PBT223 User Manual
DC-DC Sync Buck, 0.8-22VDC/3A, Programmable, OLED Display

Product Features

- PBT223 series is a UART programmable DC-DC synchronous buck module.
  - **PBT223-FIXED**: supports constant voltage (CV) mode only
  - **PBT223-ADJ**: supports 3 operation modes: constant voltage (CV), constant power (CP), and 12-bit DAC mode
- **DC-DC Buck Synchronous Step-Down Converter**
  - **Vin** = 3.8 – 30 V
  - **Vout** = 0.8 – 22 V (fixed & adjustable output)
  - **Iout** = 0 – 3 A
  - **Switching frequency** f_{sw}: default 500kHz, supports 200kHz – 2.2MHz
  - **Duty cycle**: max 98%
  - **Soft start time**: default 4.8ms
- **UART Read Command**: DC-DC output state, Vin, Vout, Iout, Pout, temperature, EEPROM data, etc
- **UART Write Command**: enabled/disable DC-DC output, configure max Vin, max Vout, max Iout, max Pout protection values, EEPROM data, etc
- **OLED Display:** shows real-time Vout, Iout, Pout, temperature sensor value
- Software and Hardware Protection Circuits: UVLO, OVP, OCP, OPP, OTP, short circuit protection, input/output reverse polarity protection, ESD protection
- **Python API & Example Codes:** Python examples, support windows, Linux and Mac
- **Operating Temperature: -**40 - 85 ℃

Figure 1 PBT223-FIXED

Figure 2 PBT223-ADJ

Product Selection

Functions	PBT223-0V8	PBT223-3V3	PBT223-5V0	PBT223-12V	PBT223-22V	PBT223-ADJ
UART Programmable	✔	✔	✔	✔	✔	✔
Vin	2 - 30V	5 - 30V	7 - 30V	14 - 30V	24 - 30V	V_{out} + 5V
Vout	0.8V	3.3V	5V	12V	22V	1 - 22V adjustable
Iout	0 - 3A	0 - 3A	0 - 3A	0 - 3A	0 - 3A	0 - 3A
Vout ripple	<150mV	<150mV	<150mV	<150mV	<150mV	<400mV
Switching frequency f_{sw}	200 - 2200kHz	200 - 2200kHz	200 - 2200kHz	200 - 2200kHz	200 - 2200kHz	200 - 2200kHz
Operating Temperature	-40 - 85 ℃	-40 - 85 ℃	-40 - 85 ℃	-40 - 85 ℃	-40 - 85 ℃	-40 - 85 ℃
Full protection circuits	✔	✔	✔	✔	✔	✔

Application Scenarios

- Industrial automation production lines
- Automated test machines
- Embedded electronic devices
- Constant power load
- High-precision power supply systems
- Battery management systems
- Universities, research institutions, and laboratories
- STEM education and training institutions

Version Control

Version Number	Release Date	Version Description and Changes
1.0	May 1, 2024	• Initial release
2.0	June 1, 2024	• Updated PBT223 communication protocol • Added detailed introduction of PBT223-ADJ

Table of Content

1 Electrical Parameter

1.1 DC-DC Synchronous Buck Converter

<table>
<tr><th>Parameter</th><th>Value</th></tr>
<tr><td>Vin</td><td>
Vin = 3.8 – 30 V
PBT223-FIXED: (Vout + 2) < Vin < 30V
PBT223-ADJ: (Vout + 5) < Vin < 30V
<table>
<tr><th>Model</th><th>Vout</th><th>Vin range</th></tr>
<tr><td>PBT223-0V8</td><td>Vout = 0.8V</td><td>Vin = 2 – 30 V</td></tr>
<tr><td>PBT223-3V3</td><td>Vout = 3.3V</td><td>Vin = 5 – 30 V</td></tr>
<tr><td>PBT223-5V0</td><td>Vout = 5.0V</td><td>Vin = 7 – 30 V</td></tr>
<tr><td>PBT223-12V</td><td>Vout = 12V</td><td>Vin = 14 – 30 V</td></tr>
<tr><td>PBT223-22V</td><td>Vout = 22V</td><td>Vin = 24 – 30 V</td></tr>
<tr><td>PBT223-ADJ</td><td>Vout = 1-22V adjustable</td><td>Vin = (Vout + 5V) – 30 V</td></tr>
</table>
</td></tr>
<tr><td>I_{in}</td><td>0 – 3 A</td></tr>
<tr><td>Vout</td><td>Vout = 0.8 – 22 V
PBT223-FIXED: fixed output
PBT223-ADJ: programmable & manually adjustable output</td></tr>
<tr><td>Iout</td><td>0 – 3 A</td></tr>
<tr><td>Vout ripple</td><td>PBT223-FIXED: <100mV
PBT223-ADJ: <400mV</td></tr>
<tr><td>Working frequency f_{sw}</td><td>Default 500kHz
Support 200 kHz – 2.2 MHz</td></tr>
<tr><td>Soft Start Time t_{ss}</td><td>Default 5ms
Support $\geq$ 1ms</td></tr>
<tr><td>Efficiency η</td><td>85 - 97%</td></tr>
</table>

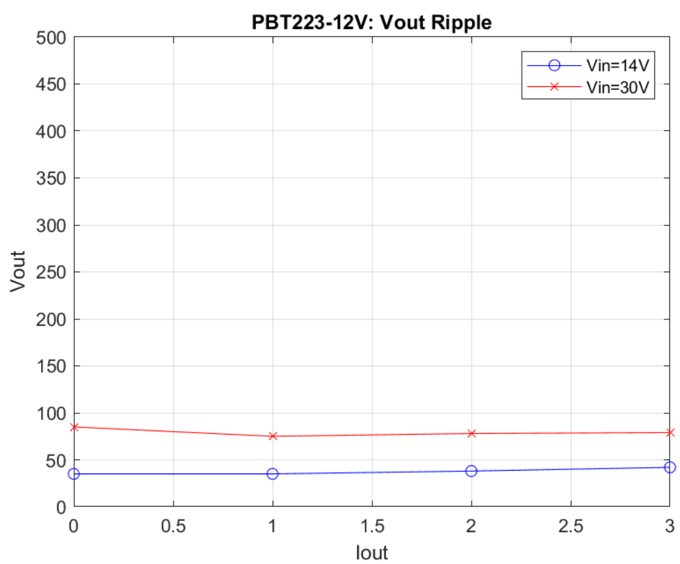
1.2 PBT223-FIXED Fixed Output

The following experimental data was obtained under the following test conditions:

- PBT223-12V module
- Room temperature 25°C
- 1 standard atmosphere

1.2.1 Vout Ripple

Test Objective: The Vout ripple should be <100mV under different Iout load conditions as the Vin varies.

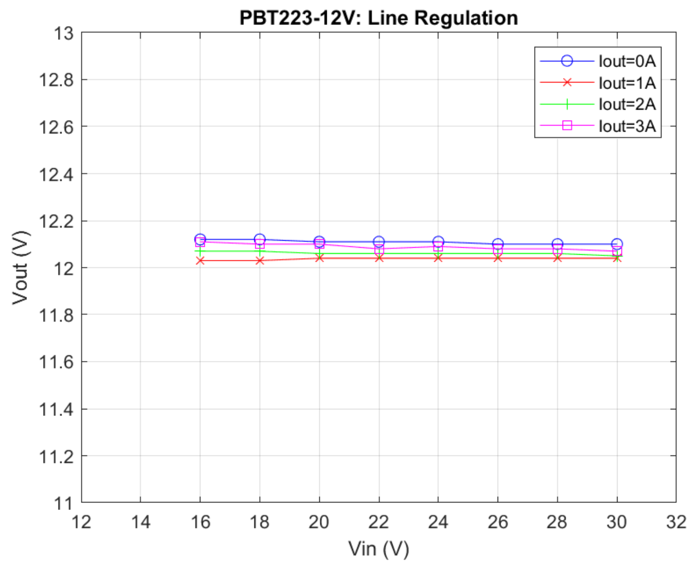


PBT223-12V: Output voltage ripple @ Vin = 14V			
Iout (A)	**Vout ripple** V_{out_pp} **(mV)**	**Pass Criteria**	**Test Result**
0	35	≤100mV	PASS
1	35	≤100mV	PASS
2	38	≤100mV	PASS
3	42	≤100mV	PASS

PBT223-12V: Output voltage ripple @ Vin = 30V			
Iout (A)	**Vout ripple** V_{out_pp} **(mV)**	**Pass Criteria**	**Test Result**
0	85	≤100mV	PASS
1	75	≤100mV	PASS
2	78	≤100mV	PASS
3	79	≤100mV	PASS

1.2.2 Line Regulation

Test Objective: The output voltage V_{out} should remain stable as the input voltage V_{in} varies.

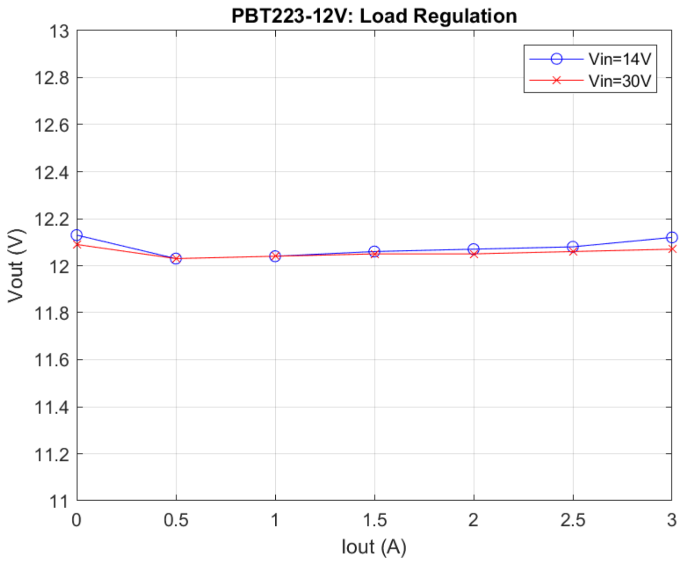


PBT223-12V: Line regulation		
I_{out} (A)	Vin (V)	Vout (V)
0	16	12.12
	18	12.12
	20	12.11
	22	12.11
	24	12.11
	26	12.1
	28	12.1
	30	12.1
1	16	12.03
	18	12.03
	20	12.04
	22	12.04
	24	12.04
	26	12.04
	28	12.04
	30	12.04
2	16	12.07
	18	12.07
	20	12.06
	22	12.06
	24	12.06
	26	12.06
	28	12.06
	30	12.05

3	16	12.11
	18	12.1
	20	12.1
	22	12.08
	24	12.09
	26	12.08
	28	12.08
	30	12.07

1.2.3 Load Regulation

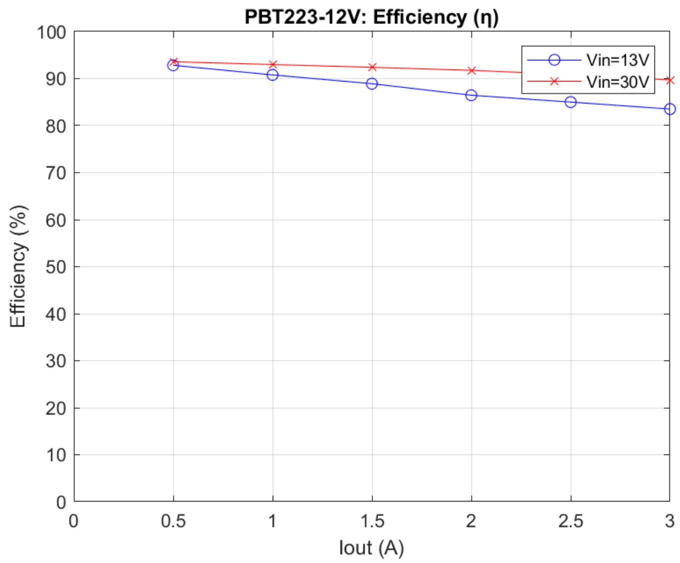
Test Objective: the output voltage Vout should remain stable under different load Iout conditions.



PBT223-12V: Load Regulation		
Vin (V)	**Iout (A)**	**Vout (V)**
14	0	12.13
	0.5	12.03
	1	12.04
	1.5	12.06
	2	12.07
	2.5	12.08
	3	12.12
30	0	12.09
	0.5	12.03
	1	12.04
	1.5	12.05
	2	12.05
	2.5	12.06
	3	12.07

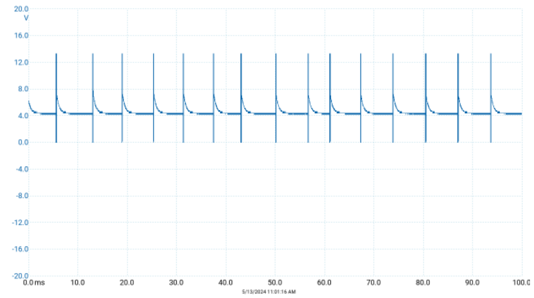
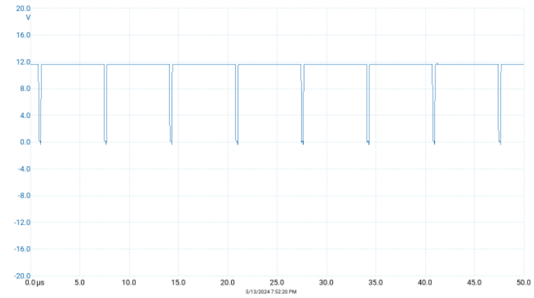
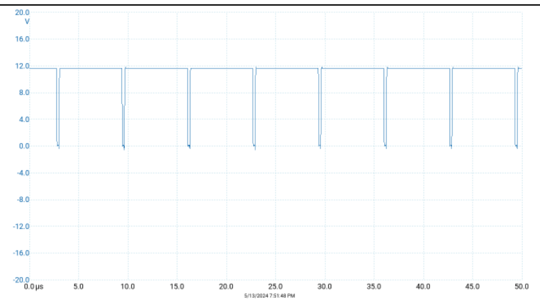
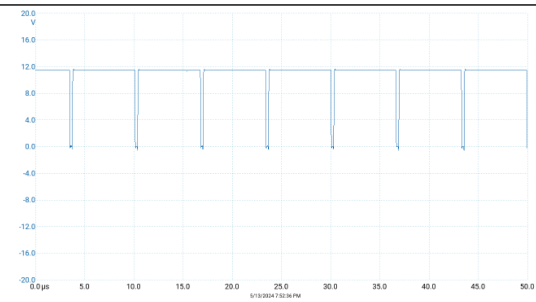
1.2.4 Efficiency (%)

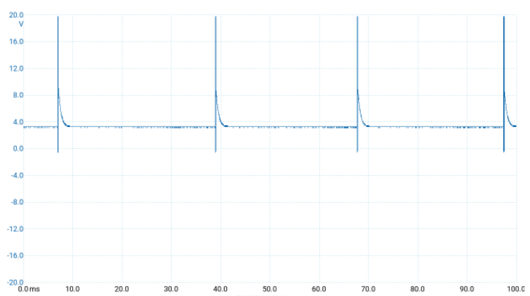
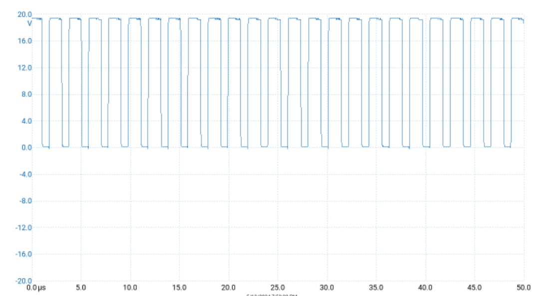
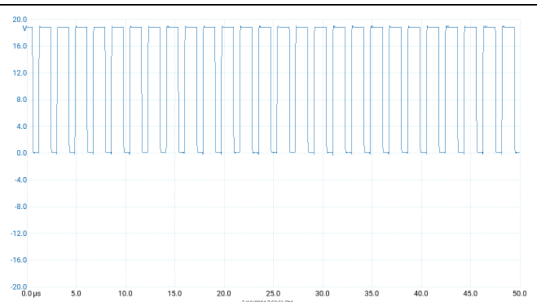
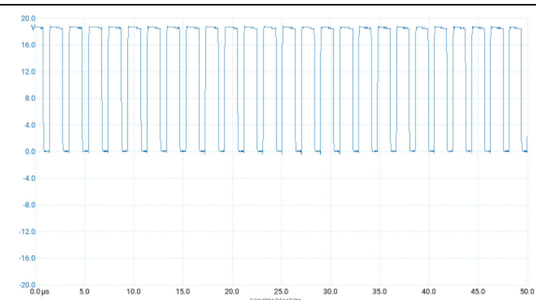
Test Objective: the lower the conversion efficiency, the higher the heat generated by the buck chip; conversely, the higher the conversion efficiency, the lower the heat generated by the buck chip.



PBT223-12V: Efficiency (η)		
Vin (V)	**Iout (A)**	**Efficiency (%)**
13V	0.5	92.83
	1	90.78
	1.5	88.91
	2	86.46
	2.5	85.00
	3	83.52
30V	0.5	93.58
	1	92.99
	1.5	92.40
	2	91.75
	2.5	90.86
	3	89.71

1.2.5 PWM

PBT223-12V: PWM @ Vin = 13V, Vout=12V	
Iout = 0A	**Iout = 1A**
	
Iout = 2A	**Iout = 3A**
	

PBT223-12V: PWM @ Vin = 30V, Vout=12V	
Iout = 0A	**Iout = 1A**
	
Iout = 2A	**Iout = 3A**
	

1.3 PBT223-ADJ Adjustable Output

PBT223-ADJ supports 3 operating modes: constant voltage (CV), constant power (CP), and DAC mode. It can be manual control or program control via UART commands.

3 Operation Modes

- **DAC Mode**: By adjusting the 12-bit digital signal from 0 to 4095, the Vout can be linearly adjusted from 1 to 22V.
- **Constant Voltage (CV) Mode**: The MCU monitors Vout in real-time and uses a PID algorithm to automatically adjust to the target Vout within 3 seconds.
- **Constant Power (CP) Mode**: The MCU monitors Vout and Iout in real-time, calculates Pout, and uses a PID algorithm to automatically adjust to the target Pout within 3 seconds.

Manual Control

- Users can rotate encoder clockwise or anti-clockwise, short press or long press the encoder button to manually control operation mode and target value. Please read <Rotary Encoder with Button> section for more details.

Program Control

- Please read the <UART Program Control> section to understand read and write commands.
- The latest Python API and example code can be downloaded from the official GitHub repository

1.3.1 DAC Mode (0-4095)

As shown in the following graph, the closer the $R^2 = 1$, the more linear the relationship between 12-bit DAC signal and Vout.

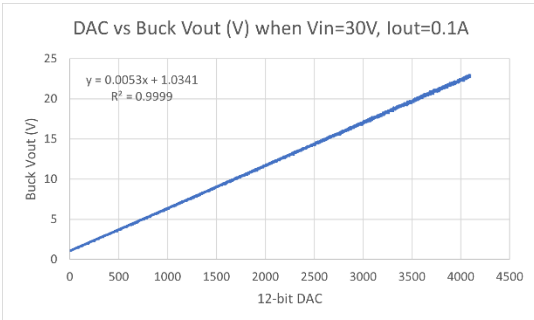


Figure 3 DAC vs Vout when Vin=30V, Iout=0.1A

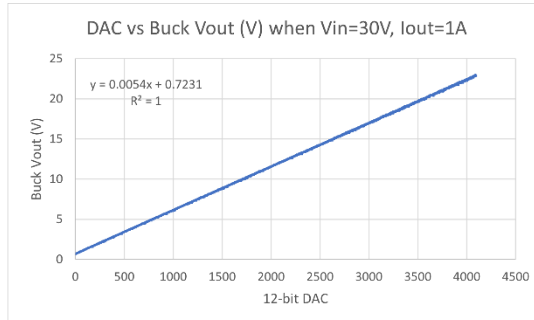


Figure 4 DAC vs Vout when Vin=30V, Iout=1A

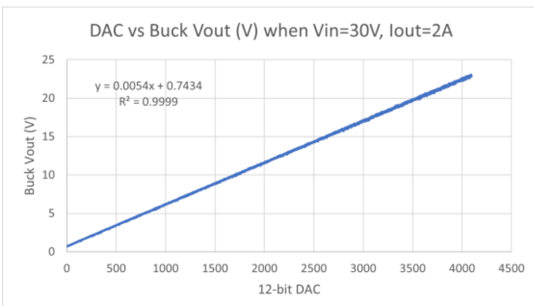


Figure 5 DAC vs Vout when Vin=30V, Iout=2A

1.3.2 Constant Voltage (CV) Mode

The following graphs shows the PBT223-ADJ CV mode with target voltage from 2 to 22V, with increment step size 2V, with output loading current Iout = 0.1/1/2 A.

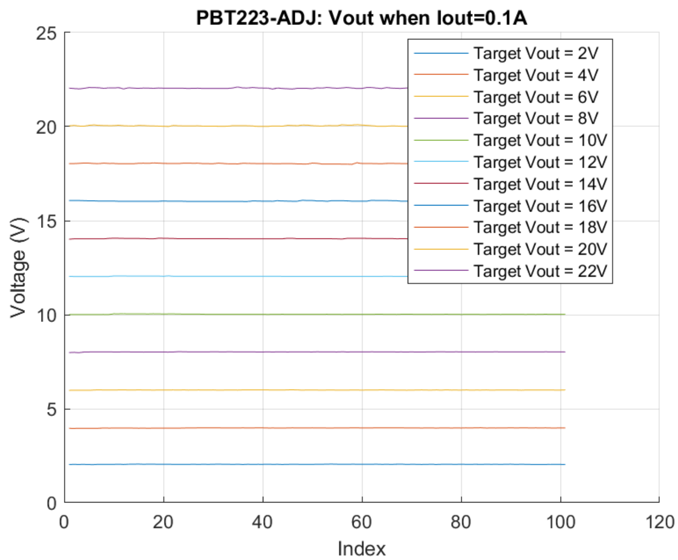


Figure 6 Constant Voltage (CV) Mode: Iout=0.1A

PBT223-ADJ CV Mode: Vout Statistics (Iout=0.1A)					
Target Vout	**Mean**	**Variance**	**Std**	**Max**	**Min**
2	2.04	0	0.01	2.06	2.03
4	3.98	0	0.01	3.99	3.95
6	5.99	0	0.01	6	5.98
8	8.02	0	0.01	8.03	7.98
10	10.02	0	0.01	10.05	10
12	12.04	0	0.01	12.06	12.03
14	14.04	0	0.01	14.07	14.01
16	16.03	0	0.02	16.08	15.99
18	18.03	0	0.02	18.08	17.99
20	20.04	0	0.02	20.1	20
22	22.04	0	0.02	22.11	22

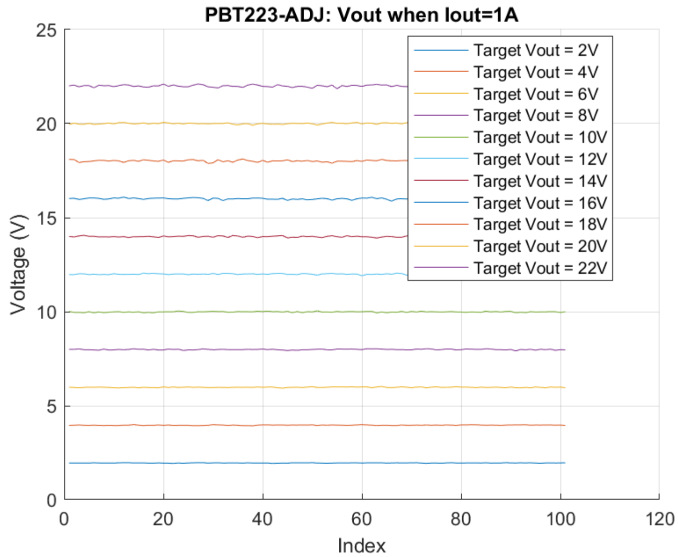


Figure 7 Constant Voltage (CV) Mode: Iout=1A

PBT223-ADJ CV Mode: Vout Statistics (Iout=1A)					
Target Vout	**Mean**	**Variance**	**Std**	**Max**	**Min**
2	1.95	0	0.01	1.97	1.93
4	3.96	0	0.01	3.99	3.93
6	5.98	0	0.02	6.02	5.93
8	7.99	0	0.02	8.03	7.92
10	9.99	0	0.02	10.04	9.93
12	11.99	0	0.03	12.05	11.9
14	13.99	0	0.03	14.08	13.91
16	16	0	0.04	16.09	15.86
18	18.01	0	0.05	18.12	17.88
20	19.99	0	0.04	20.07	19.9
22	22	0	0.06	22.12	21.83

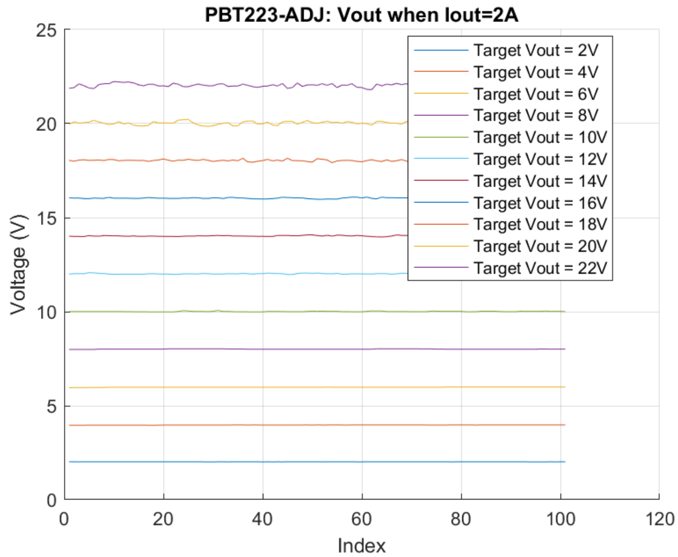


Figure 8 Constant Voltage (CV) Mode: Iout=2A

PBT223-ADJ CV Mode: Vout Statistics (Iout=2A)					
Target Vout	**Mean**	**Variance**	**Std**	**Max**	**Min**
2	2.01	0	0	2.02	2.01
4	3.97	0	0	3.98	3.96
6	5.98	0	0.01	5.99	5.96
8	8.01	0	0.01	8.02	7.99
10	10.01	0	0.01	10.06	9.99
12	12.01	0	0.02	12.07	11.97
14	14.03	0	0.02	14.08	13.97
16	16.03	0	0.03	16.09	15.97
18	18.03	0	0.05	18.16	17.92
20	20.03	0.01	0.09	20.23	19.86
22	22.02	0.01	0.1	22.24	21.81

1.3.3 Constant Power (CP) Mode

- CP mode can be used for supplying power to heating rods to achieve stable heat power dissipation.
- The heating rod is a resistive device which converts electrical energy to thermal energy. The heat dissipation formula is $P=I^2*R$. After about 100-300 hours of heating, the heating rod resistance will drift. As a result, output heat power will drift as well.
- PBT223-ADJ CP mode could continuously monitor the Vout, Iout and Pout, and automatically compensate the Pout drift due to the heating rod resistance variation. As a result, making sure the Pout is stable. It's an innovative method for power and temperature control applications.

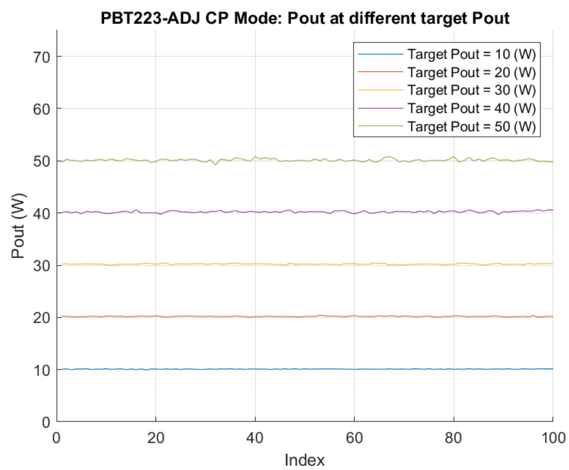


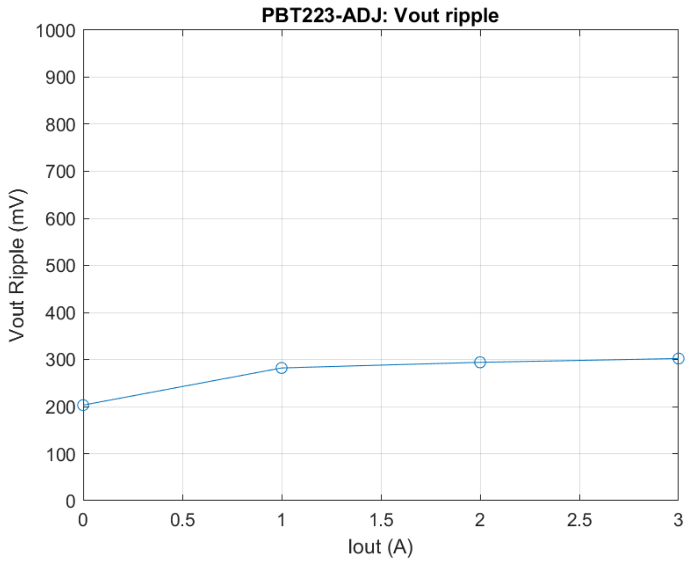
Figure 9 Constant Power (CP) Mode

The following experimental data was obtained under the following test conditions:

- PBT223-ADJ module
- Room temperature 25°C
- 1 standard atmosphere

1.3.4 Vout Ripple

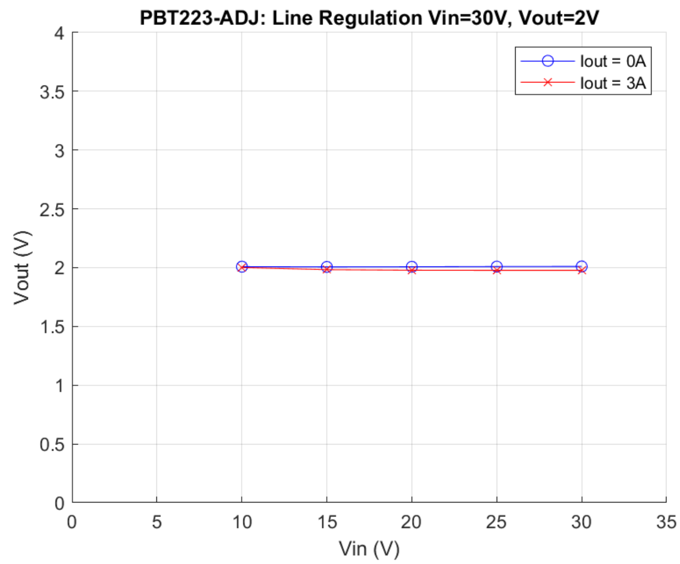
Test Objective: The Vout ripple V_{out_pp} should be <350mV under different Iout load conditions.



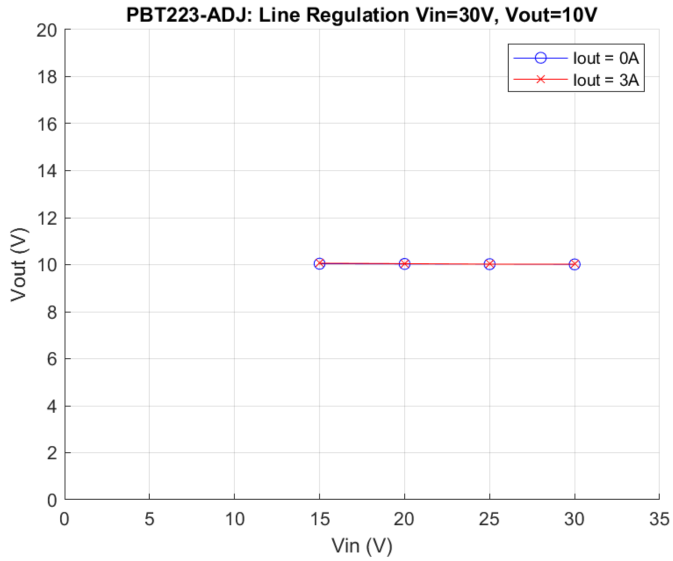
PBT223-ADJ: Vin = 30V, Vout=22V			
Iout (A)	**Vout Ripple (mV)**	**Pass Criteria**	**Test Result**
0	203	≤350mV	PASS
1	282	≤350mV	PASS
2	294	≤350mV	PASS
3	302	≤350mV	PASS

1.3.5 Line Regulation

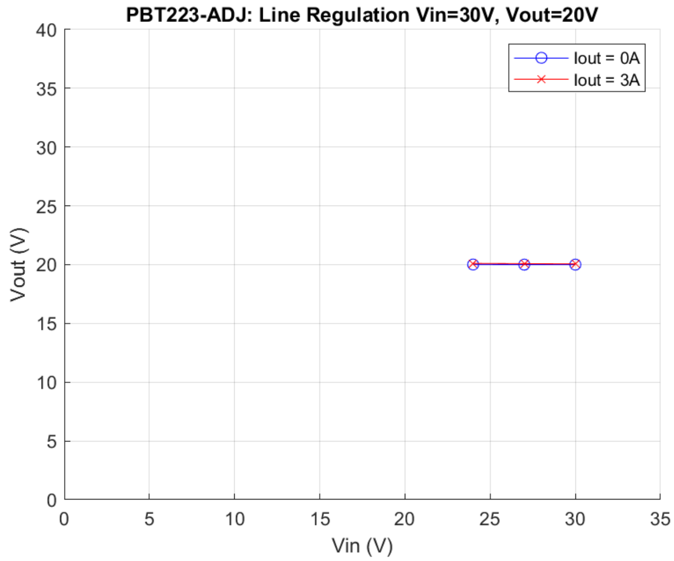
Test Objective: The Vout should remain stable as the Vin varies.



PBT223-ADJ: Line Regulation (Vin=30V, Vout=2V)		
Iout (A)	**Vin (V)**	**Vout (V)**
0	10	2.008
	15	2.006
	20	2.007
	25	2.009
	30	2.01
3	10	2.001
	15	1.983
	20	1.978
	25	1.977
	30	1.977



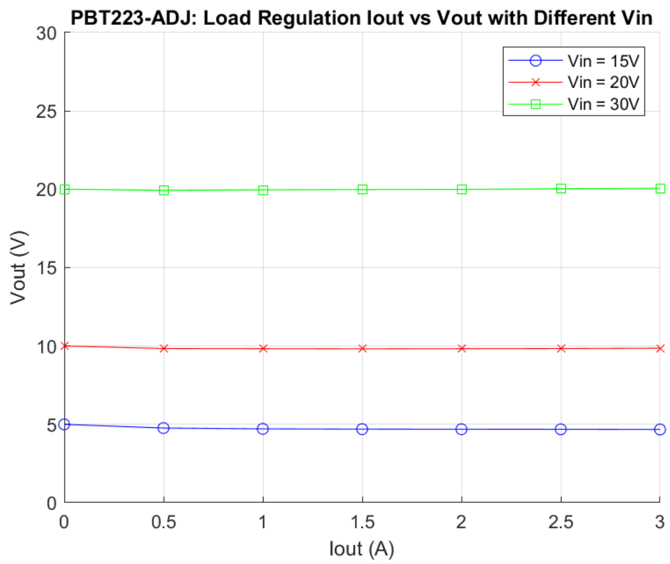
PBT223-ADJ: Line Regulation (Vin=30V, Vout=10V)		
Iout (A)	**Vin (V)**	**Vout (V)**
0	15	10.04
	20	10.03
	25	10.02
	30	10.01
3	15	10.06
	20	10.04
	25	10.02
	30	10.02



PBT223-ADJ: Line Regulation (Vin=30V, Vout=20V)		
Iout (A)	**Vin (V)**	**Vout (V)**
0	24	20.01
	27	20
	30	20
3	24	20.1
	27	20.08
	30	20.06

1.3.6 Load Regulation

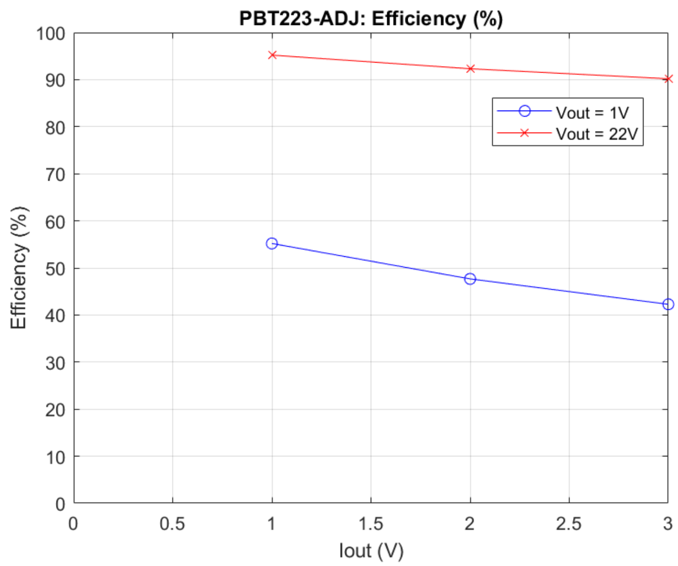
Test Objective: The Vout should remain stable under different Iout load conditions.



PBT223-ADJ: Load Regulation		
Vin (V)	**Iout (A)**	**Vout (V)**
15	0	5
	0.5	4.765
	1	4.711
	1.5	4.695
	2	4.688
	2.5	4.684
	3	4.673
20	0	10
	0.5	9.84
	1	9.83
	1.5	9.82
	2	9.83
	2.5	9.84
	3	9.86
30	0	20.01
	0.5	19.92
	1	19.96
	1.5	19.98
	2	19.99
	2.5	20.04
	3	20.06

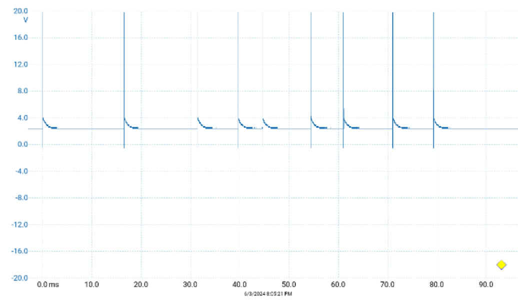
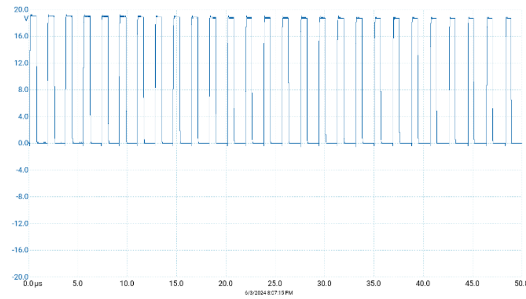
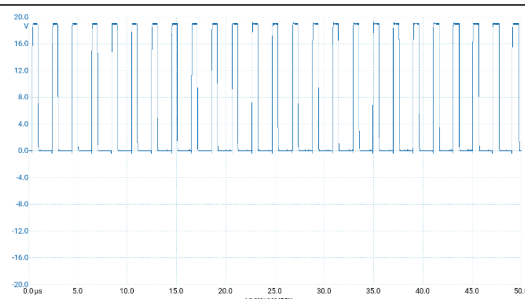
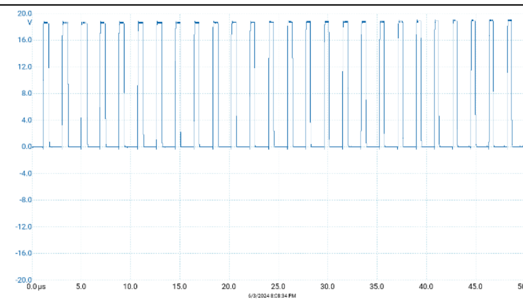
1.3.7 Efficiency (%)

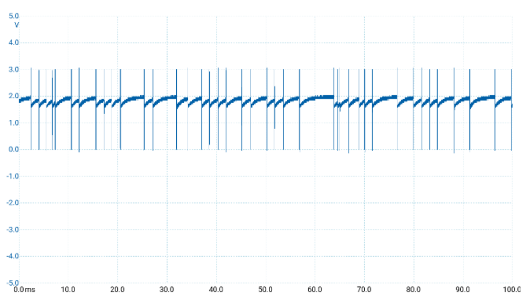
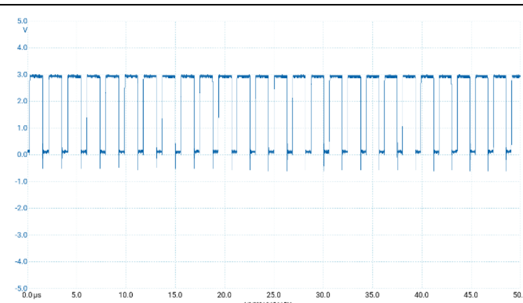
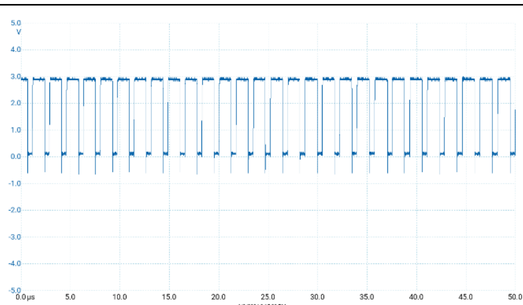
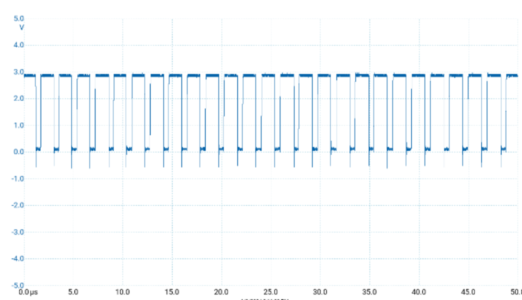
Test Objective: The higher the conversion efficiency, the lower the heat dissipation from the DC-DC buck circuit, the better energy usage.



Vin (V)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
30	1	1	1.83	1.01	55.19
		2	3.72	1.7733	47.67
		3	5.55	2.3461	42.27
	22	1	23.1	21.992	95.20
		2	47.67	44.006	92.31
		3	73.14	65.96	90.18

1.3.8 PWM

PBT223-ADJ: PWM @ Vin = 20V, Vout=5V	
Iout = 0A	**Iout = 1A**
	
Iout = 2A	**Iout = 3A**
	

PBT223-ADJ: PWM @ Vin = 30V, Vout=20V	
Iout = 0A	**Iout = 1A**
	
Iout = 2A	**Iout = 3A**
	

1.4 Rotary Encoder with Button

Only the PBT223-ADJ model includes a rotary encoder.

- **Encoder rotation**: The knob can be manually rotated clockwise or counterclockwise. Each rotatory adjustment has tactile feedback.
- **Encoder button**: it's a tactile button which resets automatically when released.

➢ **Short Press**: A press of <1 second is considered a short press. Short presses are used to adjust the step size, allowing for quick and precise adjustment of the target voltage, power or DAC value.

Adjustment Level	Constant Voltage (CV) Mode 1 – 22V	Constant Power (CP) Mode 0.1 – 66W	DAC Mode 0 - 4095
Level 1	0.01 V	0.01 W	1
Level 2	0.1 V	0.1 W	10
Level 3	1 V	1 W	100
Level 4	10 V	10 W	1000

➢ **Long Press:** A press of >1 second is considered a long press. Long presses are used to switch between 3 operating modes: constant voltage (CV), constant power (CP) or DAC mode.

Figure 10 PBT223-ADJ: CV Mode = 1V

Figure 11 PBT223-ADJ: CV Mode = 22V

Figure 12 PBT223-ADJ: CP Mode = 1W

Figure 13 PBT223-ADJ: CP Mode = 50W

Figure 14 PBT223-ADJ: DAC Mode = 0

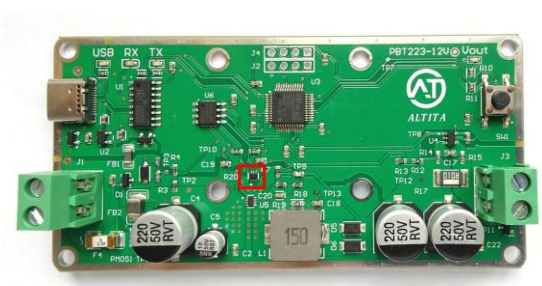
Figure 15 PBT223-ADJ: DAC Mode = 4095

1.5 UART Program Control

Parameter	Value
Communication Mode	USART
Baud Rate	115200
Data Bits	8
Stop Bits	1
Parity	Odd
Flow Control	None

1.6 Temperature Sensor

Parameter	Value
Chip Model	PN: TMP102 (Texas Instruments, USA)
Temperature Range	-40 – 125 ℃
Temperature Resolution	0.0625 ℃
Temperature Accuracy	-25 – 85 ℃ : ± 0.5℃ -40 – 125 ℃ : ± 1℃
Update Rate	4 Hz



1.7 DC-DC Switch Button

It is used to turn the DC-DC output ON or OFF.

1.8 EEPROM Data Mapping

- When the PBT223-ADJ operating mode or target DAC/Vout/Pout values are adjusted, the EEPROM automatically saves the user's last configuration.
- Upon restarting the PBT223-ADJ board, it will revert and keep the most recent configuration.
- Users can read and write EEPROM data via the USART port. The simple way is to use provided Python API from GitHub.
  - **EEPROM address**: 0x00 – 0xFF
  - **User self-defined address**: 0x00 – 0xDF
  - **Pre-defined and reversed address**: 0xE0 – 0xFF
  - EEPROM each address could read or write 1 byte data: 0x00 – 0xFF

EEPROM Data Map		
EEPROM Address	**EEPROM Data**	**Unit**
0x00 - 0xDF	User-defined	/
0xE0	PBT233-ADJ operating mode	0: Constant Voltage (CV) mode 1: Constant Power (CP) mode 2: DAC mode"
0xE1	PBT233-ADJ: Target Vout in CV mode (integer part)	Target Vout = XX.XX (V)
0xE2	PBT233-ADJ: Target Vout in CV mode (decimal part, 2 decimal places)	Target Vout = XX.XX (V)
0xE3	PBT233-ADJ: Target Pout in CP mode (integer part)	Target Pout = XX.XX (W)

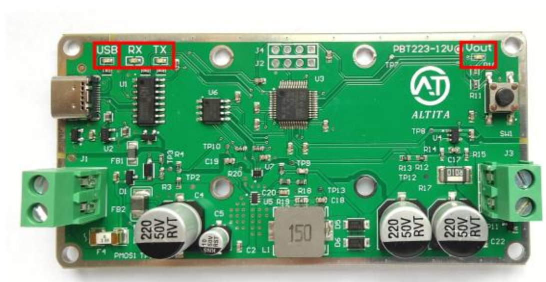
0xE4	PBT233-ADJ: Target Pout in CP mode (decimal part, 2 decimal places)	Target Pout = XX.XX (W)
0xE5	PBT233-ADJ: Target DAC value in DAC mode (high 4 bits of 12-bit DAC value)	/
0xE6	PBT233-ADJ: Target DAC value in DAC mode (low 8 bits of 12-bit DAC value)	/
0xE7 - 0xEF	Reserved, not used	/
0xF0	Software protection: max Vin integer part	**XX**.XX (V)
0xF1	Software protection: max Vin decimal part (2 decimal places)	XX.**XX** (V)
0xF2	Software protection: max Vout integer part	**XX**.XX (V)
0xF3	Software protection: max Vout decimal part (2 decimal places)	XX.**XX** (V)
0xF4	Software protection: max Iout integer part	**X**.XX (A)
0xF5	Software protection: max Iout decimal part (2 decimal places)	X.**XX** (A)
0xF6	Software protection: max Pout integer part	**XX**.XX (W)
0xF7	Software protection: max Pout decimal part (2 decimal places)	XX.**XX** (W)
0xF8 - 0xFF	Reserved, not used	/

1.9 OLED 1.3" Display

- **Screen Size**: 1.3 inches
- **Refresh Rate**: 5 Hz

1.10 LED Indicators

LED	Indication
Green LED (left)	• **ON**: digital circuit power supply is normal • **OFF**: No digital circuit power supply
Green LED (right)	• **ON**: DC-DC output is enabled • **OFF**: DC-DC output is disabled
USART RX Yellow LED	• **ON or blink**: Receiving data • **OFF**: No data received
USART RX Blue LED	• **ON or blink**: Transmitting data • **OFF**: No data transmitted

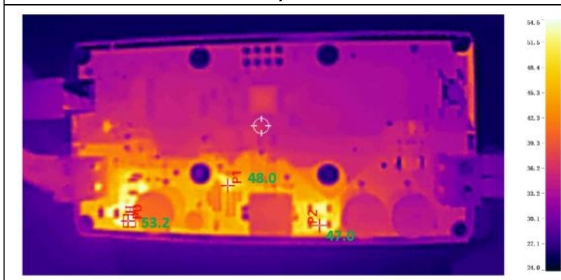
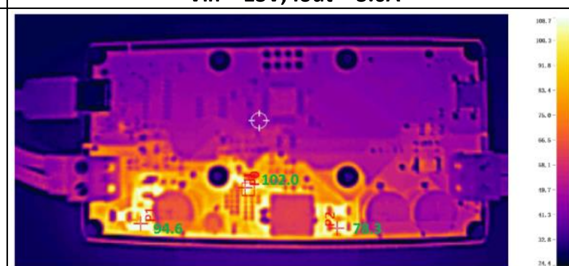
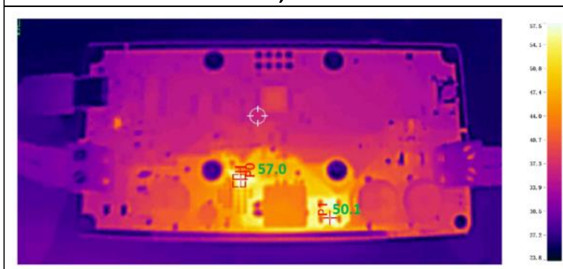
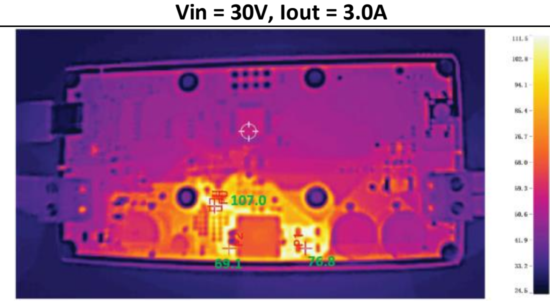


1.11 Watchdog

- The MCU firmware has the watchdog function.
- Under normal conditions, the MCU feeds the watchdog every 500ms to prevent the MCU from restarting.
- If the MCU fails to feed the watchdog >2000ms, the MCU will automatically restart.

1.12 Operating Temperature

- The product's operating temperature range is -40 to 85 ℃
- **【Note】When the Pout>50W continuously, heat sink or fan is necessary for cooling.**
- The following images show the PBT223 bare PCBA thermal performance under different working conditions.

Vin = 13V, Iout = 1.5A	**Vin = 13V, Iout = 3.0A**
	
Vin = 30V, Iout = 1.5A	**Vin = 30V, Iout = 3.0A**
	

2. Communication Protocol

2.1 Read Command

Read Command			
Byte	**Command**	**Function**	**Remarks**
Byte 0	**0x00**	Represents read command	/
Byte 1	**0x00**	Read buck status: ON/OFF	1: DCDC is ON 0: DCDC is OFF
	0x01	Read Vin	2 decimal places (V)
	0x02	Read Vout	2 decimal places (V)
	0x03	Read Iout	2 decimal places (A)
	0x04	Read Pout	2 decimal places (W)
	0x05	Read PBT223-ADJ mode	Applicable only to PBT223-ADJ, 3 modes include: 1) Constant Voltage (CV) 2) Constant Power (CP) 3) DAC mode: 0 - 4095
	0x06	Read target voltage in constant voltage (CV) mode	2 decimal places (V)
	0x07	Read target power in constant power (CP) mode	2 decimal places (W)
	0x08	Read 12-bit DAC value: 0 - 4095	* Applicable only to PBT223-ADJ
	0x09	Read max Vin software protection	2 decimal places (V)
	0x10	Read max Vout software limit	2 decimal places (V)
	0x11	Read max Iout software limit	2 decimal places (A)
	0x12	Read max Pout software limit	2 decimal places (W)
	0x13	Read LDO VDDA voltage	3 decimal places (V)
	0x14	Read MCU temperature	2 decimal places (°C)
	0x15	Read temperature sensor	2 decimal places (°C)
	0x16	Read OLED status: ON/OFF	1: OLED is ON 0: OLED is OFF
	0x17	Read data from specified EEPROM address	1) EEPROM address range = 0x00 - 0xFF 2) Data range = 0x00 - 0xFF

	0xF0	Read PN	Possible PN includes: PBT223-0V8 PBT223-3V3 PBT223-5V PBT223-12V PBT223-22V PBT223-ADJ
	0xF1	Read SN	96-bit UUID
	0xF2	Read hardware version	HW: X.Y.Z X = Major hardware change (e.g., add/remove components) Y = Minor hardware update (e.g., PN change) Z = Patch (e.g., bug fix)
	0xF3	Read firmware version	FW: X.Y.Z X = Major firmware change (e.g., new features or algorithms) Y = Minor firmware update (e.g., feature improvements) Z = Patch (e.g., bug fix)
Byte 2	**If Byte 1 is 0x17**	Read data from any EEPROM address (0x00 - 0xFF)	Data at EEPROM address 0x00 - 0xFF
	Otherwise	Undefined, can be filled with any byte	/
Byte 3	**Undefined**	Can be filled with any byte	/

2.2 Write Command

Write Command			
Byte	**Command**	**Function**	**Remarks**
Byte 0	0x01	Represents write command	/
Byte 1	0x00	Turn off DC-DC	/
	0x01	Turn on DC-DC	/
	0x02	Set target Vout in Constant Voltage (CV) mode	Applicable only to PBT223-ADJ Vout range = 1 - 22 (V), float, 2 decimal places Requires Byte 2 and Byte 3
	0x03	Set target Pout in Constant Power (CP) mode	Applicable only to PBT223-ADJ Pout range = 1 - 66 (W), float, 2 decimal places Requires Byte 2 and Byte 3
	0x04	Set target DAC value in DAC mode	Applicable only to PBT223-ADJ DAC range = 0 - 4095 (integer) Requires Byte 2 and Byte 3
	0x05	Set max Vin software protection	2 decimal places (V) Requires Byte 2 and Byte 3
	0x06	Set max Vout software protection	2 decimal places (V) Requires Byte 2 and Byte 3
	0x07	Set max Iout software protection	2 decimal places (A) Requires Byte 2 and Byte 3
	0x08	Set max Pout software protection	2 decimal places (W) Requires Byte 2 and Byte 3
	0x09	Turn on OLED screen	/
	0x10	Turn off OLED screen	/
	0x11	Enable data stream mode	2 ways to view data stream: 1) Via serial port tool, data format: ***/Vin, Vout, Iout, Pout, temperature/***, 2 decimal places 2) Download 'Serial Studio' software for real-time data graphing See User Manual for details
	0x12	Disable data stream mode	/
	0x13	Write data to EEPROM address	/
Byte 2	If Byte 1 is 0x02 - 0x08	Write integer part of value XX.XX	/

	If Byte 1 is 0x13	Select EEPROM address, save user-defined data: 0x00 - 0xDF	EEPROM addresses 0xE0 - 0xFF are reserved for specific functions
	Otherwise	Undefined, can be filled with any byte	/
Byte 3	If Byte 1 is 0x02 - 0x08	Write decimal part of value XX.XX	2 decimal places
	If Byte 1 is 0x13	Write EEPROM data: 0x00 - 0xFF	/
	Otherwise	Undefined, can be filled with any byte	/

2.3 Error Message

Error Message	
Byte 0 Error	"Error byte 0: unknown read / write command"
Byte 1 Error (Read)	"Error byte 1: unknown read command"
Byte 1 Error (Write)	"Error byte 1: unknown write command"

3. Protection Circuits

3.1 Electrical Software Protections

- User can use UART command to configure the software protection values: max Vin, max Vout, max Iout, max Pout.
- By default, the software protection

PN	Max Vin (V)	Max Vout (V)	Max Iout (A)	Max Pout (W)
PBT223-0V8	33.0	1.5	3.5	5.25
PBT223-3V3	33.0	4.5	3.5	15.75
PBT223-5V0	33.0	6.0	3.5	21.0
PBT223-12V	33.0	13.0	3.5	45.5
PBT223-22V	33.0	25.0	3.5	75.0
PBT223-ADJ	33.0	25.0	3.5	75.0

3.2 Electrical Input Protections

Protection Function	Hardware Input Protection	Software Input Protection
Over-voltage Protection (OVP)	TVS diode 36V over-voltage protection	• When Vin > max Vin for more than 300ms, MCU shuts down DC-DC output. • Users can set max input voltage max Vin via USART command (Python API).
Over-current Protection (OCP)	One-time fuse (Littlefuse USA) blows at I_{in} > 3.5A	/
Reverse Polarity Protection	PMOS reverse polarity protection	/

3.3 Electrical Output Protections

Protection	Hardware Output Protection	Software Output Protection
Over-voltage Protection (OVP)	• When Vout > 115% of the rated value, DC-DC shuts down output and Vout drops. When Vout drops to 110% of the rated value, DC-DC resumes output. • TVS diode protection to support both resistive and inductive load.	• When Vout > max Vout for more than 300ms, MCU shuts down DC-DC output • Users can set max Vout via USART command (Python API)
Under-voltage Protection (UVP)	When DC-DC malfunctions or load is abnormal and Vout < 65% of the rated value, DC-DC shuts down and enters hiccup mode.	/
Over-current Protection (OCP)	/	• When Iout > max Iout for more than 300ms, MCU shuts down DC-DC output • Users can set max Iout via USART command (Python API)
Short-circuit Protection (SCP)	DC-DC chip short-circuit protection	/
Over-power Protection (OPP)	/	• When Pout > max Pout for more than 300ms, MCU shuts down DC-DC output • Users can set max Pout via USART command (Python API)

3.4 Over Temperature Protection (OTP)

- The MCU will activate OTP and disable the DC-DC output when any of the following conditions are met:
  - The MCU internal temperature sensor >80°C for 300ms continuously
  - The temperature sensor near the DC-DC converter >120°C for 300ms continuously
  - The temperature of the DC-DC chip >165°C immediately
- The MCU will deactivate OTP and enable the DC-DC output when all of the following conditions are met:
  - The MCU internal temperature sensor <70°C for 300ms continuously
  - The temperature sensor near the DC-DC converter <110°C for 300ms continuously
  - The temperature of the DC-DC chip >135°C immediately

3.5 ESD Protection

ESD Protection Area	Protection Circuit	Notes
USB connector	TVS diode and capacitor	/
DC-DC Input Connector	TVS diode and capacitor	/
DC-DC Output Connector	TVS diode and capacitor High speed	Support both resistive and inductive load
PCBA Edge	Grounded and punched PCBA edge	/

4. Functional Block Diagram

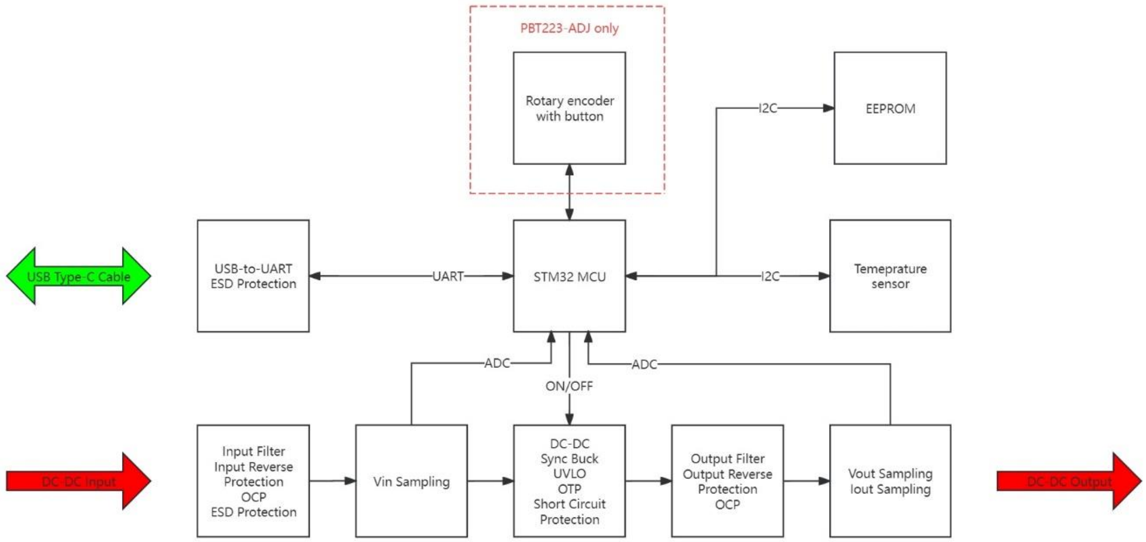


Figure 16 PBT223 Functional Block Diagram

5. Product Images

5.1 Real Product

Figure 17 PBT223-FIXED

Figure 18 PBT223-ADJ

5.2 2D Drawings

- 2D drawings formats: DWG, DXF, PNG
- Unit: mm

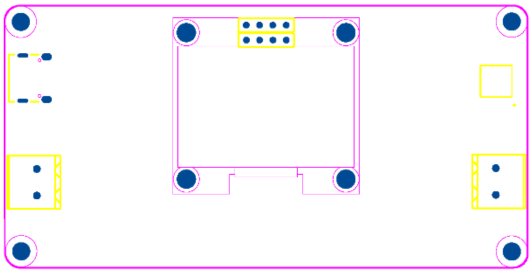


Figure 19 PBT223-FIXED

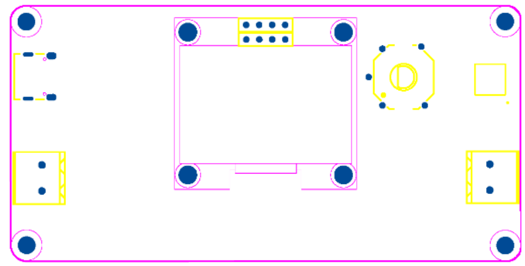


Figure 20 PBT223-ADJ

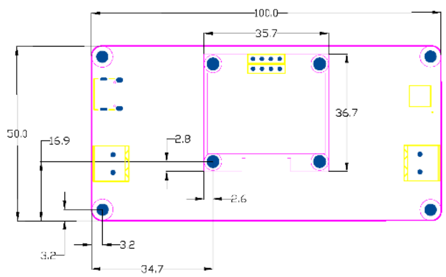


Figure 21 PBT223-FIXED

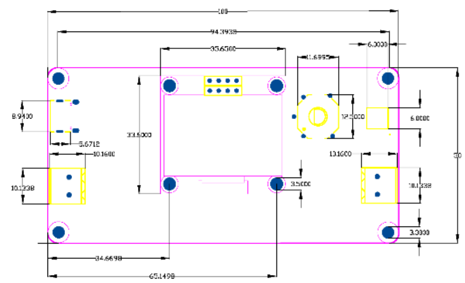


Figure 22 PBT223-ADJ

5.3 3D Models

- 3D model formats: STEP, STL, PDF 3D

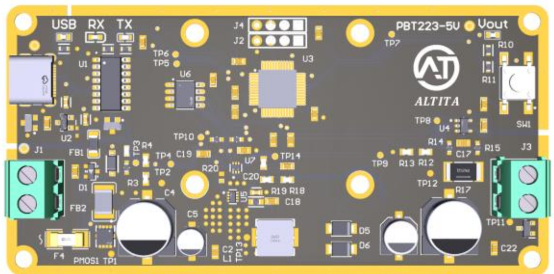


Figure 23 PBT223-FIXED

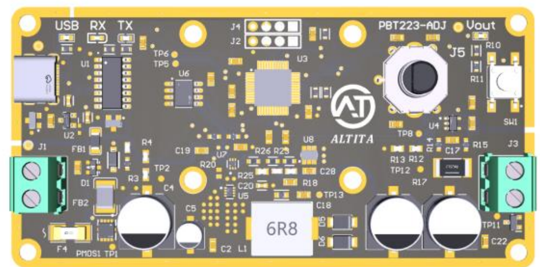


Figure 24 PBT223-ADJ

Figure 25 PBT223- FIXED

Figure 26 PBT223-ADJ

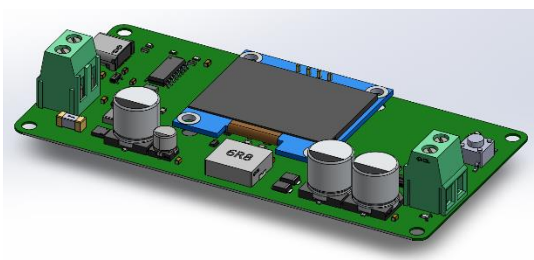


Figure 27 PBT223- FIXED

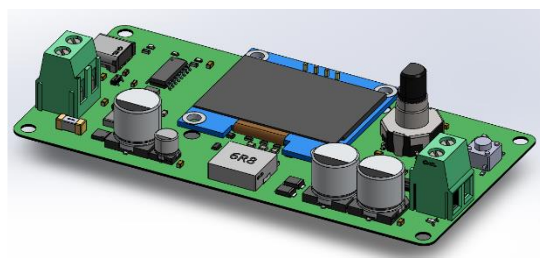
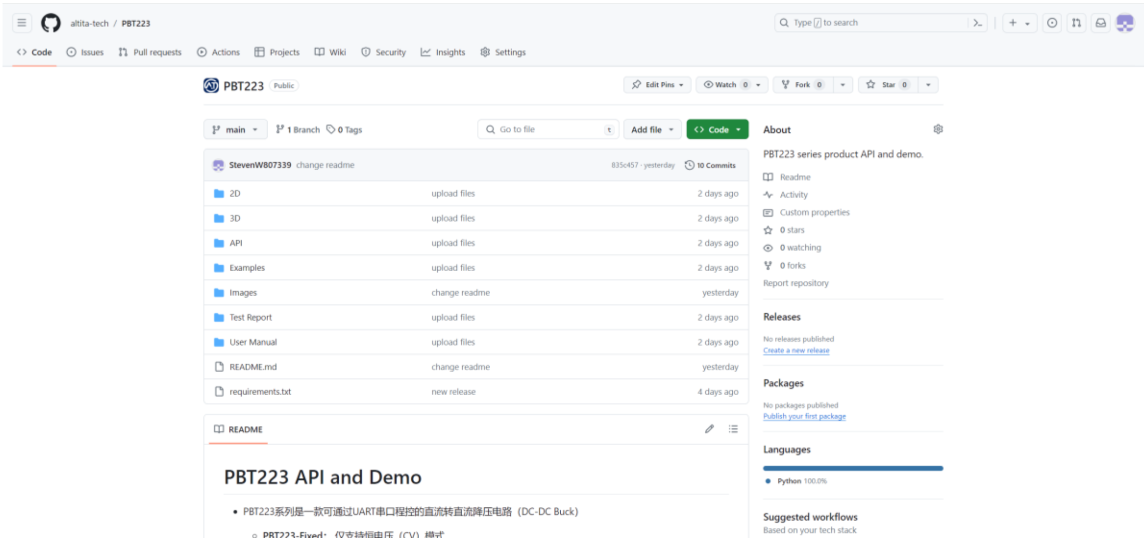


Figure 28 PBT223-ADJ

6. GitHub & Python API

- GitHub Link



7. Test Report

All products are 100% tested with a test report when delivered. Test report templates are given below.

- PBT223-FIXED test report
- PBT223-ADJ test report

8. Contact Us

- **Company Website**: https: //altita-tech.com/
- **Phone**: +86 13512122992 (Sales: Ms. Dong)
- **WeChat**: DL13512122992 (Sales: Ms. Dong)
- **Sales Email**: sales@altita-tech.com
- **Technical Support Email**: tech@altita-tech.com