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E-Cigarette Reference Software Guidance for LC709301F

3.5 W Solution

Overview

LC709301F is a Lithium ion switching charge/discharge controller for 1−Cell Li−Ion Battery (LiB). This guidance describes about reference software of LC709301F for E−Cigarette application. This device has mainly functions for E−Cigarette including battery charge, hearting and LED indicating. Our solution provides the following values.

Features

- Advanced Safety
- Heating High Accuracy
- System Flexibility

Characteristic

- 3.0 W to 4.0 W Heating Solution
- Real Time Feedback Heating with Monitoring Voltage and Current of Heater
- Multiple Safety Using Controller (LC709301F) and LiB Protection IC
- Low Power Consumption at Standby

Applications

- E−Cigarette
- Charging/Discharging Application used Li−Ion Battery

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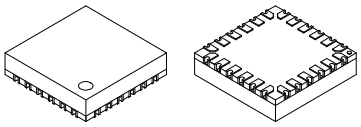
APPLICATION NOTE



VCT24 3.5x3.5, 0.5P
CASE 601AD

SOFTWARE SPEC. E−CIGARETTE BASE PROGRAM

Table 1.

Characteristic	Description
MCU	LC709301F @ Internal 8 MHz
Developer	ON Semiconductor
Circuit	See page 3
Development Environment	Tasking C Compiler Ver.dlc87 3.2.r2 TCB87−Type C (On Chip Debugger)
Document	Main Flow See page 7 Port assign See page 5 Mode transition See page 6
Use Battery	Maker: Joysun New Energy Model: Joysun08450 Type: Li−ion polymer
Charging and Discharging Specification	Charging voltage upper limit: 4.17 V Full−charge detection voltage: 4.0 V − 4.2 V Full−charge detection current: Less than 40 mA (2 s) Charging current: 190 mA 10−bit PWM 39 kHz Base cycle Charging time−out: 180 min Pre−charge voltage threshold: Less than 3.0 V Pre−charge current: 6 mA 15 min Abnormal temperature detection 58°C Discharge current: 3.5 W 10−bit PWM 7.8 kHz Discharge voltage: 3.27 V and over Discharge time−out: 5 s
LED Indicator Specification	See Table 2
USB (+5 V) Detection	When 4.5 V to 5.5 V is input to the USB terminal, the USB connection is detected.

Table 2. LED INDICATOR SPECIFICATION

P12 BLUE	P05 GREEN	P06 RED	Function	Puff Count
0	0	0		
0	0	1	Heater	
0	1	0	Charging	150
0	1	1		100
1	0	0		250 over
1	0	1		50
1	1	0		200
1	1	1		

REFERENCE BOARD CIRCUIT DIAGRAM

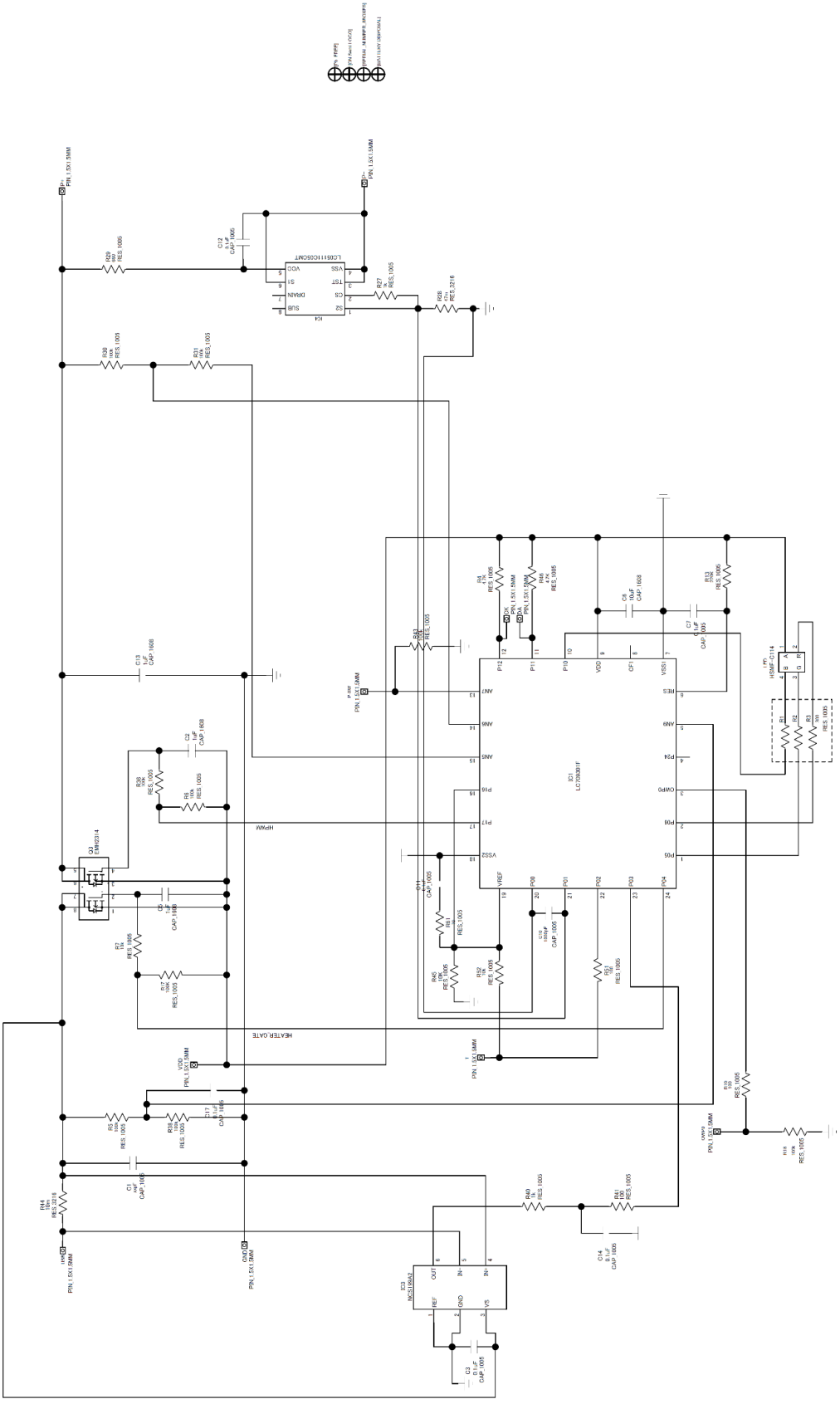


Figure 1. Reference Board Circuit Diagram

SOFTWARE BLOCK

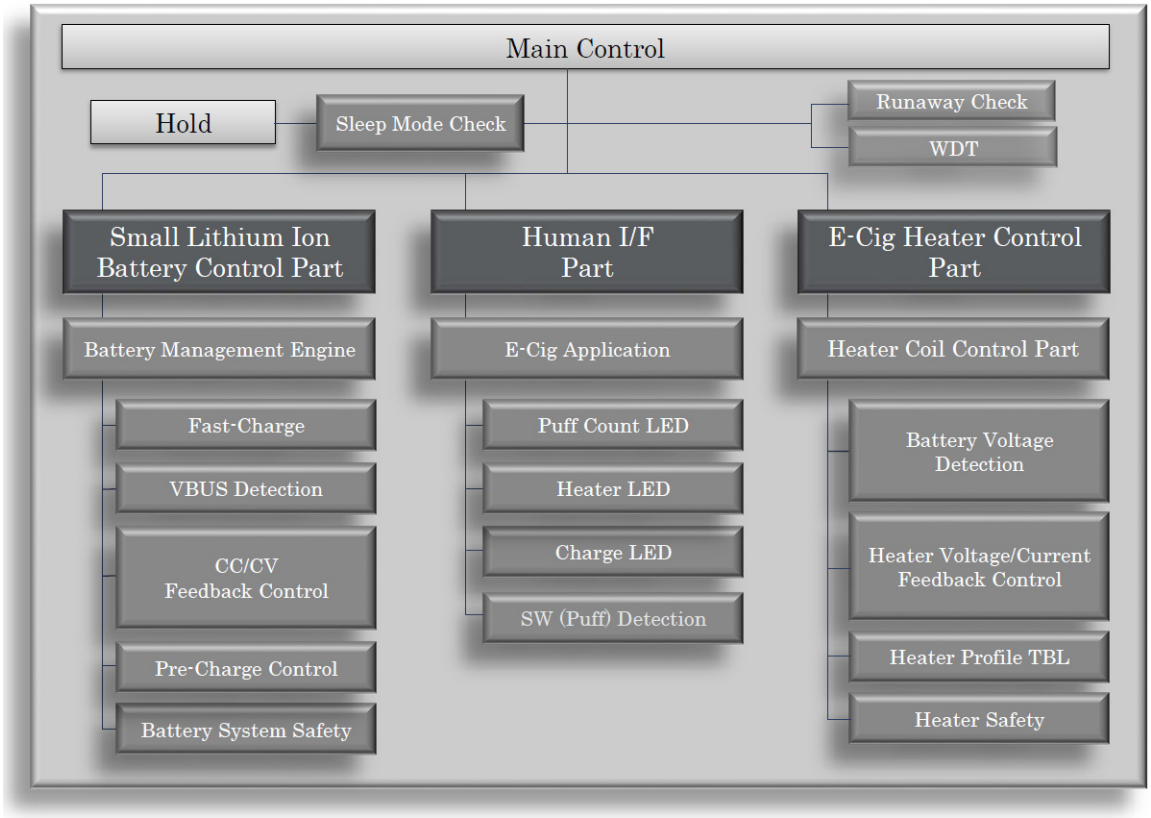


Figure 2. Software Block

Table 3. PORT ASSIGN

E−Cigarette LC709301F (Package:VCT) Heater Current IC Correspondence									IN/ OUT	Latch	IN/ OUT	Latch	IN/ OUT	Latch	IN/ OUT	Latch	IN/ OUT	Latch
No.	Terminal Name		I/O	Func-tion	Port name	Summary	Ac-tive	Inter-nal PullUp	Initial		HOLD		Cigaerette Connect Operation Mode		Cigaerette Smoking Operation Mode		USB Connect Operation Mode	
1	P05/T1PWML/CK0	CMOS	O	T0PWML	LED	GREEN (Charging)	Low		O	H	O	H	O	H	O	H	O	
2	P06/T1PWMH	CMOS	O	T1PWMH	LED	RED	Low		O	H	O	H	O	H	O	PWM	O	H
3	OWP0			OWP	Debugger													
4	P24	CMOS	O		NC				O	L	O	L	O	L	O	L	O	L
5	P70/INT0/T0LCP/AN9	Nch	I	INT0, AN9	Power	USB Detection	High		I	−	I	−	I	−	I	−	I	−
6	RES#																	
7	VSS1																	
8	CF1/XT1	Nch	O		NC				O	L	O	L	O	L	O	L	O	L
9	VDD1																	
10	P10/SO1	CMOS	O		LED	BLUE (Full Charge)	Low		O	H	O	H	O	H	O	H	O	
11	P11/SI1/SB1	Nch	O	I2C SDA					O	H	O	H	O	L	O	L	O	L
12	P12/SCK1	Nch	O	I2C SCL					O	H	O	H	O	L	O	L	O	L
13	P13/INT4/T1IN/AN7	Nch	I	INT4	Puff	Air Sensor (Key)	High		I	L	I	−	I	−	I	−	I	−
14	P14/INT4/T1IN/AN6	Nch	I	AN6	FB1	Batt. Vol.			I	−	I	−	I	−	I	−	I	−
15	P15/INT3/T0IN/AN5	Nch	O		FB1_CNT	Vatt. Partial pressure	Low		O	L	I	−	O	L	O	L	O	L
16	P16/INT2/T0IN/CPOUT/HPWM2	Nch	O		DisCharge	Vref. Load	Low		O	H	O	H	O	−	O	−	O	−
17	P17/BUZ/INT1/T0HCP/HPWM2	CMOS	O	HPWM	Charge Control	Q2 FET	Low		O	H	O	H	O	H	O	L	O	PWM
18	VSS2					AVSS												
19	VREF		O		Ref. Vol.	2V,4V								2 V		2 V		4 V
20	P00/APIM	Nch	I	APIM	Charge current				I	−	I	−	I	−	I	−	I	−
21	P01/APIP	Nch	I	APIP	Charge current				I	−	I	−	I	−	I	−	I	−
22	P02/AN2/CPIM	Nch	I	AN2	Thermistor				I	−	I	−	I	−	I	−	I	−
23	P03/AN3/VCPWM0	Nch	I	AN3	Heater current	Heater curennt IC Output (AD)			I	−	I	−	I	−	I	−	I	−
24	P04/AN4/VCPWM1	CMOS	O	VCPWM1	Heater	Smoking Q1 FET	Low		O	H	O	H	O	H	O	PWM	O	L

Table 4. CONTROL LOGIC OF FET

Mode	Q1 FET (Heater Side)	Q2 FET (Batt. Side)
USB Charge	ON (Low)	PWM
Heater On	PWM	ON (Low)
Wait, Hold	OFF (High)	OFF (High)

MODE TRANSITION

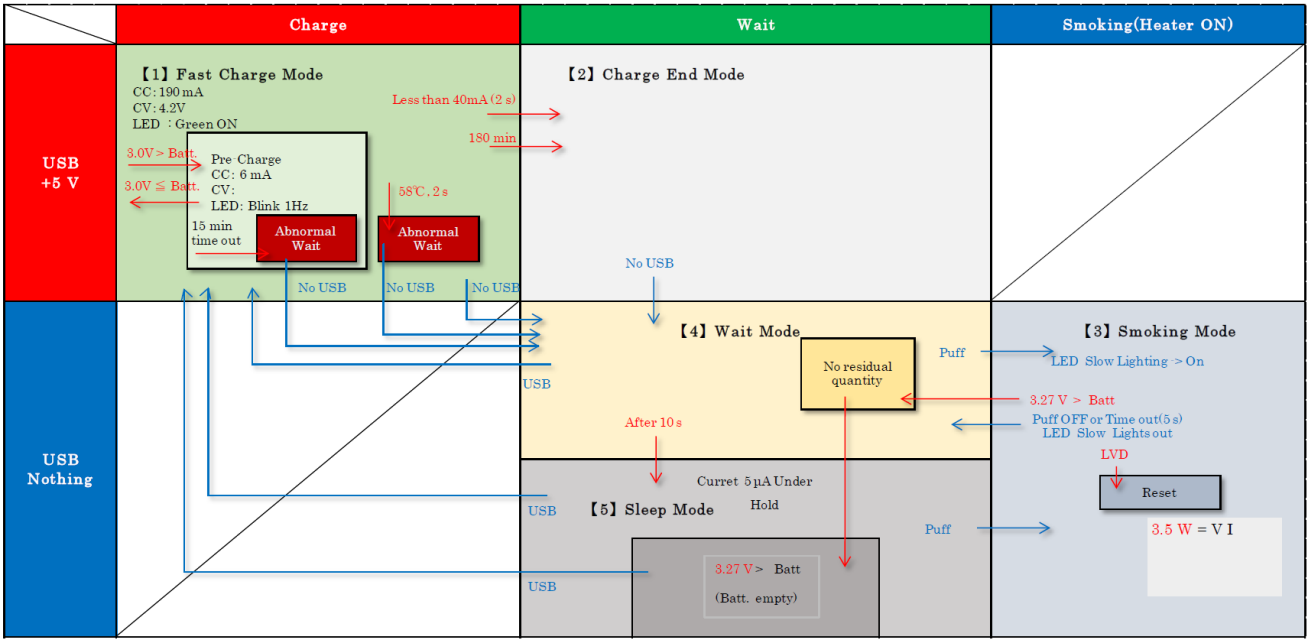


Figure 3. Mode Transition

Table 5.

Detection State	P70(INT0)	P13(Puff)	MODE		
Batt. Only	Low	Low		[4] Wait Mode	*[5] Sleep Mode*
Batt. + Cigarette	Low (High at puff)	Low/High	[3] Smoking Mode	[4] Wait Mode	*[5] Sleep Mode*
Batt. + USB	High	Low	[1] Fast Charge Mode	[2] Charge End Mode	

FLOW

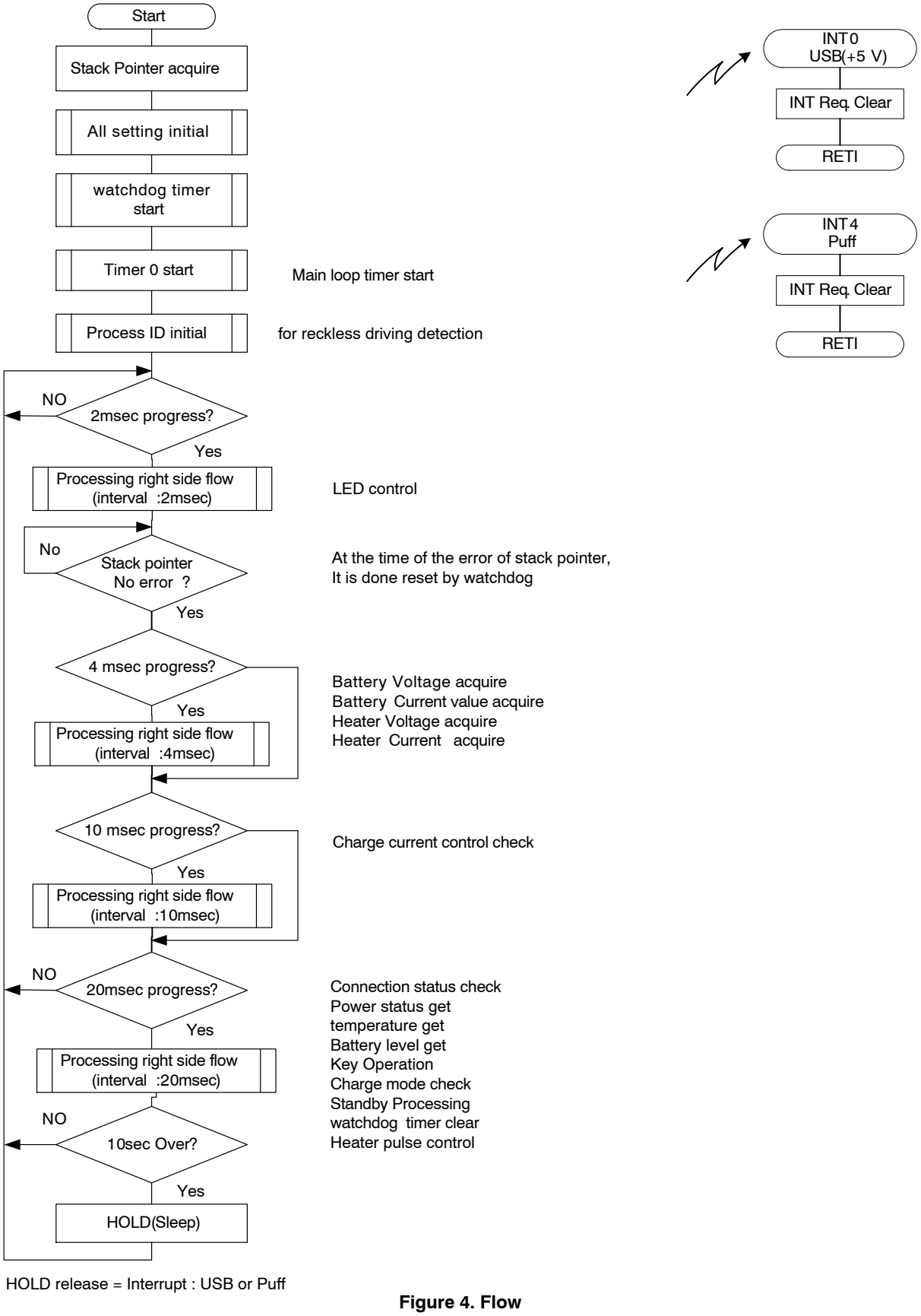


Figure 4. Flow

DESCRIPTION OF EVALUATION BOARD

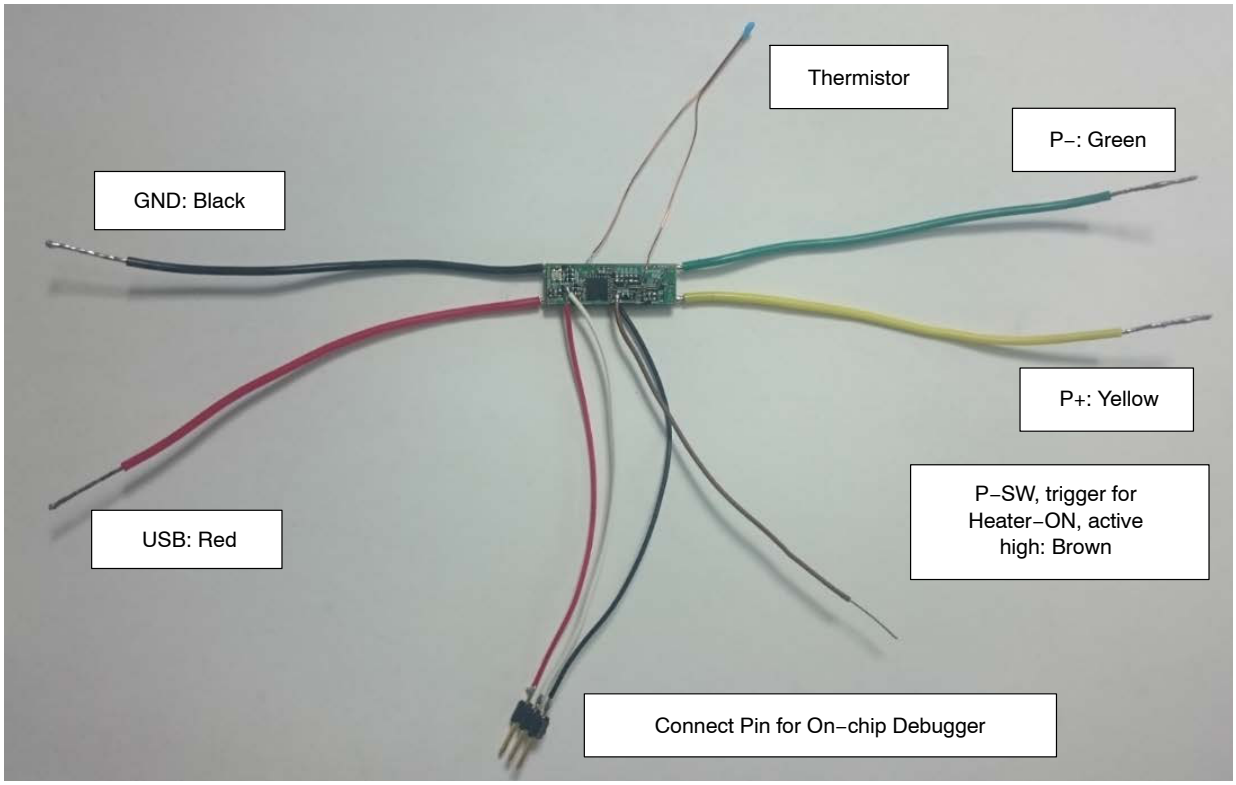


Figure 5. Description of Evaluation Board

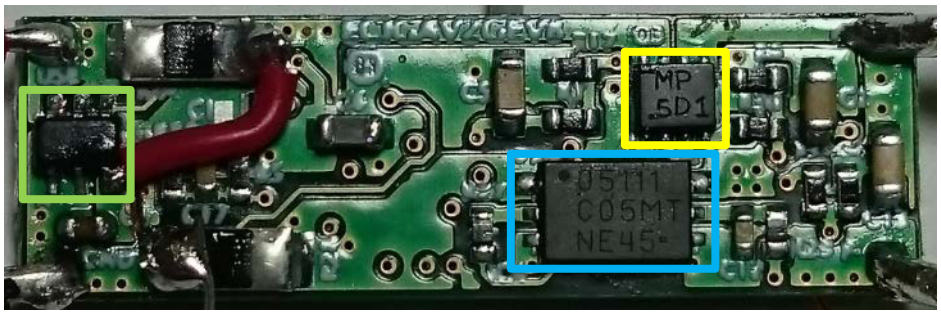


Figure 6. Top View

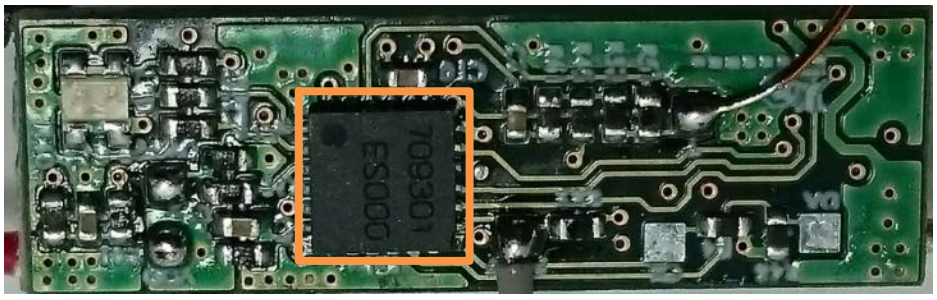


Figure 7. Top View

HOW TO CONNECT

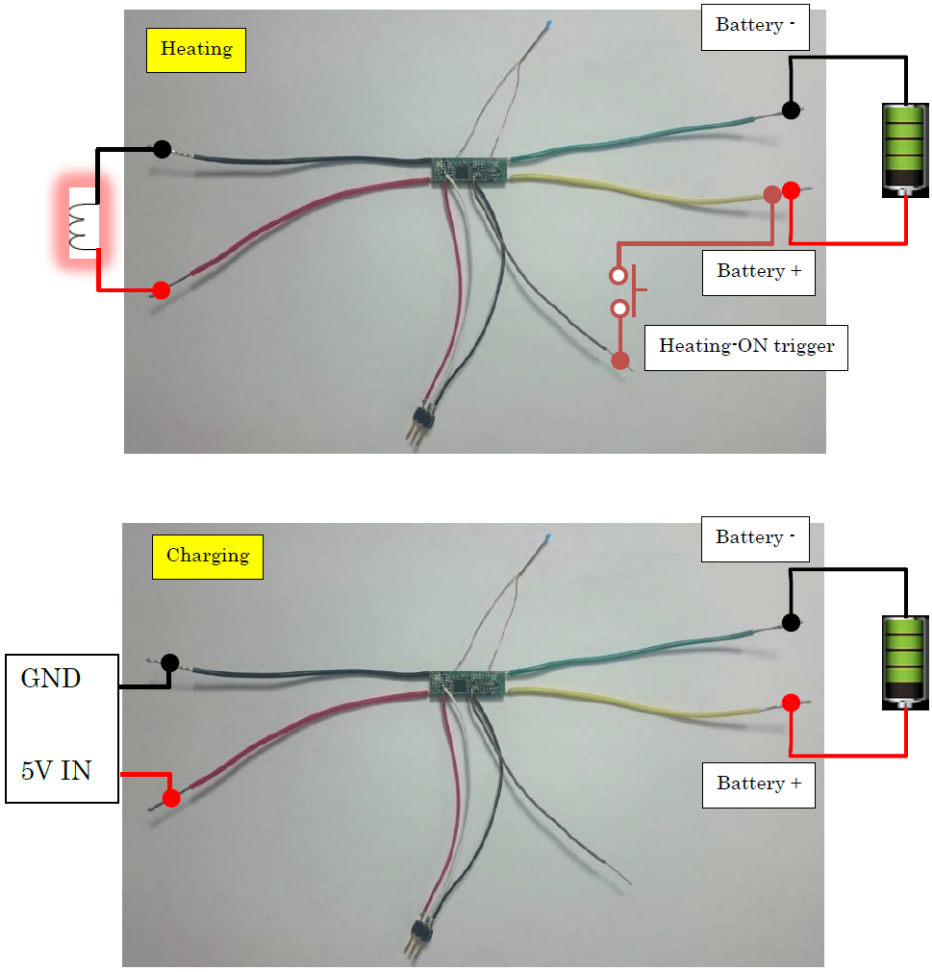
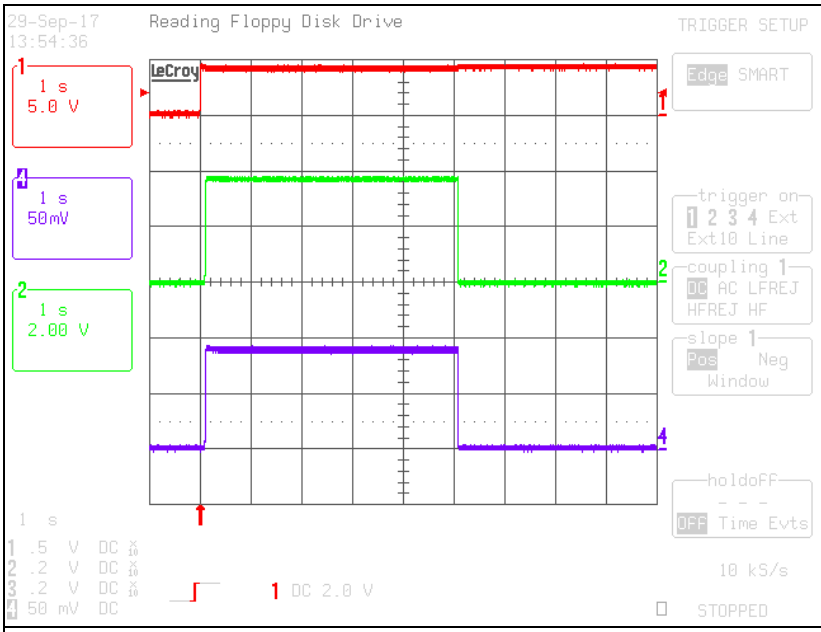
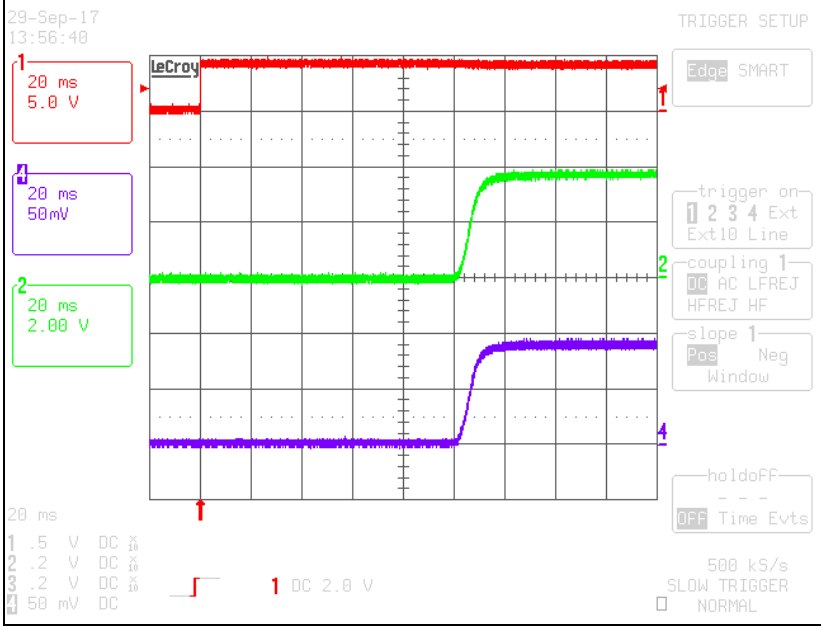
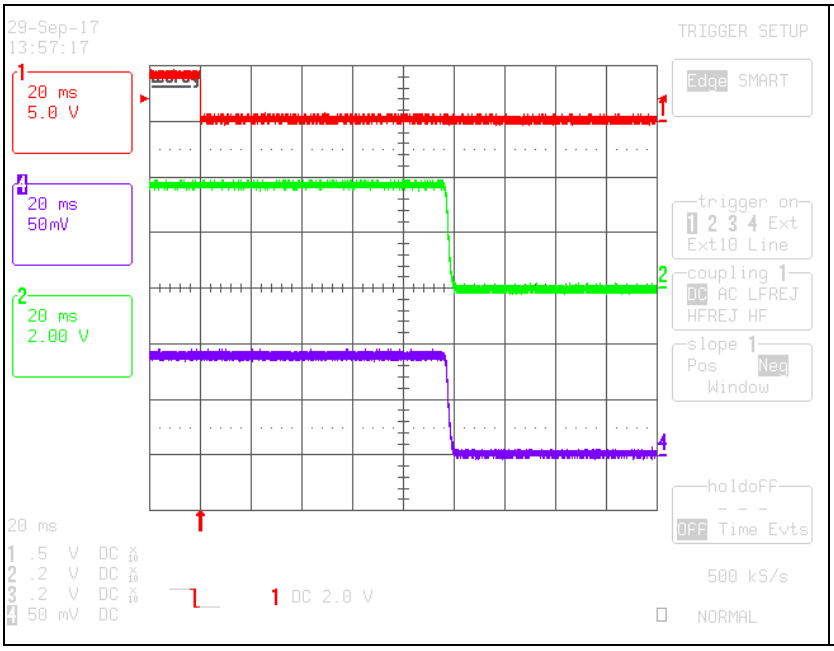


Figure 8. How to Connect

OPERATION WAVEFORM

Table 6. HEATING

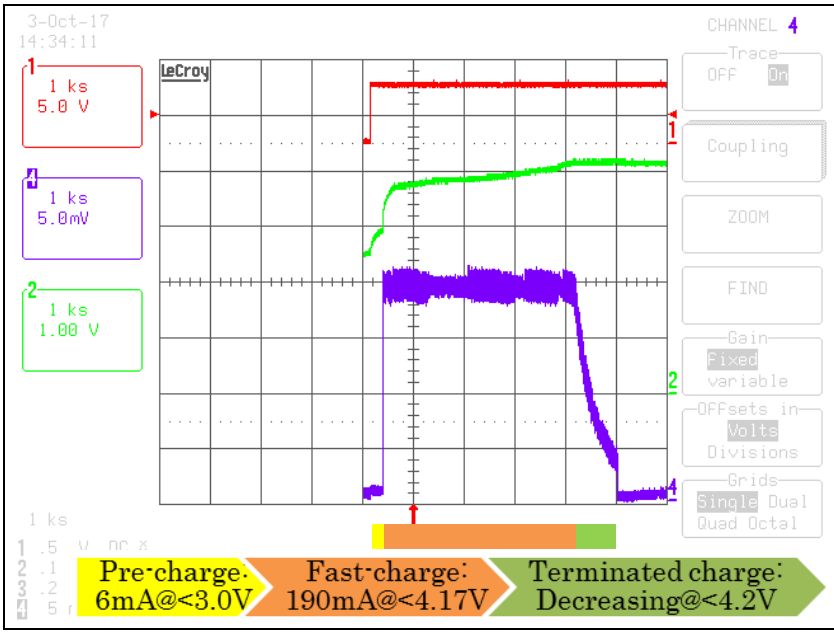
	Heating operation #1 CH1: P−SW (5V/div) CH2: USB (2V/div) CH4: USB current (500mA/div) 1s/div When inputting high level signal to P−SW, heating is started. The heating is kept 3.5W for maximum about 5s during high level input. When releasing high level signal input, the heating is stopped immediately. 3.5W heating is kept using the feedback system with monitoring the voltage and current of heater coil.
	Heating operation #2 CH1: P−SW (5V/div) CH2: USB (2V/div) CH4: USB current (500mA/div) 20ms/div When inputting high level signal to P−SW, the heating is started after about 100ms.



Heating operation #3
CH1: P−SW (5V/div)
CH2: USB (2V/div)
CH4: USB current (500mA/div)
20ms/div

When releasing high level signal input, the heating is stopped after about 100ms.

Table 7. CHARGING



Charging operation
CH1: USB (5V/div)
CH2: P + (1V/div)
CH4: Battery Charging current (50mA/div)
1000s/div

When inputting 5V to USB, charging is started. Charging has the following three states, Pre−charge, Fast−charge and Terminated charge.

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