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### 3 A, 34 V Input PWM/VFM Step Down DC/DC Converter with PLL Synchronization Evaluation Board

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No. EEV-299-0330300-191111

**R1270S001A033-0300EV is the evaluation board for R1270 which has the below features, benefits and specifications.**

#### OUTLINE

The R1270S is CMOS-based Step-down DC/DC converter with internal N-channel high side Tr. The ON resistance of the built-in high-side transistor is  $0.10\Omega$  and the R1270S can provide the maximum 3 A output current. Each of the ICs consists of an oscillator, a PWM control circuit, a voltage reference unit, an error amplifier, a phase compensation circuit, a slope compensation circuit, a soft-start circuit, protection circuits, an internal voltage regulator, and a switch for bootstrap circuit. The ICs can make up a step-down DC/DC converter with adding an inductor, resistors, a diode, and capacitors externally.

The R1270S is current mode operating type DC/DC converters without an external current sense resistor, and realizes fast response and high efficiency. As an output capacitor, a ceramic type capacitor is usable. The internal oscillator frequency is adjustable over a range of 300 kHz to 2400 kHz by an external resistor, and also can be synchronized externally by PLL.

The phase compensation is adjustable by using external resistor and capacitor. Thereby optimizations for the inductor and the capacitor can be done.

To improve performance under light load conditions, the R1270S can select automatically between two modes: the VFM mode when the inductor current is discontinuous and the PWM mode when the inductor current is continuous. The ripple voltage at VFM mode is 40 mV (Typ.).

As for protection, the R1270S has a current limit function to control an inductor peak current every a cycle, a fold-back function to reduce the oscillator frequency under the short circuit, a thermal shutdown function, an under voltage lockout (UVLO) function, and an over voltage lockout (OVLO) function. Furthermore, the R1270S can include a latch protection function to cut off the output when the output current reaches the set current limit for a certain time. That is, the R1270S supports two types of the presence (R1270S001A) or the absence (R1270S001B) of the latch protection function.

The current limit, which is fixed at 4.5 A (Typ.), is adjustable by an external resistor. And, the soft start time is fixed at 0.4 ms (Typ.) internally, but is adjustable by an external resistor.

The R1270S has the FLG pin to monitor the overvoltage of the FB pin voltage and the 6 V rated pin. When detecting an abnormal voltage, the R1270S outputs a flag.

The R1270S is available in HSOP-18 package.

## FEATURES

- Operating Voltage (Maximum Rating)..... 3.6 V to 34 V (36 V)
- Consumption Current ..... Typ. 18  $\mu$ A ( $V_{IN} = 12$  V)
- Stand-by Current ..... Typ. 0  $\mu$ A ( $V_{IN} = 34$  V,  $CE = 0$  V)
- Output Voltage ..... Externally-adjustable at 0.8 V or more  
(Max. step down ratio 160 ns  $\times$  fosc)
- Feedback Voltage and Tolerance ..... 0.8 V $\pm$ 1.0%
- Output Current ..... 3 A<sup>(1)</sup>
- Operating Frequency..... 300 kHz to 2.4 MHz settable by External resistor
- Minimum Off Time ..... Typ. 120 ns
- Maximum Duty..... Min. 93% (fosc = 300 kHz), Min. 67% (fosc = 2400 kHz)
- UVLO Function Detection Voltage ..... Typ. 2.6 V
- OVLO Function Detection Voltage ..... Min. 38 V
- Soft-start Time ..... Internal soft-start time (Typ. 0.4 ms), as a lower limit,  
Externally-adjustable by using capacitor
- High-side Switch Current Limit ..... Typ. 4.5 A, as a upper limit,  
Externally-adjustable by using resistor
- Thermal Shutdown Function ..... Typ. 160°C
- CE Threshold Voltage..... Typ. 1.0 V
- Latch Protection Delay Time ..... Typ. 2 ms (R1270S001A)
- Fold-back Protection ..... Fold-back for Oscillation frequency
- $V_{FB}$  Voltage Temperature Tolerance ( $\Delta V_{FB}/\Delta T_a$ )..... Typ.  $\pm 100$  ppm/°C ( $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ )
- Package ..... HSOP-18
- For more details on R1270 IC, please refer to  
<https://www.e-devices.ricoh.co.jp/en/products/power/dcdc/r1270/r1270-ea.pdf>.

## Part Number Information

Product Name	Package
R1270S001A033-0300	HSOP-18

001A: with Latch type protection function

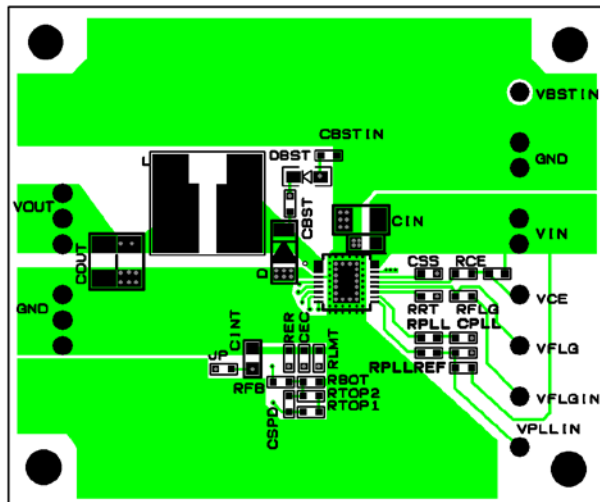
033: 3.3 V, Output voltage

0300: 300 kHz, Operating Frequency

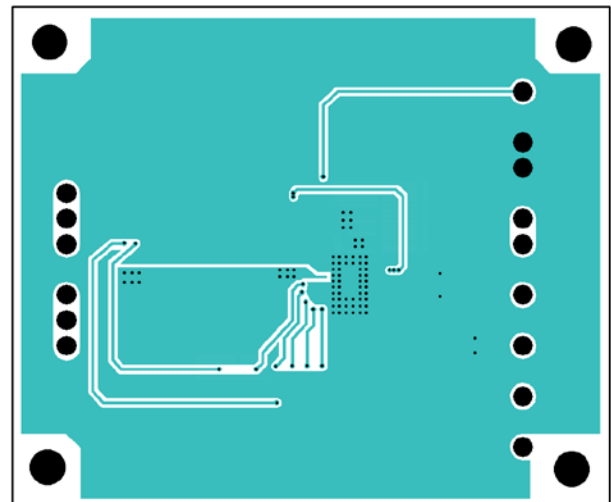
<sup>(1)</sup> The output current depends on external components and conditions.

## PCB LAYOUT

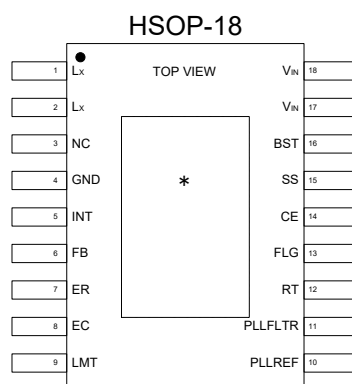
Top View



Bottom View



## PIN DESCRIPTION



### Pin Description

Pin No.	Symbol	Description
1, 2	Lx	Lx Switching Pin
3	NC	No connection
4	GND	Ground Pin
5	INT	Internal Bias Pin
6	FB	Feedback Pin
7	ER	Phase Compensation Pin for External Resistor
8	EC	Phase Compensation Pin for External Capacitor
9	LMT	Current Limit adjustment Pin
10	PLLREF	PLL Synchronization Pin
11	PLLFLTR	PLL Filter Pin
12	RT	Oscillation adjustment Pin
13	FLG	Flag Output Pin
14	CE	Chip Enable Pin (Active "H")
15	SS	Soft-start Pin
16	BST	Bootstrap Pin
17, 18	V <sub>IN</sub>	Power Supply Pin

\* The tab on the bottom of the package must be electrically connected to GND (substrate level) when mounted on the board.

## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

(GND = 0 V)

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	−0.3 to 36	V
V <sub>BST</sub>	BST Pin Voltage <sup>(1)</sup>	V <sub>LX</sub> −0.3 to V <sub>LX</sub> +6	V
V <sub>LX</sub>	L <sub>x</sub> Pin Voltage	−0.3 to 36	V
V <sub>CE</sub>	CE Pin Input Voltage	−0.3 to 36	V
V <sub>INT</sub>	INT Pin Voltage	−0.3 to 36	V
V <sub>SS</sub>	Soft-start Pin Voltage	−0.3 to 6	V
V <sub>ER</sub>	ER Pin Voltage	−0.3 to 6	V
V <sub>EC</sub>	EC Pin Voltage	−0.3 to 6	V
V <sub>FB</sub>	Feedback Pin Voltage	−0.3 to 6	V
V <sub>FLG</sub>	Flag Pin Voltage <sup>(1)</sup>	−0.3 to 24	V
V <sub>PLLREF</sub>	External Oscillation Synchronization Pin Voltage	−0.3 to 36	V
V <sub>PLLFLTR</sub>	PLL Filter Pin Voltage	−0.3 to 6	V
V <sub>RT</sub>	Oscillation adjustment Pin Voltage	−0.3 to 6	V
V <sub>LMT</sub>	Current Limit adjustment Pin Voltage	−0.3 to 6	V
P <sub>D</sub>	Power Dissipation <sup>(2)</sup> (HSOP-18, JEDEC STD.51-7 Test Land Pattern)	3100	mW
T <sub>j</sub>	Junction Temperature Range	−40 to 125	°C
T <sub>stg</sub>	Storage Temperature Range	−55 to 125	°C

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings are not assured.

## RECOMMENDED OPERATING CONDITIONS

### Recommended Operating Conditions

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	3.6 to 34	V
T <sub>a</sub>	Operating Temperature	−40 to 105	°C

### RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

<sup>(1)</sup> The pin voltage except V<sub>BST</sub> and V<sub>FLG</sub> must be prevented from exceeding V<sub>IN</sub> +0.3V.

<sup>(2)</sup> Refer to *POWER DISSIPATION* for detailed information.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = 12\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , unless otherwise specified.

The specifications surrounded by   are guaranteed by design engineering at  $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ .

### R1270S001A Electrical Characteristics

( $T_a = 25^\circ\text{C}$ )

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$I_{IN1}$	$V_{IN}$ Consumption current 1	$V_{IN} = 34\text{ V}$ , $V_{INT} = \text{Open}$ , $V_{PLLREF} = 34\text{ V}$ , $V_{FB} = 1.5\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">0.7</span>	1	<span style="border: 1px solid black; padding: 0 2px;">1.3</span>	mA
$I_{IN2}$	$V_{IN}$ Consumption current 2	$V_{IN} = 34\text{ V}$ , $V_{INT} = \text{Open}$ , $V_{PLLREF} = 0$ , $V_{FB} = 0.84\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">13</span>	18	<span style="border: 1px solid black; padding: 0 2px;">30</span>	$\mu\text{A}$
$V_{UVLO2}$	UVLO Released Voltage	$V_{IN}$ Rising	<span style="border: 1px solid black; padding: 0 2px;">2.5</span>	2.6	<span style="border: 1px solid black; padding: 0 2px;">2.7</span>	V
$V_{UVLO1}$	UVLO Detect Voltage	$V_{IN}$ Falling	<span style="border: 1px solid black; padding: 0 2px;"><math>V_{UVLO2}</math> -0.16</span>	$V_{UVLO2}$ -0.15	<span style="border: 1px solid black; padding: 0 2px;"><math>V_{UVLO2}</math> -0.11</span>	V
$V_{OVLO2}$	OVLO Released Voltage	$V_{IN}$ Falling	<span style="border: 1px solid black; padding: 0 2px;">34</span>			V
$V_{OVLO1}$	OVLO Detect Voltage	$V_{IN}$ Rising		38		V
$V_{FB}$	$V_{FB}$ Voltage Tolerance	$T_a = 25^\circ\text{C}$	0.792	0.800	0.808	V
		$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	<span style="border: 1px solid black; padding: 0 2px;">0.784</span>		<span style="border: 1px solid black; padding: 0 2px;">0.816</span>	V
$V_{VFM}$	FB High Detection at VFM mode				<span style="border: 1px solid black; padding: 0 2px;">0.831</span>	V
fosc0	Oscillation Frequency 0	$R_T = \text{Open}$	<span style="border: 1px solid black; padding: 0 2px;">270</span>	300	<span style="border: 1px solid black; padding: 0 2px;">330</span>	kHz
fosc1	Oscillation Frequency 1	$R_T = 62\text{ k}\Omega$	<span style="border: 1px solid black; padding: 0 2px;">900</span>	1010	<span style="border: 1px solid black; padding: 0 2px;">1120</span>	kHz
fosc2	Oscillation Frequency 2	$R_T = \text{GND}$	<span style="border: 1px solid black; padding: 0 2px;">2160</span>	2400	<span style="border: 1px solid black; padding: 0 2px;">2640</span>	kHz
toff	Minimum Off Time			120		ns
$D_{MAX0}$	Maximum Duty Cycle 0	$R_T = \text{Open}$	<span style="border: 1px solid black; padding: 0 2px;">93</span>			%
$D_{MAX0}$	Maximum Duty Cycle 1	$R_T = 62\text{ k}\Omega$	<span style="border: 1px solid black; padding: 0 2px;">83</span>			%
$D_{MAX2}$	Maximum Duty Cycle 2	$R_T = \text{GND}$	<span style="border: 1px solid black; padding: 0 2px;">67</span>			%
$f_{SYNC}$	Oscillation Synchronized Frequency	$f_{PLLREF} = 1000\text{ kHz}$	<span style="border: 1px solid black; padding: 0 2px;"><math>f_{osc}/2</math></span>		<span style="border: 1px solid black; padding: 0 2px;"><math>f_{osc} \times 2</math></span>	kHz
tss1	Soft-start Time 1	$SS = \text{Open}$ , $V_{FB} = 0.72\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">0.3</span>		<span style="border: 1px solid black; padding: 0 2px;">0.55</span>	ms
tss2	Soft-start Time 2	$C_{SS} = 0.01\text{ }\mu\text{F}$ , $V_{FB} = 0.72\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">3.1</span>		<span style="border: 1px solid black; padding: 0 2px;">4.5</span>	ms
$I_{tss}$	Soft-start charge current	$SS = 0\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">1.7</span>	2.0	<span style="border: 1px solid black; padding: 0 2px;">2.35</span>	$\mu\text{A}$
tdelay	Delay Time for Latch Protection	for R1270S001A	<span style="border: 1px solid black; padding: 0 2px;">1.4</span>	2	<span style="border: 1px solid black; padding: 0 2px;">2.8</span>	ms
$R_{LXH}$	Lx High Side Switch ON Resistance	$V_{BST} - V_{LX} = 4.5\text{ V}$ , $I_{LX} = 0.1\text{ A}$		0.1	<span style="border: 1px solid black; padding: 0 2px;">0.15</span>	$\Omega$
$I_{LXHOFF}$	Lx High Side Switch Leakage Current			0	<span style="border: 1px solid black; padding: 0 2px;">20</span>	$\mu\text{A}$
$I_{LIMLXH1}$	Lx High Side Switch Limited Current 1	$LMT = 220\text{ k}\Omega$ , DC Current	<span style="border: 1px solid black; padding: 0 2px;">3.0</span>	3.5	<span style="border: 1px solid black; padding: 0 2px;">4.3</span>	A
$I_{LIMLXH2}$	Lx High Side Switch Limited Current 2	$LMT = 39\text{ k}\Omega$ , DC Current	<span style="border: 1px solid black; padding: 0 2px;">1.25</span>	1.6	<span style="border: 1px solid black; padding: 0 2px;">2.4</span>	A

All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_j \approx T_a = 25^\circ\text{C}$ ).

**ELECTRICAL CHARACTERISTICS (continued)**

$V_{IN} = 12\text{ V}$ ,  $T_a = 25^\circ\text{C}$ , unless otherwise specified.

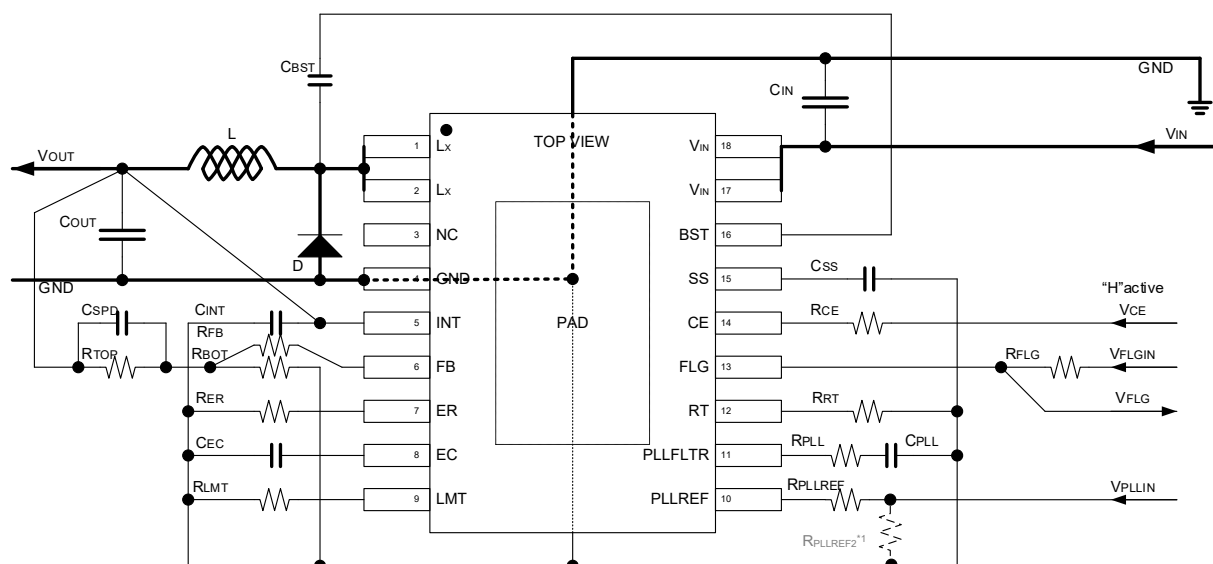
The specifications surrounded by   are guaranteed by design engineering at  $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ .

**R1270S001A Electrical Characteristics****( $T_a = 25^\circ\text{C}$ )**

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$V_{CEH}$	CE "H" Input Voltage		<span style="border: 1px solid black; padding: 0 2px;">1.15</span>			V
$V_{CEL}$	CE "L" Input Voltage				<span style="border: 1px solid black; padding: 0 2px;">0.85</span>	V
$I_{CEH}$	CE "H" Input Current		<span style="border: 1px solid black; padding: 0 2px;">-1.0</span>	0	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>	$\mu\text{A}$
$I_{CEL}$	CE "L" Input Current		<span style="border: 1px solid black; padding: 0 2px;">-1.0</span>	0	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>	$\mu\text{A}$
$I_{FBH}$	FB "H" Input Current	$V_{FB} = 1.5\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">-0.1</span>	0	<span style="border: 1px solid black; padding: 0 2px;">0.1</span>	$\mu\text{A}$
$I_{FBL}$	FB "L" Input Current	$V_{FB} = 0\text{ V}$	<span style="border: 1px solid black; padding: 0 2px;">-0.1</span>	0	<span style="border: 1px solid black; padding: 0 2px;">0.1</span>	$\mu\text{A}$
$V_{PLLH}$	PLLREF "H" Input Voltage		<span style="border: 1px solid black; padding: 0 2px;">0.95</span>			V
$V_{PLLL}$	PLLREF "L" Input Voltage				<span style="border: 1px solid black; padding: 0 2px;">0.67</span>	V
$I_{PLLH}$	PLLREF "H" Input Current		<span style="border: 1px solid black; padding: 0 2px;">-1.0</span>	0	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>	$\mu\text{A}$
$I_{PLLL}$	PLLREF "L" Input Current		<span style="border: 1px solid black; padding: 0 2px;">-1.0</span>	0	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>	$\mu\text{A}$
$T_{TSD}$	Thermal Shutdown Detect Temperature			160		$^\circ\text{C}$
$T_{TSR}$	Thermal Shutdown Release Temperature			130		$^\circ\text{C}$
$I_{standby}$	Standby Current	$V_{IN} = 34\text{ V}$ , $V_{CE} = 0\text{ V}$		0	<span style="border: 1px solid black; padding: 0 2px;">20</span>	$\mu\text{A}$
$V_{FLGL}$	FLAG "L" Voltage	$V_{IN} = 2.0\text{ V}$ , $I_{FLG} = 1\text{ mA}$			<span style="border: 1px solid black; padding: 0 2px;">0.25</span>	V
$I_{FLGOFF}$	FLAG "Off" Current	$V_{FLG} = 6.0\text{ V}$		0.0	<span style="border: 1px solid black; padding: 0 2px;">0.1</span>	$\mu\text{A}$
$V_{OVP}$	FB Pin OVP Detect Voltage		<span style="border: 1px solid black; padding: 0 2px;">0.91</span>	0.98	<span style="border: 1px solid black; padding: 0 2px;">1.04</span>	V
$V_{UVD}$	FB Pin UVD Detect Voltage		<span style="border: 1px solid black; padding: 0 2px;">0.59</span>	0.64	<span style="border: 1px solid black; padding: 0 2px;">0.69</span>	V
$V_{FLB}$	Fold Back Detect Voltage		<span style="border: 1px solid black; padding: 0 2px;">0.59</span>		<span style="border: 1px solid black; padding: 0 2px;">0.69</span>	V
$V_{POVD}$	6V-rated Pin OVP Detect Voltage	$V_{ER}$ , $V_{PLLFLTR}$ , $V_{SS}$		4.0		V
$V_{VOS0}$	INT Pin Operation Voltage		<span style="border: 1px solid black; padding: 0 2px;">2.75</span>		<span style="border: 1px solid black; padding: 0 2px;">3.1</span>	V
$V_{VOS1}$	INT Pin Disable Voltage		<span style="border: 1px solid black; padding: 0 2px;">2.68</span>		<span style="border: 1px solid black; padding: 0 2px;">2.8</span>	V

All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_j \approx T_a = 25^\circ\text{C}$ ).

## TYPICAL APPLICATION



\*1 PLLREF pin must not be "OPEN". When using the Ricoh's evaluation board, a pull-down resistor ( $R_{PLLREF2}$  : 100k $\Omega$ ) is contained on the evaluation board.

## R1270S001A033-0300 Typical Application Circuit

## R1270S001A033-0300 Recommended External Components\*2

$C_{IN}$ [ $\mu F$ ]	$C_{OUT}$ [ $\mu F$ ]	$C_{BST}$ [ $\mu F$ ]	$D$ [V/A]	$L$ [ $\mu H$ ]	$R_{BOT}$ [k $\Omega$ ]	$R_{FB}$ [k $\Omega$ ]	$R_{TOP}$ [k $\Omega$ ]	$C_{SPD}$ [pF]	$R_{ER}$ [k $\Omega$ ]	$C_{EC}$ [pF]	$R_{LMT}$	$R_{PLLREF}$ [k $\Omega$ ]
10	22*2 200	0.47	40 / 3	10	160	1	500 (470+30)	1000	220	1000	OPEN	1
$R_{PLLREF2}$ [k $\Omega$ ]	$R_{PLL}$	$C_{PLL}$	$R_{RT}$	$R_{FLG}$ [k $\Omega$ ]	$R_{CE}$ [k $\Omega$ ]	$C_{SS}$ [ $\mu F$ ]	$C_{INT}$ [ $\mu F$ ]					
100	OPEN	OPEN	OPEN	100	1	0.01	0.1					

\*2 The bill of materials will be attached on the shipment of each purchased evaluation board.



## TECHNICAL NOTES

The performance of a power source circuit using this device is highly dependent on a peripheral circuit. A peripheral component or the device mounted on PCB should not exceed its rated voltage, rated current or rated power. When designing a peripheral circuit, please be fully aware of the following points. (Refer to *PCB Layout* on page 3.)

- The backside thermal pad of the HSOP-18 package must be connected to GND. To improve the thermal dissipation on multi-layered boards, the thermal must be dissipated to another layer by putting some thermal vias on the thermal pad in the land pattern.
- NC pin must be set to "OPEN".
- Switching regulator is required some caution. Because, a large current variation occurs by the following different current loops in every switching, and a high-frequency noise occurs by parasitic current.
  - The current loop when the switch is "ON", Input Capacitor ( $C_{IN}$ ) → Hi-side Switch → Inductor → Output Capacitor ( $C_{OUT}$ ) →  $C_{IN}$
  - The current loop when the switch is "OFF", Rectifier Diode (D) → Inductor →  $C_{OUT}$  → D
  - The current loop via Diode Parasitic Capacitor when the switch is "ON",  $C_{IN}$  → Hi-side Switch → Parasitic Capacitor of D →  $C_{IN}$

A large EMI noise source is caused in this loop. Therefore, extreme caution is required. These loops have to design as short as possible, and design not to cross lines in the subsequent load side to  $C_{OUT}$  in order to avoid the influence of switching noise.

- On this evaluation board, the land for the Lx pin is wide to connect with large inductor and diode.



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