MCP73871

Stand-Alone System Load Sharing and Li-Ion / Li-Polymer Battery Charge Management Controller

Features

- Integrated System Load Sharing and Battery Charge Management
  - Simultaneously Power the System and Charge the Li-Ion Battery
  - Voltage Proportional Current Control (VPCC) ensures system load has priority over Li-Ion battery charge current
  - Low-Loss Power-Path Management with Ideal Diode Operation
- Complete Linear Charge Management Controller
  - Integrated Pass Transistors
  - Integrated Current Sense
  - Integrated Reverse Discharge Protection
  - Selectable Input Power Sources: USB Port or AC-DC Wall Adapter
- Preset High Accuracy Charge Voltage Options:
  - 4.10V, 4.20V, 4.35V or 4.40V
  - ±0.5% Regulation Tolerance
- Constant Current / Constant Voltage (CC/CV) Operation with Thermal Regulation
- Maximum 1.8A Total Input Current Control
- Resistor Programmable Fast Charge Current Control: 50 mA to 1A
- Resistor Programmable Termination Set Point
- Selectable USB Input Current Control
  - Absolute Maximum: 100 mA (L) / 500 mA (H)
- Automatic Recharge
- Automatic End-of-Charge Control
- Safety Timer With Timer Enable/Disable Control
- 0.1C Preconditioning for Deeply Depleted Cells
- Battery Cell Temperature Monitor
- Undervoltage Lockout (UVLO)
- Low Battery Status Indicator ($\overline{\text{LBO}}$)
- Power-Good Status Indicator ($\overline{\text{PG}}$)
- Charge Status and Fault Condition Indicators
- Numerous Selectable Options Available for a Variety of Applications:
  - Refer to **Section 1.0 "Electrical Characteristics"** for Selectable Options"
  - Refer to the **"Product Identification System"** for Standard Options
- Temperature Range: -40°C to +85°C
- Packaging: 20-Lead QFN (4 mm x 4 mm)

Applications

- GPSs / Navigators
- PDAs and Smart Phones
- Portable Media Players and MP3 Players
- Digital Cameras
- Bluetooth Headsets
- Portable Medical Devices
- Charge Cradles / Docking Stations
- Toys

Description

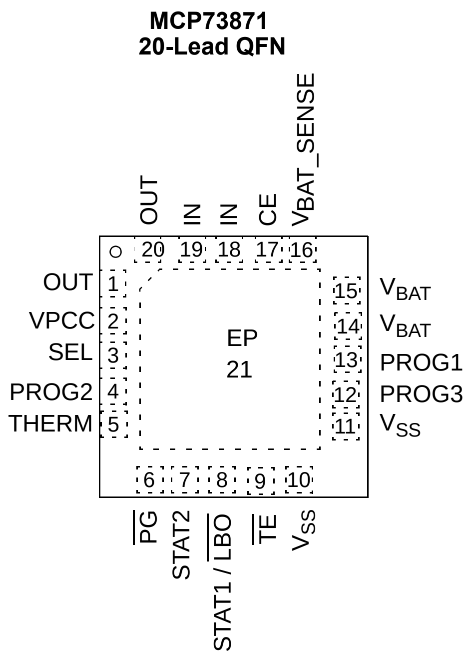
The MCP73871 device is a fully integrated linear solution for system load sharing and Li-Ion / Li-Polymer battery charge management with ac-dc wall adapter and USB port power sources selection. It's also capable of autonomous power source selection between input or battery. Along with its small physical size, the low number of required external components makes the device ideally suited for portable applications.

The MCP73871 device automatically obtains power for the system load from a single-cell Li-Ion battery or an input power source (ac-dc wall adapter or USB port). The MCP73871 device specifically adheres to the current drawn limits governed by the USB specification. With an ac-dc wall adapter providing power to the system, an external resistor sets the magnitude of 1A maximum charge current while supports up to 1.8A total current for system load and battery charge current.

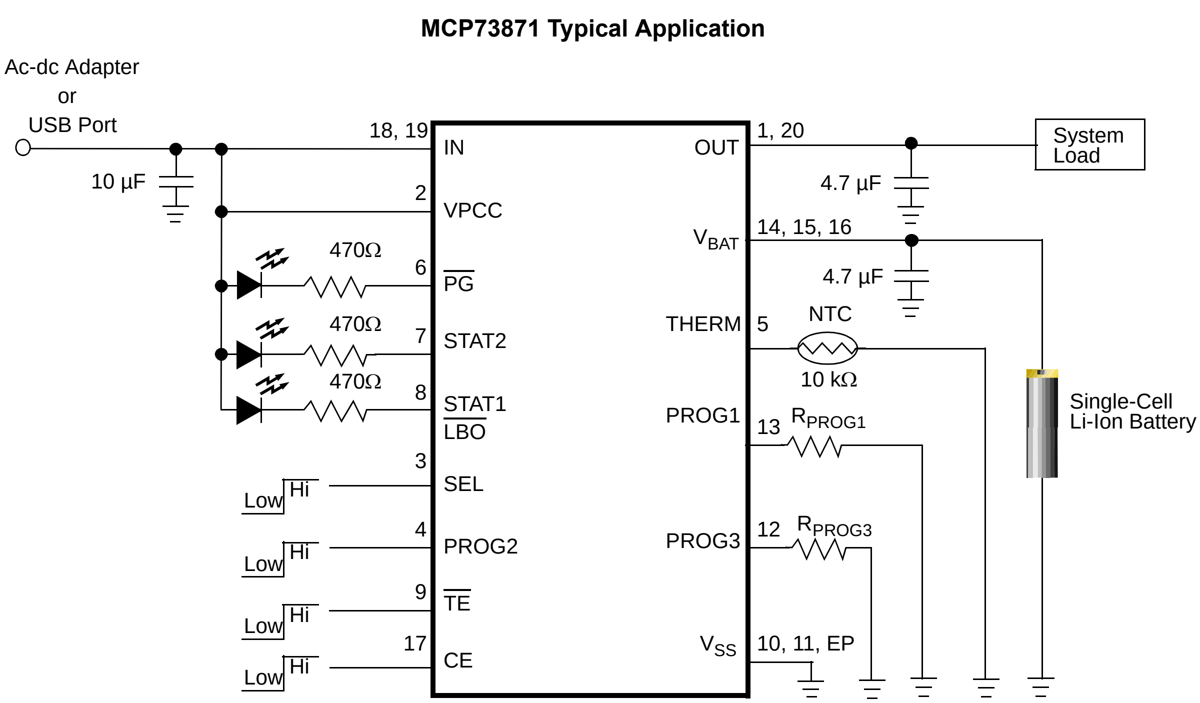
The MCP73871 device employs a constant current / constant voltage (CC/CV) charge algorithm with selectable charge termination point. The constant voltage regulation is fixed with four available options: 4.10V, 4.20V, 4.35V, or 4.40V to accommodate new, emerging battery charging requirements. The MCP73871 device also limits the charge current based on die temperature during high power or high ambient conditions. This thermal regulation optimizes the charge cycle time while maintaining device reliability.

The MCP73871 device includes a low battery indicator, a power-good indicator and two charge status indicators that allows for outputs with LEDs or communication with host microcontrollers. The MCP73871 device is fully specified over the ambient temperature range of -40°C to +85°C.

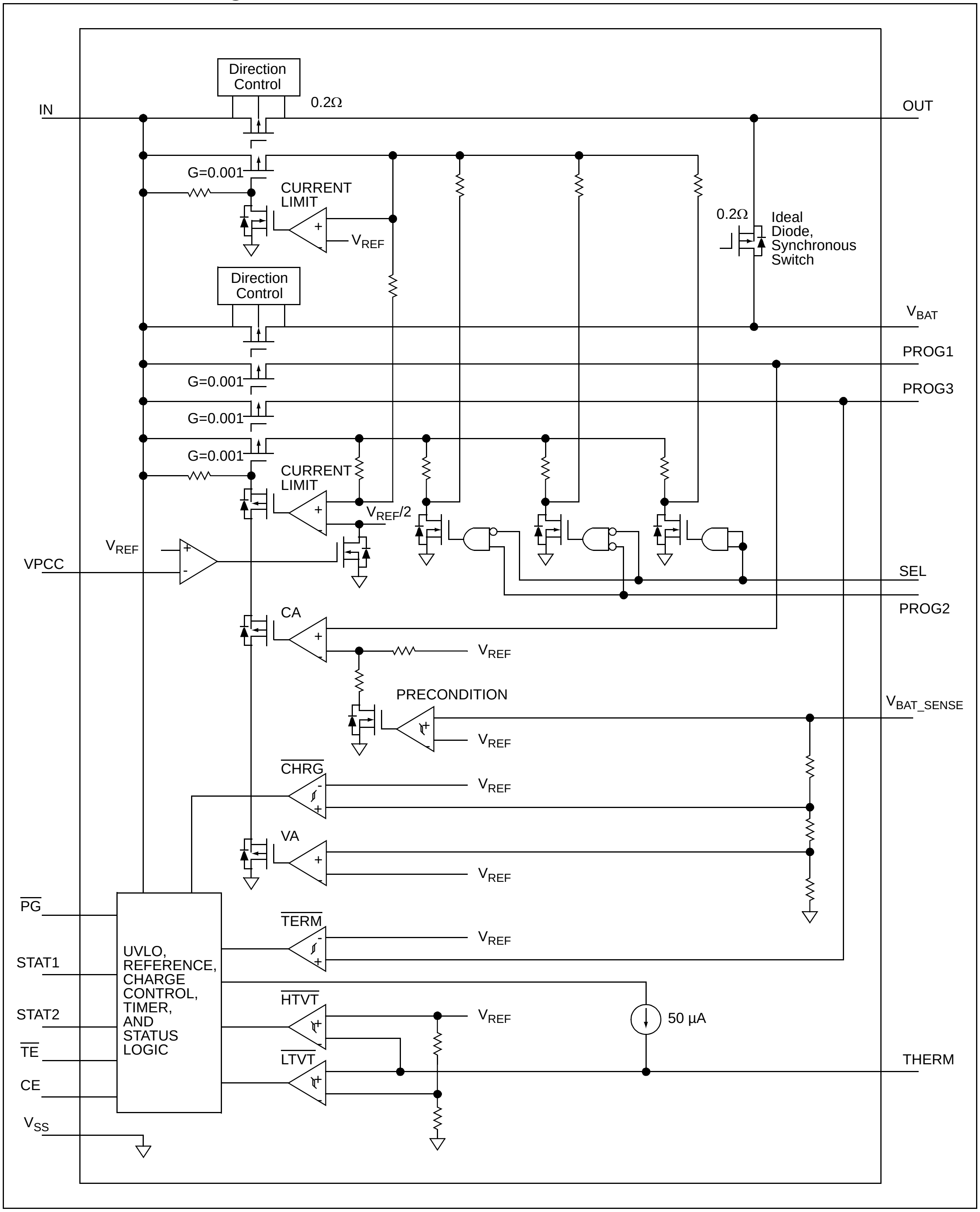
Package Types



Typical Application Circuit



Functional Block Diagram



NOTES:

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

V_{IN} 7.0V
All Inputs and Outputs w.r.t. .... V_{SS}-0.3V to V_{DD}+0.3V
(V_{DD} = V_{IN} or V_{BAT})
Maximum Junction Temperature, T_J .... Internally Limited
Storage temperature .... -65°C to +150°C
ESD protection on all pins
Human Body Model (1.5 kΩ in Series with 100pF) .... ≥ 4 kV
Machine Model (200 pF, No Series Resistance) 300V

† Notice: Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, all limits apply for V_{IN} = V_{REG} + 0.3V to 6V, T_A = -40°C to +85°C. Typical values are at +25°C, V_{IN} = [V_{REG} (typical) + 1.0V]

Parameters	Sym	Min	Typ	Max	Units	Conditions
Supply Input						
Supply Voltage	V_{IN}	V_{REG} +0.3V	—	6	V	
Supply Current	I_{SS}	—	2500	3750	µA	Charging
		—	260	350	µA	Charge Complete
		—	180	300	µA	Standby
		—	28	50	µA	Shutdown (V_{DD} ≤ V_{BAT} - 100 mV or V_{DD} < V_{STOP})
UVLO Start Threshold	V_{START}	V_{REG} + 0.05V	V_{REG} + 0.15V	V_{REG} + 0.25V	V	V_{DD}= Low-to-High
UVLO Stop Threshold	V_{STOP}	V_{REG} – 0.07V	V_{REG} + 0.07V	V_{REG} + 0.17V	V	V_{DD}= High-to-Low
UVLO Hysteresis	V_{HYS}	—	90	—	mV	
Voltage Regulation (Constant Voltage Mode)						
Regulated Charge Voltage	V_{REG}	4.080	4.10	4.121	V	V_{DD}=[V_{REG}(typical)+1V]
		4.179	4.20	4.221	V	I_{OUT}=10 mA
		4.328	4.35	4.372	V	T_A=-5°C to +55°C
		4.378	4.40	4.422		
Regulated Charge Voltage Tolerance	V_{RTOL}	-0.5	—	+0.5	%	T_A= +25°C
		-0.75	—	+0.75	%	T_A= -5°C to +55°C
Line Regulation	$\|(\Delta V_{BAT}/V_{BAT})/\Delta V_{DD}\|$	—	0.08	0.20	%/V	V_{DD}=[V_{REG}(typical)+1V] to 6V I_{OUT}=10 mA
Load Regulation	$\|\Delta V_{BAT}/V_{BAT}\|$	—	0.08	0.18	%	I_{OUT}=10 mA to 150 mA V_{DD}= [V_{REG}(typical)+1V]
Supply Ripple Attenuation	PSRR	—	-47	—	dB	I_{OUT}=10 mA, 1 kHz
		—	-40	—	dB	I_{OUT}=10 mA, 10 kHz
Current Regulation (Fast Charge Constant-Current Mode)						
AC-Adapter Fast Charge Current	I_{REG}	90	100	110	mA	PROG1 = 10 kΩ
		900	1000	1100	mA	PROG1 = 1 kΩ, T_A=-5°C to +55°C, SEL = Hi
USB Fast Charge Current	I_{REG}	80	90	100	mA	PROG2 = Low, SEL = Low, **(Note 2)**
		400	450	500	mA	PROG2 = High, SEL = Low, **(Note 2)** T_A= -5°C to +55°C

Note 1: The value is ensured by design and not production tested.
2: The maximum available charge current is also limited by the value set at PROG1 input.

DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise indicated, all limits apply for $V_{IN} = V_{REG}$ + 0.3V to 6V, T_A = -40°C to +85°C. Typical values are at +25°C, V_{IN} = [V_{REG} (typical) + 1.0V]

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Current Limit Control (ICLC)						
USB-Port Supply Current Limit	I_{LIMIT_USB}	80 400	90 450	100 500	mA mA	PROG2 = Low, SEL = Low PROG2 = High, SEL = Low T_A=-5°C to +55°C
AC-DC Adapter Current Limit	I_{LIMIT_AC}	1500	1650	1800	mA	SEL = High, T_A=-5°C to +55°C
Voltage Proportional Charge Control (VPCC - Input Voltage Regulation)						
VPCC Input Threshold VPCC Input Threshold Tolerance	V_{VPCC} V_{RTOL}	— -3	1.23 —	— +3	V %	I_{OUT}=10 mA T_A=-5°C to +55°C
Input Leakage Current	I_{LK}	—	0.01	1	µA	$V_{VPCC} = V_{DD}$
Precondition Current Regulation (Trickle Charge Constant-Current Mode)						
Precondition Current Ratio	I_{PREG} / I_{REG}	7.5	10	12.5	%	PROG1 = 1.0 kΩ to 10 kΩ T_A=-5°C to +55°C
Precondition Current Threshold Ratio	V_{PTH} / V_{REG}	69	72	75	%	V_{BAT} Low-to-High
Precondition Hysteresis	V_{PHYS}	—	105	—	mV	V_{BAT} High-to-Low
Automatic Charge Termination Set Point						
Charge Termination Current Ratio	I_{TERM}	75 7.5	100 10	125 12.5	mA mA	PROG3 = 10 kΩ PROG3 = 100 kΩ T_A=-5°C to +55°C
Automatic Recharge						
Recharge Voltage Threshold Ratio	V_{RTH}	V_{REG} - 0.21V	V_{REG} - 0.15V	V_{REG} - 0.09V	V	V_{BAT} High-to-Low
IN-to-OUT Pass Transistor ON-Resistance						
ON-Resistance	R_{DS_ON}	—	200	—	mΩ	V_{DD} = 4.5V, T_J = 105°C
Charge Transistor ON-Resistance						
ON-Resistance	$R_{DSON\_}$	—	200	—	mΩ	V_{DD} = 4.5V, T_J = 105°C
BAT-to-OUT Pass Transistor ON-Resistance						
ON-Resistance	R_{DS_ON}	—	200	—	mΩ	V_{DD} = 4.5V, T_J = 105°C
Battery Discharge Current						
Output Reverse Leakage Current	$I_{DISCHARGE}$	— — — —	30 30 30 -6	40 40 40 -13	µA µA µA µA	Shutdown ($V_{BAT} < V_{DD} < V_{UVLO}$) Shutdown ($0 < V_{DD} \leq V_{BAT}$) V_{BAT} = Power Out, No Load Charge Complete
Status Indicators - STAT1 ($\overline{LBO}$), STAT2, $\overline{PG}$						
Sink Current	I_{SINK}	—	16	35	mA	
Low Output Voltage	V_{OL}	—	0.4	1	V	I_{SINK} = 4 mA
Input Leakage Current	I_{LK}	—	0.01	1	µA	High Impedance, V_{DD} on pin
Low Battery Indicator ($\overline{LBO}$)						
Low Battery Detection Threshold	V_{LBO}	— 2.85 2.95 3.05	Disable 3.0 3.1 3.2	— 3.15 3.25 3.35	 V V V	$V_{BAT} > V_{IN}$, $\overline{PG}$ = Hi-Z T_A=-5°C to +55°C
Low Battery Detection Hysteresis	V_{LBO_HYS}	—	150	—	mV	V_{BAT} Low-to-High

Note 1: The value is ensured by design and not production tested.
2: The maximum available charge current is also limited by the value set at PROG1 input.

DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise indicated, all limits apply for V_{IN} = V_{REG} + 0.3V to 6V, T_A = -40°C to +85°C.
Typical values are at +25°C, V_{IN} = [V_{REG} (typical) + 1.0V]

Parameters	Sym	Min	Typ	Max	Units	Conditions
PROG1 Input (PROG1)						
Charge Impedance Range	R_{PROG}	1	—	20	kΩ	
PROG3 Input (PROG3)						
Termination Impedance Range	R_{PROG}	5	—	100	kΩ	
PROG2 Input (PROG2)						
Input High Voltage Level	V_{IH}	1.8	—	—	V	
Input Low Voltage Level	V_{IL}	—	—	0.8	V	
Input Leakage Current	I_{LK}	—	0.01	1	µA	$V_{PROG2} = V_{DD}$
Timer Enable ($\overline{TE}$)						
Input High Voltage Level	V_{IH}	1.8	—	—	V	**Note 1**
Input Low Voltage Level	V_{IL}	—	—	0.8	V	**Note 1**
Input Leakage Current	I_{LK}	—	0.01	1	µA	$V_{\overline{TE}} = V_{DD}$
Chip Enable (CE)						
Input High Voltage Level	V_{IH}	1.8	—	—	V	
Input Low Voltage Level	V_{IL}	—	—	0.8	V	
Input Leakage Current	I_{LK}	—	0.01	1	µA	$V_{CE} = V_{DD}$
Input Source Selection (SEL)						
Input High Voltage Level	V_{IH}	1.8	—	—	V	
Input Low Voltage Level	V_{IL}	—	—	0.8	V	
Input Leakage Current	I_{LK}	—	0.01	1	µA	$V_{SEL} = V_{DD}$
Thermistor Bias						
Thermistor Current Source	I_{THERM}	47	50	53	µA	2 kΩ < R_{THERM} < 50 kΩ
Thermistor Comparator						
Upper Trip Threshold	V_{T1}	1.20	1.24	1.26	V	V_{T1} Low-to-High
Upper Trip Point Hysteresis	V_{T1HYS}	—	-40	—	mV	
Lower Trip Threshold	V_{T2}	0.23	0.25	0.27	V	V_{T2} High-to-Low
Lower Trip Point Hysteresis	V_{T2HYS}	—	40	—	mV	
Thermal Shutdown						
Die Temperature	T_{SD}	—	150	—	°C	
Die Temperature Hysteresis	T_{SDHYS}	—	10	—	°C	

Note 1: The value is ensured by design and not production tested.
2: The maximum available charge current is also limited by the value set at PROG1 input.

AC CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, all limits apply for V_{IN} = 4.6V to 6V.
Typical values are at +25°C, V_{DD} = [V_{REG} (typical) + 1.0V]

Parameters	Sym	Min	Typ	Max	Units	Conditions
UVLO Start Delay	t_{START}	—	—	5	ms	V_{DD} Low-to-High
Current Regulation						
Transition Time Out of Precondition	t_{DELAY}	—	—	10	ms	$V_{BAT} < V_{PTH}$ to $V_{BAT} > V_{PTH}$
Current Rise Time Out of Precondition	t_{RISE}	—	—	10	ms	I_{OUT} Rising to 90% of I_{REG}
Precondition Comparator Filter Time	t_{PRECON}	0.4	1.3	3.2	ms	Average V_{BAT} Rise/Fall
Termination Comparator Filter Time	t_{TERM}	0.4	1.3	3.2	ms	Average I_{OUT} Falling
Charge Comparator Filter Time	t_{CHARGE}	0.4	1.3	3.2	ms	Average V_{BAT} Falling
Thermistor Comparator Filter Time	t_{THERM}	0.4	1.3	3.2	ms	Average THERM Rise/Fall
Elapsed Timer						
Elapsed Timer Period	$t_{ELAPSED}$	—	0	—	Hours	
		3.6	4.0	4.4	Hours	
		5.4	6.0	6.6	Hours	
		7.2	8.0	8.8	Hours	
Status Indicators						
Status Output Turn-off	t_{OFF}	—	—	500	µs	I_{SINK} = 1 mA to 0 mA
Status Output Turn-on	t_{ON}	—	—	500	µs	I_{SINK} = 0 mA to 1 mA

Note 1: Internal safety timer is tested base on internal oscillator frequency measurement.

TEMPERATURE SPECIFICATIONS

Electrical Specifications: Unless otherwise indicated, all limits apply for V_{IN} = 4.6V to 6V.
Typical values are at +25°C, V_{DD} = [V_{REG} (typical) + 1.0V]

Parameters	Sym	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+85	°C	
Operating Temperature Range	T_J	-40	—	+125	°C	
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 20LD-QFN, 4x4	θ_{JA}	—	35	—	°C/W	4-Layer JC51-7 Standard Board, Natural Convection

2.0 TYPICAL PERFORMANCE CURVES

Note:	The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

Note: Unless otherwise indicated, V_{IN} = [V_{REG}(typical) + 1V], I_{OUT} = 10 mA and T_A= +25°C, Constant-voltage mode.

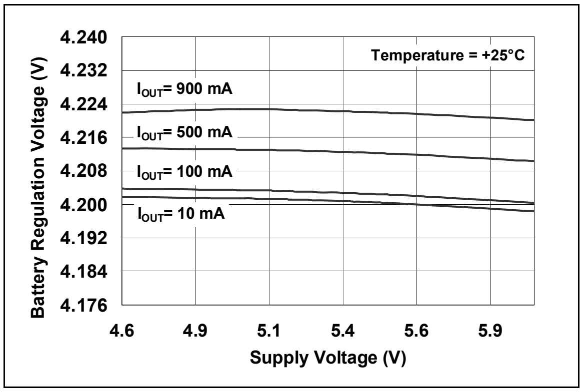


FIGURE 2-1: *Battery Regulation Voltage (V_{BAT}) vs. Supply Voltage (V_{DD}).*

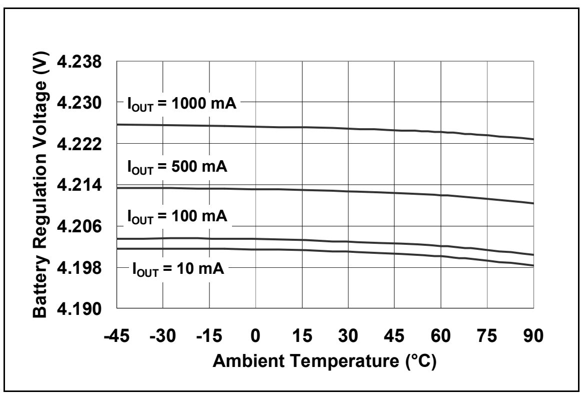


FIGURE 2-2: *Battery Regulation Voltage (V_{BAT}) vs. Ambient Temperature (T_A).*

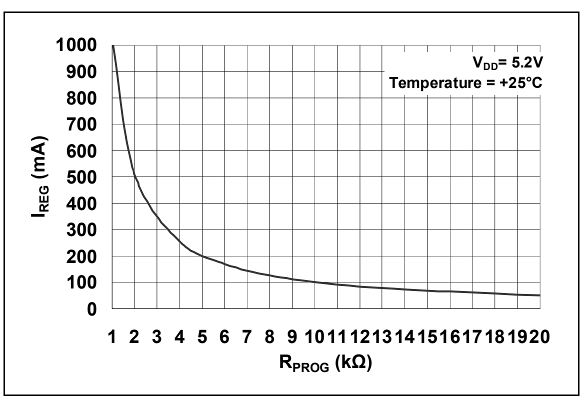


FIGURE 2-3: *Charge Current (I_{OUT}) vs. Programming Resistor (R_{PROG}).*

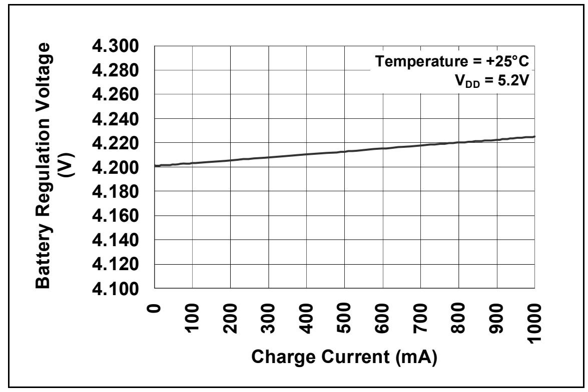


FIGURE 2-4: *Charge Current (I_{OUT}) vs. Battery Regulation Voltage (V_{BAT}).*

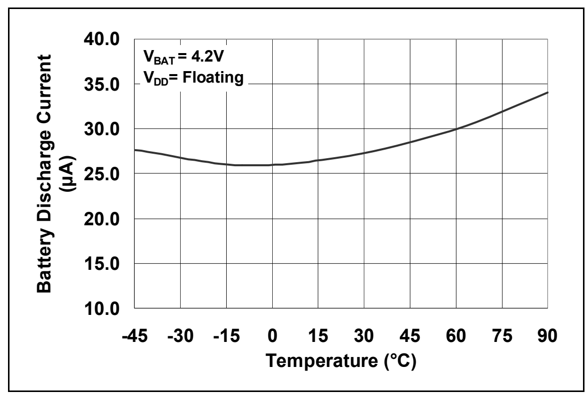


FIGURE 2-5: *Output Leakage Current ($I_{DISCHARGE}$) vs. Ambient Temperature (T_A).*

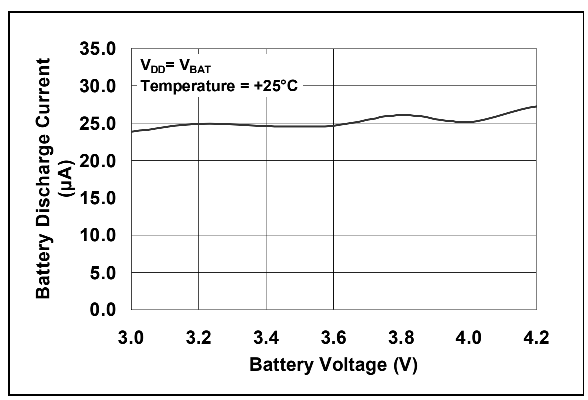


FIGURE 2-6: *Output Leakage Current ($I_{DISCHARGE}$) vs. Battery Regulation Voltage (V_{BAT}).*

Note: Unless otherwise indicated, V_{IN} = [V_{REG}(typical) + 1V], I_{OUT} = 10 mA and T_A= +25°C, Constant-voltage mode.

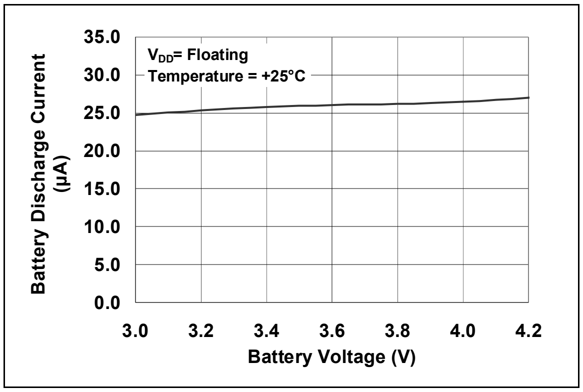


FIGURE 2-7: *Output Leakage Current ($I_{DISCHARGE}$) vs. Battery Voltage (V_{BAT}).*

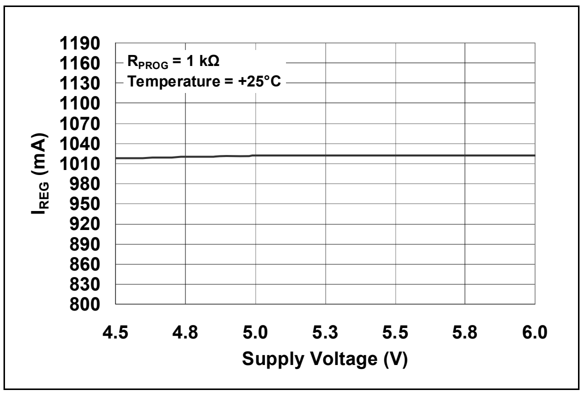


FIGURE 2-8: *Charge Current (I_{OUT}) vs. Supply Voltage (V_{DD}).*

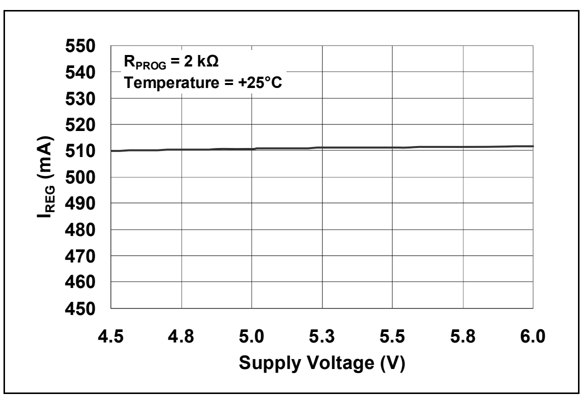


FIGURE 2-9: *Charge Current (I_{OUT}) vs. Supply Voltage (V_{DD}).*

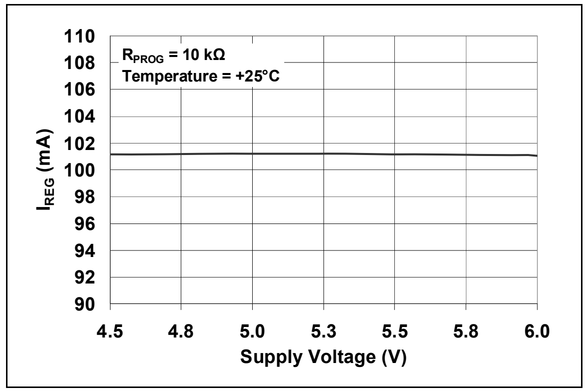


FIGURE 2-10: *Charge Current (I_{OUT}) vs. Supply Voltage (V_{DD}).*

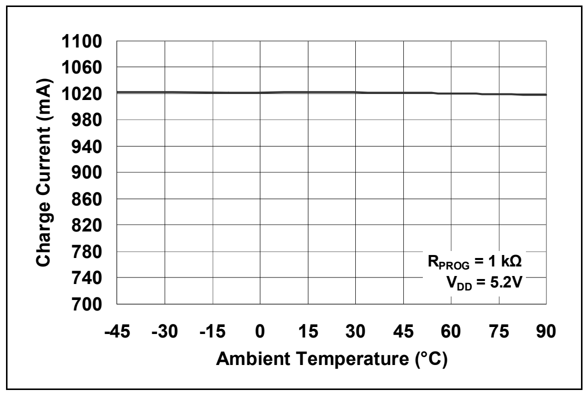


FIGURE 2-11: *Charge Current (I_{OUT}) vs. Ambient Temperature (T_A).*

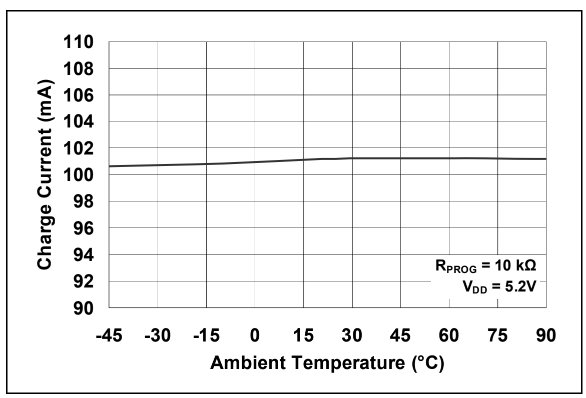


FIGURE 2-12: *Charge Current (I_{OUT}) vs. Ambient Temperature (T_A).*

Note: Unless otherwise indicated, V_{IN} = [V_{REG}(typical) + 1V], I_{OUT} = 10 mA and T_A= +25°C, Constant-voltage mode.

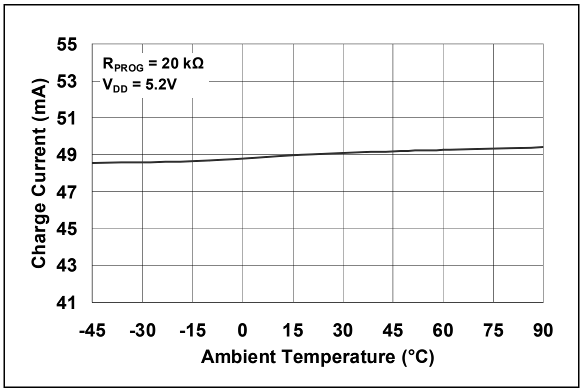


FIGURE 2-13: *Charge Current (I_{OUT}) vs. Ambient Temperature (T_A).*

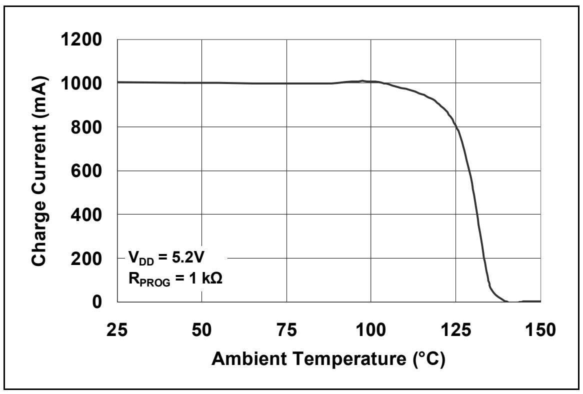


FIGURE 2-14: *Charge Current (I_{OUT}) vs. Junction Temperature (T_J).*

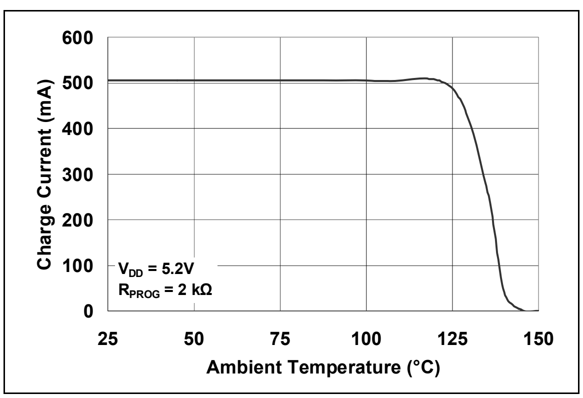


FIGURE 2-15: *Charge Current (I_{OUT}) vs. Junction Temperature (T_J).*

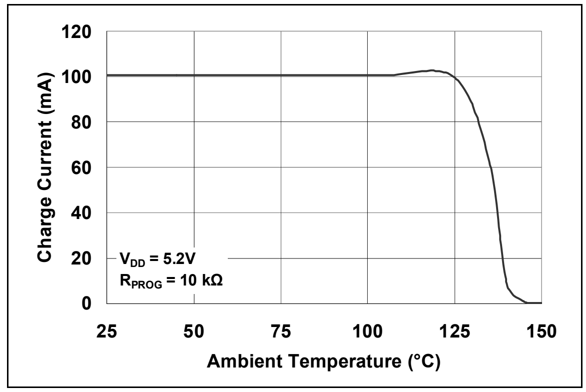


FIGURE 2-16: *Charge Current (I_{OUT}) vs. Junction Temperature (T_J).*

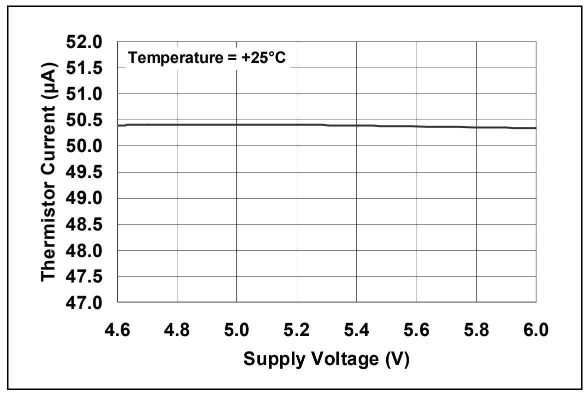


FIGURE 2-17: *Thermistor Current (I_{THERM}) vs. Supply Voltage (V_{DD}).*

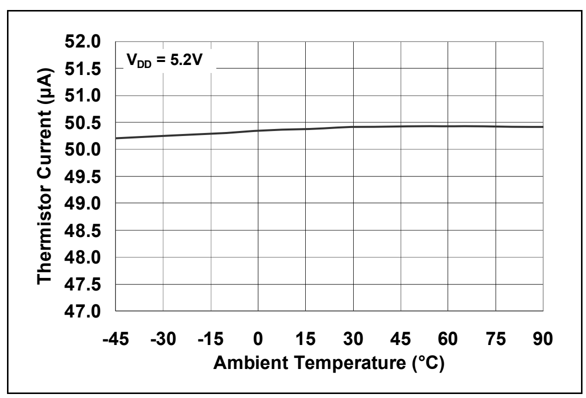


FIGURE 2-18: *Thermistor Current (I_{THERM}) vs. Ambient Temperature (T_A).*