JW3655 JW3655-1

High Efficiency, 3A, Multi-Cells Li-Ion Battery Charger

Parameters Subject to Change Without Notice

DESCRIPTION

The JW®3655 is a buck boost converter targets HVDC fast charging system.

The JW3655 support 1 to 3 cells Li-ion battery, the full charge voltage and charge current can be programmable through external resistor.

The JW3655 implements the Buck Boost converter with an H-bridge. The integrated low Rds(on) MOSFET minimizes physical footprint, maximizes charge efficiency. Built-in loop compensation simplifies the circuit and design. PFM is engaged to maintain high efficiency at light load current.

JW3655 guarantees robustness with thermal protection and battery under voltage lockout.

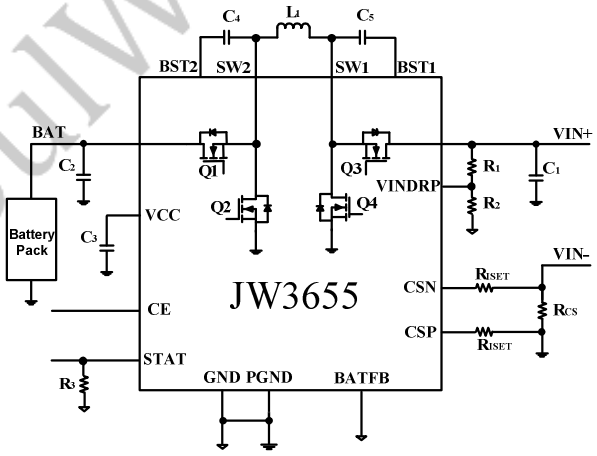
FEATURES

- Integrate low R_{DS} (on) power MOSFET
- Wide input range: 3.0V-16.0V, Support 1 to 3 cells battery charge.
- Full charge voltage: 1.2V-16.0V through external resistor or selectable by BATFB pin. JW3655 (4.2V/cell)/JW3655-1 (4.35V/cell)
- High efficiency buck-boost transition
- 500kHz Switching frequency
- Programmable charge current, up to 3A
- Output Constant Current Control.
- Quiescent current: <60uA
- Integrate output overvoltage protection and output short protection
- Integrate thermal protection
- QFN3*4 package

APPLICATIONS

- Power bank systems
- Battery and Super capacitor Charging
- USB Power Delivery
- Industrial applications
- Automotive Systems

TYPICAL APPLICATION



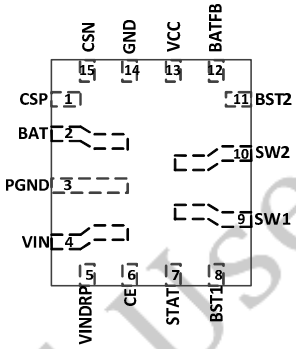
ORDER INFORMATION

LEAD FREE FINISH	TAPE AND REEL	PACKAGE	TOP MARKING
JW3655QFNE#PBF	JW3655QFNE#TRPBF	QFN3X4-15	JW3655
JW3655-1QFNE#PBF	JW3655-1QFNE#TRPBF	QFN3X4-15	JW3655-1

Note：

PIN CONFIGURATION

TOP VIEW



ABSOLUTE MAXIMUM RATING[1)]

VIN ,BAT, SW1, SW2 Pin .....-0.3V to20V
BST1-SW1, BST2-SW2 .....-0.3V to 6.5V
All Other Pins .....-0.3V to 6.5V
JunctionTemperature[2)3)] 150ºC
Lead Temperature 260ºC
Storage Temperature ..... -65ºC to +150ºC
ESD Susceptibility (Human Body Model) 2kV

RECOMMENDED OPERATING CONDITIONS

Output Voltage VIN .....1.2V to 16V
Battery Voltage VBAT .....3.0V to 16V
Operation Junction Temp (T_J) .....-40ºC to +125ºC

THERMAL PERFORMANCE[4)]

	θ_{JA}	θ_{JC}
QFN3X4-15	48	11ºC/W

Note：

1) Exceeding these ratings may damage the device.

2) The JW3655 guarantees robust performance from -40°Cto 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.

3) The JW3655 includes thermal protection that is intended to protect the device in overload conditions. Thermal protection is active when junction temperature exceeds the maximum operating junction temperature. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARATERISTICS

VIN=12V, TA=25℃, unless otherwise stated

Item	Symbol	Condition	Min.	Typ.	Max.	Units
Power supply						
VBAT voltage range	V_{BAT}		3.0		16	V
VCC UVLO voltage	V_{CCUVLO}	VIN =0V	1.8	2.1	2.4	V
BST UVLO voltage	$V_{BSTUVLO}$		2.3	2.4	2.5	V
VCC output voltage	V_{CC}			4.8		V
VCC output current limit	I_{VCC}	VCC>2.7V		80		mA
		VCC<2.7V		20		mA
Supply current in shut-down mode	I_Q	V_{BAT}=8V, EN=0V		50	60	μA
Controller						
Switch frequency	F_{sw}		450	500	550	kHz
Switch minimum off time	T_{off_min}		80	100	120	ns
CE Logic HIGH	V_{ENH}	V_{BAT}=8V	1.5			V
CE Logic LOW	V_{ENL}	V_{BAT}=8V			0.4	V
Bucktop switch on-resistance	R_{dsbkTG}			20		mΩ
Buck bottom switchon-resistance	R_{dsbkBG}			20		mΩ
Boost top switch on-resistance	$R_{dsbstTG}$			20		mΩ
Boost bottom switch on-resistance	$R_{dsbstBG}$			20		mΩ
Charge						
Floating BAT Voltage	V_{CV}	V_{BATFB} =GND, JW3655	8.34	8.4	8.46	V
		V_{BATFB} =GND, JW3655-1	8.64	8.7	8.76	V
		V_{BATFB} = VCC, JW3655	12.51	12.6	12.69	V
		V_{BATFB} = VCC, JW3655-1	12.96	13.05	13.14	V
		Set by divider resistor	3.0	-	16	V
BAT feedback voltage	V_{BATFB}	External resistor divider	1.192	1.2	1.208	V
BAT Recharge threshold	V_{REC}	V_{BATFB} = GND		8.0		V
		V_{BATFB} = VCC		12.0		V
BAT recharge feedback threshold	V_{RECFB}	JW3655		1.143		V
		JW3655-1		1.103		V
CC mode charge current	I_{CC}	R_{CS}=10 mΩ, R_{ISET}=2K	1.8	2	2.2	A
Charge termination current	I_{TER}			5%		I_{CC}
Battery current sensing ratio	K_{RATIO}			10		uA/A
Trickle mode charge current	I_{TRI}			10%		I_{CC}
Trickle mode battery threshold	V_{TRI}	Referred to one battery		3.0V		

		cell		/cell		
Trickle mode feedback threshold	V_{TRIFB}	JW3655		0.857		V
		JW3655-1		0.828		V
Trickle charge time-out duration	T_{TRI}			55		min
VIN UVP threshold	V_{IN_UVP}	rising		4.1		V
		falling		3.85		V
VIN healthy deglitch time	$t_{Healthy}$			150		mS
Charge current increase step	I_{STEP1}			100		mA
Charge current increase period	t_{STEP1}			25		mS
VIN droop voltage to foldback charge current	V_{DRP}			R1*4μA		V
Charge current limit decline step	I_{STEP2}			100		mA
Charge current limit decline period	t_{STEP2}			2.5		S
Buck exit time	t_{buck_exit}			2		S
Maximum current sense threshold	$I_{COMP(MAX)}$			8		A
Protection						
VIN OVP threshold	VIN _OVP	rising		23.2		V
		falling		21.5		V
VIN OVP deglitch time	t_{BUS_OVP}			2		μS
Thermal shutdown threshold[5)]	T_{SHUT}			150		°C
Thermal recovery threshold[5)]	T_{REC}			130		°C

Notes:

5) Guaranteed by design.

PIN DESCRIPTION

Pin No.	Name	Description
1	CSP	Positive terminal of battery charge current sense.
2	BAT	Battery positive terminal.
3	PGND	Power Ground.
4	VIN	In charge mode, main supply pin, connect to adaptor. In discharge mode, output voltage sense pin, connect this pin to Vout.
5	VINDRP	In charge mode, VIN droop allowance program pin. In discharge mode, Output feedback pin.
6	CE	Charge enable pin, a logic High on this pin indicates charge enable.
7	STAT	When charge enabled, this pin mirrors the charge current at 10uA/A. a Low to High transition on this pin indicates charge full.
8	BST1	VIN side bootstrap supply pin for top switch. 0.1uF capacitor is connected between BST1 and SW1 pins.
9	SW1	VIN side power switching node. connect to SW2 with inductor
10	SW2	BAT side power switching node.
11	BST2	BAT side bootstrap supply pin for top switch. 0.1uF capacitor is connected between BST2 and SW2 pins.
12	BATFB	Battery float voltage configuration pin. 1. This pin tied to GND or VCC, sets different float voltage. Pin short to GND: 8.4V/8.7V. Pin shorts to LDO:12.6V/13.05V. 2. And the float voltage could be set to any value (3.0V-16.0V) by the external divider resistor.
13	VCC	4.8V LDO for power driver and internal circuit. Must be bypassed to GND with a minimum of 10uF ceramic capacitor for stable operation.
14	GND	Signal GND.
15	CSN	Negative terminal of battery charge current sense.

Notes:

Highlighted pins are high current pins.

FUNCTIONAL DESCRIPTION

JW3655 is a monolithic buck-boost charger that can operate over a wide input voltage range of 3.0V to 16V. The full charge voltage and charge current can be programmable through external resistor. Low R_{DSON} N-channel power switches reduce the solution complexity and improve efficiency.

The DC-DC converter utilizes proprietary single inductor current-mode control to guarantee smooth transition between buck and boost operation with better dynamic response and cycle-by-cycle current protection.

Compensation is done internally on the chip. The JW3655 operates in PFM mode at light load. In PFM mode, switching frequency is continuously controlled in proportion to the load current, i.e. switch frequency is decreased when load current drops to boost power efficiency at light load by reducing switching-loss, minimizing the circuit.

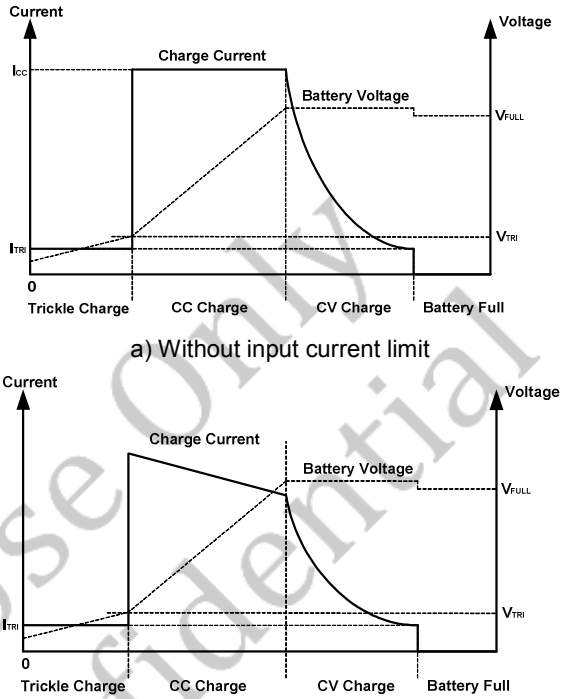
The JW3655 can operate in charge mode if a logic High is on CE pin. In charge mode, if the VIN voltage is lower than battery voltage，it is a buck converter. When the VIN voltage is larger than battery voltage, it is a boost converter.

VCC UVLO

If the VCC voltage is lower than VCC UVLO voltage, the switch is turned off.

Charge mode

In charge mode, JW3655 regulates the battery current according to input voltage and battery voltage. It charges battery with three phases: trickle charge, constant current charge, constant voltage charge and charge termination. Figure 7(a) is a typical charge profile. Figure 7(b) is a charge profile with input current limit. When the input current is limited, the system decreases the charge current.



a) Without input current limit

b) With input current limit

Figure 3 Typical Charge Profile

Trickle charge

The JW3655 charges the battery with I_{TRI} when battery voltage is less than V_{TRI}. If charging remains in TC mode beyond the trickle-charge time T_{TRI}, charging terminates.

CC charge

When the battery is higher than V_{TRI}, the device charges the battery with I_{CC} if the input current is sufficient. When input current limit is hit, the device reduces the charge current automatically. The JW3655 can set the charge current through R_{ISET}. The maximum charge current is up to 3A.

$$I_{CC}(A) = \frac{10(A) R_{ISET}(K\Omega)}{R_{CS}(m\Omega)} \quad (1)$$

CV charge

When battery voltage equals to V_{CV}, the device regulates the battery voltage and reduces the charge current reduces automatically.

The customer can select 2 or 3 cells or program the V_{CV} through BATFB pin. Connect BATFB to GND selects 2 cells. Connect BATFB to VCC

selects 3 cells. The V_{CV} also can be programmable by resistor divider connected to BATFB when the JW3655 detect a resistor connect to this pin. We recommend the 1‰ accuracy resistor should be used in order to achieve the accuracy of full charge voltage.

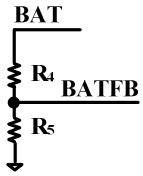


Figure 4 Full Charge Voltage Configure

$$V_{CV}(V) = \frac{1.2\,V \times (R_4 + R_5)}{R_5} \quad (2)$$

Charge termination

If the battery voltage is higher than V_{FULL}, and the charge current is less than charge termination current I_{TER} for T_{FULL}, the charge process terminates, the STAT pin is pulled high.

Auto recharge

Once the battery charge cycle completes, the charger remains off. A new charge cycle automatically begins when the battery voltage falls below the auto-recharge threshold V_{REC} if the input adaptor is present. The idle mode to charge mode transition also restarts the charge cycle.

Battery current sensing

In charge mode, the charge current is monitored continuously. The JW3655 senses the battery current and output through STAT pin, the current sensing ratio is 10uA/A.

Dynamic input Current Tracking Scheme

After the CE pin is pulled high, the device detects the VIN pin, if the VIN pin voltage is higher than V_{IN_UVP} rising threshold for 150ms, the JW3655 starts charging with a limited charging current, in the meanwhile, the adaptor voltage is detected and stored as initial input voltage. The initial voltage detection circuit is as figure 5. We recommend the ratio of R1/R2 is 3.7 in order to detect the initial input voltage.

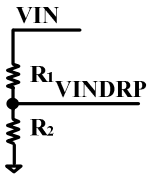


Figure 5 VIN Drop Voltage Configure

Then the JW3655 increases charge current step by step, during this process, VIN is continuously monitored. As long as VIN drops preset level (ΔV_{DRP}) below VIN initial voltage, the system step by step lower the input current limit to bring back VIN 100mV higher to maintain a healthy adaptor output. After that the new input current limit is locked up unless the adaptor is plugged out. This is proprietary dynamic input current tracking scheme.

$$\Delta V_{DRP} = R_1 \times 4uA \quad (3)$$

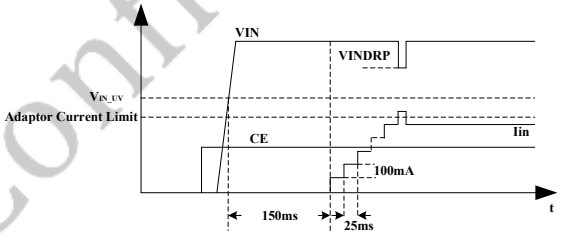


Figure 6 Dynamic input Current Tracking

Thermal Control

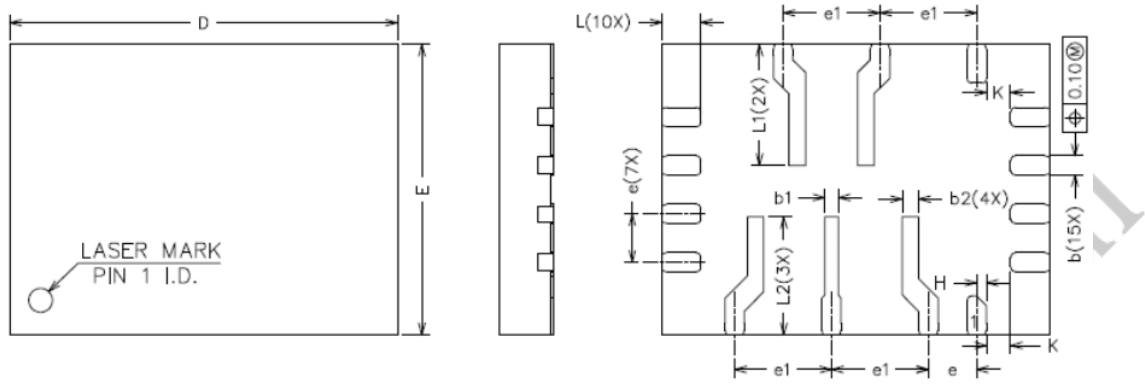
When the junction temperature of the JW3655 rises above 135°C, it begins to reduce the output power to prevent the temperature from rising further. If the junction temperature of the JW3655 rises above 150°C, the discharging process stops.

Shut-down Mode

The JW3655 shuts down when voltage at CE pin is below 0.4V. The entire regulator is off.

PACKAGE OUTLINE

QFN3X4-15 **unit: mm**



TOP VIEW SIDE VIEW BOTTOM VIEW

SIDE VIEW

SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0.00	0.02	0.05
A3		0.15REF	
b	0.15	0.20	0.25
b1	0.09	0.14	0.19
b2	0.12	0.17	0.22
D	3.90	4.00	4.10
E	2.90	3.00	3.10
e	0.40	0.50	0.60
e1	0.90	1.00	1.10
H		0.10REF	
K	0.15	0.25	0.35
L	0.30	0.40	0.50
L1	1.15	1.25	1.35
L2	1.12	1.22	1.32

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