ROHM Switching Regulator Solutions

Evaluation Board for ROHM's BU90005GWZ Synchronous Buck Converter with Integrated FET

BU90005GWZ-E2EVK-101 (2.5V | 1A Output) USAP58-A-0010

- **Introduction**
  This application note will explain the steps necessary to operate and evaluate ROHM's BU90005GWZ synchronous buck DC/DC converter using the BU90005GWZ-E2EVK-101 evaluation board. Component selection, board layout recommendations, operating procedures, and application data are included.

- **Description**
  This evaluation board has been specifically developed to evaluate the BU90005GWZ synchronous buck DC/DC converter with integrated 250mΩ high-side Pch and 220mΩ low-side Nch MOSFETs. Features include an input voltage range of 2.3V to 5.5V, 2.5V output, and a switching frequency range of 5.4MHz to 6.6MHz. Multiple protection functions are also built in, including a soft start circuit that prevents inrush current during startup, UVLO (Under Voltage Lock Out), TSD (Thermal Shutdown), and OCP (Over Current Protection). An EN pin allows for simple ON/OFF control to reduce standby current consumption, while a MODE pin enables selection between fixed PWM or fixed PFM operation to improve efficiency during light loads.

- **Applications**
  Smartphones, portables, compact DC/DC modules, USB accessories

- **Evaluation Board Operating Limits and Absolute Maximum Ratings**

Parameter		Symbol	Limit			Unit	Conditions
			MIN	TYP	MAX		
Supply Voltage							
	BU90005GWZ	V_{CC}	2.3	-	5.5	V	
Output Voltage / Current							
	BU90005GWZ	V_{OUT}	-	2.5	-	V	
		I_{OUT}	-	-	1	A	

- **Evaluation Board**
  Below is an image of the BU90005GWZ-E2EVK-101 evaluation board.

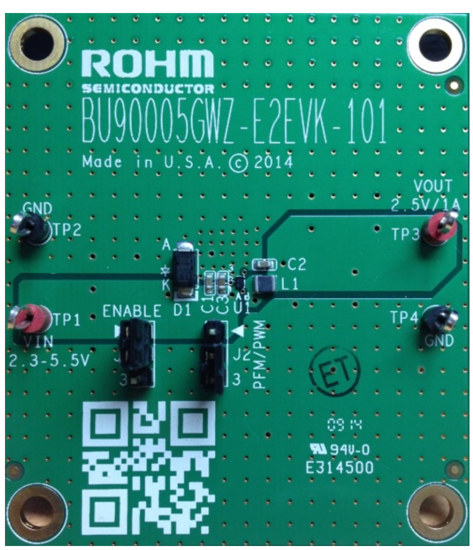
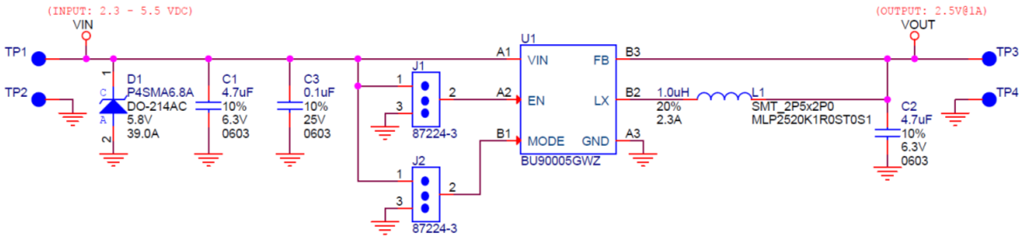


Fig 1: BU90005GWZ-E2EVK-101 Evaluation Board

Board Schematic



BU90005GWZ EVM Jumper Positions		
Reference Designator	Position	Description
J1	2 - 1	Jumper to enable U1. Active Mode
	2 - 3	Jumper to disable U1. standby Mode
J2	2 - 1	Jumper to select Forced PWM Mode
	2 - 3	Jumper to select Forced PFM Mode

Note:

2.3V =< VIN < 2.7V: IoutMAX = 0.6A
2.7V =< VIN < 3.0V: IoutMAX = 0.8A
3.0V =< VIN < 5.5V: IoutMAX = 1.0A
Forced PFM Mode : IoutMAX = 0.1A

Fig 2: BU90005GWZ-E2EVK-101 Evaluation Board Schematic

Board I/O

Below is a reference application circuit showing the inputs V_{IN}, EN, and MODE and output V_{OUT}.

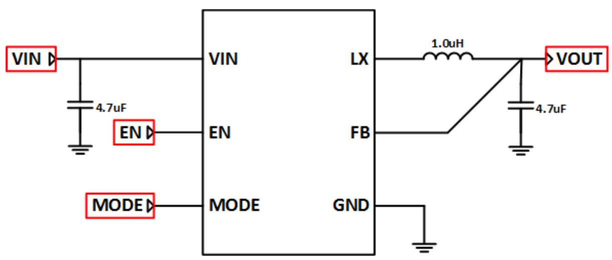


Fig 3: Evaluation Board I/O

Operating Procedures

1. Connect the power supply's GND terminal to GND test point TP2 on the evaluation board.
2. Connect the power supply's V_{CC} terminal to V_{IN} test point TP1 on the evaluation board. This will provide V_{IN} to the IC U1. Please note that V_{CC} should be in the range from 2.3V to 5.5V.
3. Set the operating mode of the IC by the position of shunt jumper J2 (connect Pin 2 to Pin1, the MODE pin of IC U1 will be pulled high and IC U1 will operate in Forced PWM mode, otherwise the MODE pin of IC U1 will be pulled low and IC U1 will operate in Forced PFM mode).
4. Check that the shunt jumper J1 is in the ON position (connect Pin 2 to Pin1, the EN pin of IC U1 is pulled high).
5. Connect the electronic load to TP3 and TP4. Do not turn the load ON (the electronic load is powered OFF).
6. Turn ON the power supply. The output voltage V_{OUT} (+2.5V) can be measured at test point TP3. Now turn the load ON. The load can be increased up to 1A MAX.

Notes:

In some instances the evaluation board may not operate after following the above power up sequence, possibly due to output current spikes that exceed current limit of 1A with the 1A electronic load setting as shown in Fig. 4. In these cases the built-inn OCP (Over Current Protection) circuit has most likely been activated to protect the IC by limiting the output voltage to 0.26V instead of the normal 2.5V. To resume normal operation, turn OFF any output loads and power down the input voltage. Then follow the operating procedure once again.

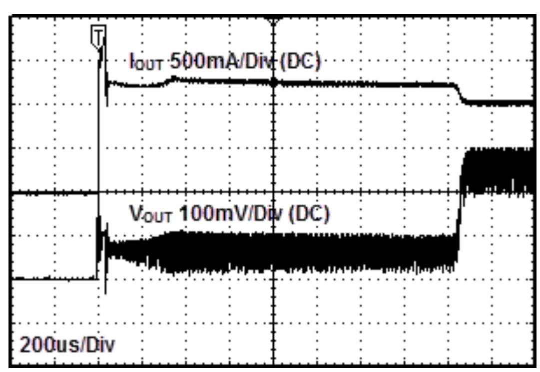


Fig 4: I_{OUT} vs. V_{OUT} When OCP is Activated

- **Reference Application Data**
  The following are graphs of the hot plugging test, quiescent current, efficiency, load response, and output voltage ripple response of the BU90005GWZ-E2EVK-101 evaluation board.

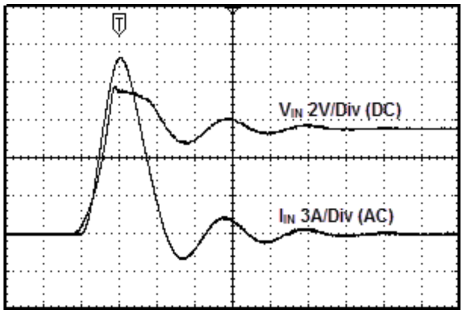


Fig 5: Hot Plug-in Test with Zener Diode P4SMA6.8A, V_{IN}=5.5V, V_{OUT}=2.5V, I_{OUT}=1A, Forced PFM Mode

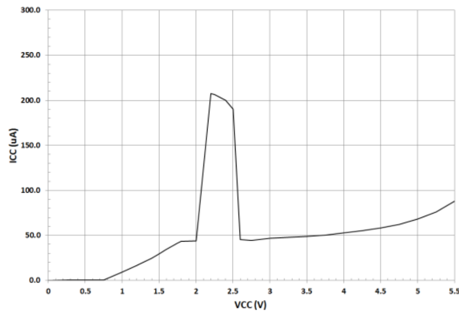


Fig 6: Circuit Current vs. Power Supply Voltage (Temp=25°C, Forced PFM Mode)

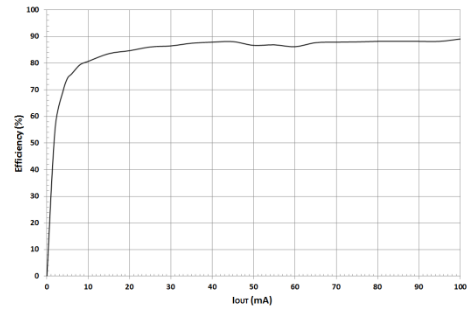


Fig 7: Electric Power Conversion Rate (V_{OUT}=2.5V, Forced PFM Mode)

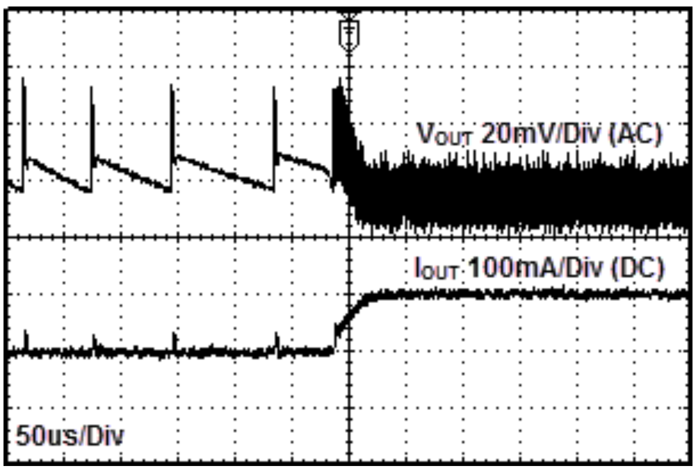


Fig 8: Load Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=0→100mA, Forced PFM Mode)

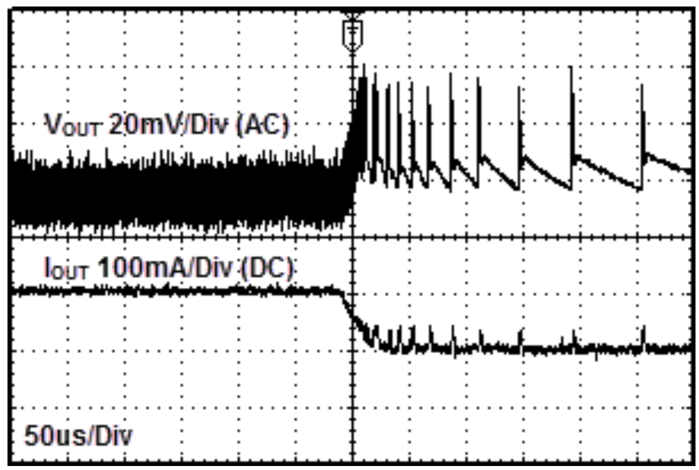


Fig 9: Load Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=100mA→0, Forced PFM Mode)

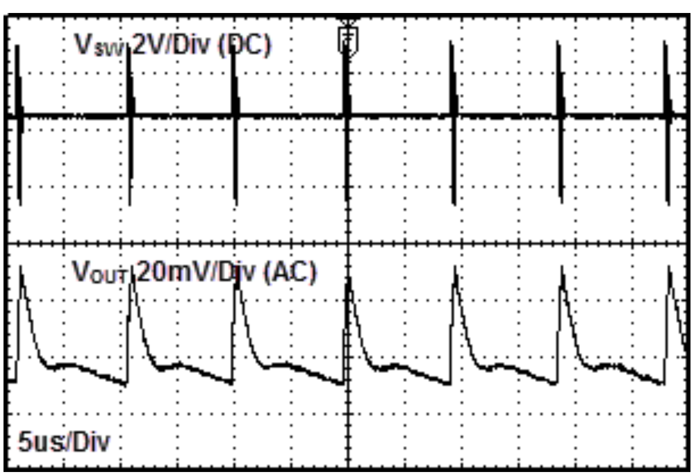


Fig 10: Output Voltage Ripple Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=10mA, Forced PFM Mode)

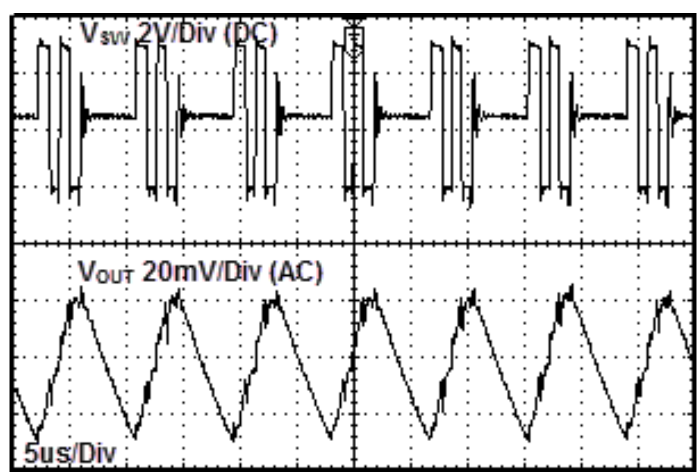


Fig 11: Output Voltage Ripple Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=100mA, Forced PFM Mode)

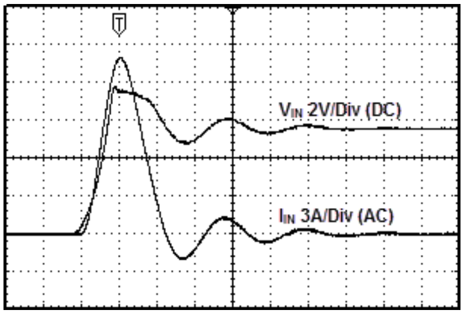


Fig 12: Hot Plug-in Test with Zener Diode P4SMA6.8A, V_{IN}=5V, V_{OUT}=2.5V, I_{OUT}=1A, Forced PWM Mode

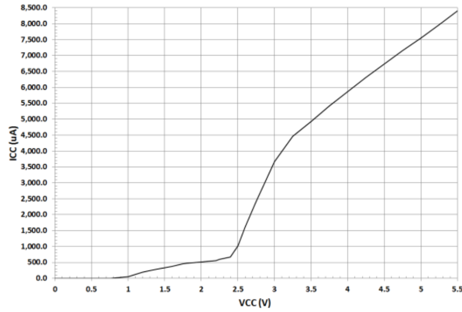


Fig 13: Circuit Current vs. Power Supply Voltage (Temp=25°C, Forced PWM Mode)

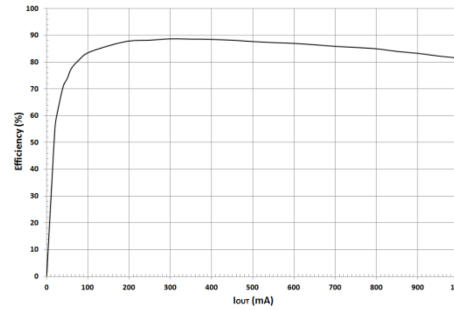


Fig 14: Electric Power Conversion Rate (V_{OUT}=2.5V, Forced PWM Mode)

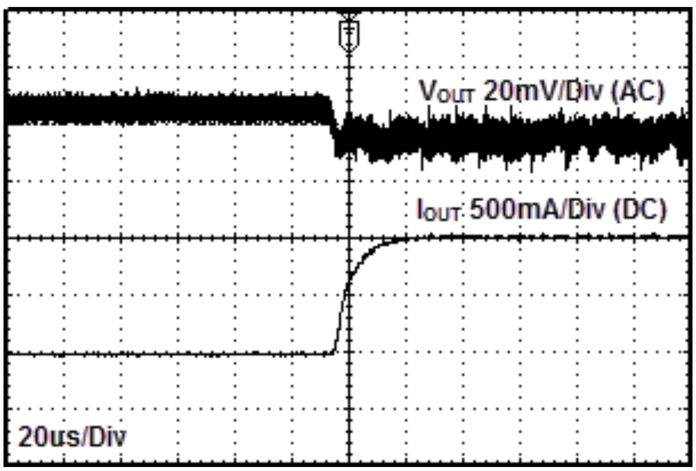


Fig 15: Load Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=0→1A, Forced PWM Mode)

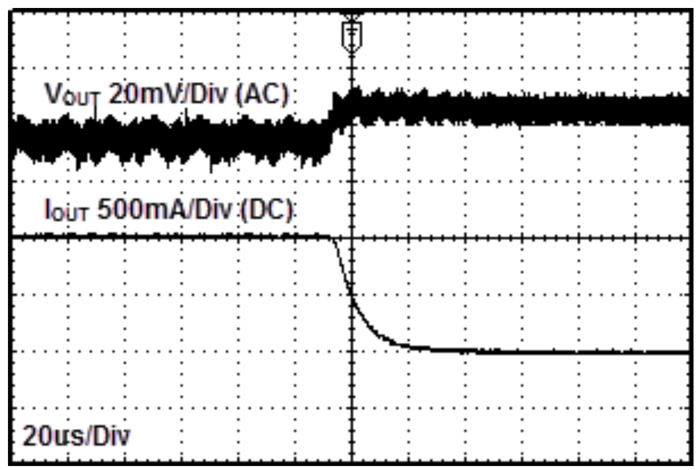


Fig 16: Load Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=1A→0, Forced PWM Mode)

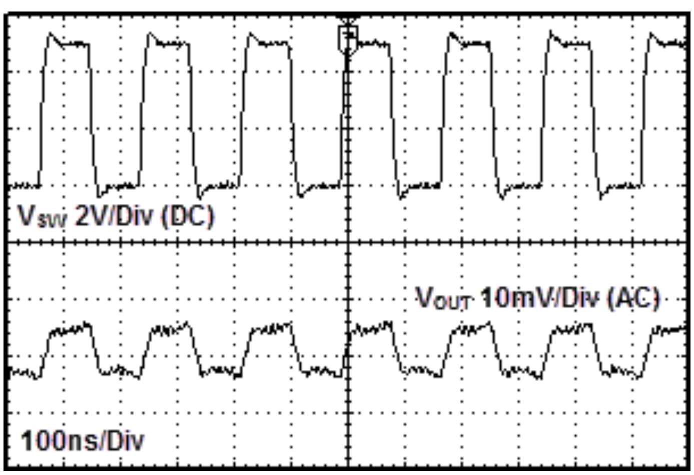


Fig 17: Output Voltage Ripple Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=0A, Forced PWM Mode)

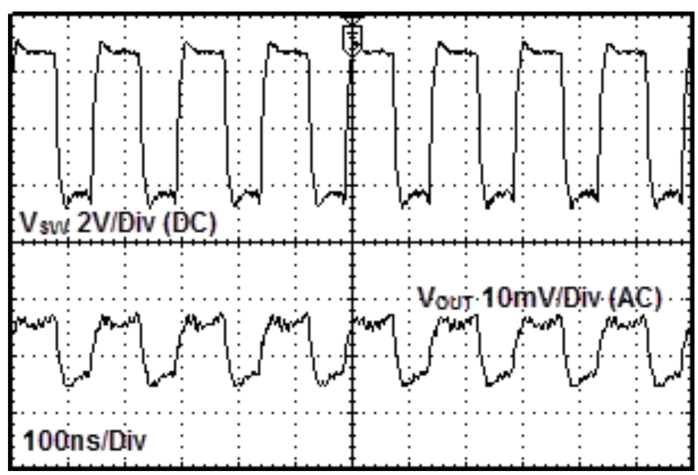


Fig 18: Output Voltage Ripple Response Characteristics (V_{IN}=5V, V_{OUT}=2.5V, L=1.0uH, C_{OUT}=4.7uF, I_{OUT}=1A, Forced PWM Mode)

- **Evaluation Board Layout Guidelines**

Below are guidelines that have been tested and recommended for BU90005GWZ designs.

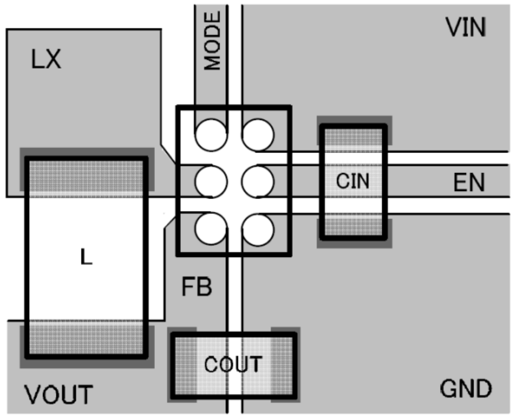


Fig 19: BU90005GWZ-E2EVK-101 PCB Layout

① The input capacitor C_{IN} should be mounted as close as possible to the IC's VIN and GND pins.
② The output voltage block should be placed as far as possible from the FB pin.
③ C_{OUT} and L should be connected as close as possible. Also, to reduce noise the L wiring should be as close as possible to the LX pin.

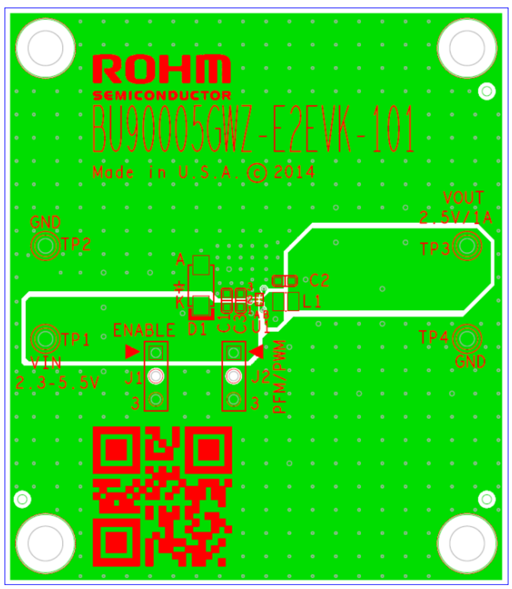


Fig 20: BU90005GWZ-E2EVK-101 Board Layout

- **Application Circuit Component Selection**

Inductor (L)

The inductance has a significant effect on the output ripple current. As shown by the following equation, the ripple current decreases as the inductor and/or switching frequency increase.

$$\Delta I_L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{L \times V_{IN} \times f}$$

(f: Switching Frequency, L: Inductance, ΔI_L: Inductor Current Ripple)

As a minimum requirement, the DC current rating of the inductor should be at least equal to the maximum load current plus half of the inductor ripple current as shown by the equation below.

$$I_{LPEAK} = I_{OUTMAX} + \frac{\Delta I_L}{2}$$

- **Evaluation Board BOM**
  Below is a table showing the bill of materials. Part numbers and supplier references are also provided.

No.	Qty.	Ref	Description	Manufacturer	Part Number
1	2	C1,C2	CAP CER 4.7UF 6.3V 10% X5R 0603	Murata	GRM188R60J475KE19D
2	1	C3	CAP CER 0.1UF 25V 10% X7R 0603	Murata	GRM188R71E104KA01D
3	1	D1	DIODE TVS 400W 6.8V UNI 5% SMD	Littelfuse Inc	P4SMA6.8A
4	2	J1,J2	CONN HEADER VERT .100 3POS 15AU	TE Connectivity	87224-3
5	1	L1	INDUCTOR POWER 1.0UH 2.3A SMD	TDK	MLP2520K1R0ST0S1
6	2	TP1,TP3	TEST POINT PC MULTI PURPOSE RED	Keystone Electronics	5010
7	2	TP2,TP4	TEST POINT PC MULTI PURPOSE BLK	Keystone Electronics	5011
8	1	U1	IC REG BUCK SYNC 2.5V 1A 6WLCSP	ROHM	BU90005GWZ-E2
9	2		Shunt jumper for header J1, J2 (item #4), CONN SHUNT 2POS GOLD W/HANDLE	TE Connectivity	881545-1

ROHM SEMICONDUCTOR

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