Contents

PWM Control & PWM/PFM Control High-Frequency Step-Up Switching Regulator-Controllers S-8340/8341 Series

The S-8340/8341 Series consists of CMOS step-up switching regulator-controllers with PWM control (S-8340) and PWM/PFM switched control (S-8341). These devices contain a reference voltage source, oscillation circuit, error amplifier, phase compensation circuit, PWM control circuit, and other components. Since the oscillation frequency is a high 300 kHz or 600 kHz, with the addition of a small external component, the ICs can function as step-up switching regulators with high efficiency and large output current. The speed of the output stage is enhanced so that the Nch power MOS with a low ON resistance can be switched quickly.

The S-8340 provides low-ripple power, high-efficiency, and excellent transient characteristics thanks to a PMW control circuit capable of varying the duty ratio linearly from 0% to 82% and optimized error amplifier, and phase compensation circuit.

The S-8341 contains a PWM/PFM switching control circuit so that it operates using PWM control with a duty ratio of 27% or higher and using PFM control with a duty ratio of lower than 27% to ensure high efficiency in all load ranges. These ICs serve as ideal main power supply units for portable devices when coupled with the 8-pin TSSOP package and high oscillation frequencies.

■ Features:

- Oscillation frequency: 600 kHz (A & B Series), 300 kHz (C & D Series).
- Output voltage:
  Internally selectable in the range 2.5 V and 6.0 V in steps of 0.1 V (Output voltage fixed output type)
- Output voltage precision: ±2.0%
- Output voltage external setting (FB) type available. FB terminal voltage (V_{FB}) 1.0 V
- The only peripheral components that can be used with this IC are a transistor, a coil, a diode, capacitors (3), and a resistor.
- Duty ratio: 0% to 82% typ. PWM control (S-8340)
  27% to 82% typ. PWM/PFM-switched control (S-8341)
- Low-voltage operation: Oscillation can start when V_{DD}=0.9 V.
- Built-in current limiting circuit: Can be set with an external resistor (RSENSE).
- Soft-start function: Can be set with an external capacitor (CSS).
- With a power-off function.

■ Applications:

- Power supplies for PDAs, electronic notebooks, and portable devices.
- Power supplies for audio equipment, including portable CD players, portable MD players and headphone stereo equipment.
- Main and sub power supplies for notebook computers and peripheral equipment.
- Fixed voltage power supply for cameras, video equipment and communications equipment.

■ Block Diagram

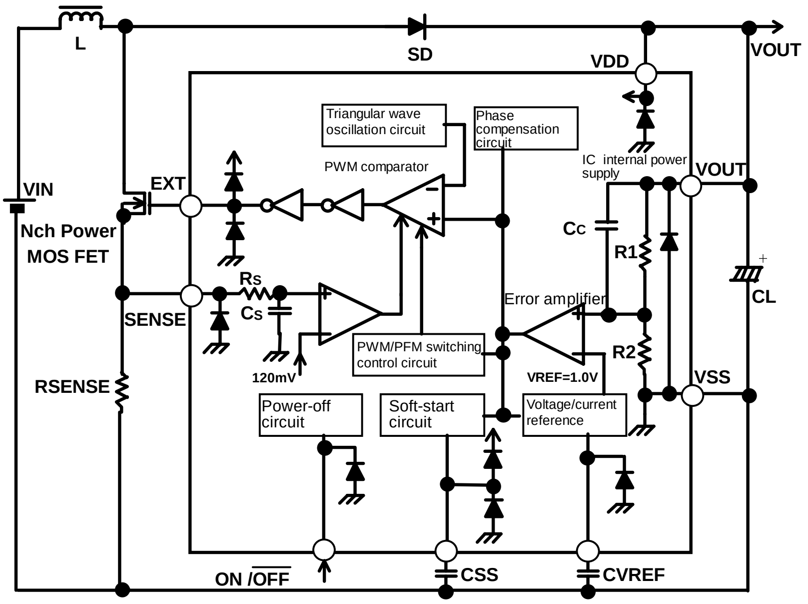


Figure 1 Block diagram <Output voltage fixed output type>

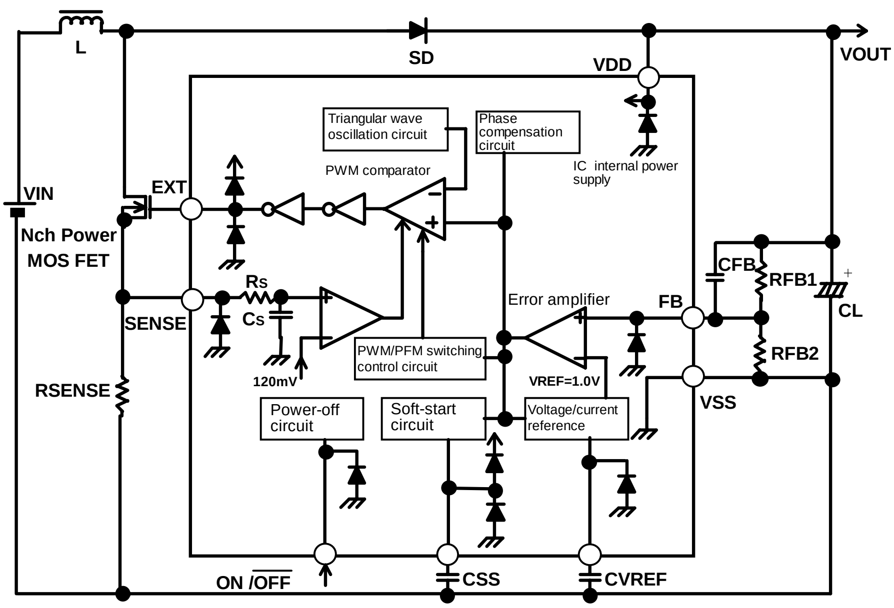


Figure 2 Block diagram <Output voltage external setting type>

■ Selection Guide

1. Product Name

S-834X X XX A FT - T2

- Tape specifications.
- Package name abbreviation.
- Output voltage × 10
- A; Output voltage fixed output type, fosc=600 kHz
  B; Output voltage external setting type, fosc=600kHz
  C; Output voltage fixed output type, fosc=300 kHz (Under development)
  D; Output voltage external setting type, fosc=300 kHz (Under development)
- 0; PWM control
  1; PWM/PFM-switched control

2. Product List

2-1 Output voltage fixed output type

Item Output Voltage (V)	S-8340AXXAFT Series fosc = 600 kHz PWM control	S-8341AXXAFT Series fosc = 600 kHz PWM/PFM-switched control
2.5 V ± 2.0%	S-8340A25AFT-T2	S-8341A25 AFT-T2
3.0 V ± 2.0%	S-8340A30AFT-T2	S-8341A30 AFT-T2
3.3 V ± 2.0%	S-8340A33AFT-T2	S-8341A33 AFT-T2
5.0 V ± 2.0%	S-8340A50AFT-T2	S-8341A50 AFT-T2

For the availability of other output voltage product, contact the SII Sales Department.

2.2 Output voltage external setting type

S-8340B00AFT-T2 : fosc = 600kHz, PWM control

S-8341B00AFT-T2 : fosc = 600 kHz, PWM/PFM-switched control

■ Pin Assignment

See the detailed drawing of the package at the end of this document.

8-pinTSSOP
Top view

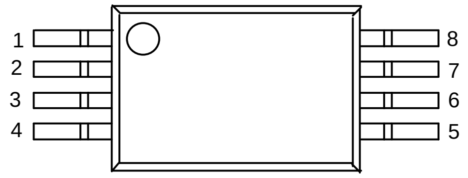


Figure 3

Pin No.	Pin Name	Function
1	VSS	GND pin
2	CVREF	Reference voltage source pass capacitor connection pin
3	CSS	Soft-start capacitor connection pin
4	ON/$\overline{\text{OFF}}$	Power-off pin H: Normal operation (Step-up operation) L: Step-up operation stopped (All circuits deactivated)
5	VDD	IC power supply pin
6	VOUT (FB)	Output voltage monitoring pin (FB for external setting type)
7	EXT	Connection pin for external transistor
8	SENSE	Current limit detection pin

■ Absolute Maximum Ratings

(Ta = 25°C unless otherwise specified)

Item	Symbol	Ratings	Unit
VDD pin voltage	V_{DD}	V_{SS} -0.3 to 12	V
VOUT pin voltage	V_{OUT}	V_{SS} -0.3 to 12	V
FB pin voltage	V_{FB}	V_{SS} -0.3 to 12	V
CVREF pin voltage	V_{CVREF}	V_{SS} -0.3 to V_{DD}+0.3	V
CSS pin voltage	V_{CSS}	V_{SS} -0.3 to V_{DD}+0.3	V
ON/$\overline{\text{OFF}}$ pin voltage	$V_{ON/\overline{OFF}}$	V_{SS} -0.3 to 12	V
SENSE pin voltage	V_{SENSE}	V_{SS} -0.3 to V_{DD}+0.3	V
EXT pin voltage	V_{EXT}	V_{SS} -0.3 to V_{DD}+0.3	V
EXT pin current	I_{EXT}	±100	mA
Power dissipation	P_D	300	mW
Operating temperature range	T_{OPR}	-40 to 85	°C
Storage temperature range	T_{STG}	-40 to 125	°C

Note: Although this IC incorporates an electrostatic protection circuit, the user is urged to avoid subjecting it to an extremely high static electricity or static voltage in excess of the performance of the said protection circuit.

■ Electrical Characteristics

1. S-834xAxxAFT

(Ta = 25 °C, unless otherwise specified)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Units	Measure-ment Circuit
Output voltage *1)	V_{OUT} (E)	$V_{IN} = V_{OUT}(S) \times 0.6$ $I_{OUT} = V_{OUT}(S) / 50\Omega$		V_{OUT} (S) $\times$ 0.98	V_{OUT} (S)	V_{OUT} (S) $\times$ 1.02	V	1
Input voltage	V_{IN}			–	–	6	V	1
Oscillation start voltage	V_{ST}	No external component. The voltage is applied to VOUT.		–	–	0.9	V	2
Current consumption 1	I_{SS} 1	$V_{OUT} = V_{OUT}(S) \times 0.95$ EXT pin open	S-834xA25 – 34	–	350	640	μA	2
			S-834xA35 – 44	–	460	810		
			S-834xA45 – 54	–	630	1060		
			S-834xA55 – 60	–	810	1250		
Current consumption 2	I_{SS} 2	$V_{OUT} = V_{OUT}(S) + 0.5$ V EXT pin open		–	180	300	μA	2
Current consumption during power off	I_{SSS}	$V_{OUT} = V_{OUT}(S) \times 0.95$ Power-off pin = 0V		–	–	3.0	μA	2
EXT pin output current	I_{EXTH}	$V_{EXT} = V_{OUT}(E) - 0.2$ V	S-834xA25 – 34	-13	-24	–	mA	–
			S-834xA35 – 44	-17	-30	–		
			S-834xA45 – 54	-21	-34	–		
			S-834xA55 – 60	-23	-37	–		
	I_{EXTL}	$V_{EXT} = 0.2$ V	S-834xA25 – 34	32	56	–	mA	–
			S-834xA35 – 44	42	69	–		
			S-834xA45 – 54	50	78	–		
			S-834xA55 – 60	56	85	–		
Line regulation	$\Delta V_{OUT}1$	$V_{OUT}(S) \times 0.4 \leq V_{IN} \leq V_{OUT}(S) \times 0.6$ $I_{OUT} = V_{OUT}(S) / 50\Omega$		–	V_{OUT} (S) $\times$ 0.5%	V_{OUT} (S) $\times$ 1%	V	1
Load regulation	$\Delta V_{OUT}2$	$V_{IN} = V_{OUT}(S) \times 0.6$ $10\mu A \leq I_{OUT} \leq V_{OUT}(S) / 40\Omega$		–	V_{OUT} (S) $\times$ 0.5%	V_{OUT} (S) $\times$ 1%	V	1
Output voltage temperature coefficient *2)	$\frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}$	$V_{IN} = V_{OUT}(S) \times 0.6$ $I_{OUT} = V_{OUT}(S) / 50\Omega$ $-40°C \leq Ta \leq 85°C$		–	±100	–	ppm/°C	1
Oscillation frequency	fosc	$V_{OUT} = V_{OUT}(S) \times 0.95$ Measure waveform at EXT pin		510	600	690	kHz	2
Maximum duty ratio	MaxDuty	$V_{IN} = V_{OUT}(S) \times 0.95$ Measure waveform at EXT pin		73	82	89	%	2
PWM/PFM-control switch duty ratio (S-8341xxxAFT)	PFM Duty	$V_{IN} = V_{OUT}(E) - 0.1$ V Under no load		19	27	35	%	1
Current limit detection voltage	V_{SENSE}	$V_{OUT} = V_{OUT}(S) \times 0.95$ Judge oscillation stop in "L", at EXT pin.		90	120	150	mV	2
Power-Off pin input voltage	V_{SH}	$V_{OUT} = V_{OUT}(S) \times 0.95$ Judge oscillation at EXT pin.		0.8	–	–	V	2
	V_{SL}	$V_{OUT} = V_{OUT}(S) \times 0.95$ Judge oscillation stop at EXT pin.		–	–	0.3		
Power-Off pin input leakage current	I_{SH}	$V_{OUT} = 6$ V, $V_{ON/\overline{OFF}} = 6$ V		–	–	0.1	μA	2
	I_{SL}	$V_{OUT} = 6$ V, $V_{ON/\overline{OFF}} = 0$ V		–	–	-0.1		
Soft-Start time	T_{SS}	$V_{IN} = V_{OUT}(S) \times 0.6$, $C_{SS} = 4700pF$ $I_{OUT} = V_{OUT}(S) / 50\Omega$ Measure time until oscillation occurs at EXT pin.		3.0	8.5	14.0	ms	1
Efficiency	EFFI	$V_{IN} = V_{OUT}(S) \times 0.6$ $I_{OUT} = V_{OUT}(S) / 50\Omega$	S-834xA25 – 34	–	83	–	%	1
			S-834xA35 – 44	–	85	–		
			S-834xA45 – 54	–	87	–		
			S-834xA55 – 60	–	87	–		

*1) $V_{OUT}(S)$: Set output voltage value
$V_{OUT}(E)$: Actual output voltage value: Output voltage value when $I_{OUT}=V_{OUT}(S)/50\ \Omega$ and $V_{IN}=V_{OUT}(S)\times 0.6$.

*2) The change of output voltage with temperature [mV/°C] is calculated from the following formula:

$$\frac{\Delta V_{OUT}}{\Delta Ta}\ [\text{mV/°C}] = V_{OUT}(S)[V] \times \frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}\ [\text{ppm/°C}] \div 1000$$

(Change of output voltage with temperature) (Set output voltage value) (Output voltage temperature factor)

Conditions:

Peripheral components:

Coil	: Sumida Electric Co., Ltd. CD54 (10 μH).
Diode	: Matsushita Electronics Corporation MA735 (Schottky type).
Capacitor	: Nichicon F93 (16 V, 47 μF tantalum type).
Transistor	: Sanyo 2SD 1628G.
Base resistor (Rb)	: 1.0 kΩ
Base capacitor (Cb)	: 2200 pF (Ceramic type)
CVREF	: 0.01μF
CSS	: 4700pF

VDD pin is connected to VOUT.

The power-off pin is connected to VOUT, SENSE pin is connected to VSS, unless otherwise specified. .

Note 1:

Boot operation is performed from V_{DD}=0.9 V. However, 2.5 V or more for VDD is recommended to stabilize the output voltage and oscillation frequency. If V_{DD} is taken from V_{IN} or other power sources, instead of V_{OUT}, V_{DD} should be 2.5 V or more. However, if V_{DD} is not taken from V_{OUT}, the output voltage precision of ±2.0% is not guaranteed due to dependency of output voltage on V_{DD}. In particular, accuracy of output voltage is degraded significantly when the V_{DD} voltage is 6.0 V or more. If V_{DD} of 2.5 V or more is applied, increase power supply so that V_{DD} becomes 2.5 V or more within the soft-start time (3 ms).

2. S-834xB00AFT

(Ta = 25 °C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units	Measure-ment Circuit
Output voltage *1)	$V_{OUT}(E)$	V_{IN} =2.4V I_{OUT} =80mA	3.920	4.000	4.080	V	3
FB pin voltage	V_{FB}	V_{IN} =2.4V I_{OUT} =80mA	0.980	1.000	1.020	V	3
Input voltage	V_{IN}		−	−	6	V	3
Oscillation start voltage	$V_{ST}2$	No external component. The voltage is applied to VDD.	−	−	0.9	V	4
Current consumption 1	$I_{SS}1$	V_{OUT} =3.8V	−	460	740	μA	4
Current consumption 2	$I_{SS}2$	V_{OUT} =4.5V	−	180	300	μA	4
Current consumption during power off	I_{SSS}	V_{OUT} =3.8V Power-off pin = 0V	−	−	3.0	μA	4
EXT pin output current	I_{EXTH}	V_{EXT} = $V_{OUT}(E)$ − 0.2 V	−19	−30	−	mA	−
	I_{EXTL}	V_{EXT} =0.2 V	46	69	−	mA	−
Line regulation	$\Delta V_{OUT}1$	1.6V ≤ V_{IN} ≤ 2.4V I_{OUT} =80mA	−	20	40	mV	3
Load regulation	$\Delta V_{OUT}2$	V_{IN} =2.4V 10μA ≤ I_{OUT} ≤ 100mA	−	20	40	mV	3
Output voltage temperature coefficient *2)	$\frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}$	V_{IN} =2.4V I_{OUT} =80mA −40°C ≤ Ta ≤ 85°C	−	±100	−	ppm/°C	3
Oscillation frequency	fosc	V_{OUT} =3.8V Measure waveform at EXT pin	510	600	690	kHz	4
Maximum duty ratio	MaxDuty	V_{IN} =3.8V Measure waveform at EXT pin	73	82	89	%	4
PWM/PFM-control switch duty ratio (S-8341B00AFT)	PFMDuty	V_{IN} =$V_{OUT}(E)$−0.1V Under no load	19	27	35	%	3
Current limit detection voltage	V_{SENSE}	V_{OUT} =3.8V Judge oscillation stop in "L", at EXT pin.	90	120	150	mV	4
FB pin input current	I_{FB}	V_{OUT} =6V, V_{FB} =1.5V	−50	−	50	nA	4
Power-Off pin input voltage	V_{SH}	V_{OUT} =3.8V Judge oscillation at EXT pin.	0.8	−	−	V	4
	V_{SL}	V_{OUT} =3.8V Judge oscillation stop at EXT pin.	−	−	0.3		
Power-Off pin input leakage current	I_{SH}	V_{OUT}=6V,$V_{ON/\overline{OFF}}$=6V	−	−	0.1	μA	4
	I_{SL}	V_{OUT}=6V,$V_{ON/\overline{OFF}}$=0V	−	−	−0.1		
Soft-Start time	T_{SS}	V_{IN} =2.4V, C_{SS} =4700pF I_{OUT} =80mA	3.0	8.5	14.0	ms	3
Efficiency	EFFI	V_{IN} =2.4V, I_{OUT} =80mA	−	85	−	%	3

*1) $V_{OUT}(E)$: Actual output voltage value: Output voltage value when I_{OUT}=80 mA and V_{IN}=2.4 V is input.

Typ. value (set output voltage value) is $1+\frac{300k\Omega}{100k\Omega}$ [V].

*2) Change of output voltage with temperature [mV / °C] is represented by the following equation:
However, the temperature change rates for RFB1 and RFB2 are assumed to be the same.

$$\frac{\Delta V_{OUT}}{\Delta Ta}\ [mV/°C] = \left(1+\frac{RFB1}{RFB2}\right) \times \frac{\Delta V_{OUT}}{\Delta Ta \cdot V_{OUT}}\ [ppm/°C] \div 1000$$

(Change of output voltage with temperature) (Set output voltage value) (Output voltage temperature factor)

Conditions:

Peripheral components:

Coil	: Sumida Electric Co., Ltd. CD54 (10 μH).
Diode	: Matsushita Electronics Corporation MA735 (Schottky type).
Capacitor	: Nichicon F93 (16 V, 47 μF tantalum type).
Transistor	: Sanyo 2SD 1628G.
Base resistor (Rb)	: 1.0 kΩ
Base capacitor (Cb)	: 2200 pF (Ceramic type)
CVREF	: 0.01μF
CSS	: 4700pF
RFB1	: 300kΩ
RFB2	: 100kΩ
CFB	: 50pF

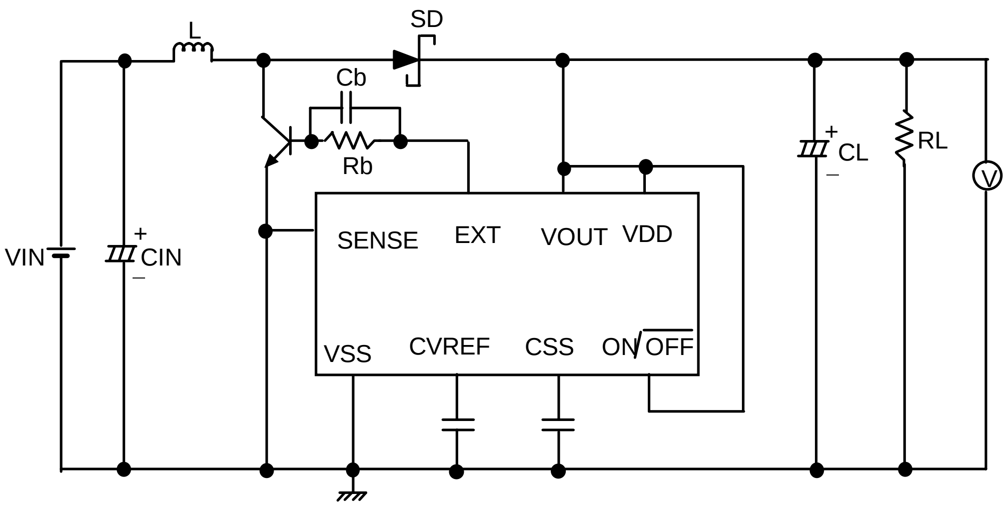
The power-off pin is connected to VOUT, SENSE pin is connected to VSS, unless otherwise specified. .

Note 1:

Boot operation is performed from V_{DD}=0.9 V. However, 2.5 V or more for VDD is recommended to stabilize the output voltage and oscillation frequency. If V_{DD} is taken from V_{IN} or other power sources, instead of V_{OUT}, V_{DD} should be 2.5 V or more. The output voltage precision is applicable when V_{DD} is 4.0 V. It should be noted that if V_{DD} is not 4.0 V, the output voltage precision of ±2.0% cannot be guaranteed due to dependency of output voltage on V_{DD}. In particular, accuracy of output voltage is degraded significantly when the V_{DD} voltage is 6.0 V or more. If V_{DD} of 2.5 V or more is applied, increase power supply so that V_{DD} becomes 2.5 V or more within the soft-start time (3 ms).

■ Measurement Circuits:

1.



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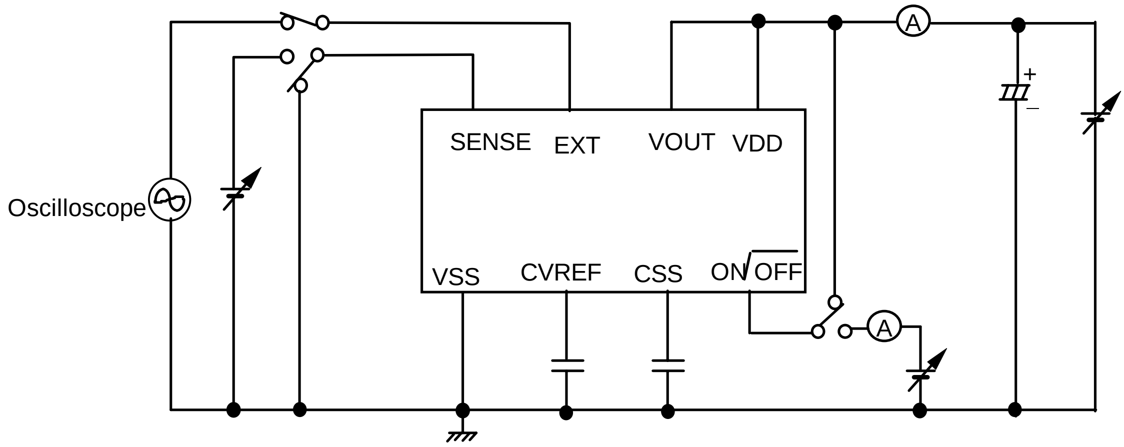
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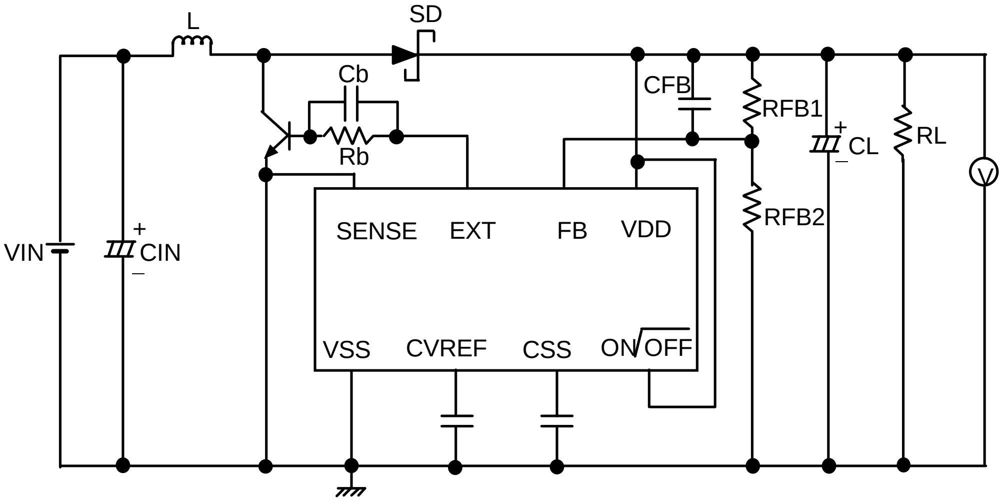
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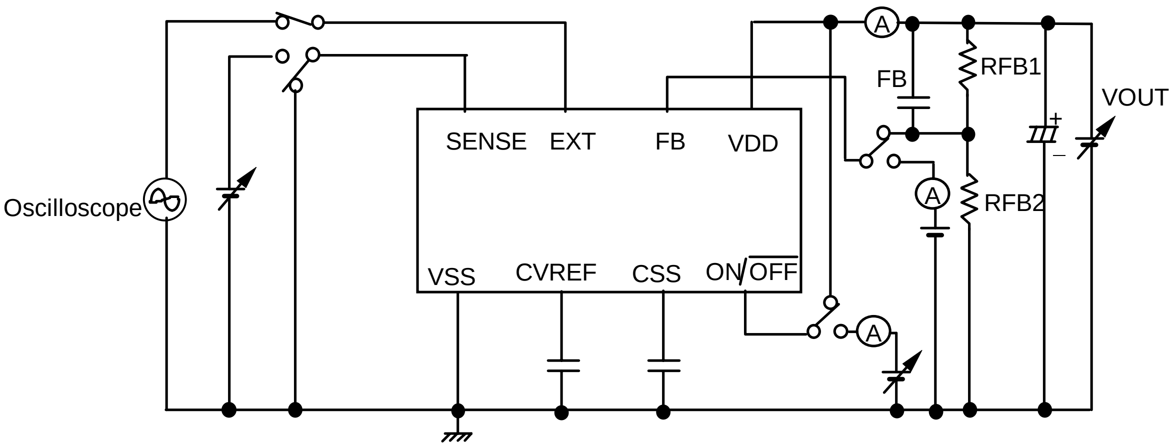
Oscilloscope
SENSE
EXT
FB
VDD
VSS
CVREF
CSS
ON/OFF
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RFB1
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Figure 4

■ Operation

1. Switching control method

1.1 PWM Control (S-8340 Series)

The S-8340 Series consists of DC/DC converters that employ a pulse-width modulation (PWM) system. In conventional PFM system DC/DC converters, pulses are skipped when they are operated with a low output load current, causing variations in the ripple frequency of the output voltage and an increase in the ripple voltage. Both of these effects constitute inherent drawbacks to those converters.

In converters of the S-8340 Series, the pulse width varies in a range from 0% to 82%, according to the load current, and yet ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant. Therefore, these converters provide a low-ripple power over broad ranges of input voltage and load current.

1.2 PWM/PFM-Switched Control (S-8341 Series)

The S-8341 Series consists of DC/DC converters capable of automatically switching the pulse-wide modulation system (PWM) over to the pulse-frequency modulation system (PFM), and vice versa, according to the load current.

In a region of high output load currents, the S-8341 Series converters function with PWM control, where the pulse-width duty varies from 27% to 82%. This function realizes low ripple power.

For certain low output load currents, the converters are switched over to PFM control, whereby pulses having their pulse-width duty fixed at 27% are skipped depending on the quantity of the load current, and are output to a switching transistor. This causes the oscillation circuit to produce intermittent oscillation. As a result, current consumption is reduced and efficiency losses are prevented under low loads. Especially for output load currents in the region of 1 mA, these DC/DC converters can operate at extremely high efficiency.

2. Power-Off Pin (ON/$\overline{\text{OFF}}$ Pin)

This pin deactivates or activates the step-up operation. When the power-off pin is set to "L", the VSS voltage appears through the EXT pin, prodding the switching transistor to go off. All the internal circuits stop working, and substantial savings in current consumption are thus achieved.

The power-off pin is configured as shown in Figure 5. Since pull-up or pull-down is not performed internally, please avoid operating the pin in a floating state. Also, try to refrain from applying a voltage of 0.3V to 0.8V to the pin, less such voltage makes the power on/off state indefinite. When this power-off pin is not used, leave it coupled to the VDD pin.

The power-off pin does not have hysterisis.

Power-Off Pin	CR Oscillation Circuit	Output Voltage
"H"	Activated	Set value
"L"	Deactivated	$\simeq V_{IN}$ *

* Voltage obtained by extracting the voltage drop due to DC resistance of the inductor and the diode forward voltage from V_{IN}.

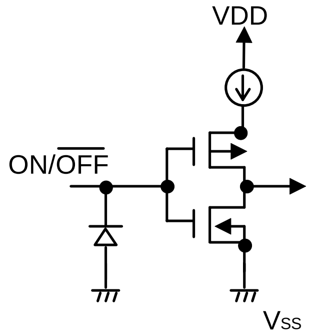


Figure 5

3. Soft-Start Function

The S-8340/41 Series comes with a built-in soft-start circuit. This circuit enables the output voltage to rise gradually over the specified soft-start time, when the power is switched on or when the power-off pin is switched to "H" level. This prevents the output voltage from overshooting and suppresses a rush current from the power supply.

Generally, the step-up circuit flows a rush current to an output capacitor through an inductor and a diode just when the power is turned on as shown in Fig. 6. The soft-start function of this IC, however, does not limit this current.

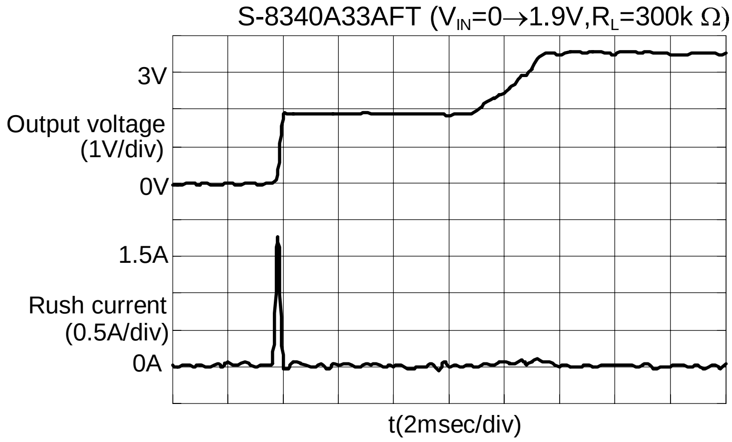


Figure 6 Waveforms of Output Voltage and Rush Current at Soft-Start

The soft-start circuit of the S-8340/41 increases the duty ratio gradually as shown in Fig. 7.

The soft-start time can be set with an external capacitor (Css).

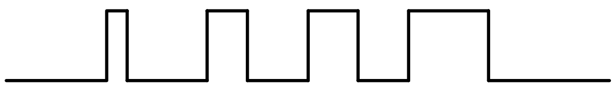


Figure 7 Image of EXT pin waveform

If f=600 kHz and Css=4700 pF, the time until the duty ratio of 50% is reached is 10.6 ms (typ.).

The time until a duty ratio is reached is calculated from the following formula:

If f=600 kHz,

$$t[ms]=C_{SS}[pF]\cdot\frac{\frac{0.5}{100}\times Duty[\%]+0.714}{467.7-0.8\times Duty[\%]}$$

4. Current Limit Circuit

The current limit circuit of the S-8340/41 series can limit current by inserting a sense resistor (RSENSE) between an external FET source or an external NPN bipolar transistor emitter and Vss and entering a connection point with a sensor resistor into the SENSE pin to prevent thermal destruction of external transistors due to overload or magnetic saturation of a coil. (See the standard circuit on pages 18 and 19.)

A current limiting comparator in the IC monitors the SENSE pin reaches the current limit detection voltage (VSENSE=120 mV (typ.)). The current flowing into the external transistor is limited by turning the external transistor off for a clock from the oscillator after detection, the transistor is turned on again with the ON signal of the next clock, and current limit detection resumes.

However, this current limit circuit contains a CR filter with a time constant τ of 220 ns (typ.) between the SENSE pin and the current limiting comparator in the IC to prevent detection errors caused by the spike voltage that occurs at the SENSE pin. If the time (pulse width ton: Hi time at EXT pin) after the external transistor turns on until the current limit circuit works is short, the current value that is actually limited becomes higher than the current limit setting value determined by VSENSE/RSENSE as a side effect. The actual limit current value I_{LIMIT} is expressed by the following equation:

$$I_{LIMIT} = \frac{VSENSE}{RSENSE} \div \left(1 - e^{-\frac{ton \times 0.5}{CR}}\right)$$

(The CR in this equation is determined by the internal CR filter and varies in the range 116 to 470 ns (220 ns typ.).)

Therefore, this current limit function does not guarantee full protection of external components by I_{LIMIT}=VSENSE/RSENSE under all operating conditions. We recommend that you evaluate it by testing performance with the actual equipment.

For example, the current value that actually activates the current limit circuit becomes much higher than the current limit setting determined by VSENSE/RSENSE when it is used under the condition that the input voltage is close to the output voltage or when the current limit circuit works and the output voltage falls and becomes close to the input voltage. Figure 8 gives an example of the actually measured increase of the peak current flowing through the coil when the current limit circuit works while the input voltage is becoming close to the output voltage. Figure 9 shows an example of the actually measured increase of the peak current flowing through the coil when the output voltage drops and approaches the input voltage by increasing the output current after the current limit circuit works.

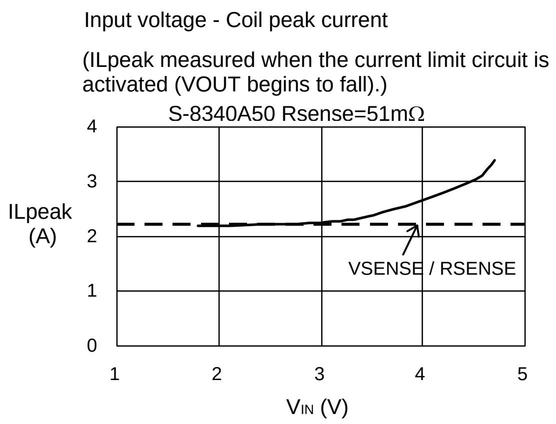


Figure 8

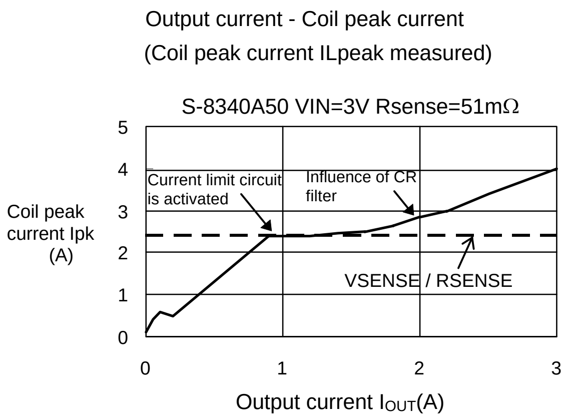


Figure 9

If the current limit circuit is not used, the sensor resistor should be removed and the external transistor source or emitter and SENSE pin should be connected to V_{SS}.

■ Selection of Series Products and Associated External Components

1. Method for selecting series products

The S-8340/41 Series is classified into eight types, according to the way the control systems (PWM and PWM/PFM-Switched), the different oscillation frequencies, and output voltage setting type are combined with one with another. Please select the type that best suits your needs by taking advantage of the features of each type described below.

(1) Control systems:

Two different control systems are available: PWM control system (S-8340 Series) and PWM/PFM-switched control system (S-8341 Series).

If particular importance is attached to the operation efficiency while the load is on standby — for example, in an application where the load current heavily varies from that in standby state as the load starts operating — a high efficiency will be obtained in standby mode by selecting the PWM/PFM-switched control system (S-8341 Series).

Moreover, for applications where switching noise poses a serious problem, the PWM control system (S-8340 Series), in which the switching frequency does not vary with the load current, is preferable because it can eliminate ripple voltages easily using a filter.

(2) Oscillation frequencies:

Two oscillation frequencies -- 600 kHz (A & B Series) and 300 kHz (C & D Series) -- are available.

Because of their high oscillation frequency, the A and B Series offer low-ripple voltages and excellent transient response characteristics. The products in these series allow the use of small-sized inductors since the L value can be reduced. In addition, they can also be used with small output capacitors. These outstanding features make the A & B Series ideal products for downsizing the associated equipment.

On the other hand, the C & D Series, having a lower oscillation frequency, are characterized by a small self-consumption of current and excellent efficiency under light loads. In particular, the C Series, which employs a PWM/PFM-switched control system, enables the operation efficiency to be improved drastically when the output load current is approximately 1 mA.

(3) Output voltage setting:

Two different types are available: fixed output type (A & C Series) and external setting type (B & D Series).

The products (A & C Series) of fixed output type can supply output voltage 2.5 to 6.0 V in 0.1V steps and assures high precision of ±2.0% by means of high-resistance and high-precision internal resistors.

For the products (B & D Series) of external setting type, the output voltage can be adjusted in the range 2.5 to 6.0 V by adding external resistors RFB1 and RFB2 and a capacitor CFB.

A temperature gradient can be provided by installing a thermistor in series to RFB1 and RFB2.

The resistance of RFB1 + RFB2 must be equal to or less than 2 MΩ, and the ratio of RFB1 to RFB2 must be set so that 1.0 V appears at FB pin. Install capacitor CFB in parallel to external resistor RFB1 to prevent unstable operation, such as output oscillation.

Set CFB so that $f=1/(2 \times \pi \times CFB \times RFB1)$ is 0.1 to 20 kHz (normally, 10 kHz).

Example: VOUT=3.0 V, RFB1=200 kΩ, RFB2=100 kΩ, CFB=100 pF

The precision of the output voltage V_{OUT} set with resistors RFB1 and RFB2 is affected by the precision of the voltage at FB pin (1 V±2.0%), the absolute precision of external resistors RFB1 and RFB2, the current input to FB pin and IC power supply voltage VDD.

When it is assumed that the FB pin input current is 0 nA, the maximum absolute value variations of external resistors RFB1 and RFB2 are RFB1max. and RFB2max., the minimum absolute value variations of external resistors RFB1 and RFB2 are RFB1min. and RFB2min., and the shift of the output voltage due to dependence of voltage on V_{DD} is ΔV, the minimum value V_{OUT} min. and maximum value V_{OUT} max. of variations of output voltage V_{OUT} are expressed by the following formulas:

$$V_{OUT}\text{min.} = \left(1 + \frac{\text{RFB1min.}}{\text{RFB2max.}}\right) \times 0.98 - \Delta V[V]$$

$$V_{OUT}\text{max.} = \left(1 + \frac{\text{RFB1max.}}{\text{RFB2min.}}\right) \times 1.02 + \Delta V[V]$$

The precision of output voltage V_{OUT} cannot be made lower than the IC output voltage precision (V_{OUT}±2.0%) without adjusting external resistors RFB1 and RFB2. The smaller RFB1/RFB2, the less it is affected by the absolute value precision of external resistors RFB1 and RFB2. The smaller RFB1 and RFB2, the less it is affected by the input current at FB pin.

To reduce the influence of input current at FB pin which effects variations of output voltage V_{OUT}, it is necessary to make the external resistor RFB2 value sufficiently lower than the input impedance at FB pin (1V/50 nA=20 MΩ max.)

Reactive current flows through external resistors RFB1 and RFB2. If the reactive current value can not be ignored with respect to the actual load current, efficiency decreases. Therefore, the resistance of external resistors RFB1 and RFB2 should be sufficiently high.

If the resistance of external resistors RFB1 and RFB2 is too high (1 MΩ or more), it is likely to be affected by external noise, and therefore, we recommend that you evaluate it by testing performance with the actual equipment.

Since the precision of output voltage V_{OUT} and reactive current must be traded off, they must be considered according to application requirements.

Note:

Connect IC power pin VDD to VOUT for both fixed output type and external setting type as in the standard circuit shown on pages 18 and 19. If VDD is inevitably taken from input voltage VIN or other power source, instead of VOUT, VDD must be raised to 2.5 V or higher within the soft-start time (3.0 ms).

If VDD pin is connected to VOUT, input voltage VIN can be increased slowly without any problems.

The table below provides a rough guide for selecting a product type depending on the requirements of the application. Choose the product that gives you the largest number of circles (O).

Table 1

	S-8340				S-8341			
	A	B	C	D	A	B	C	D
The set output voltage is 6 V or less	☆		☆		☆		☆	
Set an output voltage freely		☆		☆		☆		☆
The efficiency under light loads(1mA approx.) is an important factor					○	○	⊙	⊙
To be operated with a medium load current (200 mA class)	○	○	○	○	○	○	○	○
To be operated with a high load current (1 A class)	○	○	○	○	○	○	○	○
It is important to have a low-ripple voltage	○	○			○	○		
Importance is attached to the downsizing of external components	⊙	⊙			⊙	⊙		

The symbol "☆" denotes an indispensable condition, while the symbol "○" indicates that the corresponding series has superiority in that aspect. The symbol "⊙" indicates particularly high superiority.

2. Inductor

The inductance value greatly affects the maximum output current I_{OUT} and the efficiency η.

As the L-value is reduced gradually, the peak current Ipk increases, to finally reach the maximum output current I_{OUT} when the L-value has fallen to a certain point. If the L-value is made even smaller, I_{OUT} will begin decreasing because the current drive capacity of the switching transistor becomes insufficient.

Conversely, as the L-value is augmented, the loss due to Ipk in the switching transistor will decrease until the efficiency is maximized at a certain L-value. If the L-value is made even larger, the loss due to the series resistance of the inductor will increase to the detriment of the efficiency.

If the L-value is increased in an S-8340/41 Series product, the output voltage may turn unstable in some cases, depending on the conditions of the input voltage, output voltage, and the load current. Perform thorough evaluations under the conditions of actual service and decide on an optimum L-value. An L value should be selected from 2.2 to 22 μH for A & B Series

In many applications, selecting a value of A/B Series 10 μH will allow a S-8340/41 Series product to yield its best characteristics in a well balanced manner.

When choosing an inductor, pay attention to its allowable current, since a current applied in excess of the allowable value will cause the inductor to produce magnetic saturation, leading to a marked decline in efficiency.

Therefore, select an inductor in which the peak current Ipk will not surpass its allowable current at any moment. The peak current Ipk is represented by the following equation in non-continuous operation mode:

$$I_{PK} = \sqrt{\frac{2 \times I_{OUT} \times (V_{OUT} + V_F - V_{IN})}{fosc \times L}}$$

Where fosc is the oscillation frequency, L the inductance value of the inductor, and V_F the forward voltage of the diode (appropriate 0.4V).

For example, if a power supply with input voltage V_{IN}=3 V, output voltage V_{OUT}=5 V, and load current I_{OUT}=30 mA is used, fosc=600 kHz when S-8340A50AFT is used. When 10 μH is selected for the L value, I_{PK}=155 mA from the above formula. Therefore, select an inductor with a permissible current of 155 mA or higher for the L value of 10 μH.

3. Diode

The diode to be externally coupled to the IC should be a type that meets the following conditions:

- Its forward voltage is low (Schottky barrier diode recommended).
- Its switching speed is high (50 ns max.).
- Its reverse direction breakdown voltage is higher than V_{OUT} + V_F.
- Its current rating is higher than I_{PK}.

4. Capacitors (CIN, CL)

The capacitor inserted on the input side (C_{IN}) serves to lower the power impedance and to average the input current for better efficiency. Select the C_{IN}-value according to the impedance of the power supplied. As a rough rule of thumb, you should use a value of 47 to 100 μF, although the actual value will depend on the impedance of the power in use and the load current value.

If the input voltage is extremely high or load current is extremely large, the output voltage of the S-8340/41 Series may become unstable. The unstable range can be narrowed, however, by selecting an output side capacitor (CL) with a large capacitance. If a capacitor with high ESR (Equivalent Series Resistance), such as an aluminum electrolytic capacitor, or with low ESR, such as a ceramic capacitor, the unstable range widens. Thus, a tantalum electrolytic capacitor is recommended. We recommend that you evaluate it by testing performance with the actual equipment.

The capacity should be 47 to 200 μF and ESR should be 40 to 270 mΩ as a recommended yardstick.

5. External Switching Transistor

The S-8340/41 Series can be operated with an external switching transistor of the enhancement (Nch) MOS FET type or bipolar (NPN) type.

5.1 Enhancement MOS FET type

The EXT pin of the S-8340/41 Series is capable of directly driving a Nch power MOS FET.

When a Nch power MOS FET is chosen, because it has a higher switching speed than a NPN type bipolar transistor and because power losses due to the presence of a base current are avoided, efficiency will be 2 to 3% higher than NPN type bipolar transistor.

Since a large current may flow at power on when a certain type of MOS FET is selected, we recommend that you evaluate it by testing performance with the actual equipment. The gate capacity of the MOS FET to be used should be 1200 pF or less.

The important parameters to be kept in mind in selecting a Nch power MOS FET include the threshold voltage, breakdown voltage between gate and source, breakdown voltage between drain and source, total gate capacity, on-resistance, and the current rating.

The EXT pin swings from voltage V_{DD} over to voltage V_{SS}. If the V_{DD} voltage is low, a MOS FET with a low threshold voltage has to be used so that the MOS FET will come on as required. If, conversely, the V_{DD} voltage is high, select a MOS FET whose gate-source breakdown voltage is higher than the V_{DD} voltage by at least several volts.

Since the $V_{OUT}+V_F$ voltage is applied between the drain and source of the MOS FET during a step-up operation, the breakdown voltage between the drain and source should be at least several volts higher than the $V_{OUT}+V_F$ voltage. The total gate capacity and the on-resistance affect the efficiency.

The power loss for charging and discharging the gate capacity by switching operation will increase, when the total gate capacity becomes larger and the input voltage rises higher. Therefore the gate capacity affects the efficiency of power in a low load current region. If the efficiency under light loads is a matter of particular concern, select a MOS FET with a small total gate capacity.

In regions where the load current is high, the efficiency is affected by power losses caused due to the on-resistance of the MOS FET. Therefore, if the efficiency under heavy loads is particularly important for your application, choose a MOS FET with an resistance of lowest as possible.

As for the current rating, select a MOS FET whose maximum continuous drain current rating is higher than the peak current I_{PK}.

5.2 Bipolar NPN type

Figure 13 and 14 shows a sample circuit diagram using Sanyo 2SD1628G for the bipolar transistor (NPN). The driving capacity for increasing the output current by means of a bipolar transistor is determined by the h_{FE}-value and the Rb-value of that bipolar transistor.

The Rb-value is given by the following equation:

$$Rb=\frac{V_{DD}-0.7}{Ib}-\frac{0.4}{\left|I_{EXTH}\right|}$$

Find the necessary base current Ib using the h_{FE}-value of bipolar transistor by the equation, $Ib = I_{PK}/h_{FE}$, and select a smaller Rb-value.

A small Rb-value will certainly contribute to increasing the output current, but it will also adversely affect the efficiency. Moreover, in practice, a current may flow as the pulses or a voltage drop may take place due to the wiring resistance or some other reason. Determine an optimum value through experimentation.

In addition, if speed-up capacitor Cb is inserted in parallel with resistance Rb, as shown in Figure 12 and 13, the switching loss will be reduced, leading to a higher efficiency.

Select a Cb-value by using the following equation as a guide:

$$Cb \leq \frac{1}{2\pi \times Rb \times fosc \times 0.1}$$

However, the practically-reasonable Cb value differs depending upon the characteristics of the bipolar transistor. Optimize the Cb value based on the experiment result.

■ Standard Circuits

(1) Using a Nch MOS-FET transistor:

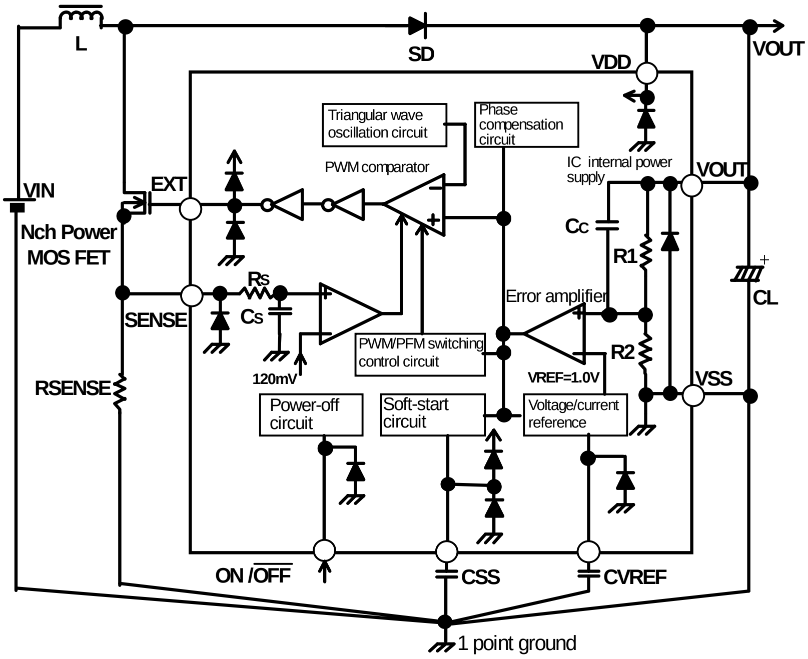


Figure 10 Block diagram <Output voltage fixed output type>

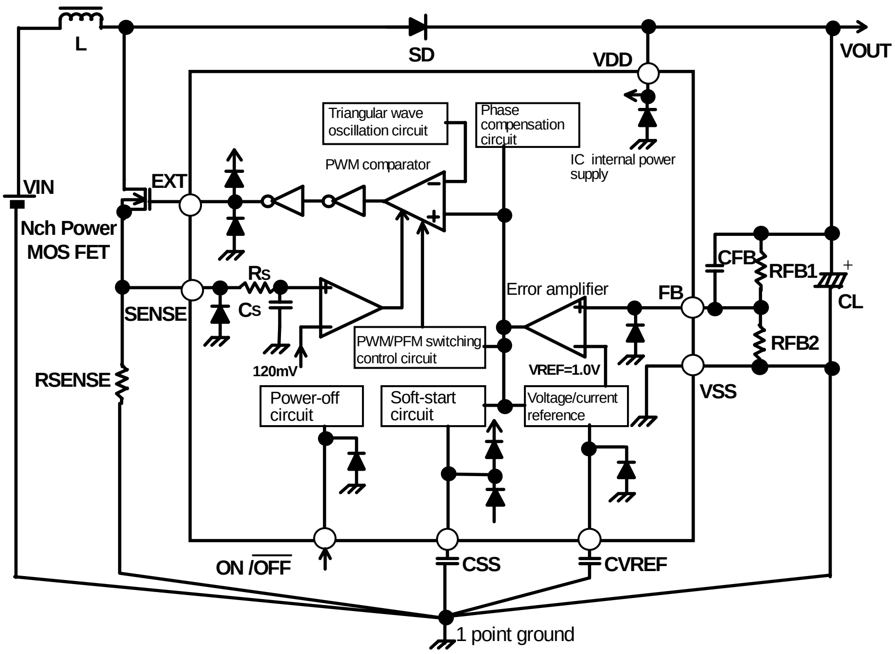


Figure 11 Block diagram <Output voltage external setting type>

(2) Using a bipolar transistor

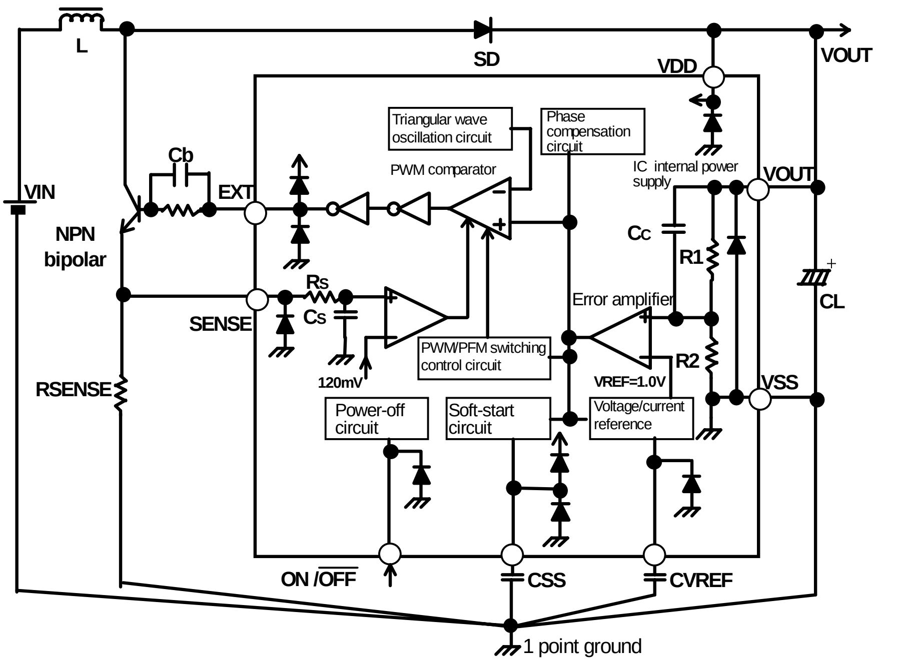


Figure 12 Block diagram <Output voltage fixed output type>

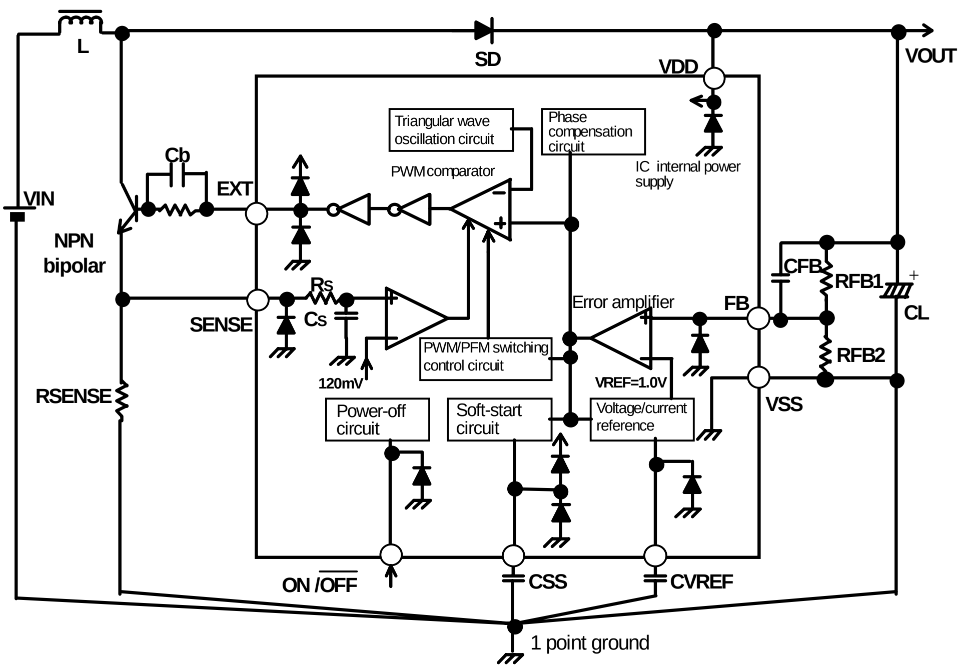


Figure 13 Block diagram <Output voltage external setting type>

■ Precautions:

- Install the external capacitors, diode, coil, and other peripheral components as close to the IC as possible, and secure grounding at a single location.
- Any switching regulator intrinsically produces a ripple voltage and spike noise, which are largely dictated by the coil and capacitors in use. When designing a circuit, first test them on actual power equipment.
- Make sure that dissipation of the switching transistor will not surpass the allowable power dissipation of the package. (especially at the time of high temperature)

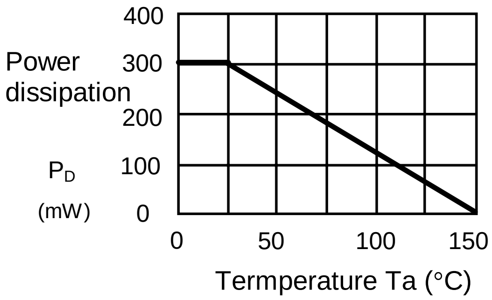


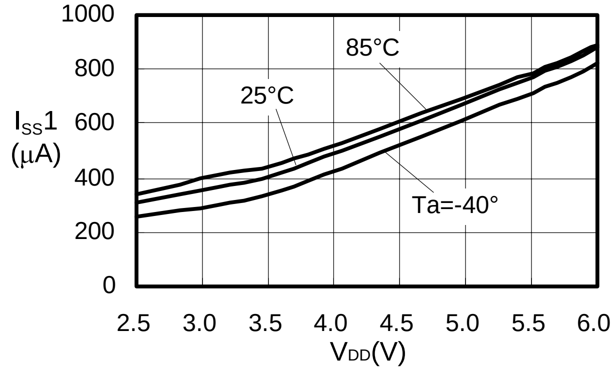
Figure 14 Power dissipation of an 8-pin TSSOP Package (When Not Mounted)

- To stabilize operation, use a capacitor with a low ESR as a bypass capacitor between VDD and VSS of the IC, and install and wire it with a short distance and a low impedance. Connect CVREF to VSS.
- The main circuit of the IC operates on the internal power supply connected to the CVREF pin. CVREF is a bypass capacitor that stabilizes the internal power supply. Use a 0.01-1μF ceramic capacitor as CVREF and install and wire it to assure a short distance and a low impedance.
- Seiko Instruments Inc. shall not be responsible for any patent infringement by products including the S-8340/8341 Series in connection with the method of using the S-8340/8341 Series in such products, the product specifications or the country of destination thereof.

■ Characteristics of Major Items (All data represents typical values):

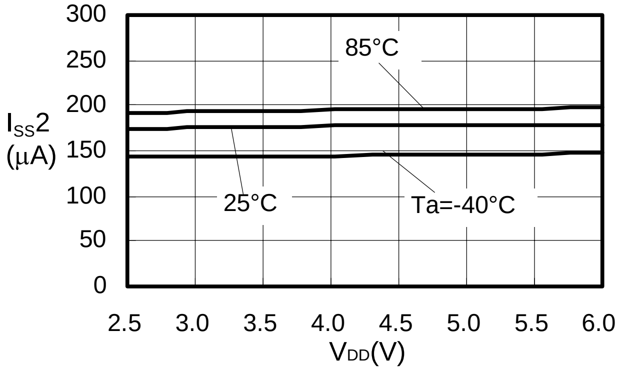
(1) $I_{SS}1$—V_{DD}

S-8340A33A(fosc:600kHz)



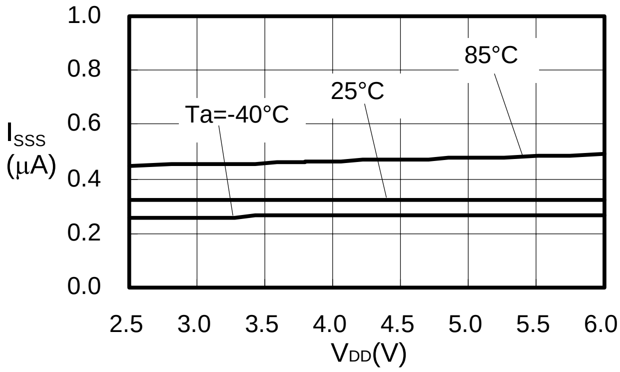
(2) $I_{SS}2$—V_{DD}

S-8340A33A(fosc:600kHz)



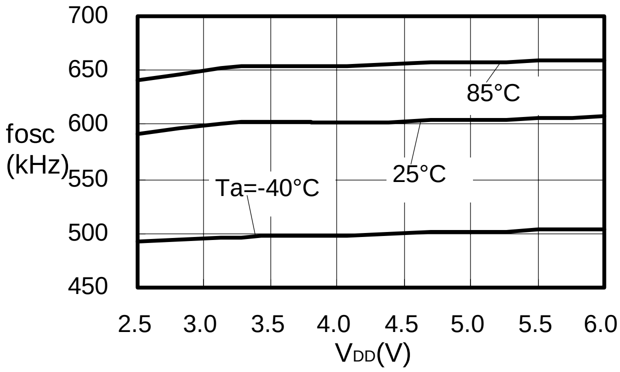
(3) I_{SSS}—V_{DD}

S-8340A33A(fosc:600kHz)



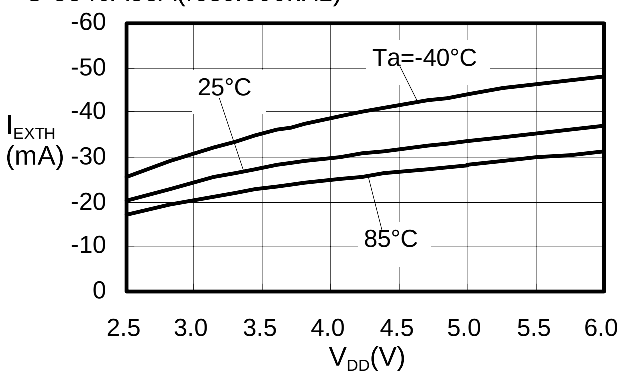
(4) fosc—V_{DD}

S-8340A33A(fosc:600kHz)



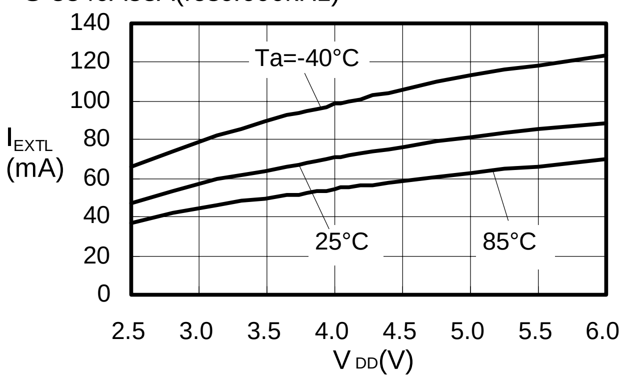
(5) I_{EXTH}—V_{DD}

S-8340A33A(fosc:600kHz)



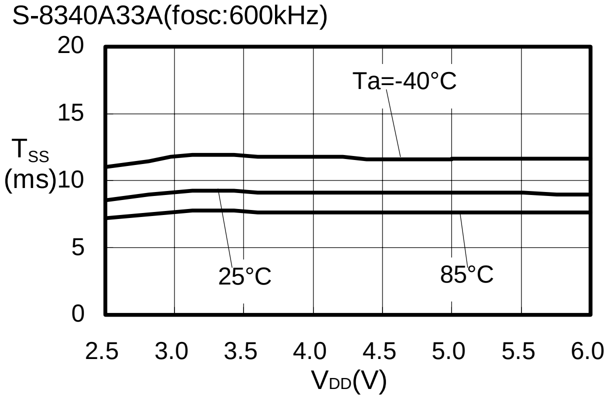
(6) I_{EXTL}—V_{DD}

S-8340A33A(fosc:600kHz)



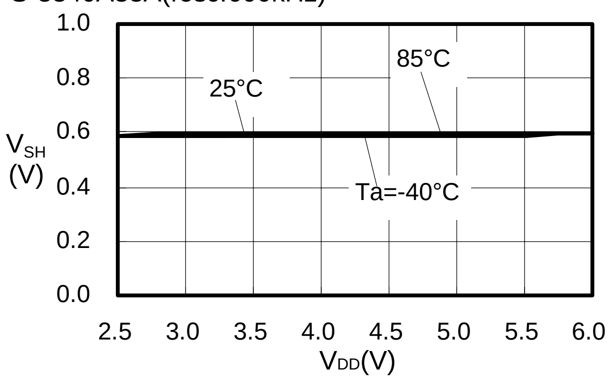
(7) T_{SS}—V_{DD}

S-8340A33A(fosc:600kHz)



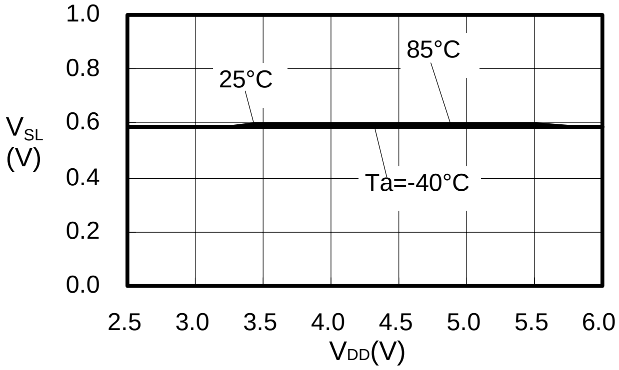
(8) V_{SH}—V_{DD}

S-8340A33A(fosc:600kHz)



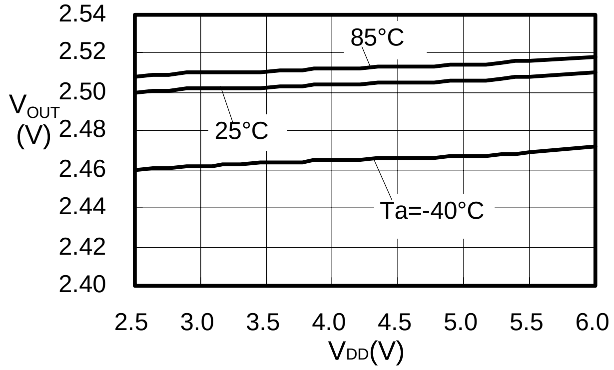
(9) VSL—VDD

S-8340A33A(fosc:600kHz)



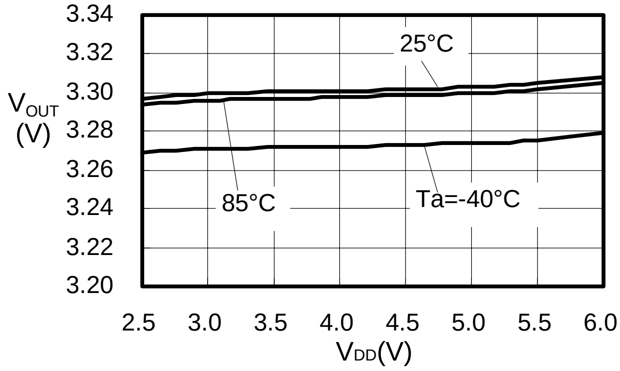
(10) VOUT—VDD

S-8340A25A(fosc:600kHz)



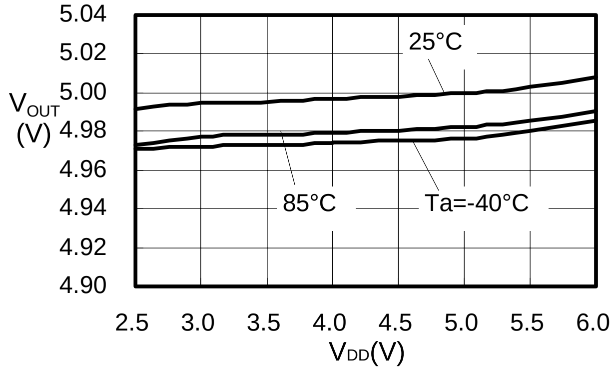
(11) VOUT—VDD

S-8340A33A(fosc:600kHz)



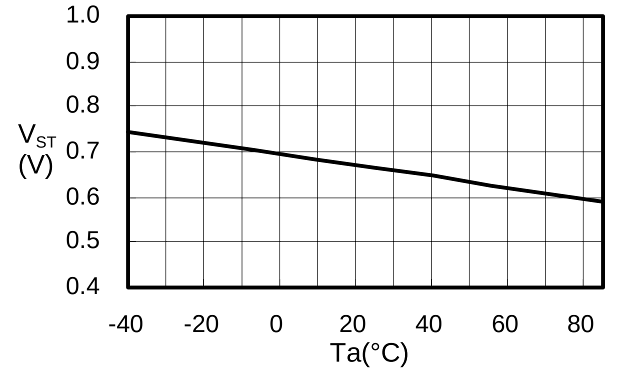
(12) VOUT—VDD

S-8340A50A(fosc:600kHz)



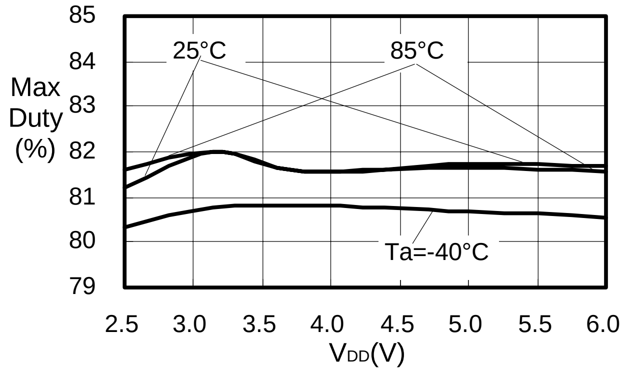
(13) V_{ST}—Ta

S-8340A33A(fosc:600kHz)



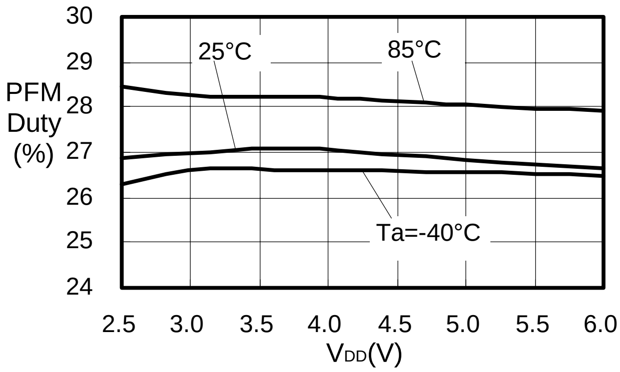
(14) MaxDuty—V_{DD}

S-8340A33A(fosc:600kHz)



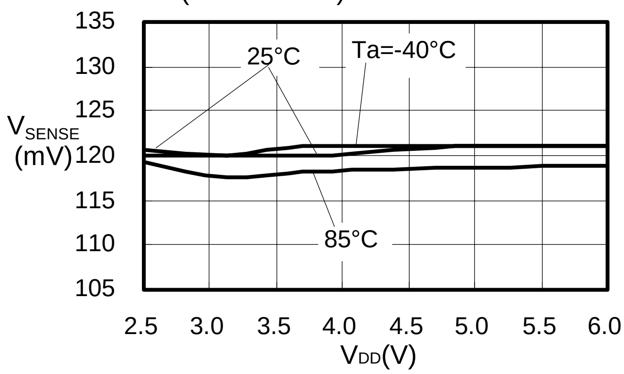
(15) PFMDuty—V_{DD}

S-8341A33A(fosc:600kHz)



(16) V_{SENSE}—V_{DD}

S-8340A33A(fosc:600kHz)

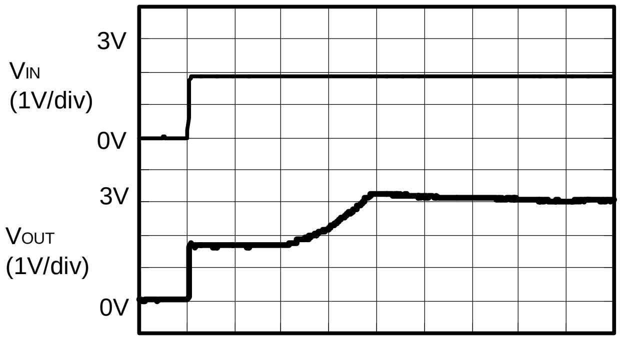


■ Transient Response Characteristics:

(S-8340A30AFT, Ta=25°C, All data represents typical values):

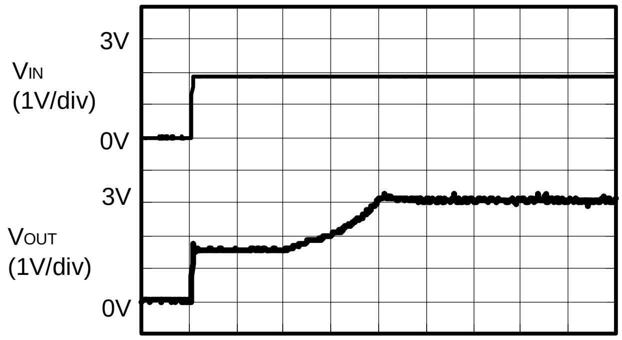
(1) Power-On

V_{IN}=0→1.8V, I_{OUT}=1mA



TIME(2msec/div)

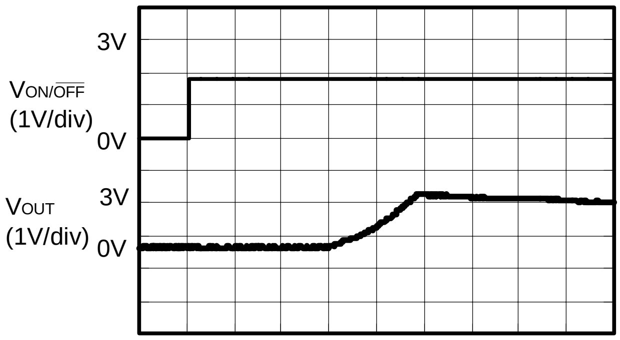
V_{IN}=0→1.8V, I_{OUT}=200mA



TIME(2msec/div)

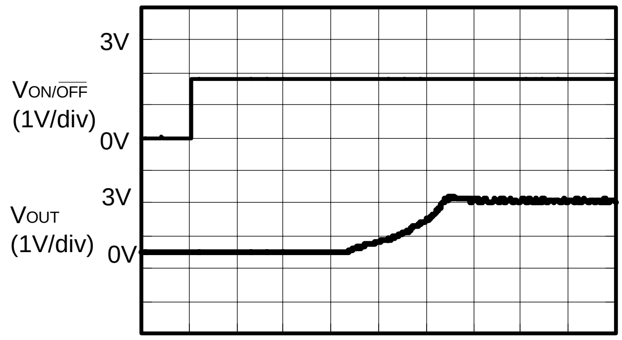
(2) Power-Off Terminal Response

ON/$\overline{OFF}$=0→1.8V, I_{OUT}=1mA



TIME(2msec/div)

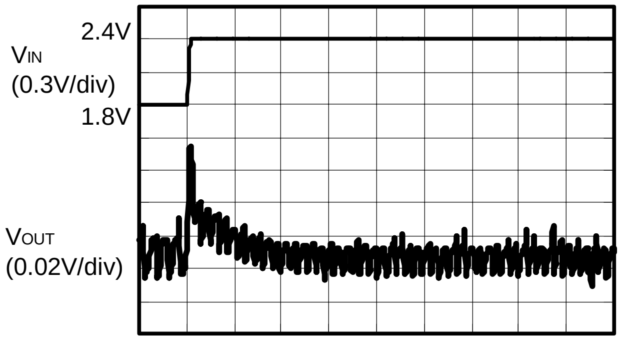
ON/$\overline{OFF}$=0→1.8V, I_{OUT}=200mA



TIME(2msec/div)

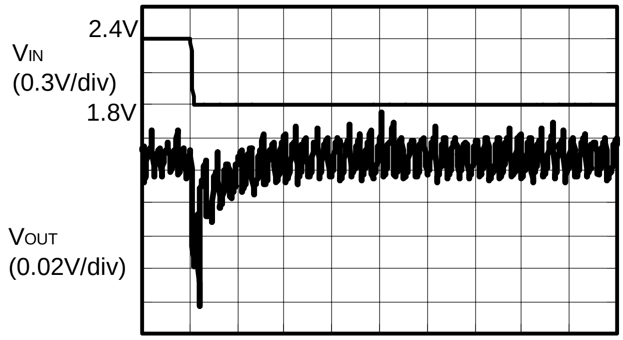
(3) Supply Voltage Variation

V_{IN}=1.8→2.4V, I_{OUT}=100mA



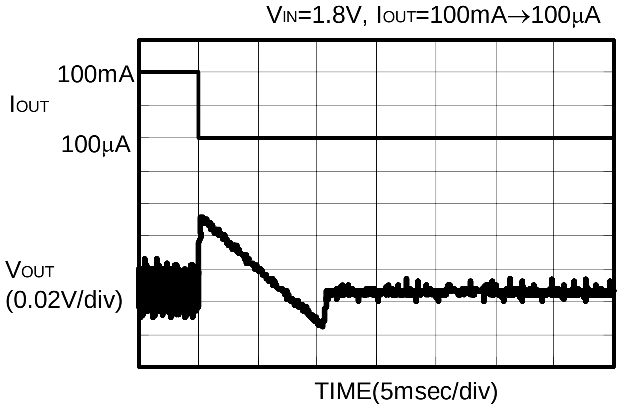
TIME(0.5msec/div)

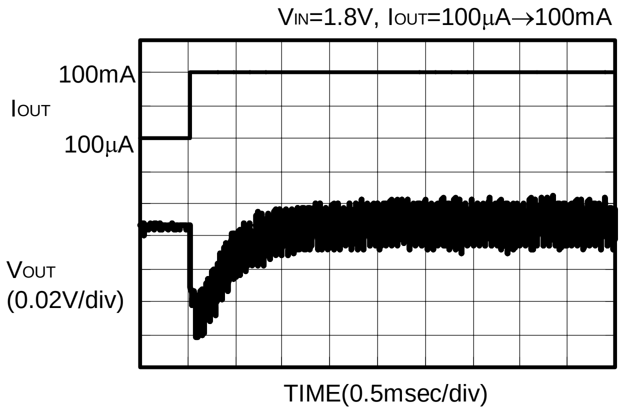
V_{IN}=2.4→1.8V, I_{OUT}=100mA



TIME(0.5msec/div)

(4) Load Variation





■ External Parts Reference Data (All data represents typical values)

This reference data is intended to help you select peripheral components to be externally connected to the IC. Therefore, this information provides recommendations on external components selected with a view to accommodating a wide variety of IC applications. Characteristic data is duly indicated in the table below.

List of external components with efficiency - output current characteristics and output voltage - output current characteristics

Table 2

No.	Product Name	Output Voltage	Inductor	Transistor	Diode	Output Capacitor	SENSE Resistance	Application
(1)	S-8340A25AFT	2.5V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(2)	S-8340A25AFT	2.5V	CDRH124/10μH	FTS2001	RB081L−20	F951C476MG1×2	0Ω	∗②
(3)	S-8341A25AFT	2.5V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(4)	S-8341A25AFT	2.5V	CDRH124/10μH	FTS2001	RBO81L−20	F951C476MG1×2	0Ω	∗②
(5)	S-8340A33AFT	3.3V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(6)	S-8340A33AFT	3.3V	CDRH124/10μH	FTS2001	RBO81L-20	F951C476MG1×2	0Ω	∗②
(7)	S-8341A33AFT	3.3V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(8)	S-8341A33AFT	3.3V	CDRH124/10μH	FTS2001	RBO81L−20	F951C476MG1×2	0Ω	∗②
(9)	S-8340A50AFT	5.0V	CDRH5D18/4.1μH	NDS335N	RB491D	F951A476MF1×1	0Ω	∗①
(10)	S-8340A50AFT	5.0V	CDRH124/10μH	FTS2001	RBO81L−20	F951C476MG1×2	0Ω	∗②
(11)	S-8341A50AFT	5.0V	CDRH5D18/4.1μH	NDS335N	RB491D	F951A476MF1×1	0Ω	∗①
(12)	S-8341A50AFT	5.0V	CDRH124/10μH	FTS2001	RBO81L−20	F951C476MG1×2	0Ω	∗②

External components with PFM/PWM-switched input voltage - output current characteristics

Table 3

No.	Product Name	Output Voltage	Inductor	Transistor	Diode	Output Capacitor	SENSE Resistance	Application
(13)	S-8341A25AFT	2.5V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(14)	S-8341A25AFT	2.5V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2	0Ω	∗②
(15)	S-8341A33AFT	3.3V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1	0Ω	∗①
(16)	S-8341A33AFT	3.3V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2	0Ω	∗②
(17)	S-8341A50AFT	5.0V	CDRH5D18/4.1μH	NDS335N	RB491D	F951A476MF1×1	0Ω	∗①
(18)	S-8341A50AFT	5.0V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2	0Ω	∗②

External components with ripple - output current characteristics

Table 4

No.	Product Name	Output Voltage	Inductor	Transistor	Diode	Output Capacitor	SENSE Resistance	Application
(19)	S-8340A25AFT	2.5V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1 F920J476MB3×2	0Ω	∗①
(20)	S-8340A25AFT	2.5V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②
(21)	S-8341A25AFT	2.5V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1 F920J476MB3×2	0Ω	∗①
(22)	S-8341A25AFT	2.5V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②
(23)	S-8340A33AFT	3.3V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1 F920J476MB3×2	0Ω	∗①
(24)	S-8340A33AFT	3.3V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②
(25)	S-8341A33AFT	3.3V	CDRH5D18/4.1μH	NDS335N	RB491D	F920J476MB3×1 F920J476MB3×2	0Ω	∗①
(26)	S-8341A33AFT	3.3V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②
(27)	S-8340A50AFT	5.0V	CDRH5D18/4.1μH	NDS335N	RB491D	F951A476MF1×1 F951A476MF1×2	0Ω	∗①
(28)	S-8340A50AFT	5.0V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②
(29)	S-8341A50AFT	5.0V	CDRH5D18/4.1μH	NDS335N	RB491D	F951A476MF1×1 F951A476MF1×2	0Ω	∗①
(30)	S-8341A50AFT	5.0V	CDRH124/10μH	FTS2001	RB081L-20	F951C476MG1×2 F951A107MG1×2	0Ω	∗②

Applications

∗① CDRH5D18 + NDS335N + RB491D -> Small thin components with a height of 2 mm or less (Maximum current of the external component is set to 1.7 A.)

∗② CDRH124 + FTS2001 + RB081L-20 -> Large load current (Maximum current of the external component is set to 4.5 A.)

Performance Data

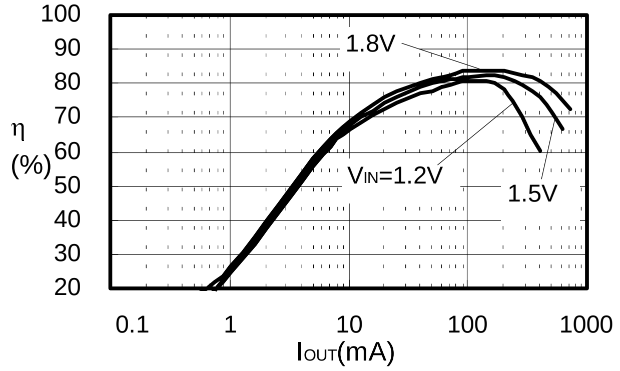
Table 5

Component	Product Name	Manufacturer's Name	L-Value	DC Resistance	Max. Allowable Current	Dia.	Height
Inductor	CDRH5D18	Sumida	4.1μH	42mΩ typ. 57mΩ max.	1.95A	5.7mm typ. 6.0mm max.	1.8mm typ. 2.0mm max.
	CDRH124	Sumida	10μH	28mΩ max.	4.5A	12.0mm typ. 12.3mm max.	4.5mm max.
Diode	RB491D	ROHM	Forward current 1.0A (When VF=0.45V), Vrm=25V				
	RB081L−20	ROHM	Forward current 5.0A (When VF=0.45V), Vrm=25V				
Output Capacity (tantalum electrolytic capacitor)	F951C476MG1	Nichicon	47μF, 16V, 5.5 × 4.8× 2.3mm max.				
	F951A476MF1	Nichicon	47μF, 10V, 5.5 × 4.8× 2.0mm max.				
	F920J476MB3	Nichicon	47μF, 6.3V, 3.6 × 3 × 1.2mm max.				
	F951A107MG1	Nichicon	100μF, 10V, 5.5 × 4.8 × 2.3mm max.				
External Transistor (MOS FET)	NDS335N	National Semiconductor	Vdss=20V max., Vgss=8V max., ID =1.7A max., Vth=0.5V to 1V Ciss 240pF typ. Ron 0.14Ω max.(Vgs=2.7V), SOT-23-3 package or equivalent				
	FTS2001	Sanyo	Vdss=20V max., Vgss=8V max., ID =5A max., Vth=0.4V to 1.3V Ciss 750pF typ. Ron 46mΩ max.(Vgs=2.5V) , 8-pin TSSOP package				

1. Efficiency η—Output current I_{OUT} Characteristics

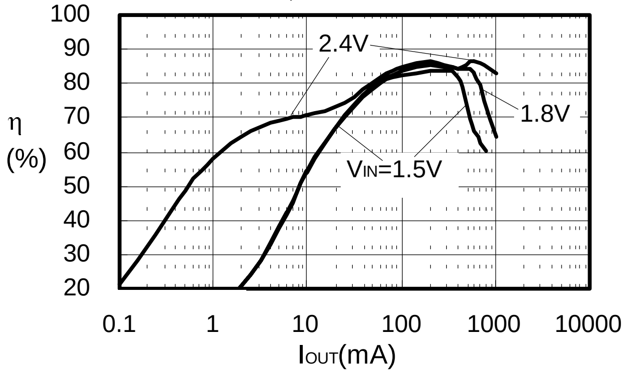
(1) S-8340A25AFT

(CDRH5D18/4.1μH, NDS335N)



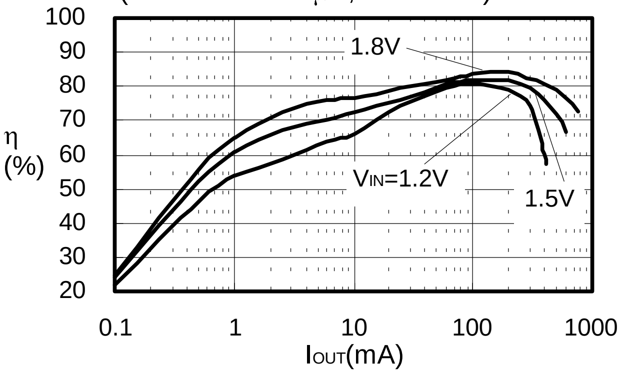
(2) S-8340A25AFT

(CDRH124/10μH, FTS2001)



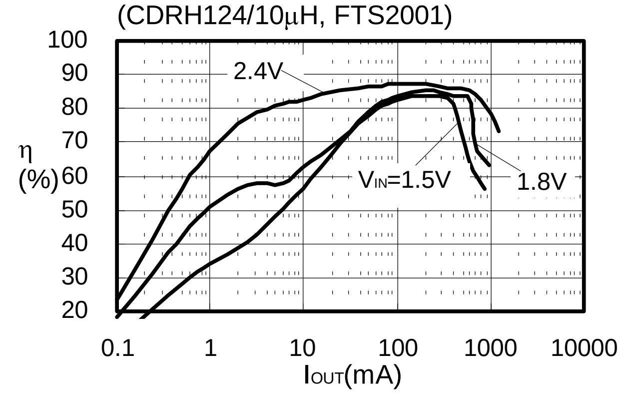
(3) S-8341A25AFT

(CDRH5D18/4.1μH, NDS335N)



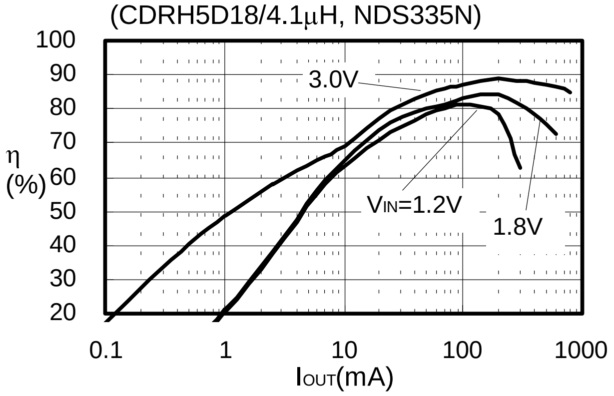
(4) S-8341A25AFT

(CDRH124/10μH, FTS2001)



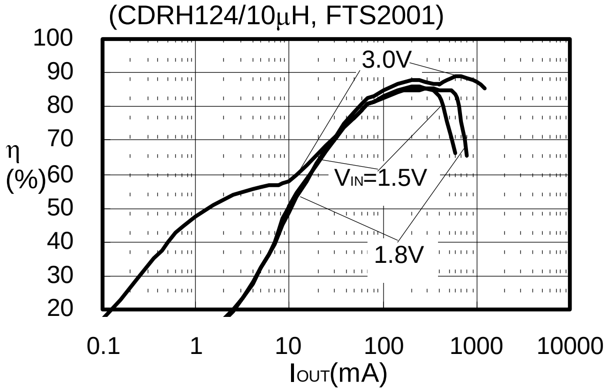
(5) S-8340A33AFT

(CDRH5D18/4.1μH, NDS335N)



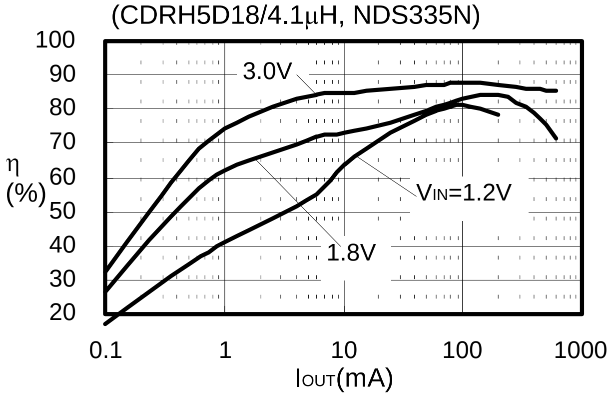
(6) S-8340A33AFT

(CDRH124/10μH, FTS2001)



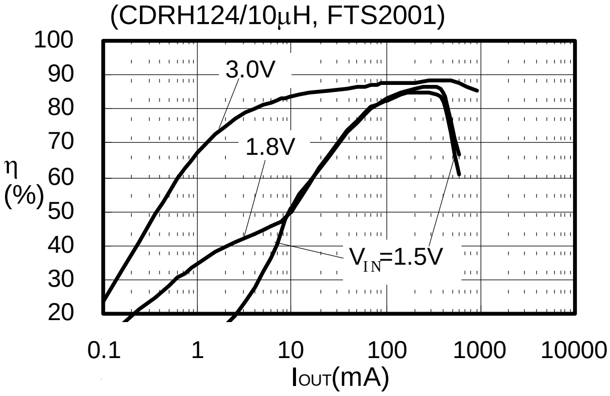
(7) S-8341A33AFT

(CDRH5D18/4.1μH, NDS335N)

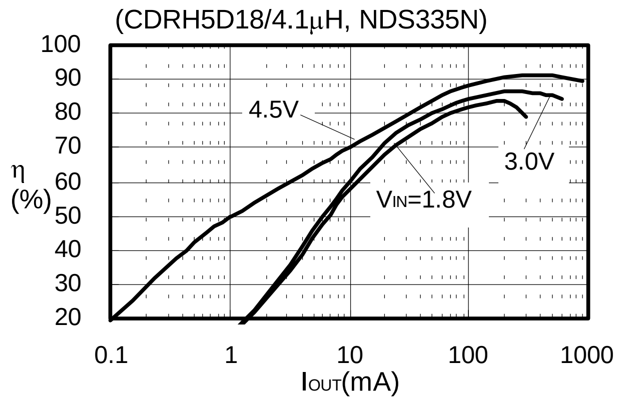


(8) S-8341A33AFT

(CDRH124/10μH, FTS2001)



(9)S-8340A50AFT



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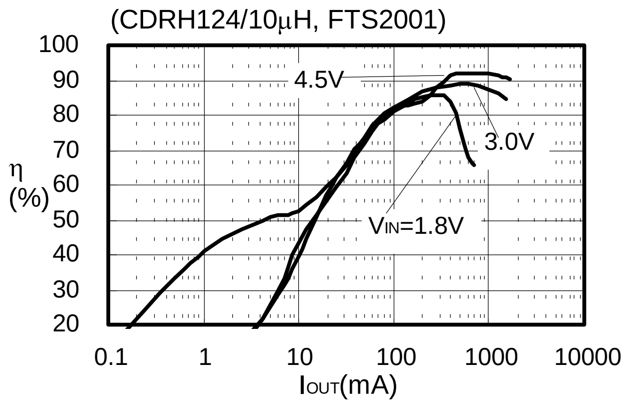
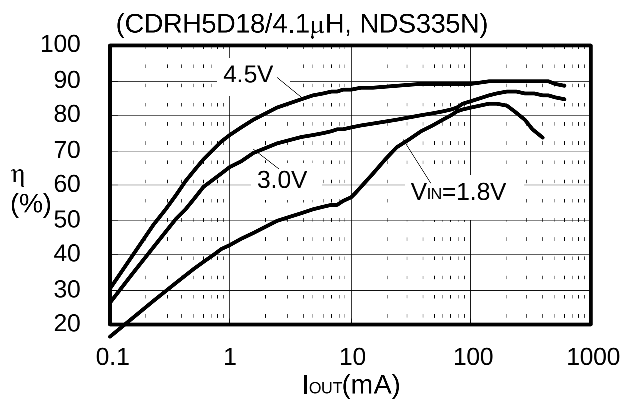
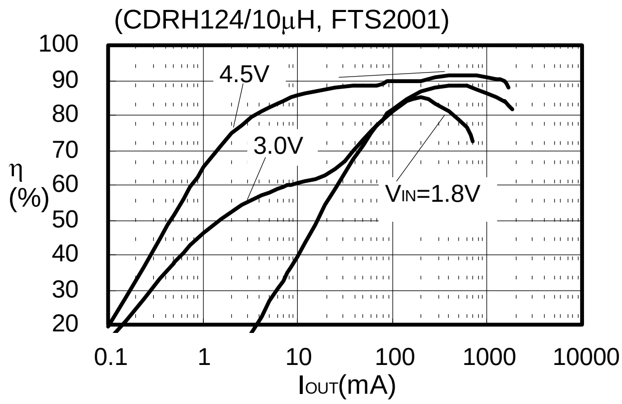


(11) S-8341A50AFT

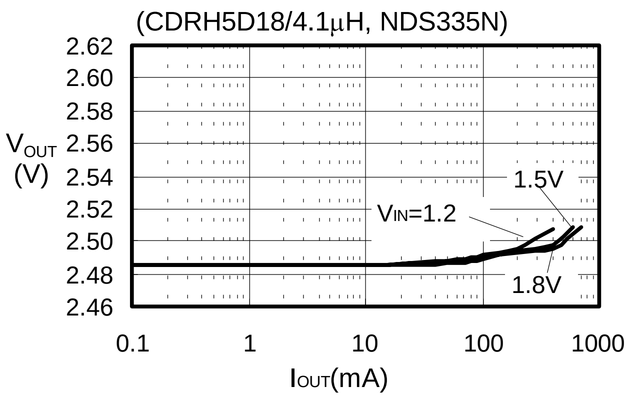


(12) S-8341A50AFT

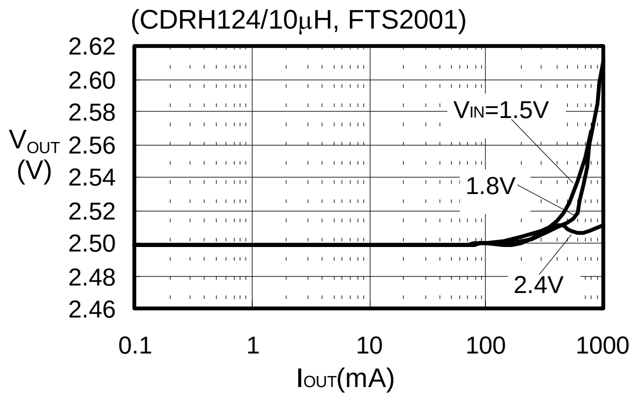


2. Output voltage VOUT. Output current IOUT Characteristics

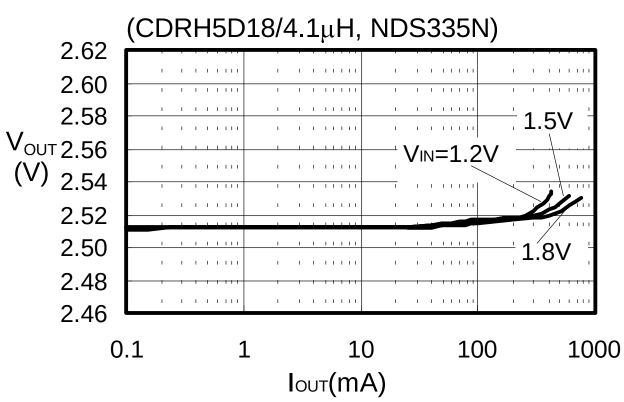
(1) S-8340A25AFT



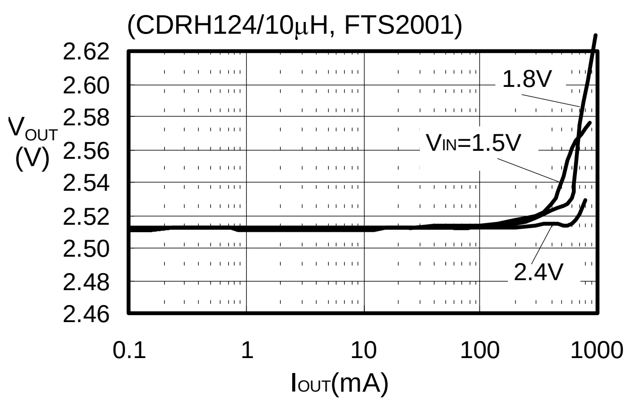
(2) S-8340A25AFT



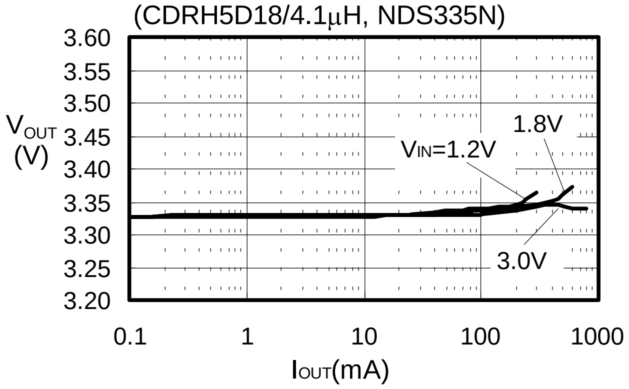
(3) S-8341A25AFT



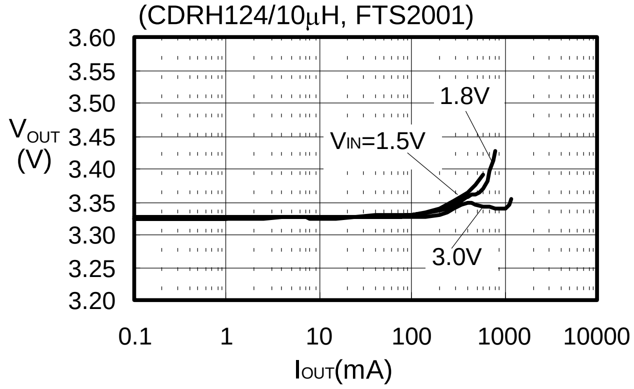
(4) S-8341A25AFT



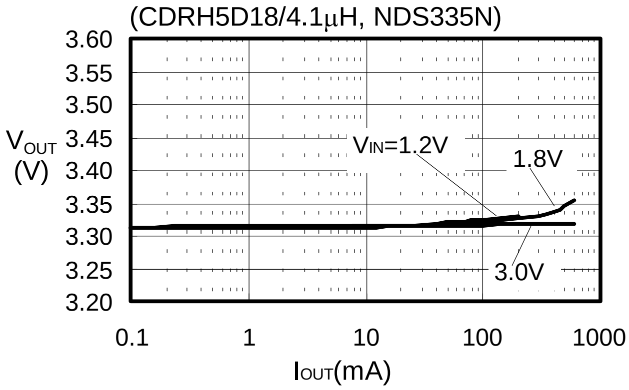
(5) S-8340A33AFT



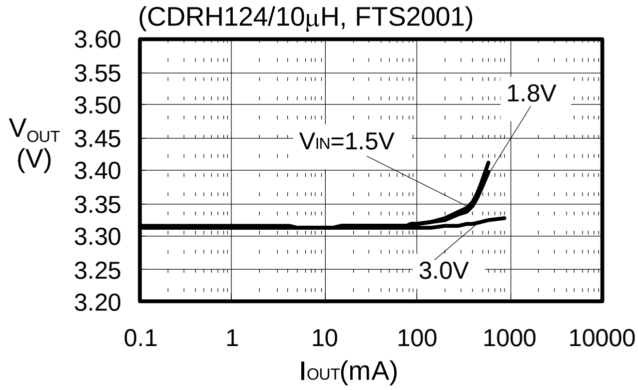
(6) S-8340A33AFT



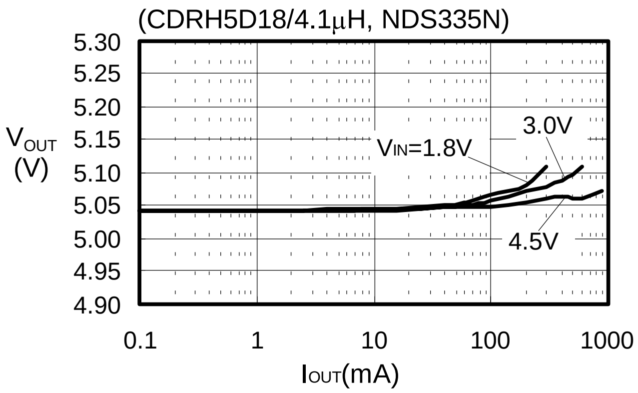
(7) S-8341A33AFT



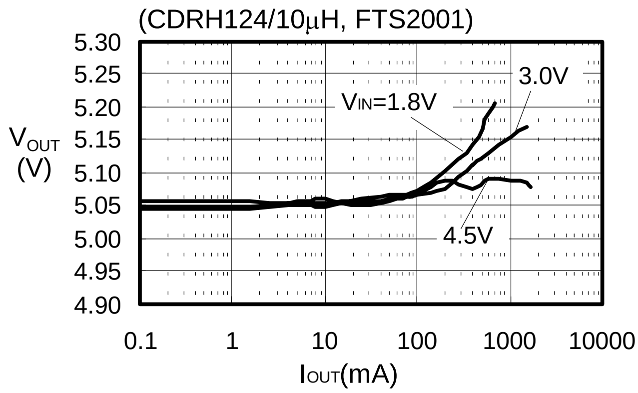
(8) S-8341A33AFT



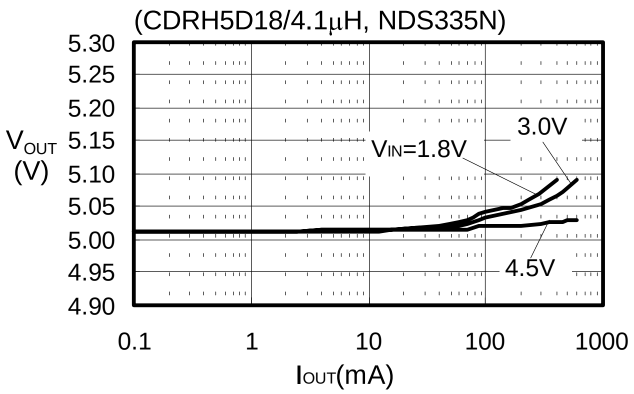
(9) S-8340A50AFT



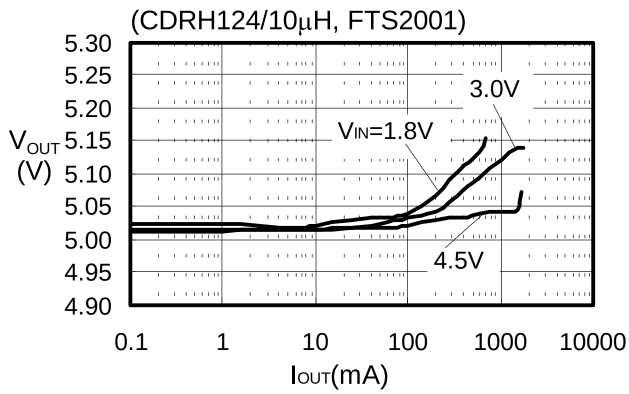
(10) S-8340A50AFT



(11) S-8341A50AFT

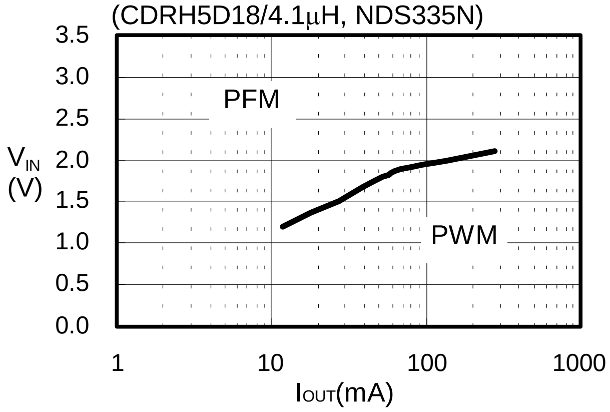


(12) S-8341A50AFT

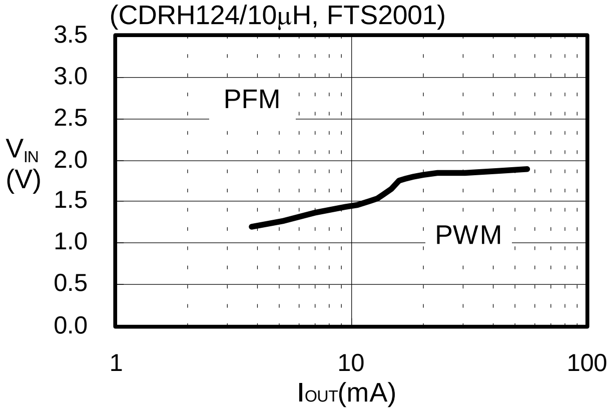


3. PFM/PWM-switched input voltage V_{IN}- output current V_{OUT} characteristics (Output current increase)

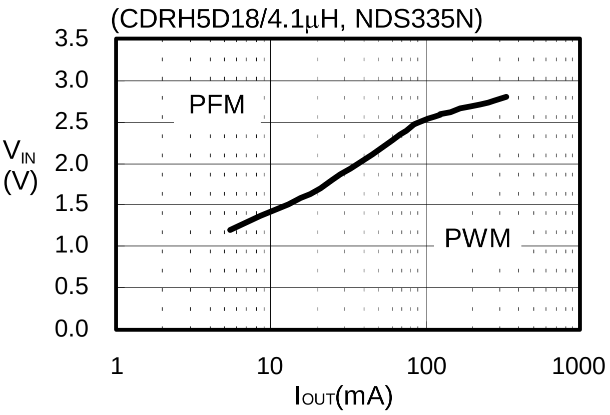
(13) S-8341A25AFT



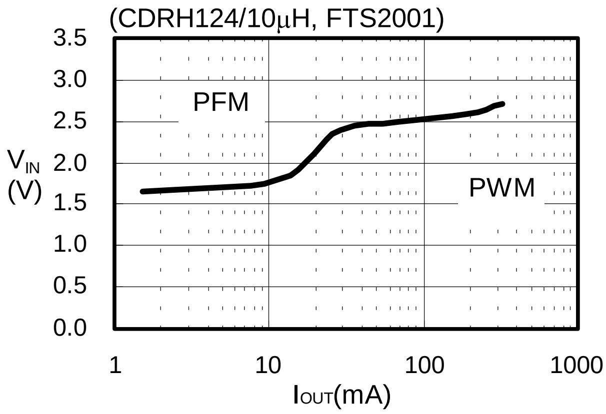
(14) S-8341A25AFT



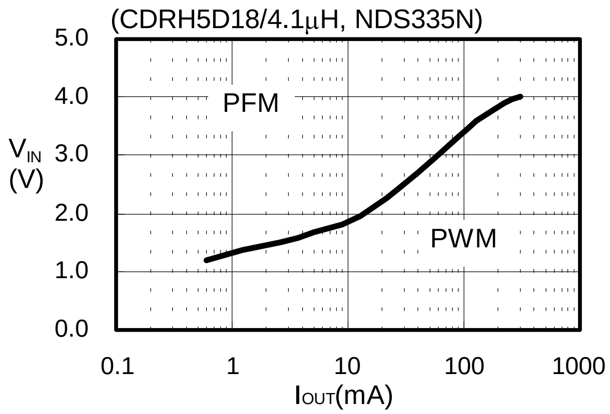
(15) S-8341A33AFT



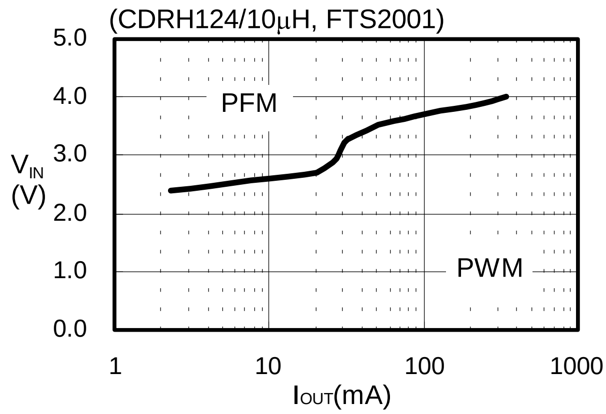
(16) S-8341A33AFT



(17) S-8341A50AFT



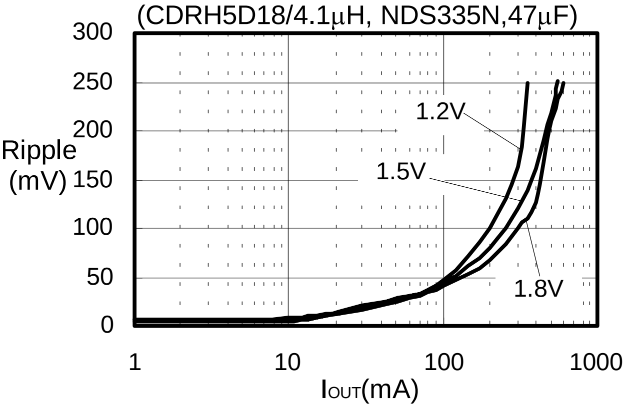
(18) S-8341A50AFT



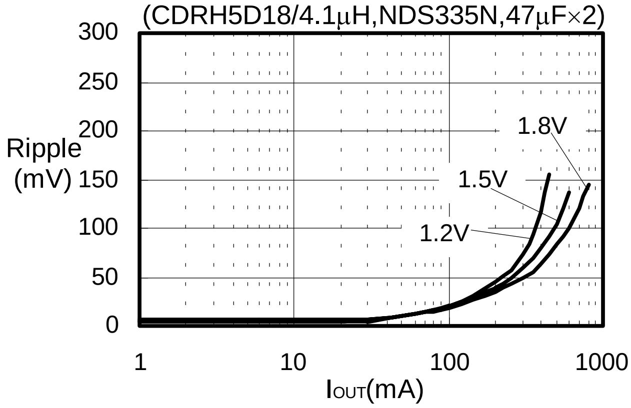
4. Ripple—Output current I_{OUT} Characteristics

(19) S-8340A25AFT

(CDRH5D18/4.1µH, NDS335N,47µF)

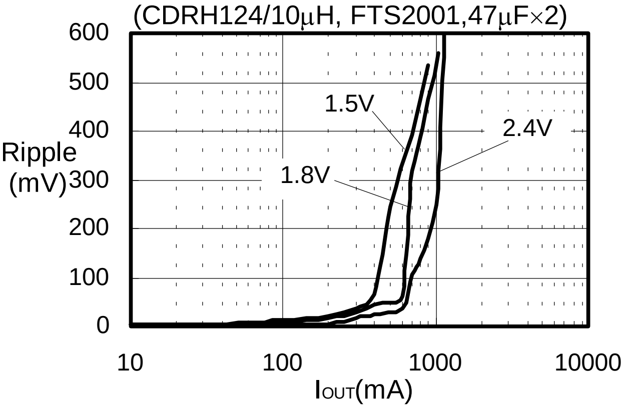


(CDRH5D18/4.1µH,NDS335N,47µF×2)

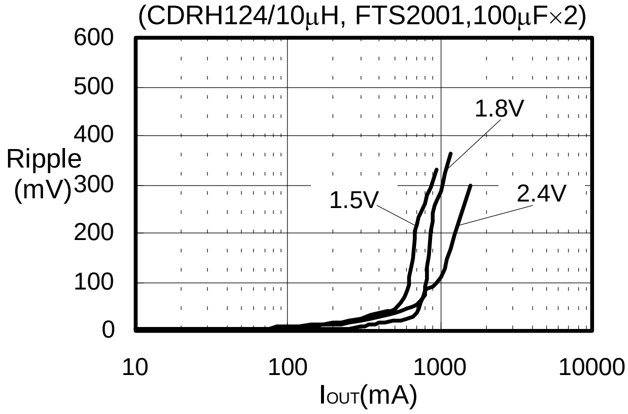


(20) S-8340A25AFT

(CDRH124/10µH, FTS2001,47µF×2)

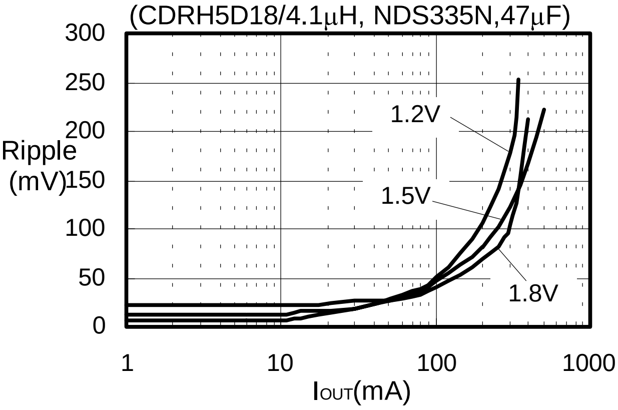


(CDRH124/10µH, FTS2001,100µF×2)

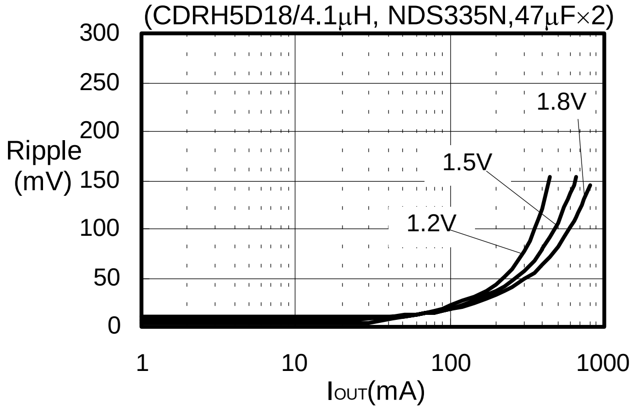


(21) S-8341A25AFT

(CDRH5D18/4.1µH, NDS335N,47µF)

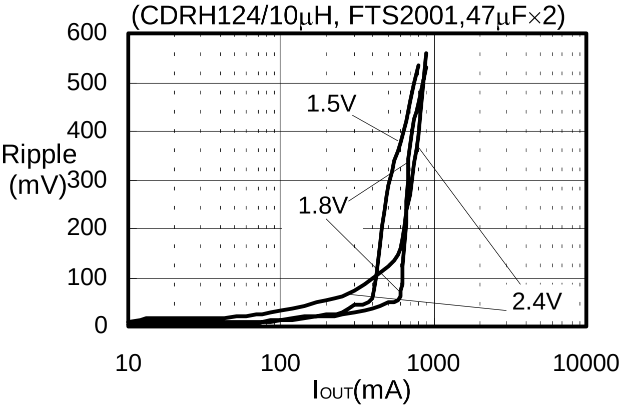


(CDRH5D18/4.1µH, NDS335N,47µF×2)

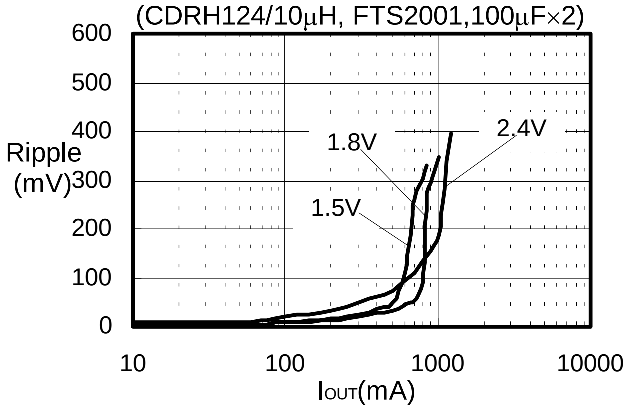


(22) S-8341A25AFT

(CDRH124/10µH, FTS2001,47µF×2)

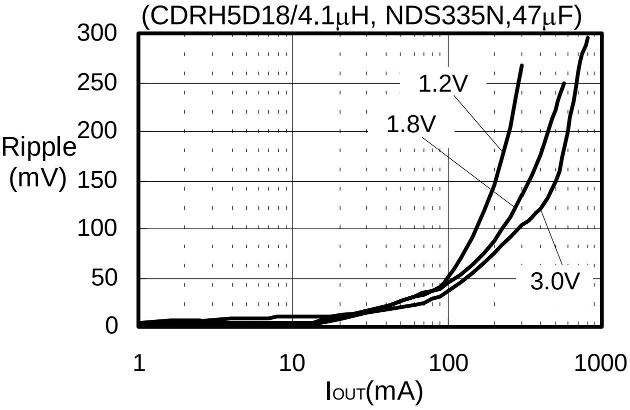


(CDRH124/10µH, FTS2001,100µF×2)

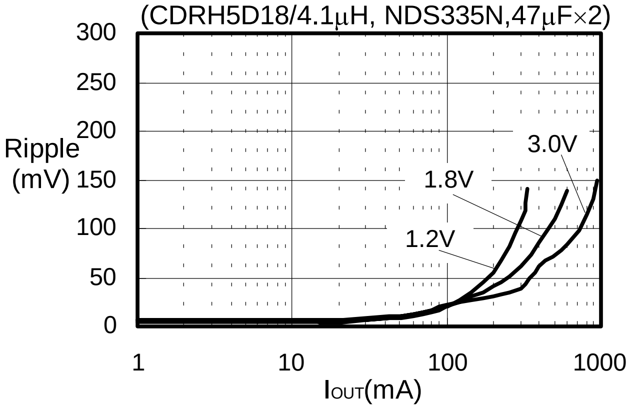


(23) S-8340A33AFT

(CDRH5D18/4.1μH, NDS335N,47μF)

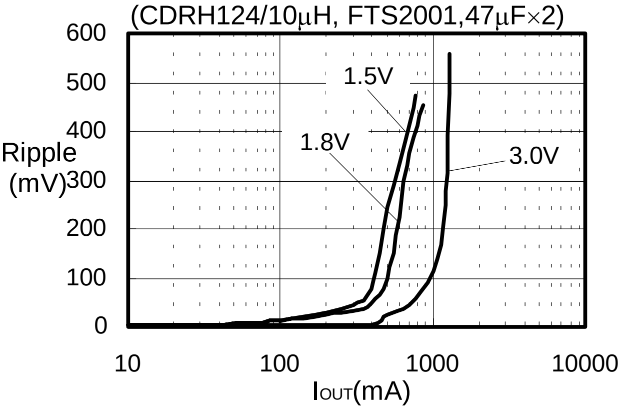


(CDRH5D18/4.1μH, NDS335N,47μF×2)

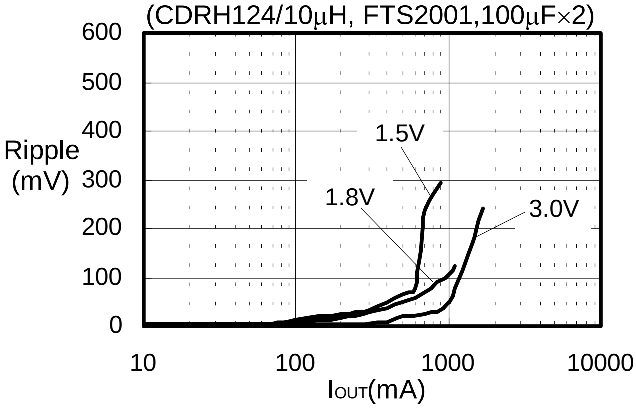


(24) S-8340A33AFT

(CDRH124/10μH, FTS2001,47μF×2)

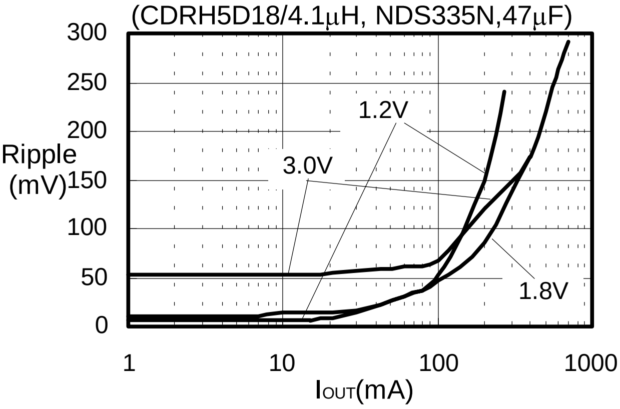


(CDRH124/10μH, FTS2001,100μF×2)

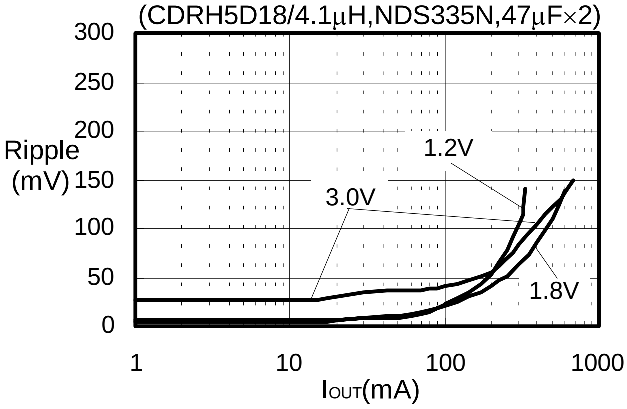


(25) S-8341A33AFT

(CDRH5D18/4.1μH, NDS335N,47μF)

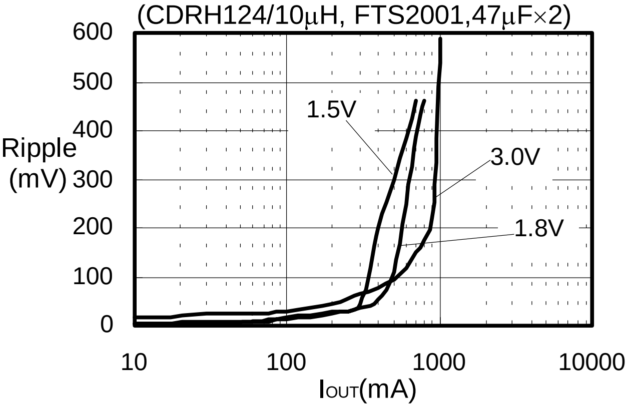


(CDRH5D18/4.1μH,NDS335N,47μF×2)

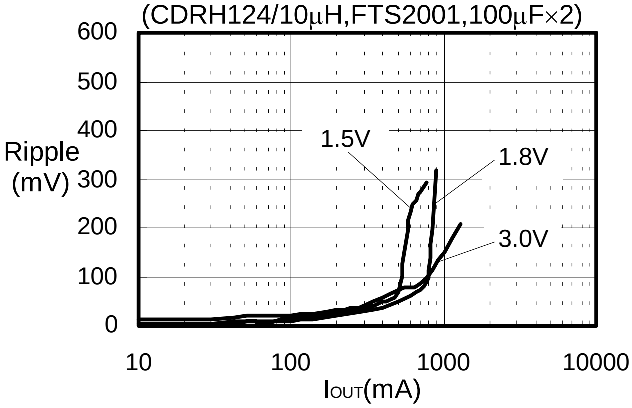


(26) S-8341A33AFT

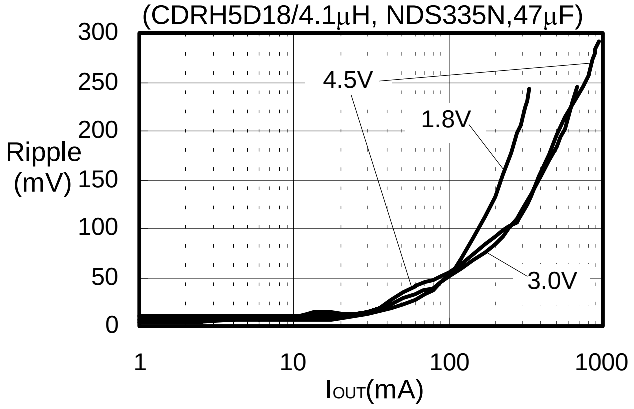
(CDRH124/10μH, FTS2001,47μF×2)

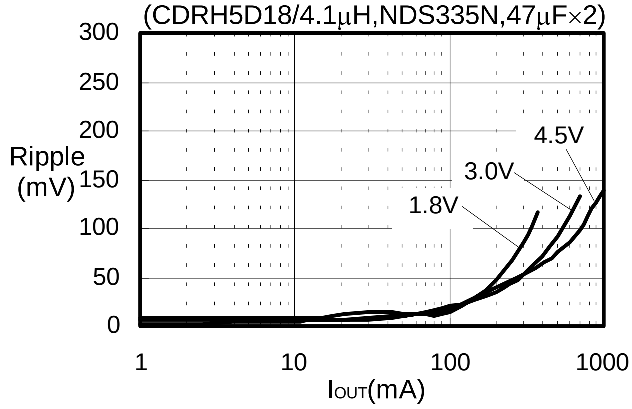


(CDRH124/10μH,FTS2001,100μF×2)



(27) S-8340A50AFT





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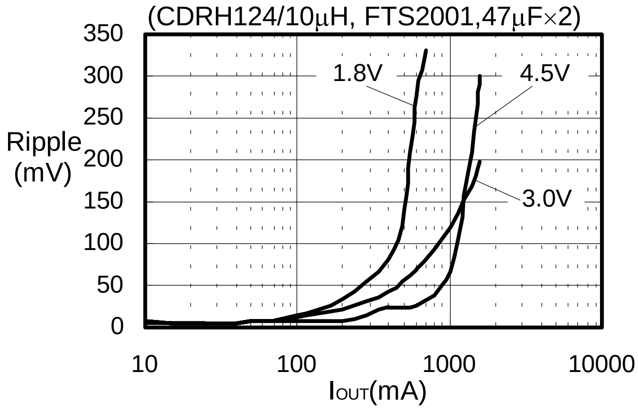

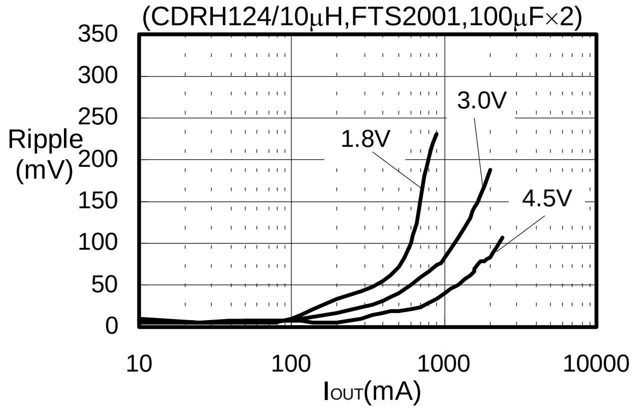

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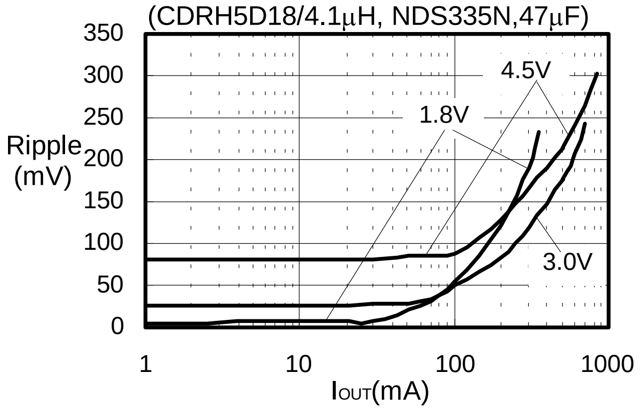

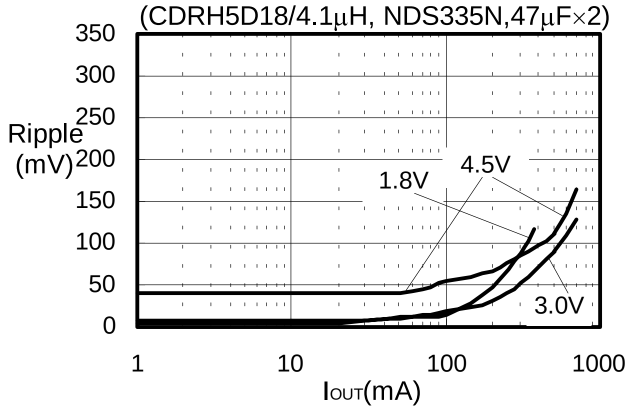

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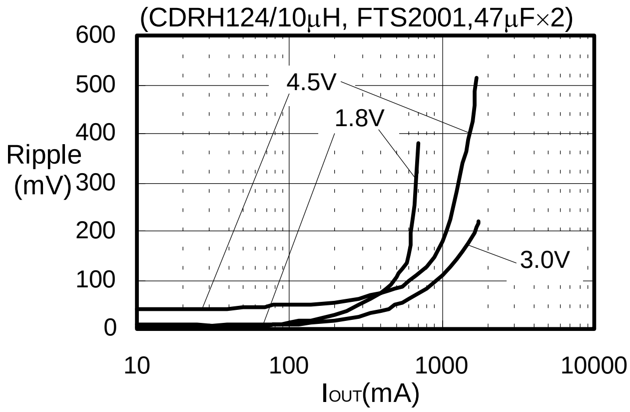
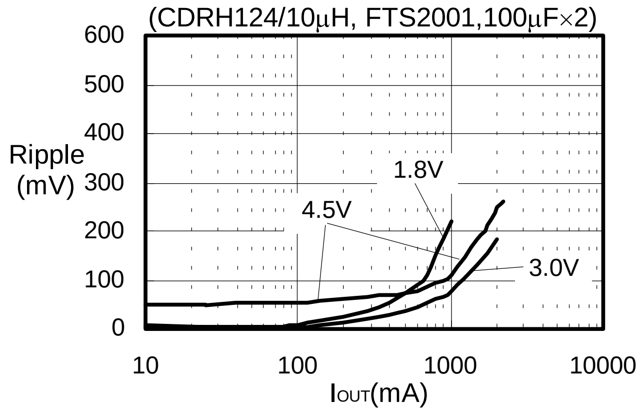


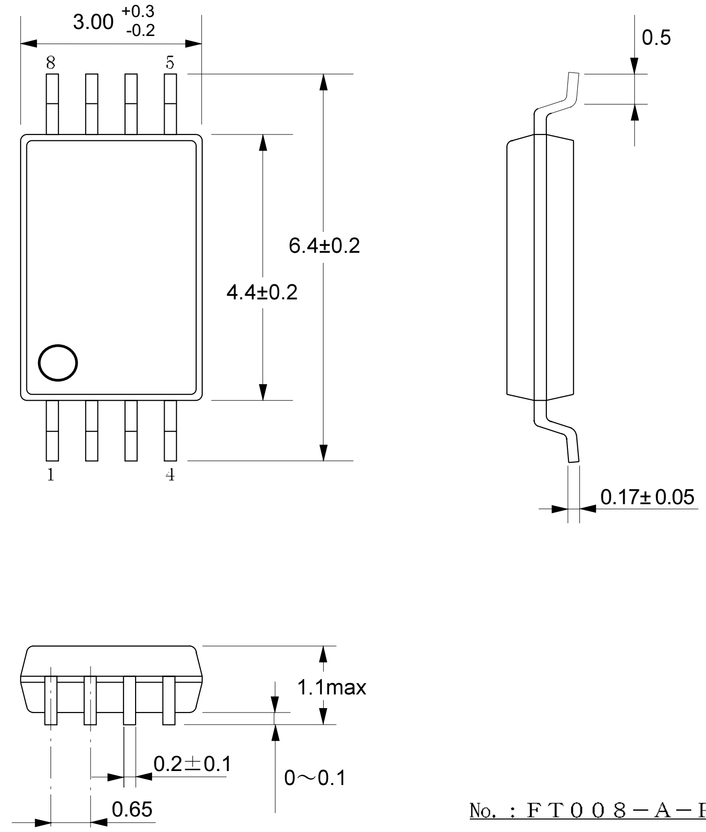


■ 8-pin TSSOP

FT008-A 990531

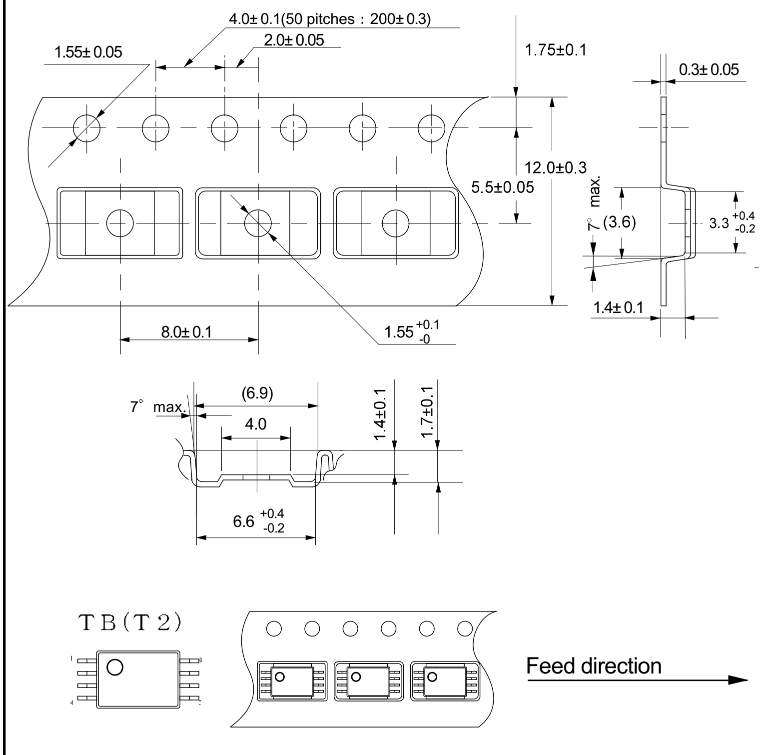
●Dimensions

Unit:mm



No.：FT008−A−P−SD−1.0

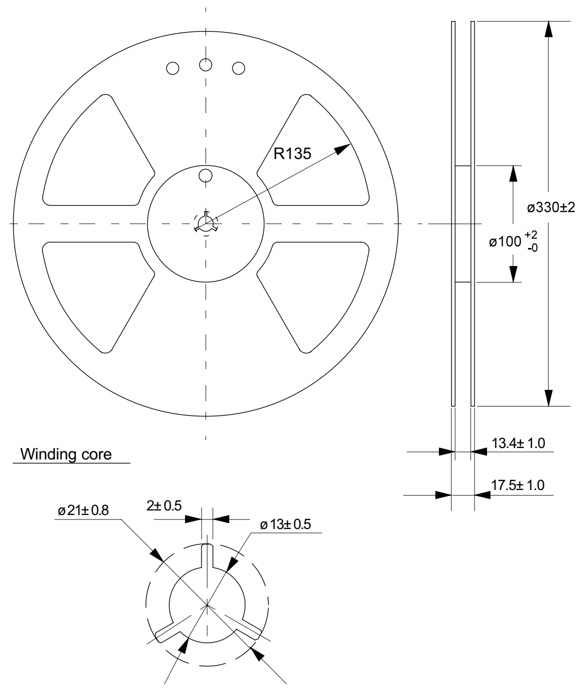
●Taping Specifications



No.：FT008−A−C−SD−1.0

●Reel Specifications

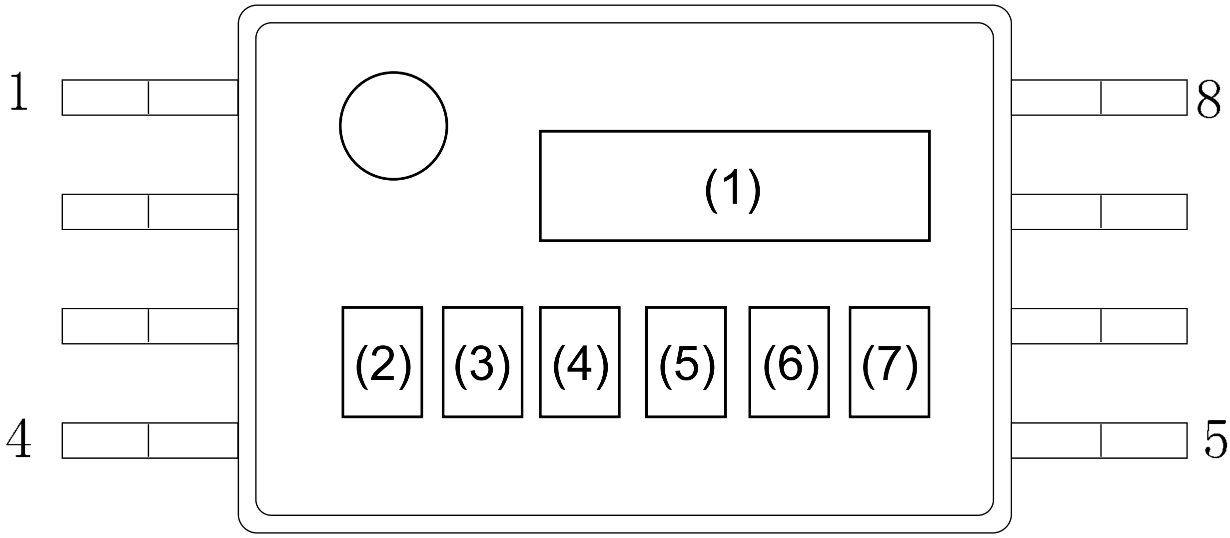
1 reel holds 3000 ICs.



No.：FT008−A−R−SD−1.0

■Markings

● 8-pin TSSOP



（１） ： Product lot

（２） to （７） ： Product name

No.：ＦＴ００８－Ａ－Ｍ－Ｓ１－１．０