# User's Guide

## FJ05S06NAL-A 5V, 6A BUCK Regulation Evaluation Module User's Guide

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# ABSTRACT

With an input operating voltage range from 3V to 5.7V and rated output current 6 A, the FJ05S06NAL-A buck power module provides flexibility, scalability, and optimized solution size for 5V bus applications. With integrated power MOSFETs, buck inductor and PWM controller, the module Enable DC/DC solutions with high density, low EMI, and increased flexibility.

The FJ05S06NAL-A EVM uses the FJ05S06AL-A easy-to-use synchronous buck module with a output voltage range of 0.9V to 3.7V and an output current up to 6A. The default output voltage of the EVM is set to 1.0V can be adjusted to 3.3 V through a jumper setting.

# 1. EVM Description

The FJ05S06NAL-A EVM features the FJ05S06NAL-A synchronous buck power module configured for operation with typical 5V bus applications. The output voltage can be set to either 1.0 V or 3.3 V and switching frequency fixed to 1MHz. The EVM provides the full 6A output current rating of the device. The selected input and output capacitors accommodate the entire range of input voltage and the selectable output voltages on the EVM and are available from multiple component vendors. Input and output voltage sense terminals and a test point header facilitate measurement of the following.

- Efficiency and power dissipation
- Line and load regulation
- Enable ON, OFF

# 2. Test Setup and Procedure

## 2.1 EVM Connections

Referencing the EVM connections described in Table 2-1, use the recommended test setup in Figure 2-1 to evaluate the FJ05S06NAL-A. Working at an ESD-protected workstation, make sure that any wrist straps, bootstraps, or mats are connected and referencing the user to earth ground before power is applied to the EVM.

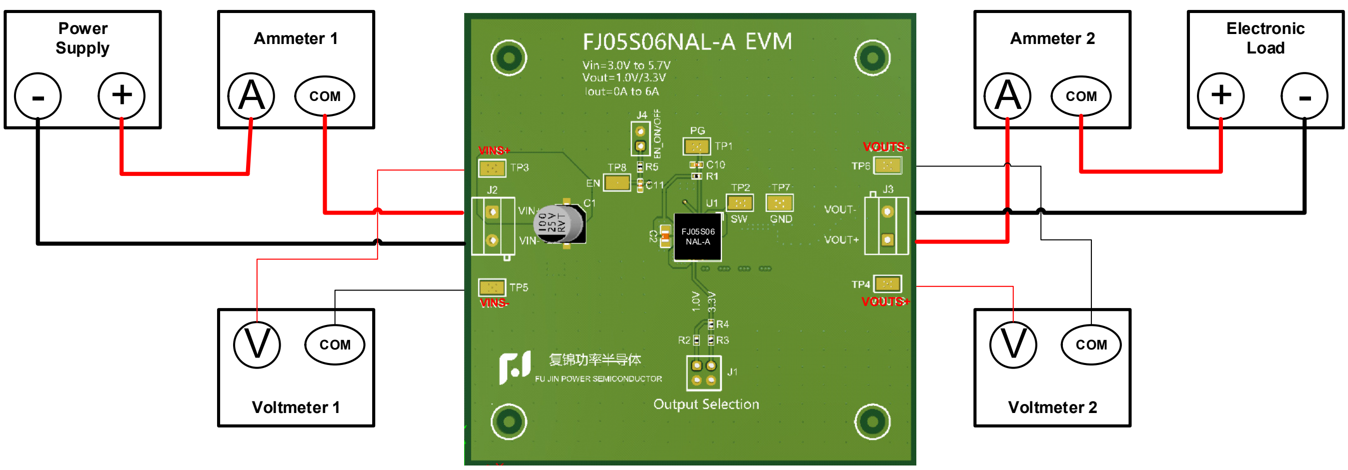



Figure 2-1 EVM test connection

Table 2-1 EVM Power connection

| LABEL | Description |
|---|---|
| VIN+ | Positive input power connection |
| VIN- | Negative input power connection |
| VOUT+ | Positive output power connection |
| VOUT- | Negative output power connnection |

Table 2-2 EVM signal connection

| LEBAL | Description |
|---|---|
| VINS+ | Positive input sense terminal. Connect the multimeter positive lead for measuring efficiency |
| VINS- | Negative input sense terminal. Connect the multimeter negative lead for measuring efficiency |
| VOUTS+ | Positive output sense terminal. Connect a multimeter positive lead for measuring efficiency and line and load regulation. |
| VOUTS- | Negative output sense terminal. Connect a multimeter negative lead for measuring efficiency and line and load regulation |
| GND | Ground reference point |
| SW | Switch node |
| EN | Connect EN to GND to disable the regulator. Leave EN open for default enabled. |
| PG | Power-good monitor output. PG is an open drain output. |

## 2.2 EVM Setup

Use the VINS+ and VINS– test points along with the VOUTS+ and VOUTS– test points located near the power terminal blocks as voltage monitoring points where voltmeters are connected to measure the input and output voltages, respectively. Do not use these sense terminals as the input supply or output load connection points. The PCB traces connected to these sense terminals are not designed to support high currents.The **OUTPUT SELECTION** header (J1) allows selection of either 1.0 V or 3.3 V. Before applying power to the EVM, make sure that the jumper is present and properly positioned for the intended output voltage. Always remove input power before changing the jumper settings.

## 2.3 Test Equipment

**Voltage source:** the input voltage source VIN must be a 5.0V variable DC source capable of suppling 6A.

**Multimeters:**
**Voltmeter 1:** Measure the input voltage.

**Voltmeter 2:** Measure the output voltage.

**Ammeter 1:** Measure the input current.

**Ammeter 2:** Measure the output current.

**Electronic Load:** Use an electronic load set to constant-resistance (CR) or constant-current (CC) mode. For a no-load input current measurement, disconnect the electronic load as it can draw a small residual current.

**Oscilloscope:** With the scope set to 20-MHz bandwidth and AC coupling, measure the output voltage ripple directly across an output capacitor with a short ground lead normally provided with the scope probe. Place the oscilloscope probe tip on the positive terminal of the output capacitor, holding the ground barrel of the probe through the ground lead to the negative terminal of the capacitor. FJ does not recommend using a long-leaded ground connection because this may induce additional noise given a large ground loop. To measure other waveforms, adjust the oscilloscope as needed.

## 2.4 Recommended Test Setup

### 2.4.1 input connection

- Prior to connecting the DC input source, set the current limit of the input supply to 0.1A maximum. Ensure the input source is initially set to 0 V and connected to the VIN+ and VIN– connection points as shown in Figure 2-1.
- Connect voltmeter 1 at VINS+ and VINS– connection points to measure the input voltage.
- Connect ammeter 1 to measure the input current and set it to at least a 0.1-second aperture time.

### 2.4.2 Output connection

- Connect an electronic load to the VOUT+ and VOUT– connections as shown in Figure 2-1. Set the load to constant-resistance mode or constant-current mode at 0 A before applying input voltage.
- Connect voltmeter 2 at VOUTS+ and VOUTS– sense points to measure the output voltage.
- Connect ammeter 2 to measure the output current and set it to at least a 0.1-second aperture time.

## 2.5 Test Procedure

### 2.5.1 Line, Load Regulation and Efficiency

Set up the EVM as described in *Test Setup and Procedure*.

- Set load to constant resistance or constant current mode to sink 0A.
- Increase the input source voltage from 0 V to 5.0 V; use voltmeter 1 to measure the input voltage.
- Increase the current limit of the input supply to 6 A.
- Use voltmeter 2 to measure the output voltage, and vary the load current from 0A to 6A DC; VOUT must remain within the load regulation specification.
- Set the load current to 3 A (50% rated load) and vary the input source voltage from 3.0 V to 5.0 V; $V_{OUT}$ must remain within the line regulation specification.
- Set the load current to 6 A (100% rated load) and measure the efficiency at typical input voltages (3.3V, 5.0V).
- Decrease the load to 0 A. Decrease the input source voltage to 0 V.

# 3. Test Data and Performance Curves

Because actual performance data can be affected by measurement techniques and environmental variables, these curves are presented for reference and can differ from actual field measurements. Unless otherwise indicated, $V_{IN}$ = 5.0 V, $V_{OUT}$ = 1.0 V, $I_{OUT}$ = 6 A, and $F_{SW}$ = 1 MHz.

## 3.1 Efficiency and Load Regulation Performance

This section provides efficiency and load regulation plots for the EVM.

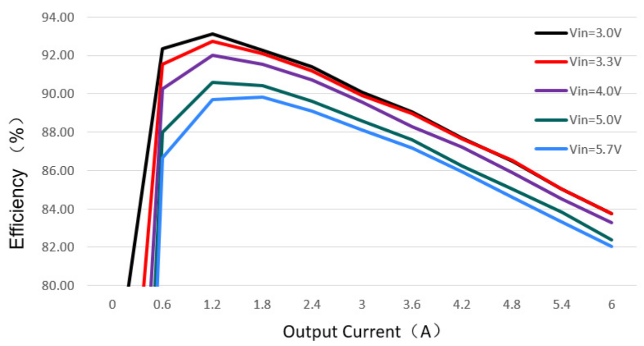



Figure 3-1. Efficiency Vout=1.0V, Fsw=1MHz

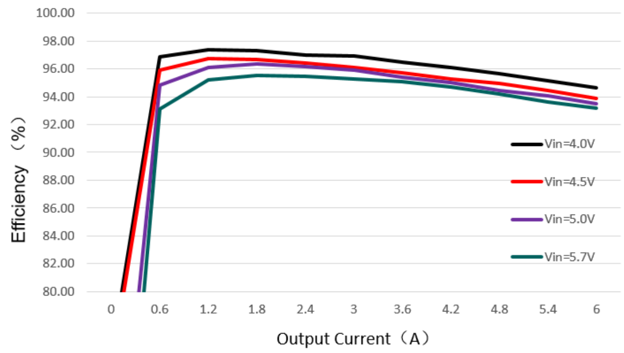



Figure 3-2. Efficiency Vout=3.3V, Fsw=1MHz

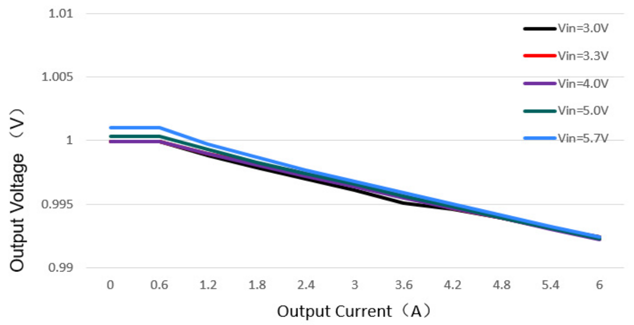



Figure 3-3. Load Regulation Vout=1.0V, Fsw=1MHz

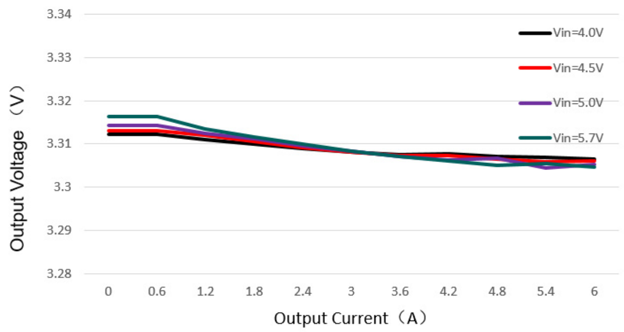



Figure 3-4. Load Regulation Vout=3.3V, Fsw=1MHz

## 3.2 Waveforms

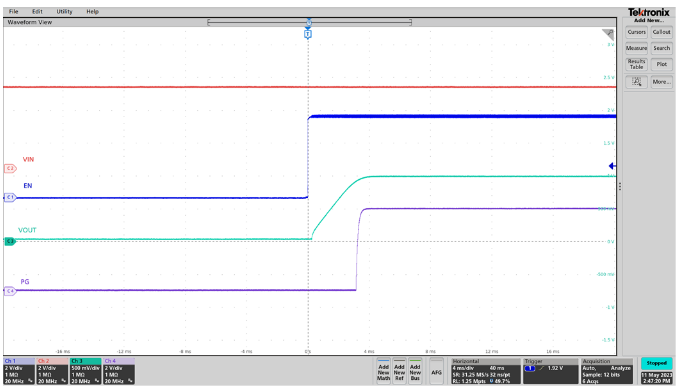



Figure3-5. EN ON @5Vin, 1Vout

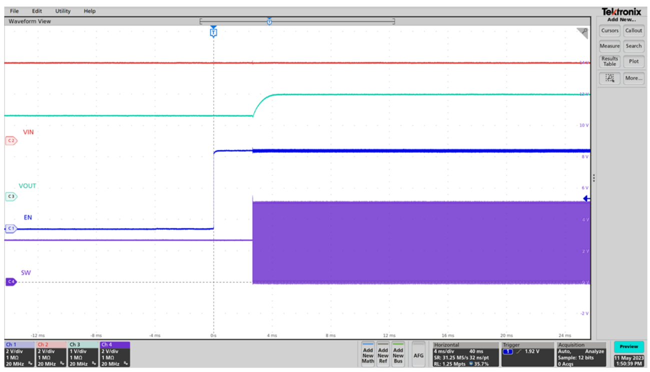



Figure3-6. 3.3Vout pre-bias

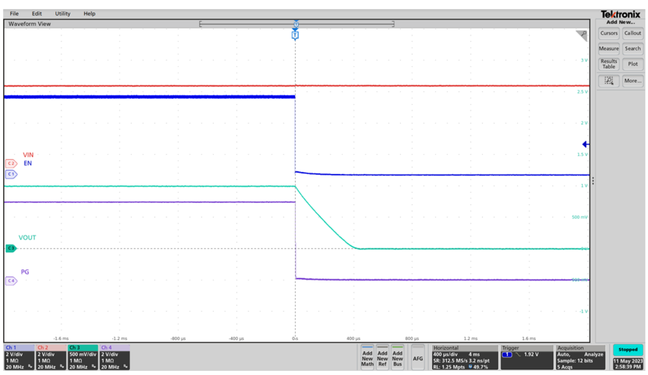



Figure3-7. EN OFF @5Vin,1Vout

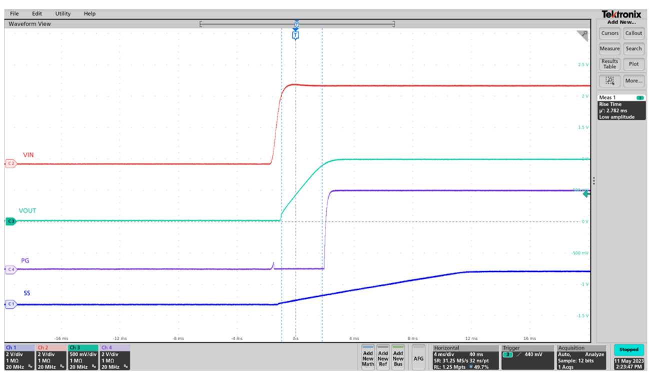



Figure3-8. Start up, 5Vin and 1.0Vout

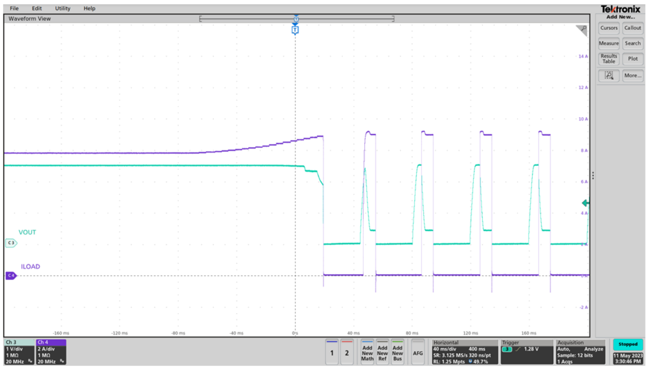


Figure3-9. OCP @3.3Vout

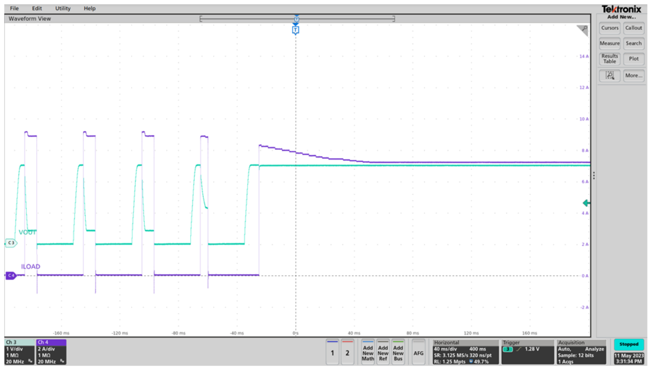


Figure3-10. OCP recovery @3.3Vout

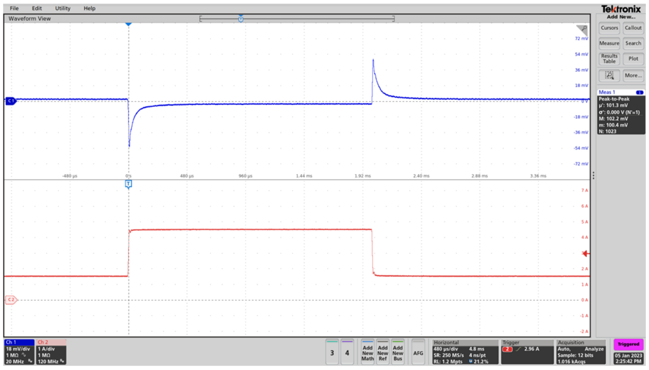


Figure3-11. Dynamic @1.0V out, 1.5A to 4.5A 1A/us

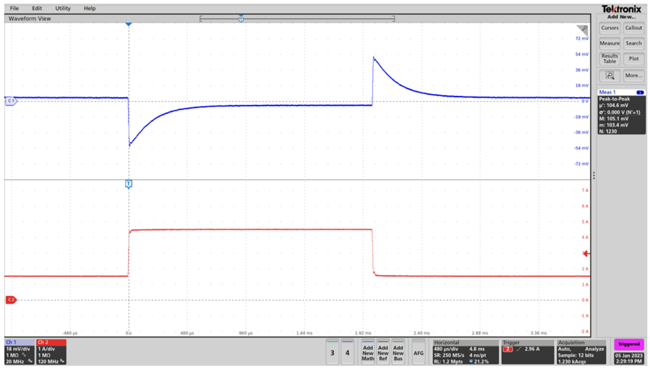
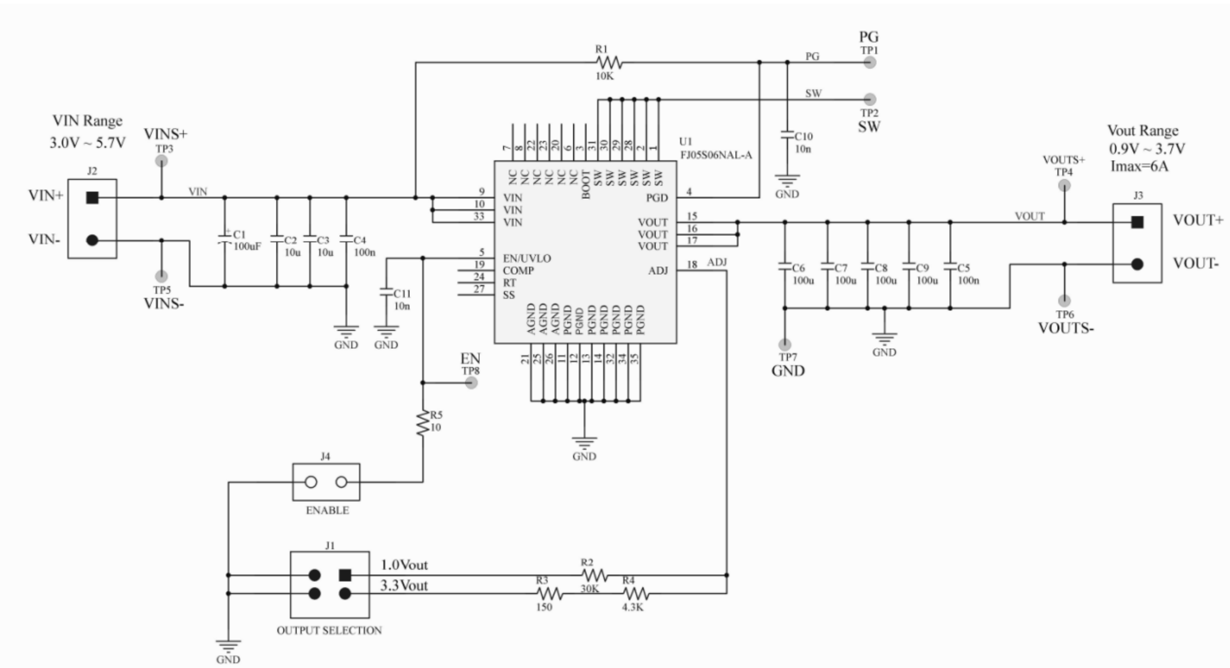


Figure3-12. Dynamic @3.3V out, 1.5A to 4.5A 1A/us

# 4. EVM documentation

## 4.1 Sechmatic



## 4.2 Bill of Materials

Table 4-1 Components BOM

| REF DES | QTY | VALUE | DESCRIPTION | PACKAGE | PART NUMBER | MANUFACTURER |
|---|---|---|---|---|---|---|
| J1 | 1 | | Header, 100mil, 2 × 2, Tin, TH | | | |
| J2, J3 | 2 | | TERM BLOCK 2POS 5mm, TH | | 1729018 | Phoenix Contact |
| J4 | 1 | | Header, 100mil, 2 × 1, Tin, TH | | | |
| C1 | 1 | 100uF | 100uF,±20%,16V,-55~+105℃ | SMD,D6.3xL5.3mm | VES101M1CTR-0605 | lelon |
| C2, C3 | 2 | 10uF | 10uF, ±10%, 25 V, X7R | C0805 | GRM21BZ71E106KE15L | Murata |
| C4, C5, C10 | 3 | 100nF | 100nF, ±10%, 50 V, X7R | C0402 | CC0402KRX7R9BB104 | YAGEO |
| C6, C7, C8, C9 | 4 | 100uF | 100uF, ±20%, 6.3 V, X7S | 1210 | GRM32EC70J107ME15L | Murata |
| C10,C11 | 2 | 10nF | 10nF, ±10%, 50 V, X7R | C0402 | CC0402KRX7R9BB103 | YAGEO |
| U1 | 1 | | 3.0V~5.7Vin, .09V~3.7Vout, Imax=6A | 7x7x4mm | FJ05S06NAL-A | FJ |
| R1 | 1 | 10k | ±1% | R0402 | RC0402FR-0710KL | YAGEO |
| R2 | 1 | 30k | ±1% | R0402 | RC0402FR-0730KL | YAGEO |
| R3 | 1 | 150 | ±1% | R0402 | RC0402FR-07150RL | YAGEO |
| R4 | 1 | 4.3k | ±1% | R0402 | RC0402FR-074K3L | YAGEO |
| R5 | 1 | 10 | ±1% | R0402 | RC0402FR-0710RL | YAGEO |
| TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8 | 8 | | Test Point, Miniature, SMT | - | 5019 | Keystone |

## 4.3 PCB LAYOUT

Figure 4-1 through Figure 4-4 show the PCB layout copper images.

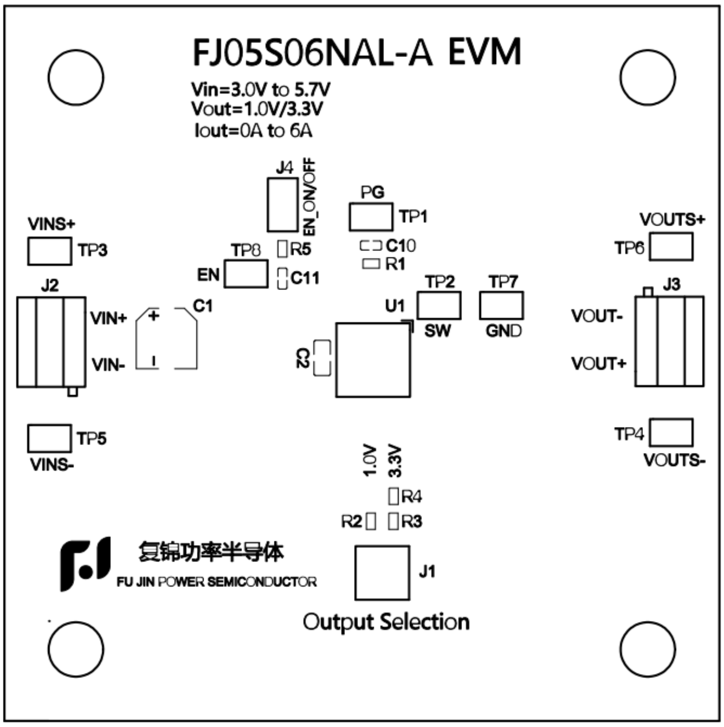


**Figure 4-1. TOP VIEW**

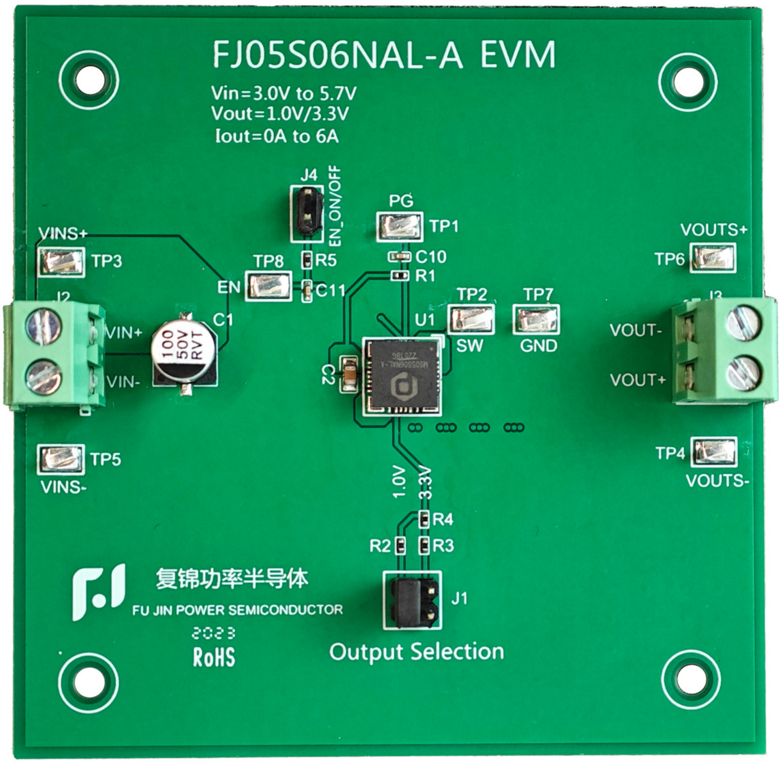
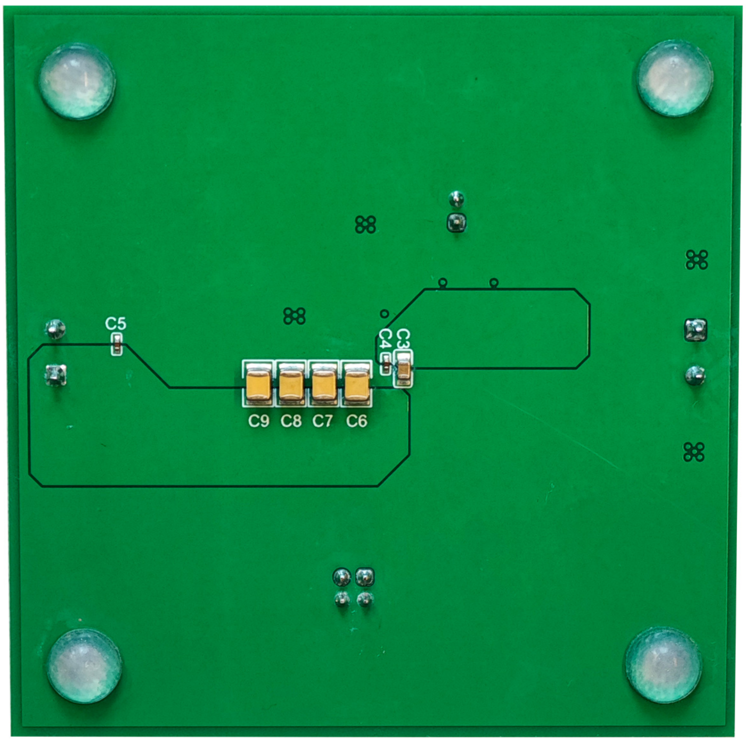



**Figure 4-2. BOTTOM VIEW**



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