# JW7951C

## 15W High Efficiency Full-Bridge Power Stage for Wireless Charger Transmitter

*Parameters Subject to Change Without Notice*

## DESCRIPTION

The JW®7951C is a high efficiency full-bridge power stage (integrated MOS plus driver) designed for wireless charger transmitter. With a transmitter controller, it can provide flexible wireless charger solutions compliant with WPC v1.2.3 Baseline Power Profile and Extended Power Profile.

The integrated low $R_{DSON}$ power MOSFETs maximizes the system efficiency with better heat performance.

The JW7951C also provides input current sense function. The chip measures the input current with the current sampling resistor and reports it on the ISENSE pin, so that the total current can be read by the controller to realize the FOD (Foreign Object Detection) and in-band communication.

The JW7951C guarantees robustness with input over-current protection, thermal shutdown and under voltage lockout.

*Company's Logo is Protected, "JW" and "JOULWATT" are Registered Trademarks of JoulWatt technology Inc.*
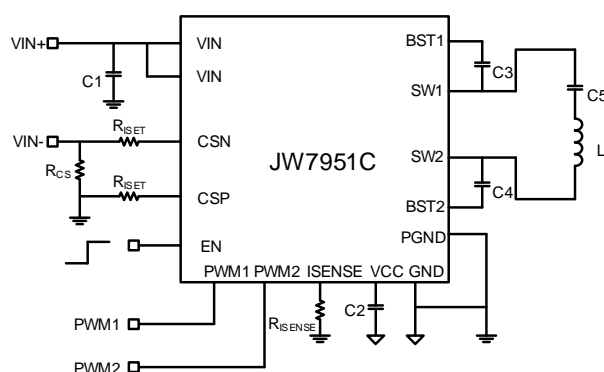
## FEATURES

- 4.0V to 20V wide input voltage range.
- Output power: 15W
- Integrate low $R_{DSON}$ switch power MOS.
- Independent two PWM control for flexible transmitter design.
- Integrate input current sense and programmable current sense ratio.
- Support all wireless charger switch frequency.
- High efficiency over full load range.
- Over-current protection
- Thermal shutdown.
- Package: QFN3x4-15 and ETSSOP20

## APPLICATIONS

- Wireless Charger Transmitter
- Motor Drivers

## TYPICAL APPLICATION



**Typical application circuit**

JW7951C Rev.0.2

JoulWatt® Proprietary Information. Patent Protected.
Unauthorized Photocopy and Duplication Prohibited.

**1**

## ORDER INFORMATION

| DEVICE[1] | PACKAGE | TOP MARKING[2] |
|---|---|---|
| JW7951CQFNE#TRPBF | QFN3×4-15 | JW7951C <br> YW☐☐☐☐☐ |
| JW7951CETSSOP#TRPBF | ETSSOP20 | JW7951C <br> YW☐☐☐☐☐ |

**Notes：**

1) JW☐☐ ☐☐ # TRPBF
   - PB Free
   - Tape and Reel(If"TR" is not shown, it means tube)
   - Package Code
   - Part No.

2) Line1: JW ☐☐☐☐☐
   - Product code
   - Joulwatt LOGO

   Line2: YW☐☐☐☐☐
   - Lot number
   - Week code
   - Year code
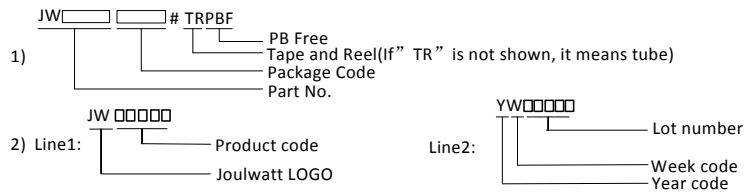
## PIN CONFIGURATION

**TOP VIEW**

ETSSOP20

VCC 1
ISENSE 2
BST2 3
SW2 4
SW2 5
PGND 6
SW1 7
SW1 8
BST1 9
EN 10

GND

20 GND
19 CSN
18 CSP
17 VIN
16 VIN
15 PGND
14 VIN
13 VIN
12 PWM1
11 PWM2

QFN3x4-15

CSN 15
GND 14
VCC 13
ISENSE 12

CSP 1
VIN 2
PGND 3
VIN 4

11 BST2
10 SW2
9 SW1

PWM1 5
PWM2 6
EN 7
BST1 8
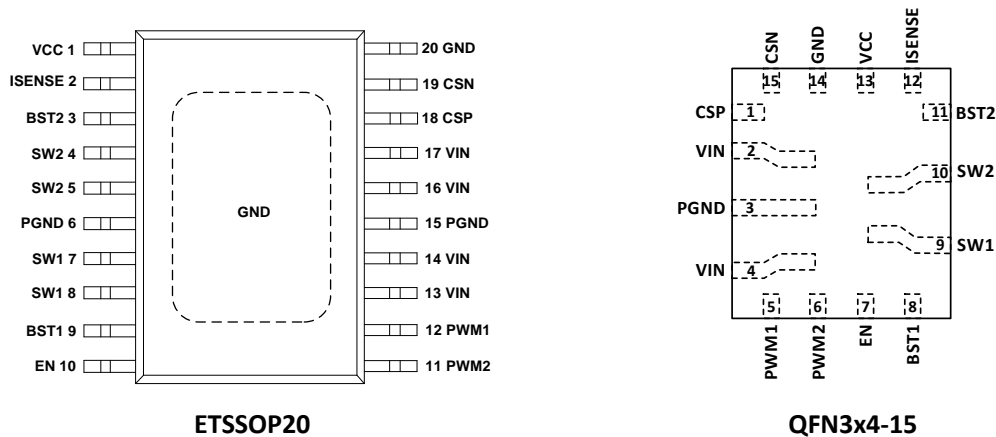
## ABSOLUTE MAXIMUM RATING[1]

VIN, SW, EN ................................................................................................................-0.3V to 29V

PWM1, PWM2………………………………………………………………………..-0.3 to 9V

BST1-SW2, BST2-SW2 ......………........................................................................-0.3V to 4V

All Other Pins ...............................................................................................................-0.3V to 4V

JunctionTemperature[2][3] ...............................................................................................150ºC

Lead Temperature ........................................................................................................260ºC

Storage Temperature ............................................................................... -65ºC to +150ºC

JW7951C Rev.0.2       JoulWatt® Proprietary Information. Patent Protected.       **2**

Unauthorized Photocopy and Duplication Prohibited.

## RECOMMENDED OPERATING CONDITIONS

VIN ............................................................................................................................4.0V to 20V

PWM1, PWM2, EN ....................................................................................................2.0V to 5V

Operation Junction Temp ($T_J$) …...............................................................................-40ºC to +125ºC

## THERMAL PERFORMANCE[4)]                                    $\theta_{JA}$      $\theta_{JC}$

QFN3X4-15..........................................................................................................48…11ºC/W

ETSSOP20...........................................................................................................34…20ºC/W

**Note：**

1) Exceeding these ratings may damage the device.

2) The JW7951C guarantees robust performance from -40°C to 150°C junction temperature. The junction temperature range specification is assured by design, characterization and correlation with statistical process controls.

3) The JW7951C 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.

JW7951C Rev.0.2          JoulWatt® Proprietary Information. Patent Protected.          **3**

Unauthorized Photocopy and Duplication Prohibited.

# ELECTRICAL CHARACTERISTICS

| *VIN=5V, TA=25℃, unless otherwise stated* | | | | | | |
|---|---|---|---|---|---|---|
| **Item** | **Symbol** | **Condition** | **Min.** | **Typ.** | **Max.** | **Units** |
| *Power Supply* | | | | | | |
| VIN Voltage Range | $V_{IN}$ | | 4 | | 20 | V |
| VIN UVLO threshold | $V_{IN\_UVLO}$ | VIN rising | 3.55 | 3.7 | 3.85 | V |
| | | VIN falling | 3.25 | 3.4 | 3.55 | V |
| VCC output voltage | $V_{CC}$ | EN=3.3V 0mA load | 3.1 | 3.3 | 3.4 | V |
| | | EN=3.3V 50mA load | 3.0 | 3.2 | 3.35 | V |
| VCC output current limit | $I_{VCC}$ | $V_{IN}$=8V, $V_{CC}$>2.7V | | 50 | | mA |
| Supply current in shut-down mode | $I_Q$ | $V_{IN}$=5V, EN=0V | | 37 | 50 | µA |
| *Interface* | | | | | | |
| PWM1, PWM2 logic high threshold | $V_{PWMH}$ | Input rising | | | 2.0 | V |
| PWM1, PWM2 logic low threshold | $V_{PWML}$ | Input falling | 0.8 | | | V |
| EN logic high threshold | $V_{ENH}$ | $V_{EN}$ rising | | | 2.0 | V |
| EN logic low threshold | $V_{ENL}$ | $V_{EN}$ falling | 0.8 | | | V |
| *Current Sense* | | | | | | |
| ISENSE current sense ratio | CS_gain | $R_{CS}$=10mΩ, $R_{ISET}$=2k, $R_{ISENSE}$=10kΩ, $I_{IN}$=1A, | | 24 | | uA/A |
| ISENSE current sense offset | CS_offset | $R_{CS}$=10mΩ, $R_{ISET}$=2k, $R_{ISENSE}$=10kΩ, $I_{IN}$=1A, | -2 | | 2 | uA |
| *Power MOS* | | | | | | |
| *ETSSOP* | | | | | | |
| Top switch on-resistance[5] | $R_{dsbkTG}$ | | | 40 | | mΩ |
| Bottom switch on-resistance[5] | $R_{dsbkBG}$ | | | 40 | | mΩ |
| *QFN* | | | | | | |
| Top switch on-resistance[5] | $R_{dsbkTG}$ | | | 20 | | mΩ |
| Bottom switch on-resistance[5] | $R_{dsbkBG}$ | | | 20 | | mΩ |
| Switch minimum off time[5] | $T_{off\_min}$ | | | 100 | | ns |
| Switch minimum on time[5] | $T_{on\_min}$ | | | 100 | | ns |
| *Protection* | | | | | | |
| Input over-current threshold[5] | $I_{OCP}$ | | | 9 | | A |
| Thermal shutdown threshold[5] | $T_{SHUT}$ | | | 150 | | °C |
| Thermal recovery threshold[5] | $T_{REC}$ | | | 130 | | °C |

**Notes:**

5) Guaranteed by design.

JW7951C Rev.0.2          JoulWatt® Proprietary Information. Patent Protected.          **4**

Unauthorized Photocopy and Duplication Prohibited.

## PIN DESCRIPTION

| Pin No. | Name | Description |
|---------|------|-------------|
| 1 | CSP | Positive terminal of input current sense. |
| 2, 4 | VIN | Power supply input. |
| 3 | PGND | Power Ground. |
| 5 | PWM1 | PWM input for the control of the arm at SW1 side. When PWM1 is high, the top switch Q1 is turned on and the bottom switch Q2 is turned off. When PWM1 is low, the top switch Q1 is turned off and the bottom switch Q2 is turned on. |
| 6 | PWM2 | PWM input for the control of the arm at SW2 side. When PWM2 is high, the top switch Q4 is turned on and the bottom switch Q3 is turned off. When PWM2 is low, the top switch Q4 is turned off and the bottom switch Q3 is turned on. |
| 7 | EN | Chip enable pin. Active High to enable the chip. When EN is low, the chip is disabled, and both SW1 and SW2 are High-Z. |
| 8 | BST1 | Bootstrapped supplies to the high side floating driver of Q1. An 0.1μF ceramic capacitor is suggested to be connected between this pin and SW1 pin. |
| 9 | SW1 | Power switching node 1. |
| 10 | SW2 | Power switching node 2. |
| 11 | BST2 | Bootstrapped supplies to the high side floating driver of Q4. An 0.1μF ceramic capacitor is suggested to be connected between this pin and SW2 pin. |
| 12 | ISENSE | Input current sense output pin. Connect a resistor from this pin to GND. |
| 13 | VCC | 3.3V LDO for power driver and internal circuit. Must be bypassed to GND with a minimum of 4.7μF ceramic capacitor for stable operation. |
| 14 | GND | Signal GND. |
| 15 | CSN | Negative terminal of input current sense. |

JW7951C Rev.0.2                JoulWatt® Proprietary Information. Patent Protected.                **5**

Unauthorized Photocopy and Duplication Prohibited.

## BLOCK DIAGRAM

**6**

JW7951C Rev.0.2     JoulWatt® Proprietary Information. Patent Protected.     **6**

Unauthorized Photocopy and Duplication Prohibited.
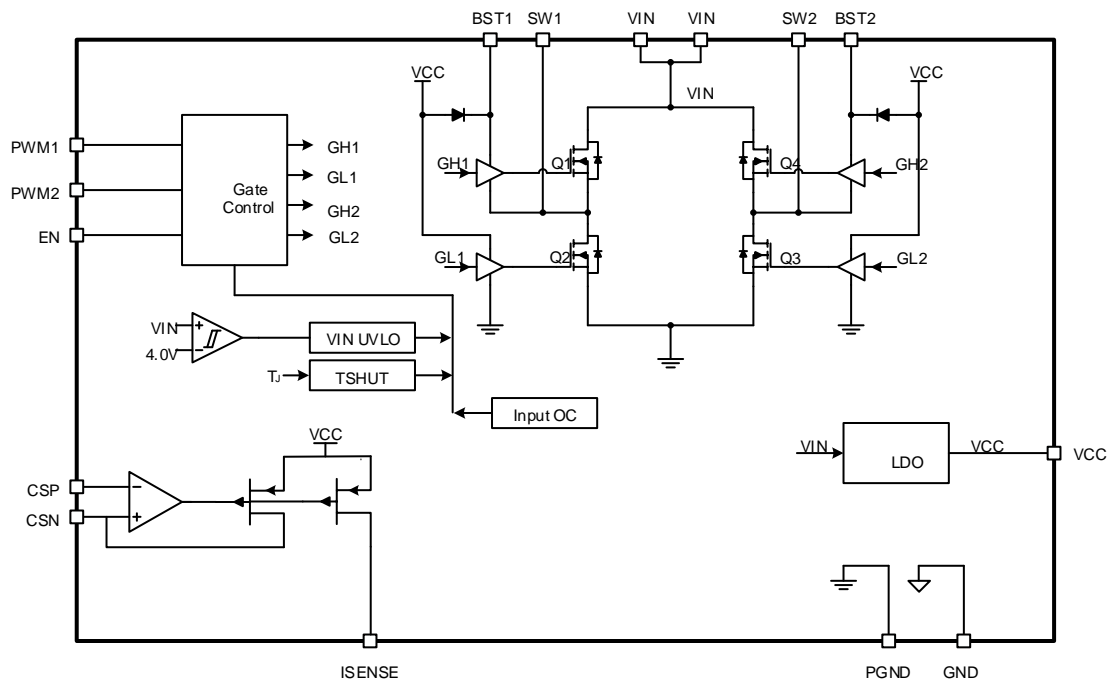
## FUNCTIONAL DESCRIPTION

JW7951C is a high-efficiency full-bridge power stage (integrated MOS plus driver) for wireless charger transmitter. With a transmitter controller, it can provide flexible wireless transmitter solutions, compliant with WPC v1.2.3 Baseline Power Profile and Extended Power Profile.

### Integrated Full-Bridge Stage

The JW7951C integrates a full-bridge power stage with low $R_{DSON}$ N-channel MOSFETs and can work with wide input voltage ranging from 4.0V to 20V. All circuits needed to drive the full-bridge stage are integrated, such as gate drivers and bootstrap circuits. With the PWM control signals from the controller, it can be widely used in wireless transmitter applications.

### PWM Control

The JW7951C has two PWM input pins, PWM1 and PWM2. Each input signal can control one arm of the integrated full-bridge independently. The PWM1 input controls the arm of Q1 and Q2, and the PWM2 input controls the arm of Q3 and Q4.

When the input PWM signal is high, the top switch of the corresponding arm is turned on, and the bottom switch of this arm is turned off. When the input PWM signal is low, the bottom switch of the corresponding arm is turned on, and the top switch is turned off. For example, when PWM1 is high, the Q1 is turned on and Q2 is turned off. When PWM1 is low the Q1 is turned off and Q2 is turned on.

For a typical WPC transmitter, the PWM1 and PWM2 are complementary and the duty cycle is fixed in 50% with the frequency range from 100kHz to 205kHz. When the frequency reaches 205kHz, the output power can be limited furtherly by reducing the duty cycle of PWM1 and PWM2.

### Current Sense

The JW7951C provides input current sense function. The total input current is measured by the current sensing resistor and reported on ISENSE pin.

As seen in the figure 1, the current ISENSE pin outputs can be calculated by the formula below.

$$I_{ISENSE}(\mu A) = R_{CS}(m\Omega) / R_{ISET}(k\Omega) \times 5 \times I_{IN}(A)$$
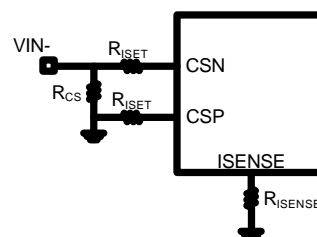


**Figure 1. Current sensing configuration**

Where $R_{CS}$ and $R_{ISET}$ are the resistors in figure 1, $I_{IN}$ is the input current.

If the resistance from ISENSE pin to GND is $R_{ISENSE}$, the voltage on ISENSE pin can be achieved by the expression below.

$$V_{ISENSE}(mV) = I_{ISENSE}(\mu A) \times R_{ISENSE}(k\Omega)$$

### Protection

The JW7951C guarantees robustness with input over-current protection, thermal shutdown and under voltage lockout.

#### Input Over-Current Protection

The JW7951C measures the inductor peak current by top switches. And the over-current protection threshold is constant 9A.

When the inductor peak current exceeds the input over current threshold, the device turns off the top switches and turns on the bottom switches regardless of the status of PWM1 and PWM2 to protect the chip from damage. When the over current event happens 4 times, IC will

JW7951C Rev.0.2    JoulWatt® Proprietary Information. Patent Protected.    **7**

Unauthorized Photocopy and Duplication Prohibited.

enter hiccup mode.

### Under-Voltage Lockout

When the input voltage falls below the $V_{IN\_UVLO}$ falling threshold, the device stops switching. When the input voltage rises above the $V_{IN\_UVLO}$ rising threshold, the device resumes working, if EN is still high.

### Thermal Shutdown

When the junction temperature of the JW7951C rises above 150°C, the device enters shut down mode. When the temperature of JW7951C drops below 130°C, the JW7951C can be resumed.

## Current Sensing Offset Correction

For minimizing current sensing error, zero calibration can be made by external MCU as reference in figure 2. VIN- is the voltage of input power source negative pole. VCC is the voltage on VCC pin of the JW7951C.
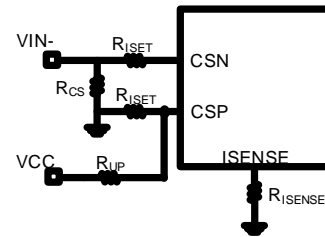


**Figure 2. Current sensing offset correction**

MCU's ADC reads $V_{ISENSE0}$ when JW7951C works without loading. The value of $R_{UP}$ and $R_{ISET}$ are advised to satisfy the below expression.

$$\frac{R_{ISET}}{R_{UP}+R_{ISET}} \times VCC \geq 5mV$$

JW7951C Rev.0.2     JoulWatt® Proprietary Information. Patent Protected.     **8**

Unauthorized Photocopy and Duplication Prohibited.

## PACKAGE OUTLINE

QFN3X4-15 | UNIT: mm

| | MIN | NOM | MAX |
|---|---|---|---|
| A | 0.50 | 0.55 | 0.60 |
| A1 | 0.00 | 0.02 | 0.05 |
| c | | 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 |

TOP VIEW

BOTTOM VIEW

LASER MARK
PIN 1 I.D.

SIDE VIEW

ETSSOP-20                                                        UNIT: mm
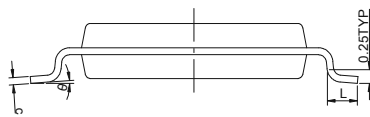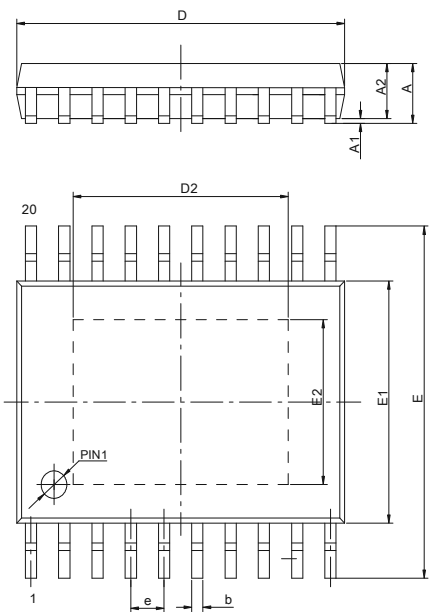
| Symbol | MILLIMETER | | |
|--------|-----|-----|-----|
|        | MIN | NOM | MAX |
| A      | —   | —   | 1.10 |
| A1     | 0.02 | —  | 0.15 |
| A2     | 0.80 | 0.90 | 1.00 |
| b      | 0.19 | —  | 0.30 |
| c      | 0.09 | —  | 0.20 |
| D      | 6.40 | 6.50 | 6.60 |
| D2     | 4.10 | 4.20 | 4.30 |
| E      | 6.25 | 6.40 | 6.55 |
| E1     | 4.30 | 4.40 | 4.50 |
| E2     | 2.90 | 3.00 | 3.10 |
| e      | 0.65(BSC) | | |
| L      | 0.50 | —  | 0.70 |
| θ      | 0 ° | —  | 8 ° |

JW7951C Rev.0.2            JoulWatt® Proprietary Information. Patent Protected.              10

Unauthorized Photocopy and Duplication Prohibited.

## IMPORTANT NOTICE

- **Joulwatt Technology Inc. reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein.**

- **Any unauthorized redistribution or copy of this document for any purpose is strictly forbidden.**

- **Joulwatt Technology Inc. does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.**

JW7951C Rev.0.2       JoulWatt® Proprietary Information. Patent Protected.       **11**

Unauthorized Photocopy and Duplication Prohibited.