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MAX77818

Dual Input, Power Path, 3A Switching Mode Charger with FG

General Description

The MAX77818 is a high-performance companion PMIC for the latest smartphones and tablet computers. The PMIC includes a dual input, smart power path 3.0A switch mode charger with reverse boost capability and adapter input protection up to $16V_{DC}$ withstand, proprietary ModelGauge™ (m5) fuel gauge technology.

The switch mode battery charger's operating frequency is 4MHz and includes integrated, low-loss switches to provide the industry's smallest L/C size, lowest heat, and fastest battery charging programmable up to 3.0A. The charger has two inputs that accept adapter/USB (CHIN) and/or wireless type inputs (WCIN). The wireless input can simultaneously charge the battery while powering USB-OTG type accessories. The USB-OTG output provides true-load disconnect and is protected by an adjustable output current limit.

The battery charger includes smart power path and I^2C adjustable settings to accommodate a wide range of battery sizes and system loads. When external power is applied from either input, battery charging is enabled. With a valid input power source (adapter or wireless charger), the BYP pin voltage is equal to the input voltage minus resistive voltage drop. During battery-only reverse boost operation, the BYP output can be regulated with the reverse boost feature and provides up to 5V at 1.5A and requires no additional inductor, allowing the MAX77818 to power USB OTG accessories.

The switching charger is designed with a special CC, CV, and die temperature regulation algorithm. ModelGauge (m5) provides accurate battery fuel gauging without calibration and operates with extremely low battery current.

The safeout LDO drive system USB interface devices.

The MAX77818 features a I^2C revision 3.0-compatible serial interface that comprises a bidirectional serial data line (SDA) and a serial clock line (SCL).

Applications

- Smartphones and Tablets
- Other Handheld Devices

Benefits and Features

- Dual Input Switchmode Battery Charger
  - Adapter/USB Input
    - Up to 13.4V Adapter Charging
    - Up to 4.0A rated, Input Current Protection (Programmable)
  - Wireless Charging Input
    - Up to 5.9V Wireless Charging
    - Up to 1.26A, Input Current Protection (Programmable)
    - Support USB-OTG Accessories
  - Battery Charge Current, Up to 3.0A
    - No Sense Resistor
    - CC, CV, and Die Temperature Control
    - Integrated Battery True-Disconnect FET
    - $R_{DS}(ON)$ = 12.8mΩ
    - Rated Up to $4.5A_{RMS}$, Discharge Current Limit (Programmable)
  - Reverse Boost Capability
    - Supports USB-OTG Accessories
    - Up to 5.1V/1.5A
    - Adjustable OCP
- ModelGauge (m5) Battery Fuel Gauge
  - ±1% SOC Accuracy, No Calibration Cycles, Very Low I_Q
  - Time-to-Empty and Time-to-Full Prediction
- Two Safeout LDOs
- I^2C Serial Interface
- 72-Bump. 3.867mm x 3.608mm WLP with 0.4mm Pitch

***Ordering Information* appears at end of data sheet.**

maxim integrated™

Absolute Maximum Ratings

Switching Charger
CHGIN to GND..-0.3V to +16V
BYP to GND ....-0.3V to +16V
WCIN, PVL, AVL, BAT_SP, BATT, SYS,
DETBATB to GND ....-0.3V to +6V
BST to PVL..-0.3V to +16V
BST to CHGLX ....-0.3V to +6V
WCINOKB, INOKB to GND..........................-0.3V to SYS+0.3V
BAT_SN, CHGPG to GND ....-0.3V to +0.3V
CHGLX, CHGPG Continuous Current ....$3.5A_{RMS}$
SYS, BATT Continuous Current..................................$4.5A_{RMS}$
CHGIN, BYP Continuous Current ....$4.0A_{RMS}$
WCIN Continuous Current..$1.5A_{RMS}$
Fuel Gauge
V_{BFG}, to GND ....-0.3V to +2.2V
THMB, THM to GND .... -0.3V to V_{AVL} + 0.3V

Safeout LDOs
SAFEOUT1, SAFEOUT2 to GND ....-0.3V to 6V
SAFEOUT1, SAFEOUT2 Continuous Current 100mA
I[2]C and Interface Logic
V_{IO} to GND...-0.3V to +6V
SDA, SCL to GND ....-0.3V to V_{IO}+0.3V
INTB to GND ....-0.3V to V_{SYS_A} + 0.3V
TEST_, V_{CCTEST}, SYS_ to GND...........................-0.3V to +6V
GND_ to GND ....-0.3V to +0.3V
Thermal Ratings
Operating Temperature Range.......................... -40°C to +85°C
Junction Temperature ....+150°C
Storage Temperature Range .... -65°C to +150°C
Soldering Temperature (reflow) ....+260°C
Continuous Power Dissipation (T_A = +70°C)
(derate 28.9mW/°C with 4L board, above 70°C)...........2.31W

CHGLX has internal clamp diodes to CHGPG and BYP. Applications that forward bias these diodes should take care not to exceed the IC's package power dissipation limits.

Package Thermal Characteristics (Note 1)

WLP
Junction-to-Ambient Thermal Resistance (θ_{JA}) ....34.6°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

General Electrical Characteristics

(V_{SYS} = +3.7V, C_{HGIN} = 0V , V_{IO} = 1.8V, T_A =-40°C to +85°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Shutdown Supply Current (BATT)		All circuits off V_{BATT} = 3.6V		23	50	µA
No Load Supply Current (BATT)		Fuel gauge is on All other circuits off, V_{BATT} = 3.6V		50	100	µA
SYS INPUT RANGE						
SYS Operating Voltage		Guaranteed by $V_{SYSUVLO}$ and $V_{SYSOVLO}$	2.8		5	V
SYS Undervoltage Lockout Threshold		V_{SYS} falling, 200mV hysteresis	2.45	2.5	2.55	V
SYS Overvoltage Lockout Threshold		V_{SYS} rising, 200mV hysteresis	5.2	5.36	5.52	V

Electrical Characteristics (continued)

General Electrical Characteristics

(V_{SYS} = +3.7V, C_{HGIN} = 0V , V_{IO} = 1.8V, T_A =-40°C to +85°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
LOGIC AND CONTROL INPUT						
SCL, SDA Input Low Level		T_A = +25°C			0.3 x V_{IO}	V
SCL, SDA Input High Level		T_A = +25°C	0.7 x V_{IO}			V
SCL, SDA Input Hysteresis		T_A = +25°C		0.05 x V_{IO}		V
SCL, SDA Logic Input Current		V_{IO} = 3.6V	-10		+10	µA
SCL, SDA Input capacitance				10		pF
SDA Output Low Voltage		Sinking 20mA			0.4	V
Output Low Voltage INTB		I_{SINK} = 1mA			0.4	V
I^2C-COMPATIBLE INTERFACE TIMING FOR STANDARD, FAST, AND FAST-MODE PLUS (Note 2)						
Clock Frequency	f_{SCL}				1000	kHz
Hold Time (Repeated) START Condition	$t_{HD;STA}$		0.26			µs
CLK Low Period	t_{LOW}		0.5			µs
CLK High Period	t_{HIGH}		0.26			µs
Setup Time Repeated START Condition	$t_{SU;STA}$		0.26			µs
DATA Hold Time	$t_{HD:DAT}$		0			µs
DATA Valid Time	$t_{VD:DAT}$				0.45	µs
DATA Valid Acknowledge Time	$t_{VD:ACK}$				0.45	µs
DATA Setup Time	$t_{SU;DAT}$		50			ns
Setup Time for STOP Condition	$t_{SU;STO}$		0.26			µs
Bus Free Time Between STOP and START	t_{BUF}		0.5			µs
Pulse Width of Spikes that Must Be Suppressed by the Input Filter		(Note 3)		50		ns

Electrical Characteristics (continued)

General Electrical Characteristics

(V_{SYS} = +3.7V, C_{HGIN} = 0V , V_{IO} = 1.8V, T_A =-40°C to +85°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	C_B = 100pF			UNITS
			MIN	TYP	MAX	
I^2C-COMPATIBLE INTERFACE TIMING FOR HS MODE (Note 2)						
Clock Frequency	f_{SCL}				3.4	MHz
Setup Time Repeated START Condition	$t_{SU;STA}$		160			ns
Hold Time (Repeated) START Condition	$t_{HD;STA}$		160			ns
CLK Low Period	t_{LOW}		160			ns
CLK High Period	t_{HIGH}		60			ns
DATA Setup time	$t_{SU;DAT}$		10			ns
DATA Hold Time	$t_{HD:DAT}$		0			ns
SCL Rise Time	t_{RCL}	T_A = +25°C	10		40	ns
Rise Time of SCL Signal After a Repeated START condition and After an Acknowledge Bit	t_{RCL1}	T_A = +25°C	10		80	ns
SCL Fall Time	t_{FCL}	T_A = +25°C	10		40	ns
SDA Rise Time	t_{RDA}	T_A = +25°C	10		80	ns
SDA Fall Time	t_{FDA}	T_A = +25°C			80	ns
Setup Time for STOP Condition	$t_{SU;STO}$		160			ns
Pulse Width of Spikes that Must be Suppressed by the Input Filter				10		ns

Switching Charger Electrical Characteristics

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
CHGIN INPUT						
CHGIN Operating Voltage Range		Operating voltage	3.2		V_{OVLO}	V
WCIN Operating Voltage Range		Operating voltage	3.2		V_{OVLO}	V
CHGIN Overvoltage Threshold (Note 4)	$V_{CHGIN-OVLO}$	V_{CHGIN} rising	13.4	13.7	14	V
WCIN Overvoltage Threshold (Note 4)	$V_{WCIN-OVLO}$	V_{WCIN} rising	5.9		6	V
WCIN Overvoltage Threshold Hysteresis	$V_{WCINH-OVLO}$	V_{WCIN} falling		100		mV
CHGIN Overvoltage Threshold Hysteresis	$V_{CHGINH-OVLO}$	V_{CHGIN} falling		300		mV
WCIN/CHGIN Overvoltage Delay	T_{D-OVLO}	V_{WCIN/BUS_DET} rising, 100mV overdrive, not production tested		10		us
		V_{WCIN/BUS_DET} falling, 100mV overdrive, not production tested		20		us
WCIN/CHGIN to GND Minimum Turn-On Threshold Range (Note 4)	$V_{WCIN/CHGIN\_UVLO}$	V_{CHGIN} rising, 100mV hysteresis, programmable at 4.5V, 4.9V, 5.0V, 5.1V, WCIN input is disabled when valid CHGIN input is detected	4.5		5.1	V
WCIN/CHGIN to GND Minimum Turn-On Threshold Accuracy	$V_{WCIN/CHGIN\_UVLO}$	$V_{WCIN/CHGIN}$ rising, 4.5V setting	4.4	4.5	4.6	V
WCIN/CHGIN to SYS Minimum Turn-On Threshold (Note 4)	$V_{WCIN/CHGIN2SYS}$	V_{CHGIN} rising, 50mV hysteresis, WCIN input is disabled when valid CHGIN input is detected	V_{SYS} + 0.12	V_{SYS} + 0.20	V_{SYS} + 0.28	V
WCIN/CHGIN Turn-On Threshold Delay	T_{D-UVLO}	Not production tested		10		us
WCIN/CHGIN Adaptive Current Regulation Threshold Range (Note 5)	$V_{WCIN/CHGIN\_REG}$	Programmable at 4.3V, 4.7V, 4.8V, 4.9V	4.3		4.9	V
WCIN/CHGIN Adaptive Voltage Regulation Threshold Accuracy	$V_{WCIN/CHGIN\_REG}$	4.9V setting	4.8	4.9	5	V
CHGIN Current-Limit Range		Programmable, 500mA default, factory programmable option of 100mA, production tested at 100mA, 500mA, 1000mA, 1800mA, 4000mA settings only	0.1		4	A
WCIN Current-Limit Range		Programmable, 500mA default, factory programmable option of 100mA, production tested at 100mA, 250mA, 500mA, 1000mA settings only	0.06		1.26	A

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
WCIN or CHGIN Supply Current	I_{IN}	$V_{WCIN/CHGIN}$ = 2.4V, the input is undervoltage and R_{INSD} is the only loading		0.075		mA
		$V_{WCIN/CHGIN}$ = 5.0V, charger disabled		0.17	0.5	
		$V_{WCIN/CHGIN}$ = 5.0V, charger enabled, V_{SYS} = V_{BATT} = 4.5V, (no switching, battery charged)		2.7	4	
VWCIN or VCHGIN Input Current Limit	$I_{INLIMIT}$	V_{WCIN} or V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 100mA input current setting, T_A = +25°C	90	102	108	mA
		V_{WCIN} or V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 500mA Input current setting, T_A = +25°C	462.5	487.5	500	
		V_{WCIN} or V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 1000mA Input current setting, T_A = +25°C	950	975	1000	
		V_{WCIN} or V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 1000mA input current setting, T_A = 0°C to +85°C	926	975	1024	
VCHGIN Input Current Limit	$I_{INLIMIT}$	V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 1800mA input current setting, T_A = +25°C	1710	1755	1800	mA
		V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 1800mA input current setting, T_A = 0°C to +85°C	1667	1755	1843	
		V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 4000mA input current setting, T_A = +25°C	3800	3900	4000	
		V_{CHGIN} = 5.0V, charger enabled, V_{BATT} = 3.8V, 4000mA input current setting, T_A = 0°C to +85°C	3705	3900	4095	
WCIN, CHGIN Self-Discharge Down to UVLO Time	t_{INSD}	Time required for the charger input to cause a 10µF input capacitor to decay from 6.0V to 4.3V.		100		ms
WCIN, CHGIN Input Self-Discharge Resistance	R_{INSD}	For CHGIN, this resistor is disconnected from the CHGIN pin during MUIC microphone mode		35		kΩ
WCINOK/CHGINOK to Start Switching	t_{START}			150		ms

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SWITCH IMPEDANCES AND LEAKAGE CURRENTS							
CHGIN to BYP Resistance	R_{IN2BYP}	Bidirectional			0.0144	0.04	Ω
WCIN to BYP Resistance	$R_{WCIN2BYP}$				0.093	0.26	Ω
CHGLX High-Side Resistance	R_{HS}				0.0327	0.1	Ω
CHGLX Low-Side Resistance	R_{LS}				0.0543	0.14	Ω
BATT to SYS Dropout Resistance	$R_{BAT2SYS}$				0.0128	0.04	Ω
CHGIN to BATT Dropout Resistance	R_{IN2BAT}	Calculation estimates a 0.04Ω inductor resistance (R_L) R_{IN2BAT} = R_{IN2BYP} + R_{HS} +R_L + $R_{BAT2SYS}$			0.0999		Ω
CHGLX Leakage Current		CHGLX = CHGPG or BYP	T_A = +25°C		0.01	10	µA
			T_A = +85°C		1		µA
BST Leakage Current		V_{BST} = 5.5V	T_A = +25°C		0.01	10	µA
			T_A = +85°C		1		µA
BYP Leakage Current		V_{BYP} = 5.5V, V_{CHGIN} = 0V, V_{CHGLX} = 0V, charger disabled	T_A = +25°C		0.01	10	µA
			T_A = +85°C		1		µA
WCIN Leakage Current		V_{BYP} = 0V, V_{CHGIN} = 0V, V_{WCIN} = 5.5V	T_A = +25°C		0.01		µA
			T_A = +85°C		1		µA
SYS Leakage Current		V_{SYS} = 0V, V_{BATT} = 4.2V, charger disabled	T_A = +25°C		0.01	10	µA
			T_A = +85°C		1		µA

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
BATT Quiescent Current (I_{SYS} = 0A, I_{BYP} = 0A)	I_{MBAT}	V_{CHGIN} = 0V, V_{SYS} = 0V, V_{BATT} = 4.2V, QBAT is off	T_A = +25°C		20	30	µA
			T_A = +85°C		20		µA
		V_{CHGIN} = 0V, V_{BATT} = 4.2V, QBAT is on, main-battery overcurrent protection disabled	T_A = +25°C		15.3		µA
			T_A = +85°C		15.3		µA
		V_{CHGIN} = 0V, V_{BATT} = 4.2V, QBAT is on, main-battery overcurrent protection enabled	T_A = +25°C		20		µA
			T_A = +85°C		20		µA
		V_{SYS} = 4.2V, V_{BATT} = 0V, charger disabled	T_A = +25°C		0.01	10	µA
			T_A = +85°C		1		µA
	I_{MBDN}	V_{CHGIN} = 5V, V_{BATT} = 4.2V, QBAT is off, main-battery overcurrent protection disabled, Charger is enabled but in its done mode	T_A = +25°C		3	10	µA
			T_A = +85°C		3		µA
CHARGER DC-DC BUCK							
Minimum On-Time	t_{ON-MIN}				75		ns
Minimum Off-Time	t_{OFF}				75		ns
Current Limit (Note 6)	I_{LIM}	T_A = 0°C to +85°C I_{ND} = 0 (0.47µH inductor option) Production tested at I_{LIM} = 00 setting (Note 7)	I_{LIM} = 00 (3.00A out)	4.15	5.05	5.95	A
			I_{LIM} = 01 (2.75A out)		4.75		A
			I_{LIM} = 10 (2.50A out)		4.45		A
			I_{LIM} = 11 (2.25A out)		4.15		A
		T_A = 0°C to +85°C I_{ND} = 1 (1.0µH inductor option) Production tested at I_{LIM} = 11 setting (Note 7)	I_{LIM} = 00 (3.00A out)		4.60		A
			I_{LIM} = 01 (2.75A out)		4.30		A
			I_{LIM} = 10 (2.50A out)		4.00		A
			I_{LIM} = 11 (2.25A out)	3.00	3.70	4.40	A

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
REVERSE BOOST							
BYP Voltage Adjustment Range		2.5V < V_{BATT} < 4.5V. Adjustable from 3V to 5.75V, production tested at 3V, 5.0V and 5.75V settings		3		5.75	V
Reverse Boost Quiescent Current	I_{BYP}	Not switching: output forced 200mV above its target regulation voltage			1150		µA
Reverse Boost BYP Voltage in OTG Mode	$V_{BYP.OTG}$	5.1V setting		4.94	5.1	5.26	V
CHGIN Voltage in OTG Mode	$V_{CHGIN.OTG}$	Mode = 0x05 or 0x0F, WCIN switch is on, VCHGIN_REG = 4.9V, RIN2WCIN + RDSCHGIN < 300ml, OTG load current ≤ 450mA		4.75			V
CHGIN Output Current Limit	$I_{CHGIN.OTG.LIM}$	3.4V < V_{BATT} < 4.5V, T_A = +25°C	OTG_ILIM = 00	500		550	mA
			OTG_ILIM = 01	900		990	mA
			OTG_ILIM = 10	1200		1320	mA
			OTG_ILIM=11	1500		1650	mA
Reverse Boost Output Voltage Ripple		Discontinuous inductor current (i.e., skip mode)			±150		mV
		Continuous inductor current			±150		mV
CHARGER							
BATT Regulation Voltage Range	$V_{BATTREG}$	Programmable in 25mV steps (4 bits), production tested at 3.65V and 4.4V only.		3.65		4.7	V
BATT Regulation Voltage Accuracy		3.65V and 4.7V settings	T_A = +25°C	-0.75		+0.75	%
			T_A = 0°C to +85°C	-1		+1	%
Fast-Charge Current Program Range		0A to 3.0A in 50mA steps, production tested at 500,1000, 2000 and 3000mA settings		0		3	A
Fast-Charge Current Accuracy		Programmed currents ≥ 500mA, V_{BATT} > V_{SYSMIN} (short mode), production tested at 500mA, 800mA, 1000mA, 2000mA, 3000mA settings	T_A = +25°C	-2.5		+2.5	%
			T_A = 0°C to +85°C	-5		+5	%
		Programmed currents ≥ 500mA, V_{BATT} < V_{SYSMIN} (LDO mode), production test at 800mA		-10		+10	%

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Fast-Charge Currents	I_{FC}	T_A = +25°C, V_{BATT} > V_{SYSMIN}	Programmed for 3.0A	2925	3000	3075	mA
			Programmed for 2.0A	1950	2000	2050	mA
			Programmed for 1.0A	975	1000	1025	mA
			Programmed for 0.5A	487.5	500	512.5	mA
Low-Battery Prequalification Threshold	V_{PQLB}	V_{BATT} rising		2.8	2.9	3	V
Dead-Battery Prequalification Threshold	V_{PQDB}	V_{BATT} rising		1.9	2	2.1	V
Prequalification Threshold Hysteresis	V_{PQ-H}	Applies to both V_{PQLB} and V_{PQDB}			100		mV
Low-Battery Prequalification Charge Current	I_{PQLB}	Default setting = disabled		75	100	140	mA
Dead-Battery Prequalification Charge Current	I_{PQDB}			40	55	80	mA
Charger Restart Threshold Range	V_{RSTRT}	Adjustable, 100, 150, and 200; it can also be disabled		100	150	200	mV
Charger Restart Deglitch Time		10mV overdrive, 100ns rise time			130		ms
Top-Off Current Program Range		Programmable from 100 to 350mA in 8 steps.		100		350	mA
Top-Off Current Accuracy (Note 8)		Gain				5	%
		Offset				20	mA
Charge Termination Deglitch Time	t_{TERM}	2mV overdrive, 100ns rise/fall time			30		ms
Charger State Change Interrupt Deglitch Time	t_{SCIDG}	Excludes transition to timer fault state, watchdog timer state			30		ms
Charger Soft-Start Time	t_{SS}				1.5		ms

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SMART POWER SELECTOR						
BATT to SYS Reverse Regulation Voltage	V_{BSREG}	I_{BATT} = 10mA		30		mV
		I_{BATT} = 1A		60		mV
		Load regulation during the reverse regulation mode		30		mV/A
Minimum SYS Voltage Accuracy	V_{SYSMIN}	Programmable from 3.4V to 3.7V in 100mV steps, V_{BATT} = 2.8V, tested at 3.4V and 3.7V settings	-3		3	%
Maximum SYS Voltage	V_{SYSMAX}	The maximum system voltage: V_{SYSMAX} = V_{BATREG} + $R_{BAT2SYS}$ x I_{BATT}; V_{BATREG} = 4.2V, I_{BATT} = 3.0A		4.245	4.32	V
		The maximum system voltage: V_{SYSMAX} = V_{BATREG} + $R_{BAT2SYS}$ x I_{BATT}.; V_{BATREG} = 4.7V, I_{BATT} = 3.0A		4.745	4.82	V
WATCHDOG TIMER						
Watchdog Timer Period	t_{WD}		80			s
Watchdog Timer Accuracy			-20	0	+20	%
CHARGE TIMER						
Prequalification Time	t_{PQ}	Applies to both low-battery prequalification and dead-battery prequalification modes		35		min
Fast-Charge Constant Current + Fast-Charge Constant Voltage Time	t_{FC}	Adjustable from 4hrs to 16hrs in 2 hour steps including a disable setting		8		hrs
Top-Off Time	t_{TO}	Adjustable from 0min to 70min in 10min steps		30		min
Timer Accuracy			-20		+20	%
AVL FILTER						
Internal AVL Filter Resistance				12.5		Ω

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
THERMAL FOLDBACK						
Junction Temperature Thermal Regulation Loop Setpoint Program Range	T_{JREG}	Junction temperature when charge current is reduced. Programmable from +85°C to +130°C in 15°C steps, default value is +100°C	85		130	°C
Thermal Regulation Gain	A_{TJREG}	The charge current is decreased 6.7% of the fast charge current setting for every degree that the junction temperature exceeds the thermal regulation temperature. This slope ensures that the full-scale current of 3.0A is reduced to 0A by the time the junction temperature is 20°C above the programmed loop set point. For lower programmed charge currents such as 500mA, this slope is valid for charge current reductions down to 100mA; below 100mA the slope becomes shallower but the charge current still reduced to 0A if the junction temperature is 20°C above the programmed loop set point.		-150		mA/°C
BATTERY OVERCURRENT PROTECTION						
Battery Overcurrent Threshold Range	I_{BOVCR}	Programmable from 3.0A to 4.5A in 0.25A steps, can be disabled	3		4.5	A
Battery Overcurrent Debounce Time	t_{BOVRC}	This is the response time for generating the overcurrent interrupt flag	3	6	10	ms
Battery Overcurrent Protection Quiescent Current	I_{BOVRC}			3 + I_{BATT} /22000		µA
System Power-Up Current	I_{SYSPU}		35	50	80	mA
System Power-Up Voltage	V_{SYSPU}	V_{SYS} rising, 100mV hysteresis	2	2.1	2.2	V
System Power-Up Response Time	t_{SYSPU}	Time required for circuit to activate from an unpowered state (i.e., main-battery hot insertion)		1		µs
SYSTEM SELF DISCHARGE WITH NO POWER						
BATT Self-Discharge Resistor				600		Ω
SYS Self-Discharge Resistor				600		Ω
Self-Discharge Latch Time				300		ms

Switching Charger Electrical Characteristics (continued)

(V_{CHGIN} = 5V, V_{BATT} = 4.2V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = 25°C. Fast-charge current is set for 1.5A, done current is set for 150mA. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
DETBATB, INOKB, WCINOKB							
DETBATB Logic Threshold	V_{IH}	4% hysterisis			0.8 x V_{IO}		V
Logic Input Leakage Current	$I_{DETBATB}$				0.1	1	µA
Output Low Voltage INOKB, WCINOKB		I_{SINK} = 1mA				0.4	V
Output High Leakage INOKB, WCINOKB		V_{SYS} = 5.5V	T_A = +25°C	-1	0	+1	µA
			T_A = +85°C		0.1		µA

Safeout LDOs Electrical Characteristics

(V_{SYS} = 2.8V to 4.5V, T_A = -40°C to 85°C, typical values are at T_A = +25°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SAFEOUT1						
Output Voltage (Default On)		5V < V_{CHGIN} < 5.5V, I_{OUT} = 10mA, SAFEOUT1 = 01 (default)	4.8	4.9	5	V
		SAFEOUT1 = 00		4.85		V
		SAFEOUT1 = 10		4.95		V
		SAFEOUT1 = 11		3.3		V
Maximum Output Current			60			mA
Output Current Limit			60	150	320	mA
Dropout Voltage		V_{CHGIN} = 5V, I_{OUT} = 60mA		120		mV
Load Regulation		V_{CHGIN} = 5.5V, 30µA < I_{OUT} < 30mA		50		mV
Quiescent Supply Current		Not production tested		72		µA
Output Capacitor for Stable Operation (Note 9)		0µA < I_{OUT} < 30mA, MAX ESR = 50mΩ		1		µF
Minimum Output Capacitor for Stable Operation (Note 9)		0µA < I_{OUT} < 30mA, MAX ESR = 50mΩ		0.7		µF
Internal Off-Discharge Resistance				1200		Ω

Safeout LDOs Electrical Characteristics (continued)

(V_{SYS} = 2.8V to 4.5V, T_A = -40°C to 85°C, typical values are at T_A = +25°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.))

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
SAFEOUT2						
Output Voltage (Default Off)		5V < V_{CHGIN} < 5.5V, I_{OUT} = 10mA, SAFEOUT2 = 01 (default)	4.8	4.9	5	V
		SAFEOUT2 = 00		4.85		V
		SAFEOUT2 = 10		4.95		V
		SAFEOUT2 = 11		3.3		V
Maximum Output Current			60			mA
Output Current Limit			60	150	320	mA
Dropout Voltage		V_{CHGIN} = 5V, I_{OUT} = 60mA		120		mV
Load Regulation		V_{CHGIN} = 5.5V, 30µA < I_{OUT} < 30mA		50		mV
Quiescent Supply Current		Not production tested		72		µA
Output Capacitor for Stable Operation (Note 9)		0µA < I_{OUT} < 30mA, MAX ESR = 50mΩ		1		µF
Minimum Output Capacitor for Stable Operation (Note 9)		0FA < I_{OUT} < 30mA, MAX ESR = 50mΩ		0.7		µF
Internal Off-Discharge Resistance				1200		Ω

Fuel Gauge Electrical Characteristics

(V_{SYS} = 2.8V to 4.5V, T_A = -40°C to 85°C, typical values are at T_A = +25°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Current	I_{DD0}	Fuel gauge shut down (Note 10)		0.5		µA
	I_{DD1}	Fuel gauge active, average with 7.5% ADC duty cycle (Note 10)		35	70	µA
ADC Duty Cycle	Duty			7.5		%
Parameter Capture Rate	t_{ACQ}	Period of ADC activation loop		0.1758		s
Regulator Output	V_{BFG}		1.5	1.8	1.98	V
VOLTAGE CHANNEL						
V_{BATT} Measurement Error	V_{GERR}	V_{BATT} = 2.8V to 4.5V, T_A = +25°C	-7.5		+7.5	mV
		T_A = -40°C to +85°C	-20		+20	mV
V_{BATT} Measurement Resolution	V_{LSB}			1.25		mV
V_{BATT} Measurement Range	V_{RANGE}		2.8		4.98	V

Fuel Gauge Electrical Characteristics (continued)

(V_{SYS} = 2.8V to 4.5V, T_A = -40°C to 85°C, typical values are at T_A = +25°C, unless otherwise noted. Limits are 100% production tested at T_A = +25°C . Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Typical values are not guaranteed.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
CURRENT CHANNEL							
Current Measurement Resolution	I_{LSB}				1.25		mA
Current Measurement Range	I_{RANGE}			-3.6		+3.6	A
Current Measurement Offset	I_{OERR}	Long term average at zero input current			±0.25		mA
Current Measurement Symmetrical Error	I_{SERR}	(Notes 11, 12, 13)			2%		%
Current Measurement Asymmetrical Error	I_{AERR}	±3000mA	(Notes 12, 13, 14)	-150		+150	mA
		±1000mA		-20		+20	
		±300mA		-9.5		+9.5	
Linear Regulator Mode Current Measurement Error	I_{LRERR}	+1500mA	(Note 15)	-225		+225	mA
		+100mA		-40		+40	
Time-Base Accuracy	t_{ERR}	V_{SYS} = 3.7V at T_A = +25°C			±1		%
		T_A = -40°C to +85°C		-3.5		+3.5	
THERMAL CHANNEL							
Ratiometric Measurement Accuracy, THM	T_{GERR}	(Note 13)		-0.5		+0.5	% of full scale
Ratiometric Measurement Resolution, THM	T_{LSB}				0.0244		% of full scale
THMB Output Drive	V_{OH_THMB}	I_{OH_THMB} = -0.5mA		V_{AVL} - 0.1			V
THMB Precharge Time	t_{PRE_THMB}				12.7		ms
THMB Operating Range	V_{THMB}			2.8		V_{AVL}	V
THMB Input Leakage	I_{IN_THMB}	V_{THMB} = 5V		-1		+1	µA
THM Input leakage	I_{IN_THM}			-1		+1	µA

Electrical Characteristics (continued)

Note 2: Design guidance only, not tested during final test.

Note 3: Input filters on the SDA and SCL inputs suppress noise spikes of less than 50ns.

Note 4: The CHGIN input must be less than V_{OVLO} and greater than both V_{CHGIN_UVLO} and $V_{CHGIN2SYS}$ for the charger to turn-on.

Note 5: The input voltage regulation loop decreases the input current to regulate the input voltage at V_{CHGIN_REG}. If the input current is decreased to $I_{CHGIN\_REG\_OFF}$ and the input voltage is below V_{CHGIN_REG}, then the charger input is turned off.

Note 6: Production tested to ¼ of the threshold with LPM bit = 1 (¼ FET configuration).

Note 7: Production tested in charger DC-DC low-power mode.

Note 8: Not production tested.

Note 9: Not production tested.

Note 10: The total chip supply current includes the charger supply current in addition to the supply current for the fuel gauge.

Note 11: Symmetrical error is the sum of odd order errors in the measured values at two inputs symmetrical around zero; for example, ISERR_0.3A = (Error 0.3A - Error -0.3A)/2/0.3A x 100.

Note 12: Total current measurement error is the sum of the symmetrical and asymmetrical errors. Fuel gauge accuracy is sensitive to asymmetrical error but insensitive to symmetrical error.

Note 13: Current and ratiometric measurement errors are production tested at V_{SYS} = 3.7V and guaranteed by design at V_{SYS} = 2.8V and 4.5V.

Note 14: Asymmetrical error is the sum of even order errors in the measured values at two inputs symmetrical around zero; for example IAERR_0.3A = (Error 0.3A + Error -0.3A)/2.

Note 15: Total linear regulator mode current measurement error is simply the total error with respect to the input. This mode exists for a short duration when charging an empty battery, hence this error has limited consequence.

Pin Configuration

TOP VIEW
(BUMP SIDE DOWN)

MAX77818

	1	2	3	4	5	6	7	8	9
A	+ N.C.	TEST4	SDA	SCL	WCINOKB	GND_Q	WCIN	WCIN	N.C.
B	VCC_TEST	TEST3	TEST5	TEST6	VIO	DETBATB	SAFEOUT2	BYP	SAFEOUT1
C	TEST1	TEST2	INTB	N.C.	INOKB	N.C.	BYP	CHGIN	CHGIN
D	GND_A	GND_A	GND_A	GND_A	GND_A	AVL	BYP	CHGIN	CHGIN
E	SYS_A	N.C.	GND_D	N.C.	SYS	N.C.	PVL	BYP	BYP
F	VBFG	SYS_A	N.C.	N.C.	SYS	BAT_SN	BST	CHGLX	CHGLX
G	THMB	N.C.	BATT	BATT	SYS	BAT_SP	CHGR GSUB	CHGLX	CHGLX
H	N.C.	THM	BATT	BATT	SYS	SYS	CHGPG	CHGPG	CHGPG

WLP
(72 BUMPS WLP 9X8 BUMP ARRAY 0.4MM PITCH)

N/C PINS ARE FLOATING AND CAN BE CONNECTED AT BOARD-LEVEL IF NEEDED.

ALL TEST PINS (TEST1-6 AND VCCTEST) SHOULD BE GROUNDED IN THE END-USE APPLICATION.

*TOP VIEW = WAFER BACK-SIDE VIEW (BUMPS NOT VIEWABLE)

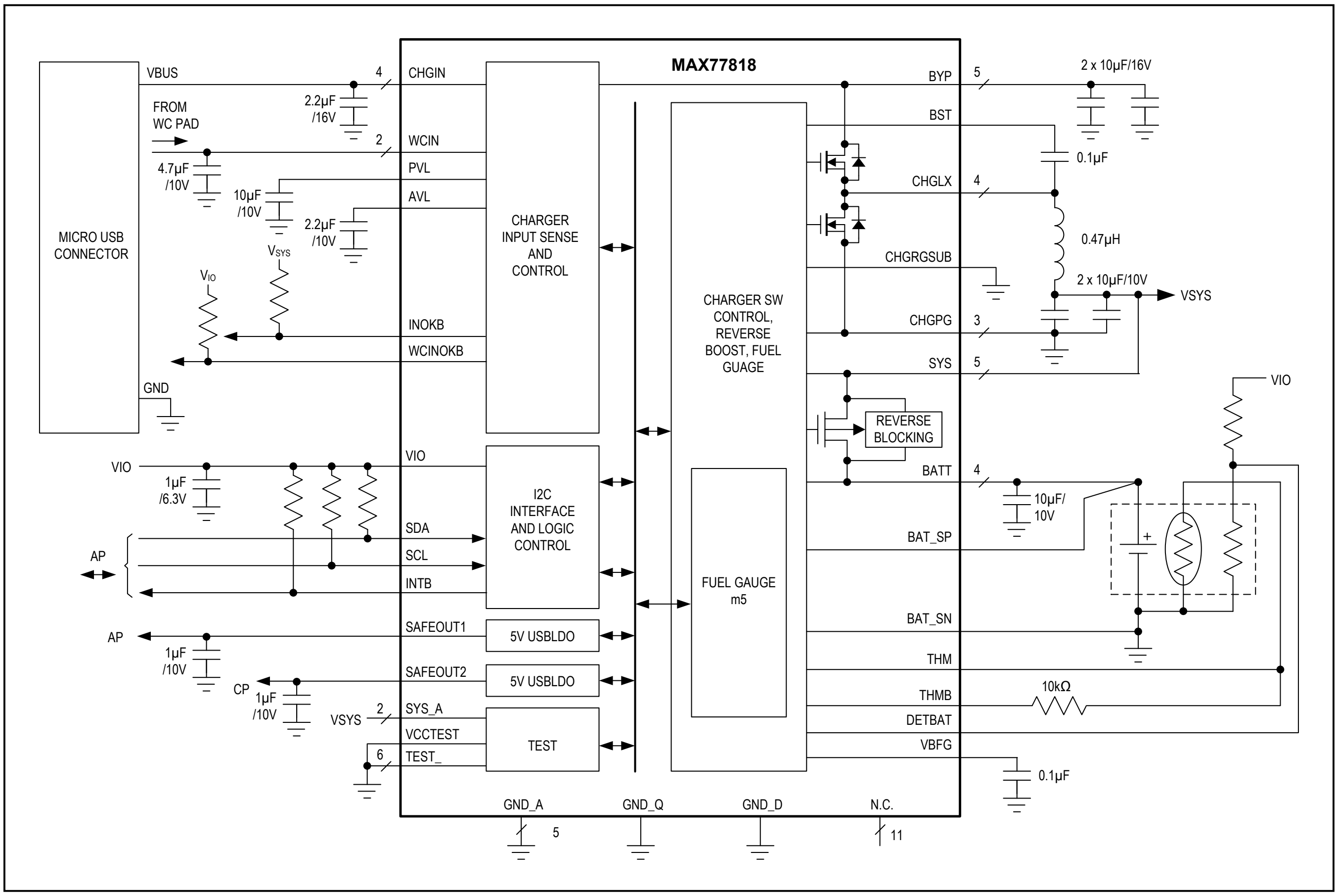
Pin Description

PIN	NAME	FUNCTION
A1, A9, C4, C6, E2, E4, E6, F3, F4, G2, H1	N.C.	No Connection
A2	TEST4	Test I/O Pin. Ground this pin in the application.
A3	SDA	I^2C Serial Data. Add an external 2.2kΩ pullup resistor to V_{IO}.
A4	SCL	I^2C Serial Clock. Add an external 2.2kΩ pullup resistor to V_{IO}.
A5	WCINOKB	Wireless Charger Input Valid, Active-Low Logic Output Flag. Open-drain, active-low output that indicates when valid voltage is present at WCIN and SYS.
A6	GND_Q	Quiet Ground. Short to GND_A and GND_D.
A7, A8	WCIN	Wireless Charger Input. $6V_{DC}$ protected input pin connected to Wireless charger power source. The wireless charger may be active during OTG mode, or disabled using the WCINSEL bit. Connect a 4.7µF/10V ceramic capacitor from WCIN to GND plane
B1	V_{CCTEST}	Test Mux Supply. Ground this pin in the application.
B2	TEST3	Test I/O. Ground this pin in the application.
B3	TEST5	Test I/O. Ground this pin in the application.
B4	TEST6	Test I/O. Ground this pin in the application.
B5	V_{IO}	Digital I/O Supply Input for I^2C Interface.
B6	DETBATB	Battery Detection Active-Low Input. Connect this pin to the ID pin on the battery pack. If DETBATB is pulled below 80% of the externally applied V_{IO} voltage, this is an indication that the battery is present and the charger starts when valid CHGIN and/or WCIN power is present. If DETBATB is driven high to VIO voltage or left unconnected, this is an indication that the battery is not present and the charger does not start. DETBATB is pulled high to V_{IO} pin through an off-chip pullup resistor.
B7	SAFEOUT2	Safeout LDO2 Output. Default off. Bypass with a 1µF ceramic capacitor to GND.
B8, C7, D7, E8, E9	BYP	CHGIN Bypass. This pin can see up to OVP limit. Output of adapter Input current Limit block and input to switching charger. BYP is also the boost converter output when the charger is operating in reverse boost mode. Bypass with 2x10µF/16V ceramic capacitors from BYP to CHGPG ground plane.
B9	SAFEOUT1	Safeout LDO1 Output. Default 4.9V and on when CHGIN power is valid. Bypass with a 1µF ceramic capacitor to GND.
C1	TEST1	Test I/O. Ground this pin in the application.
C2	TEST2	Test I/O. Ground this pin in the application.
C3	INTB	Interrupt Output. Active-low, open-drain output. Add a 200kΩ pullup resistor to V_{IO}.
C5	INOKB	Charger Input Valid, Active-Low Logic Output Flag. Open-drain output indicates when valid voltage is present at both CHGIN and SYS or WCIN and SYS.

Pin Description (continued)

PIN	NAME	FUNCTION
C8, C9, D8, D9	CHGIN	Charger Input. The adapter/USB charger input may be active, or disabled using the CHGINSEL bit. Connect a 2.2μF/16V ceramic capacitor from CHGIN to GND plane.
D1–D5	GND_A	Analog Ground. Short to GND_D and GND_Q.
E3	GND_D	Digital Ground. Short to GND_A and GND_Q.
D6	AVL	Analog Voltage Level. Output of on-chip 5V LDO used to power on-chip, low-noise circuits. Bypass with a 2.2μF/10V ceramic capacitor to GND. Powering external loads from AVL is not recommended, other than pulldown resistors.
E1, F2	SYS_A	Analog SYS Input
E5, F5, G5, H5, H6	SYS	System Power Connection. Connect system loads to this node. Bypass with 2x10μF ceramic capacitors from SYS to CHGPG ground plane.
E7	PVL	Internal Bias Regulator High-Current Output Bypass. Supports internal noisy and high-current gate drive loads. Bypass to GND with a minimum 10μF/10V ceramic capacitor.
F1	V_{BFG}	1.8V power supply output for Fuel Gauge. Bypass V_{BFG} with a 0.1μF ceramic capacitor, V_{BFG} is not intended to power external circuitry.
F6	BAT_SN	Battery Negative Differential Sense Connection. Connect to the negative or ground terminal close to the battery.
F7	BST	High-Side FET Driver Supply. Bypass BST to LX with a 0.1μF ceramic capacitor.
F8, F9, G8, G9	CHGLX	Charger Switching Node. Connect the inductor between CHGLX and SYS.
G1	THMB	Pullup Voltage for THM Pin Pullup Resistor. Can be switched to save power.
G3, G4, H3, H4	BATT	Battery Power Connection. Connect to the positive terminal of a single-cell (or parallel cell) Li Ion battery. Bypass BATT to CHGPG ground plane with a 10μF ceramic capacitor.
G6	BAT_SP	Battery Positive Differential Sense Connection. Connect to the positive terminal close to the battery.
G7	CHGRGSUB	Substrate Charger Ground Connection. Connect with GND_A.
H2	THM	Thermistor Connection. Determines battery temperature using ratiometric measurement.
H7–H9	CHGPG	Charger Power Ground Connection

Block Diagram



Detailed Description

System Faults

MAX77818 monitors the system for the following faults:

V_{SYS} undervoltage lockout

V_{SYS} overvoltage lockout

V_{SYS} Fault

The system monitors the V_{SYS} node for undervoltage and overvoltage. The following describes the IC behavior if any of these events is to occur.

V_{SYS} Undervoltage Lockout (VSYSUVLO)

When charger input is valid and SYS node falls below SYS UVLO, all charger and fuel gauge O type registers are reset and following happen:

when DEADBAT < SYS < UVLO (= 2.5V), QBAT is on and SYS is shorted to BAT.

when 0 < SYS < DEADBAT (= 2.0V), QBAT is off, but the charger pulls up SYS from BAT with a constant current of 50mA.

When charger input is invalid and battery is present:

when DEADBAT < SYS < UVLO (= 2.5V), QBAT is on and SYS is shorted to BAT.

when 0 < SYS < DEADBAT (= 2.0V), QBAT is off.

V_{SYS} Overvoltage Lockout (VSYSOVLO)

The absolute maximum ratings state that the SYS node withstands up to 6V. The SYS OVLO threshold is set to 5.36V (typ). Ideally, V_{SYS} should not exceed the battery charge termination threshold. Systems must be designed so that V_{SYS} never exceeds 4.8V (transient and steady-state). If the V_{SYS} should exceed $V_{SYSOVLO}$ during a fault, the MAX77818 resets the charger and fuel gauge O type registers.

INTB

The MAX77818 uses one interrupt pin: INTB. The interrupt is meant to indicate to the application processor that the status of MAX77818 has changed. The INTB signal is asserted whenever one or more interrupts are toggled, and those interrupts are not masked. The application processor reads the interrupts in two steps. First, the AP reads the INTSRC register. This is a read-only register that indicates which functional block is generating the interrupt (i.e., charger and FG). Depending on the result of the read, the next step is to read the actual interrupt registers pertaining to the functional block.

For example, if the application processor reads 0x02 from INTSRC register, it means the top-level MAX77818 block has an interrupt generated. The next step is to read the related interrupt register of the MAX77818 functional block.

The INTB pin becomes high (cleared) as soon as the read sequence of the last INT_ register that contains an active interrupt starts. FG interrupts are cleared by setting new threshold values. All interrupts can be masked to prevent the INTB from being asserted for masked interrupts. A mask bit in the INTM register implements masking. The INTSRC register can still provide the actual interrupt status of the masked interrupts, but the INTB pin is not asserted.

Safeout LDO

SAFEOUT1 is enabled by default once charger detection is complete and CHGIN is valid regardless of DETBATB. SAFEOUT2 can also be enabled once the same conditions are met, and the user sets the ENSAFEOUT2 register bit.

Switching Mode Charger

Features:

- Complete Li+/Li-poly battery charger
- Prequalification, constant current, constant voltage
- 55mA dead-battery prequalification
- 100mA low-battery prequalification current
- Adjustable constant current charge
  - 0A to 3.0A in 50mA steps
  - ±5% accuracy
- Adjustable charge termination threshold
  - 100mA to 200mA in 25mA steps and 200mA to 350mA in 50mA steps
  - ±5% accuracy
- Adjustable battery regulation voltage
  - 3.625V to 4.700V in 25mV steps
  - ±0.5% accuracy at T = +25°C
  - ±1% accuracy
  - Remote differential sensing
- Synchronous switch-mode design
- Reverse boost mode with adjustable V_{BYP} from 3.0V to 5.8V
- Smart Power Selector™
  - Optimally distributes power between charge adapter, system, and main battery
  - When powered by a charge adapter, the main battery can provide supplemental current to the system
  - The charge adapter and can support the system without a main battery
- No external MOSFETs required
- Dual input
  - Reverse leakage protection prevents the battery leaking current to the inputs
  - 4.0A adapter input
    - 16V withstand, 14V operating
    - Adjustable input current limit (100mA to 4.0A in 33.3mA steps (CHGIN_ILIM), 500mA default)
    - Support AC-to-DC wall warts and USB adapters
  - 1.26A wireless charger input
    - 6V fault tolerant
    - Adjustable input current limit (60mA to 1.26A in 20mA steps (WCIN_ILIM), 500mA default)

- Charge safety timer
  - Selectable: 4hr to 16hr in 2hr steps plus a disable setting
- Die temperature monitor with thermal foldback loop
  - Selectable die temperature thresholds (°C): 70, 85,100, and 115
- Input voltage dropout control allows operation from high-impedance sources. Charge current is reduced so input is not pulled below 4.3V.
- BATT to SYS switch is 12.8mΩ (typ).
- Dead battery detection
- Short-circuit protection
  - Programmable BAT to SYS overcurrent threshold from 3.0A to 4.5A in 0.25A steps plus a disable setting
  - DISIBS bit allows the host to disable the battery to system discharge path to protect against a short-circuit
  - SYS short to ground
    - BUCK current is limited by by the ILIM current limit. BATT currents above the programmed by B2SOVRC threshold generate an interrupt. The host can then disable the battery to system discharge path by setting DISIBS.

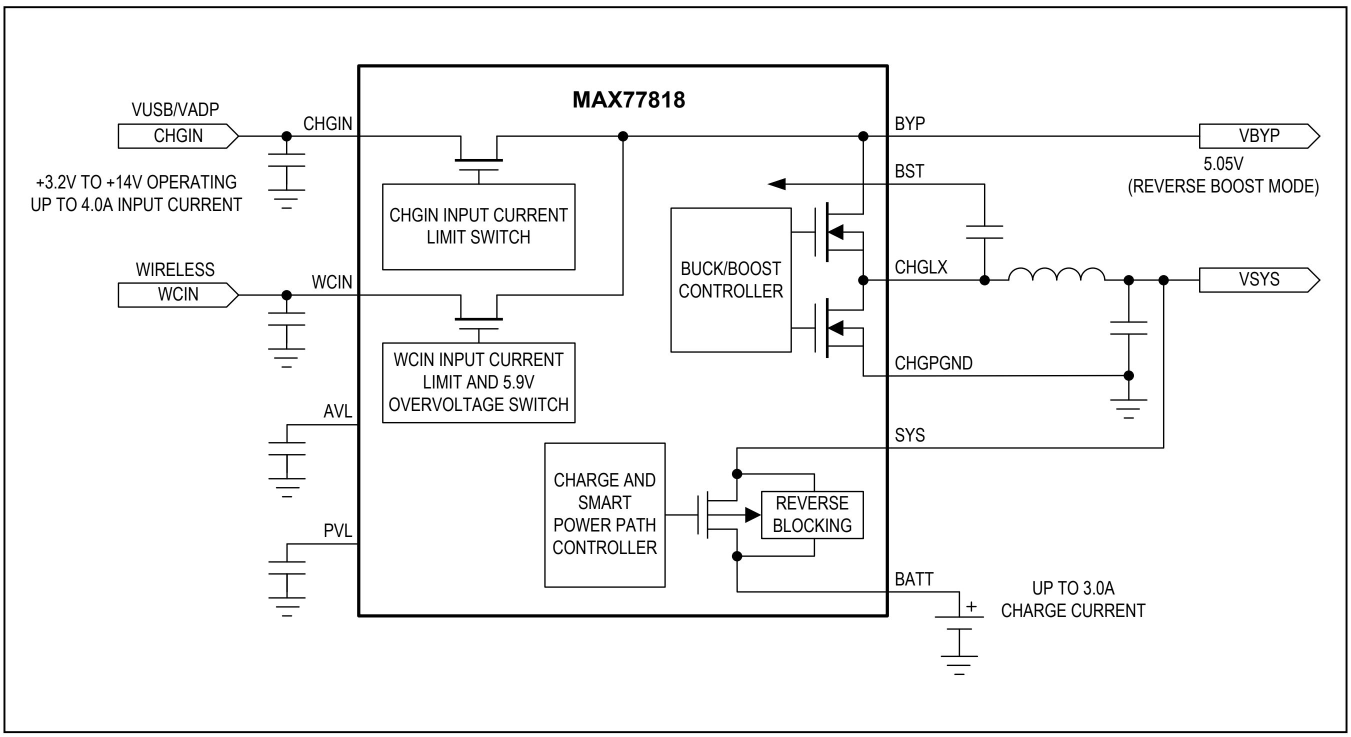


Figure 1. Simplified Charger Functional Diagram

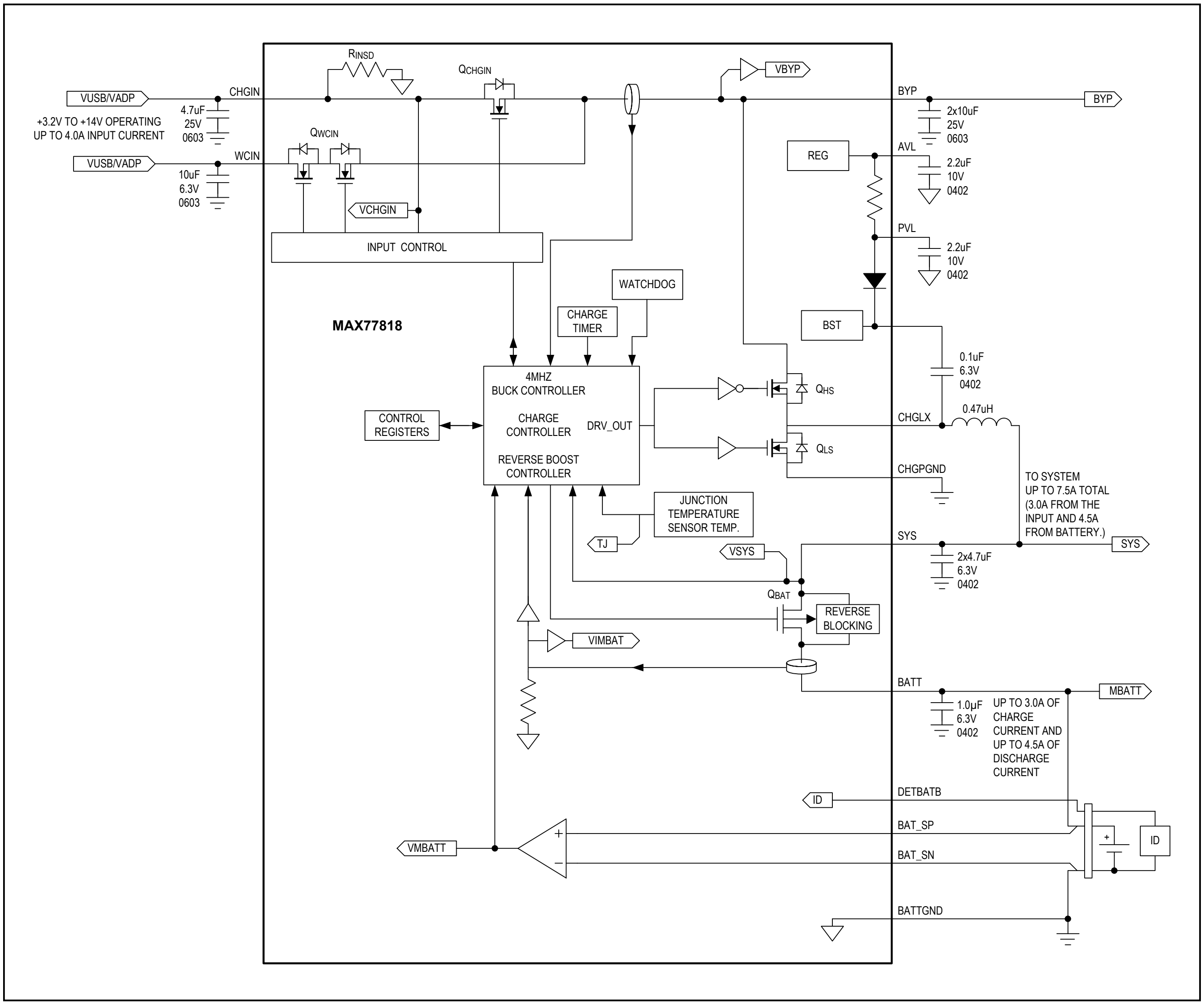


Figure 2. Main Battery Charger Detailed Functional Diagram

Detailed Description

The MAX77818 includes a full-featured switch-mode charger for a one-cell lithium ion (Li+) or lithium polymer (Li-poly) battery. As shown in Figure 2, the current limit for CHGIN input is independently programmable from 0 to 3.0A in 33.3mA steps allowing the flexibility for connection to either an AC-to-DC wall charger or a USB port. CHGIN current limit default is set between 100mA and 500mA with 500mA being the programmed default.

The synchronous switch-mode DC-DC converter utilizes a high 4.0MHz switching frequency which is ideal for portable devices because it allows the use of small components while eliminating excessive heat generation. The DC-DC has both a buck and a boost mode of operation. When charging the main battery the converter operation as a buck. The DC-DC buck operates from a 3.2V to 14V source and delivers up to 3.0A to the battery. Battery charge current is programmable from 0A to 3.0A. As a boost converter, the DC-DC uses energy from the main battery to boost the voltage at BYP. The boosted BYP voltage is useful to provide the supply the USB OTG voltage.

Maxim's Smart Power Selector architecture makes the best use of the limited adapter power and the battery's power at all times to supply up to 3.0A continuous (4A peak) from the buck to the system. Additionally, supplement mode provides additional current from the battery to the system up to $4.5A_{RMS}$. Adapter power that is not used for the system goes to charging the battery. All power switches for charging and switching the system load between battery and adapter power are included on chip. No external MOSFETs are required.

Maxim's proprietary process technology allows for low-R_{DSON} devices in a small solution size. The total dropout resistance from adapter power input to the battery is 0.0999Ω (typ) assuming that the inductor has 0.04Ω of ESR. This 0.0999Ω typical dropout resistance allows for charging a battery up to 3.0A from a 5V supply. The resistance from the BATT to SYS node is 0.0128Ω, allowing for low power dissipation and long battery life.

A multitude of safety features ensures reliable charging. Features include a charge timer, watchdog, junction thermal regulation, over/undervoltage protection, and short-circuit protection.

The BATT to SYS switch has overcurrent protection. See the *Main battery Overcurrent Protection* section for more information.

Smart Power Selector

The Smart Power Selector architecture is a network of internal switches and control loops that distributes energy between an external power source CHGIN, BYP, SYS, and BATT.

Figure 1 shows a simplified arrangement for the smart power selector's power steering switches. Figure 2 shows a more detailed arrangement of the smart power selector switches and gives them the following names: Q_{CHGIN}, Q_{HS}, Q_{LS}, and Q_{BAT}.

Switch and Control Loop Descriptions

Input Switch: Q_{CHGIN} provides the input current limit. The input switch is completely on and does not provide forward blocking. As shown in Figure 2, there are SPS control loops that monitor the current through the input switches as well as the input voltage.

DC-DC Switches: Q_{HS} and Q_{LS} are the DC-DC switches that can operate as a buck (step-down) or a boost (step-up). When operating as a buck, energy is moved from BYP to SYS. When operating as a boost, energy is moved from SYS to BYP. SPS control loops monitor the DC-DC switch current, the SYS voltage, and the BYP voltage.

Battery-to-System Switch: Q_{BAT} controls the battery charging and discharging. Additionally Q_{BAT} allows the battery to be isolated from the system (SYS). An SPS control loop monitors the Q_{BAT} current.

Control Bits

MODE configures the Smart Power Selector.

MINVSYS sets the minimum system voltage.

VBYPSET sets the BYP regulation voltage target.

B2SOVRC configures the main battery overcurrent protection.

Energy Distribution Priority:

With a valid external power source:

The external power source is the primary source of energy.

The main battery is the secondary source of energy.

Energy delivery to BYP is the highest priority.

Energy delivery to SYS is the second priority.

Any energy that is not required by BYP or SYS is available to the main battery charger.

With no power source available at CHGIN:

The main battery is the primary source of energy.

Energy delivery to BYP is the highest priority.

BYP includes the CHGIN if they are asked to supply energy in a USB OTG type of application.

Energy delivery to SYS is the second priority.

BYP Regulation Voltage

When the DC-DC is enabled in boost only mode (MODE = 0x08), the voltage from BYP to ground (V_{BYP}) is regulated to VBYPSET.

When the DC-DC is enabled in one of its USB OTG modes (MODE = 0x09 or MODE = 0x0A), V_{BYP} is set for 5.1V ($V_{BYP.ORG}$).

When the DC-DC is off or in one of its buck modes (MODE = 0x00 or MODE = 0x04 or MODE = 0x05) and there is a valid power source at CHGIN, $V_{BYP} = V_{CHGIN} - I_{CHGIN} \times R_{QCHGIN}$ When the DC-DC is off and there is no valid power source at CHGIN, BYP is connected to SYS with an internal 200Ω resistor. This 200Ω resistor keeps BYP biased as SYS and allows for the system to draw very light loads from BYP. IF the system loading on BYP is more than 1.0mA then the DC-DC should be operated in boost mode. Note that the inductor and the high-side switch's body diode are in parallel with the 200Ω from SYS to BYP.

SYS Regulation Voltage

When the DC-DC is enabled as a buck and the charger is disabled (MODE = 0x04), V_{SYS} is regulated to V_{BATREG} (CHG_CV_PRM) and Q_{BAT} is off.

When the DC-DC is enabled as a buck and the charger enabled but in a non-charging state such as done, watchdog suspend or timer fault (MODE = 0x05 and not charging), V_{SYS} is regulated to V_{BATREG} (CHG_CV_PRM) and Q_{BAT} is off.

When the DC-DC is enabled as a buck and charging in prequalification, fast-charge, or top-off modes (MODE = 0x05 and charging), V_{SYS} is regulated to V_{SYSMIN} when the $V_{BATT} < V_{SYSMIN}$; in this mode the Q_{BAT} switch acts like a linear regulator and dissipates power [$P = (V_{SYSMIN} - V_{BATT}) \times I_{BATT}$]. When $V_{BATT} > V_{SYSMIN}$, then $V_{SYS} = V_{BATT} - I_{BATT} \times R_{BAT2SYS}$; in this mode the Q_{BAT} switch is closed.

In all of the above modes, if the combined SYS and BYP loading exceed the input current limit, then V_{SYS} drops to $V_{BATT} - V_{BSREG}$ and the battery provides supplemental current. If the fuel gauge requests main battery information (voltage and current) during this supplement mode, then the Q_{BAT} switch is closed ($V_{SYS} = V_{BATT} - I_{BATT} \times R_{BAT2SYS}$) during the fuel gauge sample. If the fuel gauge wants requests continuous samples from the main battery during supplement mode, then the Q_{BAT} switch eventually opens when I_{BATT} decreases below 40mA.

When the DC-DC is enabled as a boost (MODE = 0x08 or 0x09 or 0x0A), then the QBAT switch is closed and $V_{SYS} = V_{BATT} - I_{BATT} \times R_{BAT2SYS}$

Battery Detect Input Pin (DETBATB)

DETBATB is tied to the ID pin of the battery pack. If DETBATB is pulled below 80% of V_{IO} pin voltage, this is an indication that the main battery is present and the battery charger starts upon valid CHGIN. If DETBATB is left unconnected or equal to V_{IO} voltage, this indicates that the battery is not present and the charger does not start upon valid CHGIN, see Figure 3. The DETBATB is internally pulled to BATT through an external resistor.

DETBATB status bit is valid when BATT is not present.

Input Validation

As shown in Figure 4, the charger input is compared with several voltage thresholds to determine if it is valid. A charger input must meet the following three characteristics to be valid:

CHGIN must be above V_{CHGIN_UVLO} to be valid.

CHGIN must be below its overvoltage lockout threshold (V_{OVLO}).

CHGIN must be above the system voltage by $V_{CHGIN2SYS}$.

CHGIN input generates a CHGIN_I interrupt when its status changes. The input status can be read with CHGIN_OK and CHGIN_DTLS. Interrupts can be masked with CHGIN_M.

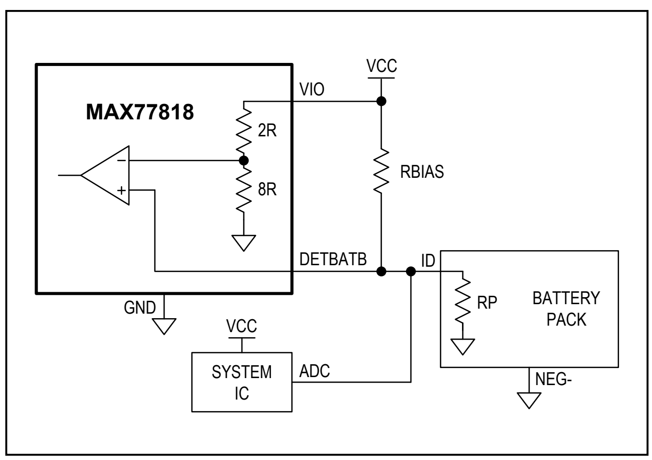


Figure 3. DETBATB Internal Circuitry and System Diagram