature protects the DIO5518CST5 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the DIO5518CST5. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

9.3. Power dissipation

The conditions that cause the DIO5518CST5 to reduce charge current through thermal feed-back can be approximated by considering the power dissipated in the IC. Nearly all of this power dissipation is generated by the internal MOSFET. This is calculated to be approximately:

$$P_D = (V_{CC} - V_{BAT}) \times I_{BAT} \qquad (2)$$

Remember that DIO5518CST5 applications do not be designed for worst-case thermal conditions because the IC will automatically reduce power dissipation when the junction temperature reaches approximately 165°C (constant temperature mode).

9.4. V_{CC} bypass capacitor

Many types of capacitors can be used for input bypass, however, caution must be exercised when using multilayer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, a 10 μF ceramic capacitor is recommended for this bypass capacitor. Because of a high voltage transient will be generated under some start-up conditions, such as connecting the charger input to a live power source.

9.5. Charge current soft-start

The DIO5518CST5 includes a soft-start circuit to minimize the inrush current at the start of a charge cycle. When a charge cycle is initiated, the charge current ramps from zero to the full-scale current over a period of approximately 100 μs. This has the effect of minimizing the transient current load on the power supply during start-up.

9.6. Application examples

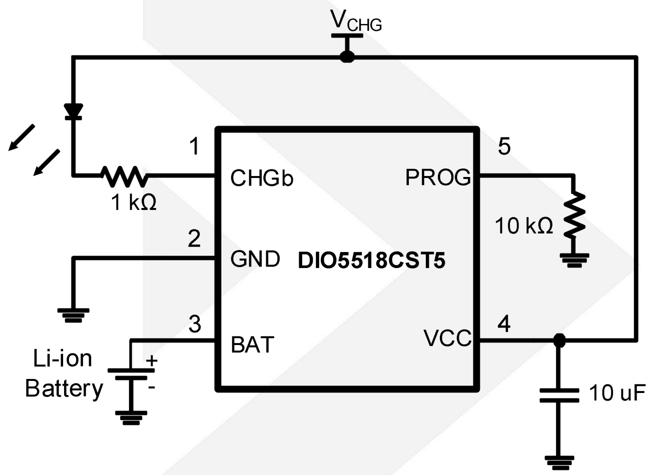


Figure 3. Typical applications W/T LED indication

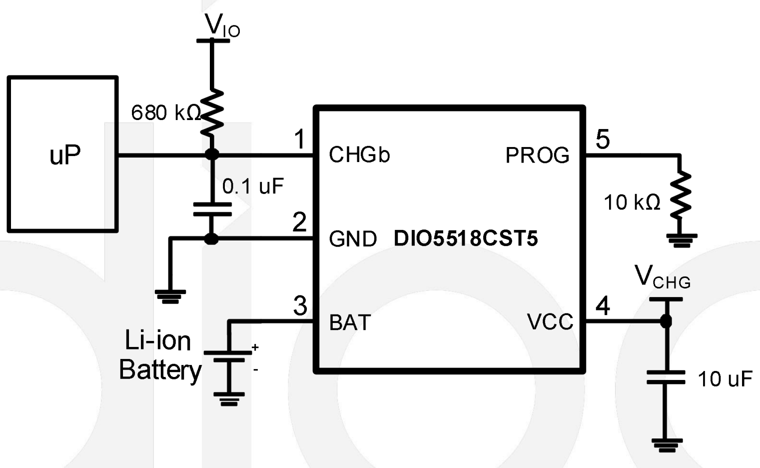
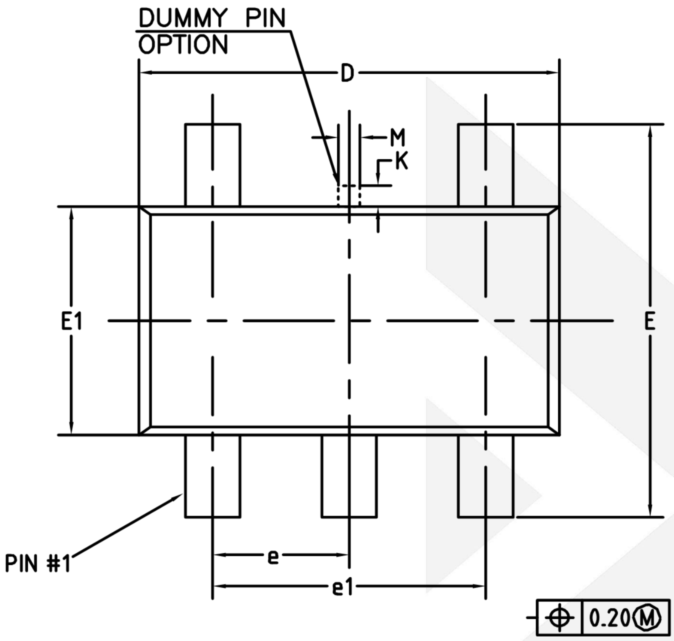
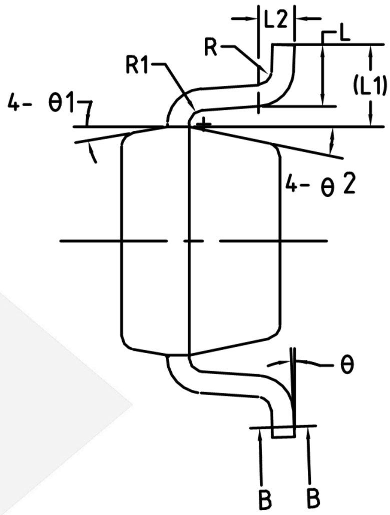
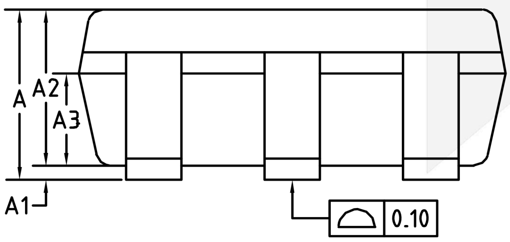


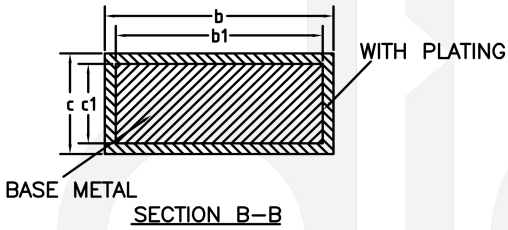
Figure 4. Typical applications W/T microprocessor detection

10. Physical Dimensions: SOT23-5









Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.25
A1	0	-	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	-	0.45
b1	0.35	0.38	0.41
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
K	0	-	0.25
L	0.30	0.40	0.60
L1	0.59 REF		
L2	0.25 BSC		
M	0.10	0.15	0.25
R	0.05	-	0.20
R1	0.05	-	0.20
Θ	0°	-	8°
Θ1	8°	10°	12°
Θ2	10°	12°	14°

Disclaimer

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