

2.3 μ A I_q/High Switching Frequency RBCOT Buck Converter for Fast Transient Response

General Description

The RT5716 is a synchronous step-down converter with 4MHz typical switching frequency. This document only specifies the RT5716 in WL-CSP package. It explains the function and operation of the RT5716 evaluation board (EVB) and provides information about the setting of the evaluation board.

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Performance Specifications

Performance specifications of the RT5716 are listed in Table 1.

($V_{IN} = 3.6V$, $C_{IN} = 4.7\mu F$, $C_{OUT} = 4.7\mu F \times 2$, $L = 0.47\mu H$, $T_J = -40^\circ C$ to $125^\circ C$, typical values are at $T_J = 25^\circ C$, unless otherwise specified)

Table 1. Performance Specifications of the RT5716

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Input Voltage	V_{IN}		1.8	--	5.5	V
Output Current	I_{OUT}	$V_{IN} \geq 2.3V$ For RT5716P-ABA, RT5716P-BBA, RT5716P-CBA, RT5716P-DBA	--	--	1	A
		$V_{IN} < 2.3V$ For RT5716P-ABA, RT5716P-BBA, RT5716P-CBA, RT5716P-DBA	--	--	0.7	A
Switching Frequency	f_{SW}		--	4	--	MHz
Quiescent Current into VIN Pin (Non-Switching)	$I_{Q_IN-NONSW}$	$EN = V_{IN}$, $V_{OUT} = 1.2V$, $I_{OUT} = 0A$, $RSEL/MODE = GND$, $T_J = -40^\circ C$ to $85^\circ C$	--	2.3	3.7	μA
Quiescent Current into VIN Pin (Switching)	I_{Q_IN-SW}	$EN = V_{IN}$, $V_{OUT} = 1.2V$, $I_{OUT} = 0A$, $RSEL/MODE = GND$	--	2.5	--	
Shutdown Current	I_{SHDN}	$EN = GND$, $RSEL/MODE = GND$, $T_J = -40^\circ C$ to $85^\circ C$	--	55	290	nA

Power-up Procedure

Equipment Required

- RT5716 Evaluation Board
- DC power supply capable of at least 5.5V and 3A
- Electronic load capable of 1A
- Function Generator
- Oscilloscope

Quick Start Procedures

The evaluation board is fully assembled and tested. Follow the steps listed below to verify its functionality. Do not turn on power supplies until all equipment is well-connected. Do not measure the output voltage ripple with a long ground lead on the oscilloscope probe. Instead, touch the probe tip and ground ring directly across the output capacitor.

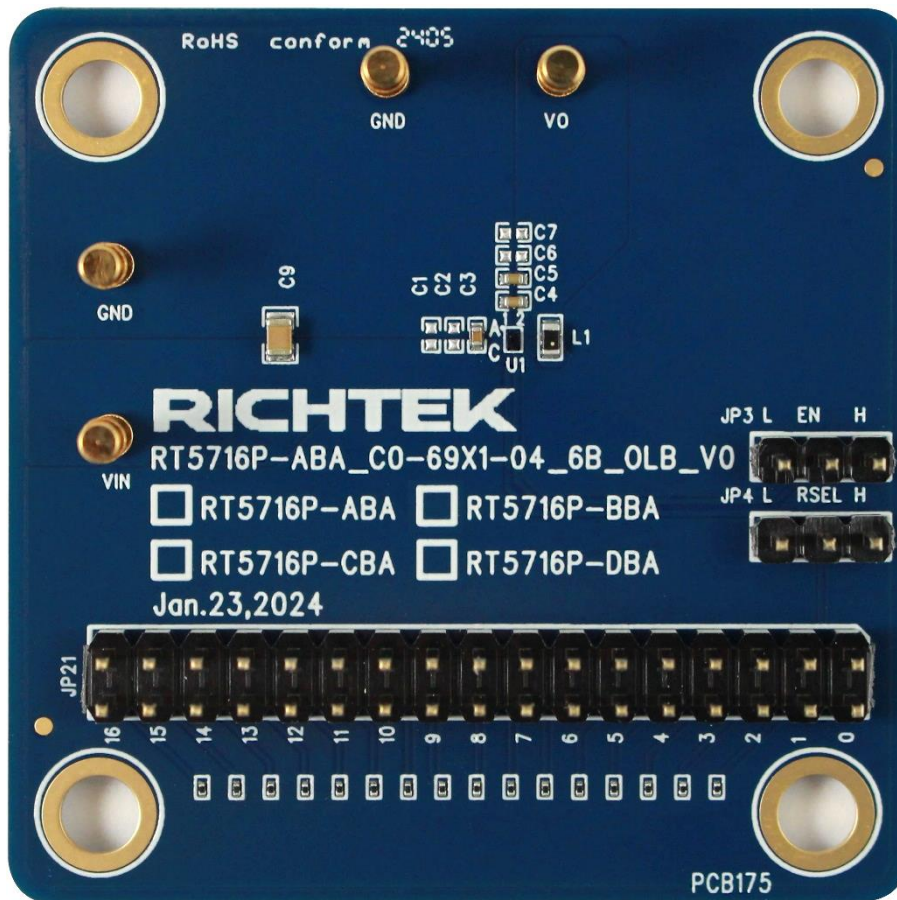
The setup procedures are listed below.

- 1) Connect JP4 between the RSEL/MODE pin and GND to set output voltage level.
- 2) Connect the power supply to VIN and GND pins and the electronic load to the VO and nearest GND pins before power on.
- 3) Turn on the input power supply and make sure that the input voltage does not exceed 5.5V.

- 4) Enable/disable the RT5716 by the EN pin. When the EN pin is higher than the threshold voltage of logic-high, the IC operates at normal mode; When the EN pin goes low, the RT5716 enters shutdown mode. In shutdown mode, the converter stops switching, internal control circuitry is turned off and discharge function is triggered.
- 5) When RT5716 starts up, the RSEL/MODE pin operates as an input used for mode selection. When connecting the RSEL/MODE pin to L, the RT5716 operates at Auto Mode, which is PFM mode; On the other hand, the RT5716 operates at FPWM mode when connecting the RSEL/MODE pin to H.
- 6) Check the output voltage by a voltmeter.
- 7) Adjust the load within the operating range and measure the output voltage regulation, ripple voltage, power efficiency and other performances.

Detailed Description of Hardware

Headers Description and Placement



Carefully inspect all the components used on the EVB according to the following Bill of Materials table, and make sure all the components are undamaged and correctly installed. If there is any missing or damaged component, which may occur during transportation, please contact our distributors or e-mail us at evb_service@richtek.com.

Test Points

The test points and pin names are listed in the table below.

Test Point/ Pin Name	Function
VIN	Input voltage.
VO	Output voltage.
GND	Ground.
EN	Enable pin.
RSEL/MODE	Output voltage level and operation mode selection pin.

Bill of Materials

RT5716P-ABA/RT5716P-BBA/RT5716P-CBA/RT5716P-DBA

Reference	Qty	Part Number	Value	Description	Package	Manufacturer
U1	1	RT5716P-ABA RT5716P-BBA RT5716P-CBA RT5716P-DBA	RT5716	Step-Down Converter	TWL-CSP-6B 0.69x1.04 (BSC)	RICHTEK
C3, C4, C5	3	GRM155R60J475ME47D	4.7 μ F	Capacitor, Ceramic, 6.3V, X5R	0402	Murata
C9	1	GRM21BC80J476ME01	47 μ F	Capacitor, Ceramic, 6.3V, X6S	0805	Murata
L1	1	DFE18SANR47MG0L	0.47 μ H	0.47 μ H	0603	Murata
JP21	16	RC0201FR-0710KL (Resistor E96 series)	Refer to Table 2	1%, TC \pm 200ppm	0201	YAGEO

Output Voltage Selection

The RT5716 provides 1 fixed and 16 different levels of V_{OUT} which can be set by an external resistor connected between the RSEL/MODE pin and GND. Table 2 indicates the setting to different output voltage level.

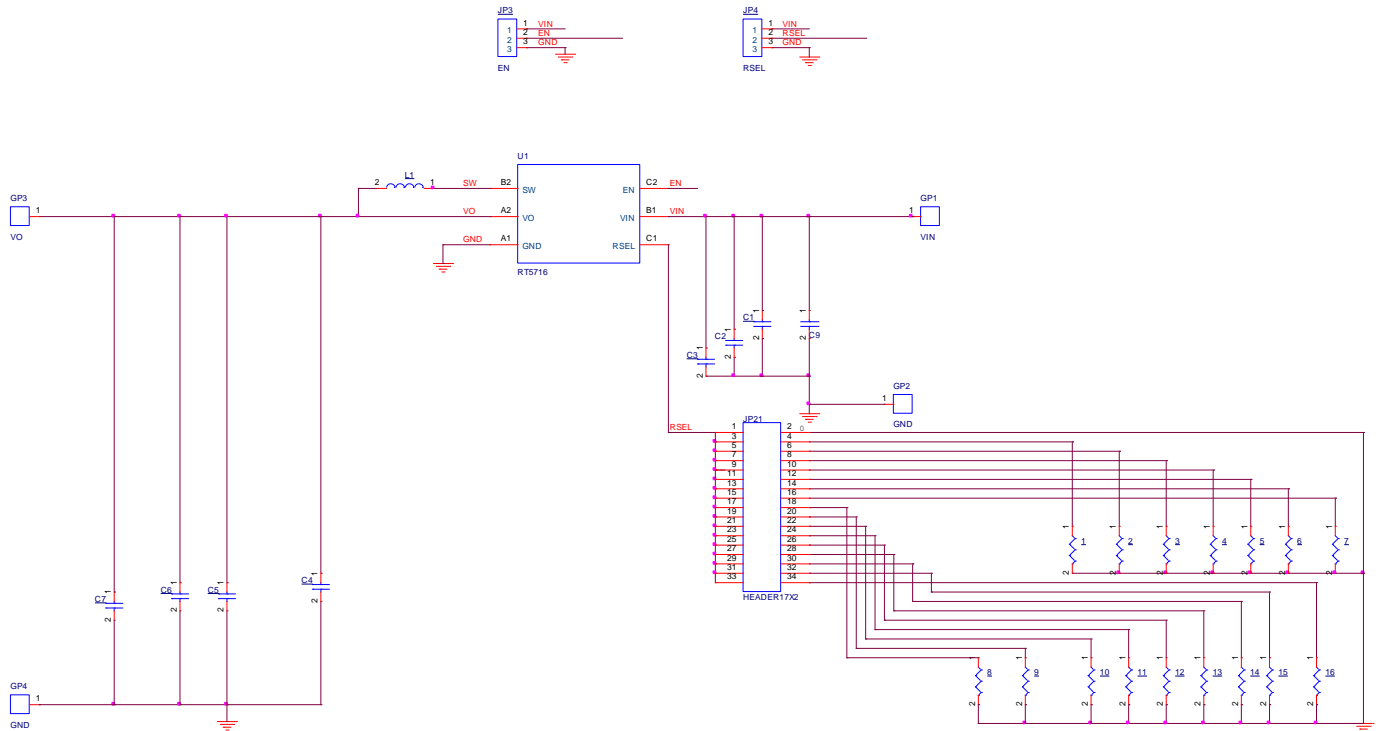
Table 2. Output Voltage Setting

Type	Output-1 (V)	Output-2 (V)	Output-3 (V)	Output-4 (V)	RSEL (kΩ) *		
Level	0.4V to 3.3V	0.4V to 0.775V	0.8V to 1.55V	1.8 V to 3.3V	Min	Nom	Max
0	3.3	0.7	1.2	1.8	Connected to GND (No resistor needed)		
1	0.4	0.4	0.8	1.8	9.9	10	10.1
2	0.58	0.425	0.85	1.9	12	12.1	12.2
3	0.6	0.45	0.9	2	15.2	15.4	15.6
4	0.7	0.475	0.95	2.1	18.5	18.7	18.9
5	0.75	0.5	1	2.2	23.5	23.7	23.9
6	0.8	0.525	1.05	2.3	28.4	28.7	29
7	1.1	0.55	1.1	2.4	36.1	36.5	36.9
8	1.2	0.575	1.15	2.5	43.8	44.2	44.6
9	1.3	0.6	1.2	2.6	55.6	56.2	56.8
10	1.5	0.625	1.25	2.7	67.4	68.1	68.8
11	1.6	0.65	1.3	2.8	85.7	86.6	87.5
12	1.8	0.675	1.35	2.9	104	105	106.1
13	1.9	0.7	1.4	3	131.7	133	134.3
14	2.5	0.725	1.45	3.1	160.4	162	163.6
15	3	0.75	1.5	3.2	203	205	207.1
16	3.3	0.775	1.55	3.3	≥249	≥249	≥249

*: E96 resistor series, 1% accuracy, temperature coefficient better or equal than ±200 ppm/°C.

Typical Applications

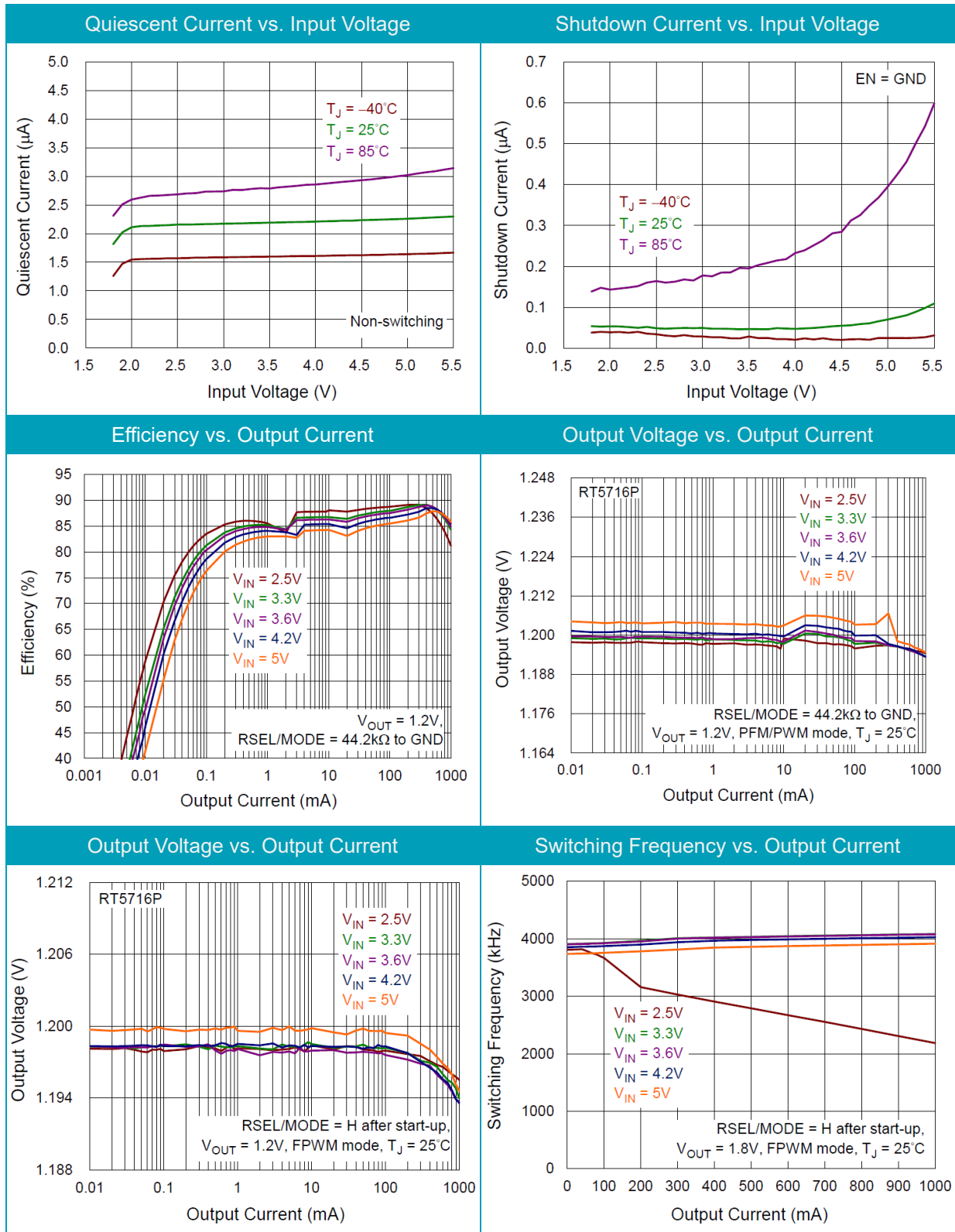
EVB Schematic Diagram

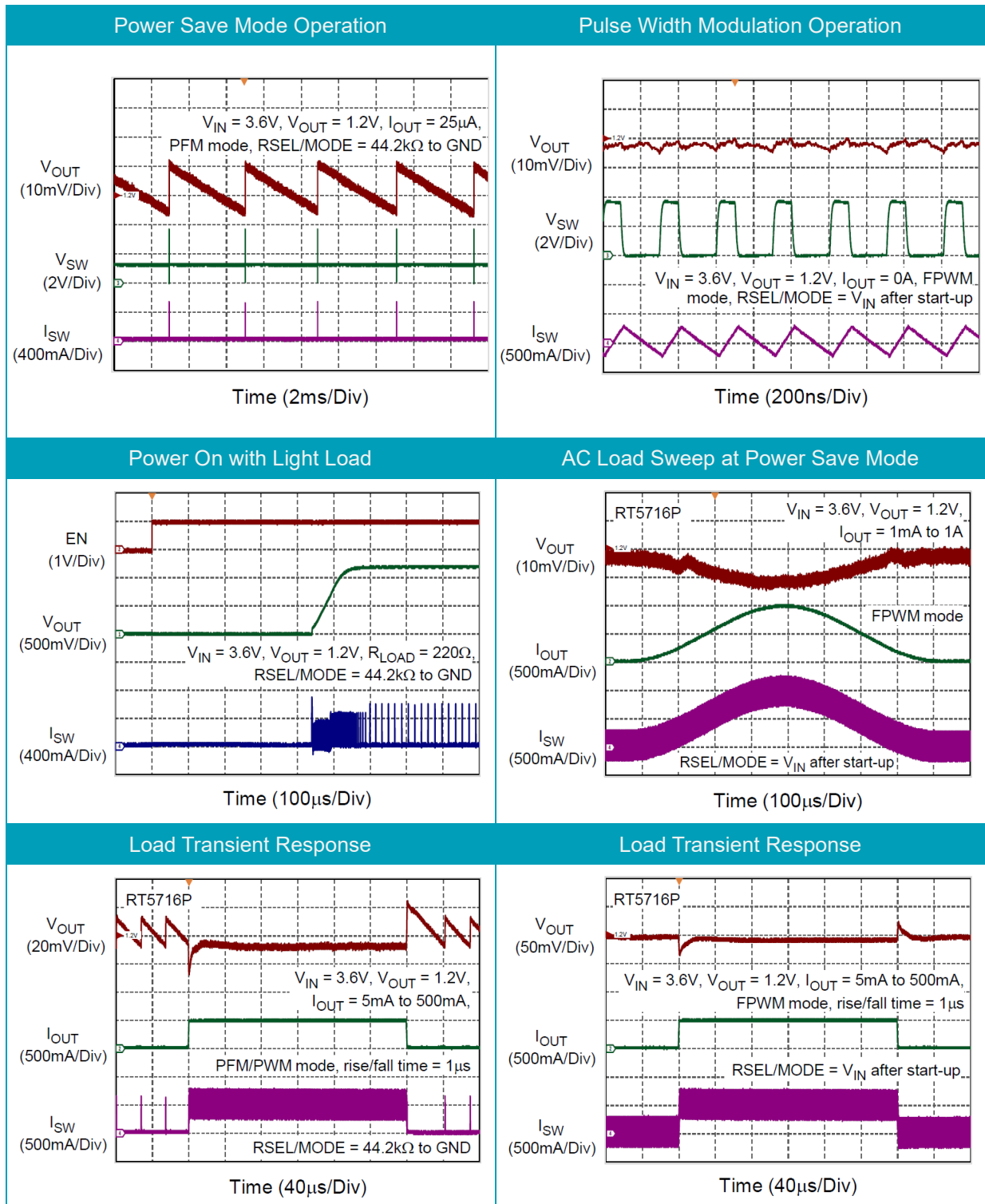


1. The capacitance of the input and output will influence the input and output voltage ripple, respectively.
2. MLCC capacitance degrades at different DC bias voltage. The smaller package size of MLCC capacitors, the more capacitance degradation there would be under the same test condition.

Measure Result

The following curves and waveforms are the measure results of the RT5716P-ABA.





Note: Do not measure the output voltage ripple with a long ground lead on the oscilloscope probe. Instead, touch the probe tip and ground ring directly across the output capacitor.

Evaluation Board Layout

Figure 1 to Figure 4 are the RT5716 evaluation board layout for TWL-CSP package. This board size is 84.6mm x 55.7mm and is constructed on four-layer PCB.

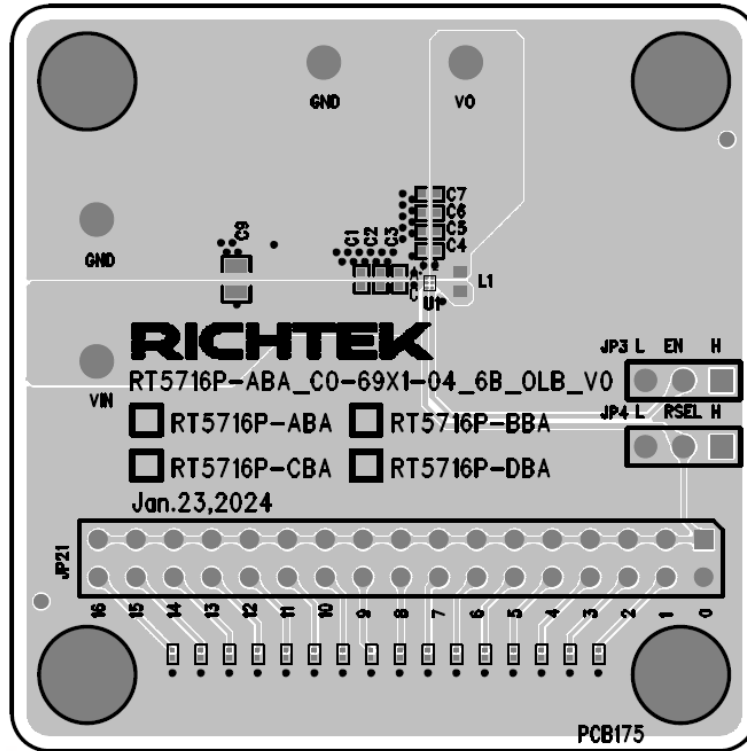


Figure 1. Top View (1st layer)

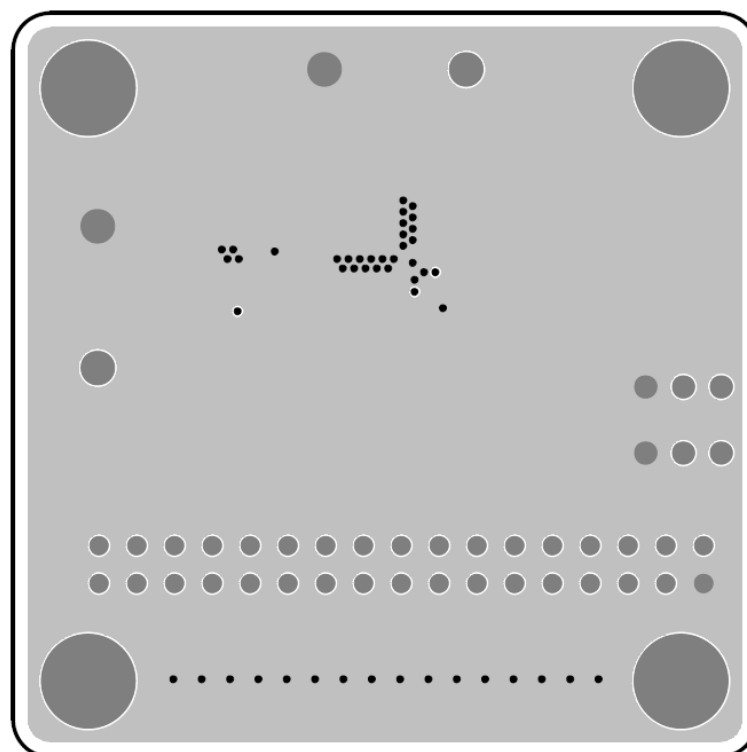


Figure 2. PCB Layout—Inner Side (2nd Layer)

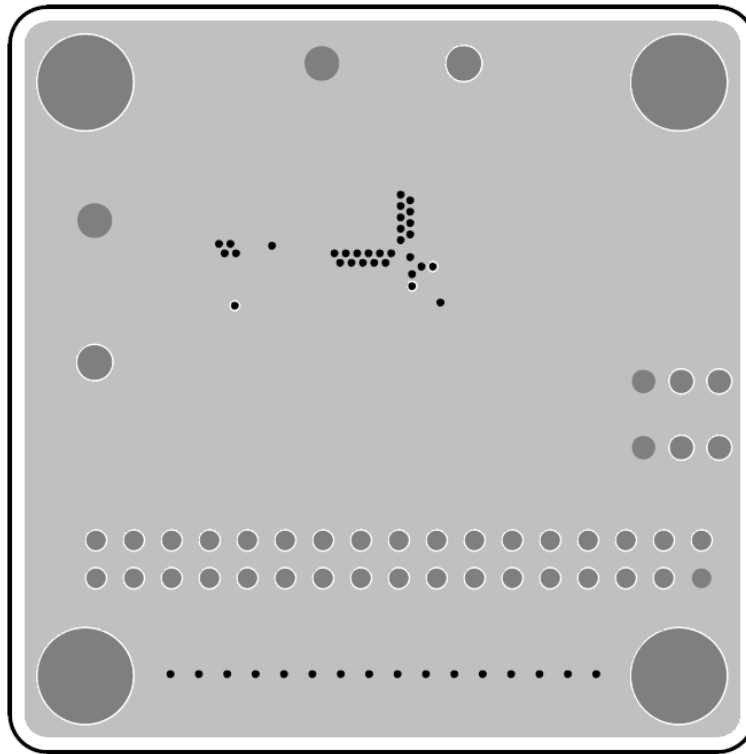


Figure 3. PCB Layout—Inner Side (3rd Layer)

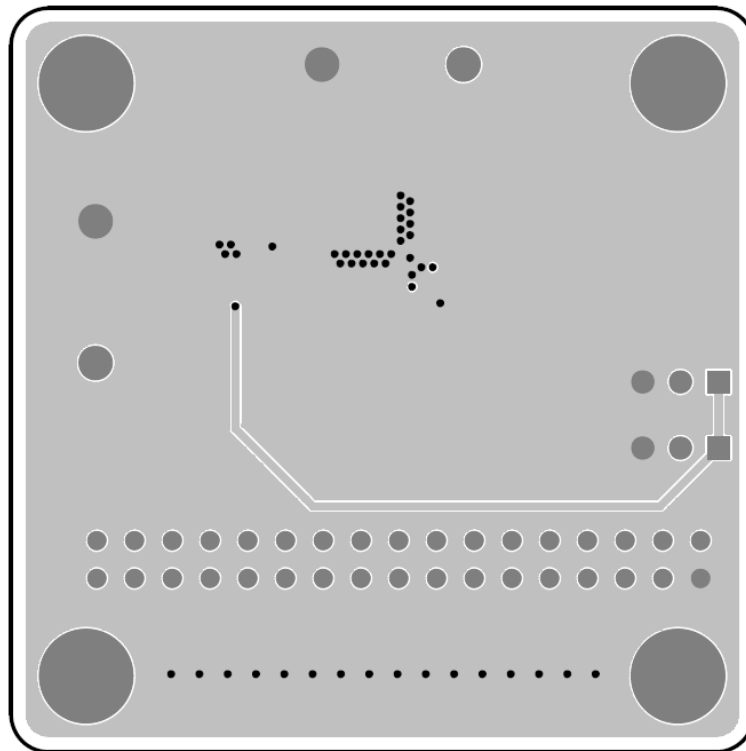


Figure 4. Bottom View (4th Layer)

More Information

For more information, please find the related datasheet or application notes from Richtek website
<http://www.richtek.com>.

Important Notice for Richtek Evaluation Board

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