3-CHANNEL WHITE LED DRIVER IC (CHARGE PUMP IC WITH A BUILT-IN CONSTANT-CURRENT CIRCUIT) S-8813 Series

The S-8813 Series is a PFM control charge pump DC-DC converter with a built-in constant-current circuit, and was developed using CMOS technology. Its constant current output makes this series ideal as a power supply for current drive LEDs.

The S-8813 Series features three output channels and can drive three LEDs.

This series is available in two types: a variable voltage type and a variable current setting resistance type.

Moreover, since small ceramic capacitors can be used as external capacitors (pump capacitors, input capacitors, output capacitors), the S-8813 Series contributes to set miniaturization.

■ Features

- PFM control CMOS charge pump
- Built-in constant-current circuit
- Power supply voltage: 2.7 V to 4.5 V
- Output current value: A current variable is possible between 5.0 mA and 18 mA (at $V_{IOUT1,2,3}$≤4.0 V, V_{IN}=3.0 V) Variable voltage type and Variable current setting resistance type are available.
- Terminal output current matching: ±1% max.
- Built-in soft start circuit: 1.5 ms typ.
- Constant current output pins: 3 channels, ±5% accuracy
- Oscillation frequency: 600 kHz typ.
- ON/OFF function provided (During standby: 1 μA max.)
- Ultra-small package: SON10

■ Applications

- Power supply for white LED display backlights
- Constant-current circuit
- Cellular phones and PDAs using 1-cell lithium batteries
- Power supply for flat panel displays

■ Package

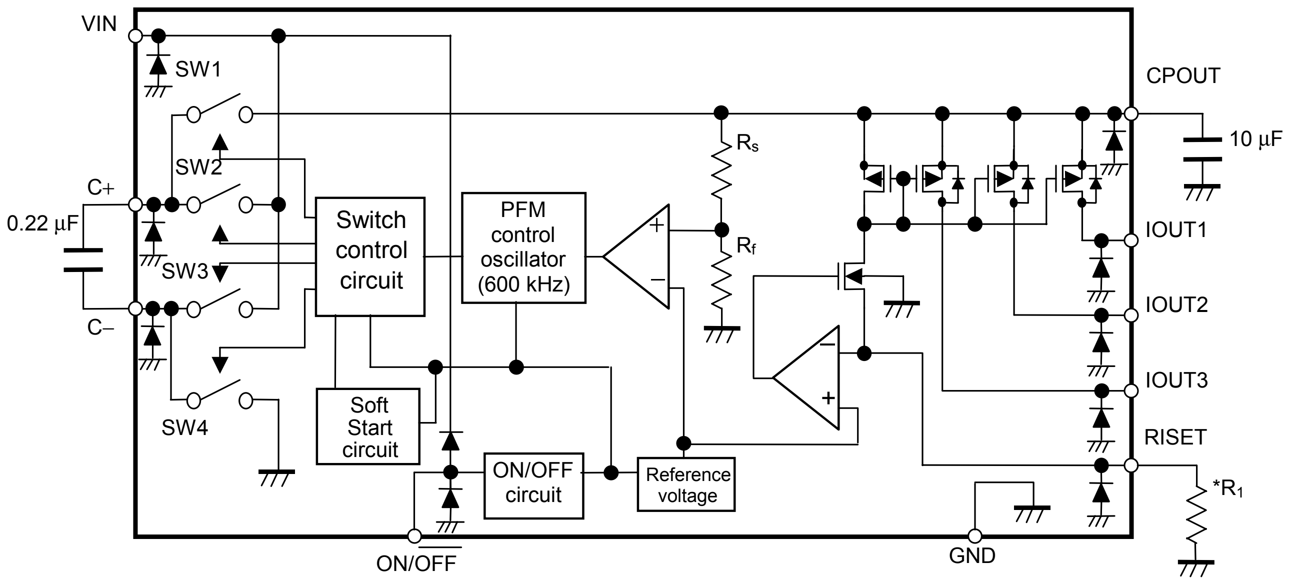
- 10-pin SON(B) (package drawing code: PE010-A)

■ Part Numbers

- S-881300BPE-TB (Variable voltage type)
- S-881300CPE-TB (Variable current setting resistance type)

■ Block Diagram

S-881300CPE



*R1: Current setting resistance

Figure 1 Block Diagram

■ Pin Assignment

10-Pin SON(B)
Top View

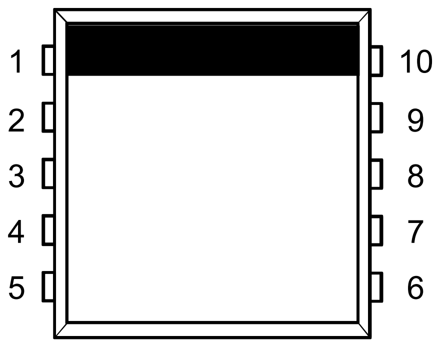


Figure 2 Pin Assignment

Table 1 Pin Descriptions

Pin No.	Pin Name	Function
1	IOUT1	Output pin (constant-current output)
2	IOUT2	Output pin (constant-current output)
3	IOUT3	Output pin (constant-current output)
4	C+	Pump capacitor connection pin (positive pin)
5	C−	Pump capacitor connection pin (negative pin)
6	GND	GND pin
7	VIN	Voltage input pin
8	CPOUT	Charge pump output pin (capacitor connection pin)
9	RISET/ VISET	Variable output current pins In the case of RISET, a resistor is connected to this pin and the output current can be varied by changing the resistance value. In the case of VISET, the output current can be varied by changing the voltage applied to this pin.
10	ON/OFF	Power-off pin High level: Normal operation (Step-up operation) Low level: Stepping-up halt (Whole circuit stopped)

■ Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings

(Unless otherwise specified, Ta = 25°C)

Parameter	Symbol	Absolute Maximum Rating	Unit
IOUT 1, 2, 3 pin voltage	$V_{IOUT1,2,3}$	V_{SS}–0.3 to V_{SS}+7	V
C+ pin voltage	V_{C+}	V_{SS}–0.3 to V_{SS}+7.5	V
C– pin voltage	V_{C-}	V_{SS}–0.3 to V_{SS}+7	V
VIN pin voltage	V_{IN}	V_{SS}–0.3 to V_{SS}+5	V
CPOUT pin voltage	V_{CPOUT}	V_{SS}–0.3 to V_{SS}+7	V
RISET/VISET pin voltage	V_{RISET}/V_{VISET}	V_{SS}–0.3 to V_{SS}+7	V
ON/$\overline{OFF}$ pin voltage	$V_{ON/\overline{OFF}}$	V_{SS}–0.3 to V_{IN}+0.3	V
Operating temperature range	T_{opr}	–40 to +85	°C
Storage temperature range	T_{stg}	–40 to +125	°C
Power dissipation	P_D	290	mW

Caution: Although this IC contains a protection circuit against static electricity, take due care not to apply a large electrostatic charge or voltage exceeding the limit of the protection circuit.

■ Electrical Characteristics

1. S-881300CPE

Table 3 Electrical Characteristics

(Unless otherwise specified, V_{IN} = 3.0 V, current setting resistance = 5.6 kΩ, Ta = 25°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Operation input voltage	V_{IN}		2.7	—	4.5	V	2
Stabilized output current	I_{OUT}	V_{IN} = 3.0 V to 4.5 V $V_{IOUT1,2,3}$*1 ≤ 3.6 V	23	—	—	mA	2
		V_{IN} = 3.0 V to 4.5 V $V_{I\,OUT1,2,3}$*1 ≤ 4.0 V	18	—	—	mA	2
		V_{IN} = 2.7 V to 3.0 V $V_{I\,OUT1,2,3}$*1 ≤ 3.6 V	14	—	—	mA	2
Output current VI_{OUT} characteristics	ΔI_{OUT1}	V_{IN} = 3.0 V, V_{IOUT}= 3.0 V to 4.0 V	—	0.5	1	mA	2
Output current input stability	ΔI_{OUT2}	V_{IN} = 3.0 V to 4.5 V V_{IOUT} ≤ 3.6 V	—	0.5	1	mA	2
Output current accuracy	$\frac{\Delta I_{OUT1}}{I_{OUT}}$	$I_{OUT1,2,3}$ = 17.8 mA	−5.0	—	+5.0	%	2
Inter-pin output current variation	ΔI_M	VI_{OUT} = 3.6 V	−1.0	—	+1.0	%	2
Ripple voltage	V_{RIP}	V_{IN} = 2.7 V to 4.5 V $I_{OUT1,2,3}$ = 18 mA	—	—	100	$mV_{p\text{-}p}$	2
Maximum oscillation frequency	f_{osc}	V_{CPOUT} = 4.75 V Measure waveform at C– pin	540	600	660	kHz	1
Efficiency*2	η	V_{IN} = 3.0 V, $I_{OUT1,2,3}$ = 18 mA	—	82	—	%	2
Operation consumption current	I_{SS1}	V_{IN} = 2.7 V to 4.5 V V_{CPOUT} = 4.75 V	—	1	1.5	mA	1
Standby consumption current	I_{SSS}	V_{IN} = 2.7 V to 4.5 V	—	0.3	1	μA	1
Power-off pin input voltage (high level)	V_{SH}	V_{IN} = 2.7 V to 4.5 V	2.0	—	—	V	1
Power-off pin input voltage (low level)	V_{SL}	V_{IN} = 2.7 V to 4.5 V	—	—	0.3	V	1
Power-off pin input current (high level)	I_{SH}	V_{IN} = 2.7 V to 4.5 V	−0.1	—	0.1	mA	1
Power-off pin input current (low level)	I_{SL}	V_{IN} = 2.7 V to 4.5 V	−0.1	—	0.1	mA	1
Soft start time	t_{SS}	V_{IN} = 2.7 V to 4.5 V	0.3	1.5	3	ms	2
RISET pin voltage	V_{RISET}	V_{IN} = 2.7 V to 4.5 V	0.98	1	1.02	V	2

***1.** $V_{IOUT1,\,2,\,3}$ are the voltages of the IOUT pin.

***2.** "Efficiency" in the electrical characteristics means the efficiency of the charge pump circuit block. The ideal efficiency is indicated by the following expression.

Efficiency =[$V_{CPOUT} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

The ideal efficiency including the constant current circuit is expressed as following expression.

Efficiency =[$(V_{IOUT1} \times I_{OUT1}) + (V_{IOUT2} \times I_{OUT2}) + (V_{IOUT3} \times I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

Remark: The numbers in the "test circuit" column correspond to the circuit numbers in the **Measurement Circuits** section.

2. S-881300BPE

Table 4 Electrical Characteristics

(Unless otherwise specified, V_{IN} = 3.0 V, current setting voltage = 1.8 V, Ta = 25°C)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test Circuit
Operation input voltage	V_{IN}		2.7	—	4.5	V	2
Stabilized output current	I_{OUT}	V_{IN} = 3.0 V to 4.5 V $V_{IOUT1,2,3}$*1 ≤ 3.6 V	23	—	—	mA	2
		V_{IN} = 3.0 V to 4.5 V $V_{I\,OUT1,2,3}$*1 ≤ 4.0 V	18	—	—	mA	2
		V_{IN} = 2.7 V to 3.0 V $V_{I\,OUT1,2,3}$*1 ≤ 3.6 V	14	—	—	mA	2
Output current VI_{OUT} characteristics	ΔI_{OUT1}	V_{IN} = 3.0 V, V_{IOUT} = 3.0 V to 4.0 V	—	0.5	1	mA	2
Output current input stability	ΔI_{OUT2}	V_{IN} = 3.0 V to 4.5 V V_{IOUT} ≤ 3.6 V	—	0.5	1	mA	2
Output current accuracy	$\frac{\Delta I_{OUT1}}{I_{OUT}}$	$I_{OUT1,2,3}$ = 18 mA	–5.0	—	+5.0	%	2
Inter-pin output current variation	ΔI_M	V_{IOUT} = 3.6 V	–1.0	—	+1.0	%	2
Ripple voltage	V_{RIP}	V_{IN}=2.7 V to 4.5 V	—	—	100	mV_{p-p}	2
Maximum oscillation frequency	f_{osc}	V_{CPOUT} = 4.75 V Measure waveform at C- pin	540	600	660	kHz	1
Efficiency*2	η	V_{IN} = 3.0 V	—	82	—	%	2
Operation consumption current	I_{SS1}	V_{IN} = 2.7 V to 4.5 V V_{CPOUT} = 4.75 V	—	1	1.5	mA	1
Standby consumption current	I_{SSS}	V_{IN} = 2.7 V to 4.5 V	—	0.3	1	mA	1
Power-off pin input voltage (high level)	V_{SH}	V_{IN} = 2.7 V to 4.5 V	2.0	—	—	V	1
Power-off pin input voltage (low level)	V_{SL}	V_{IN} = 2.7 V to 4.5 V	—	—	0.3	V	1
Power-off pin input current (high level)	I_{SH}	V_{IN} = 2.7 V to 4.5 V	–0.1	—	0.1	mA	1
Power-off pin input current (low level)	I_{SL}	V_{IN} = 2.7 V to 4.5 V	–0.1	—	0.1	mA	1
Soft start time	t_{SS}	V_{IN} = 2.7 V to 4.5 V	0.3	1.5	3	ms	2
VISET pin voltage	V_{VISET}	V_{IN} = 2.7 V to 4.5 V	0.5	—	1.8	V	2

***1.** $V_{IOUT1,\,2,\,3}$ are the voltages of the IOUT pin.

***2.** "Efficiency" in the electrical characteristics means the efficiency of the charge pump circuit block. The ideal efficiency is indicated by the following expression.

Efficiency =[$V_{CPOUT} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

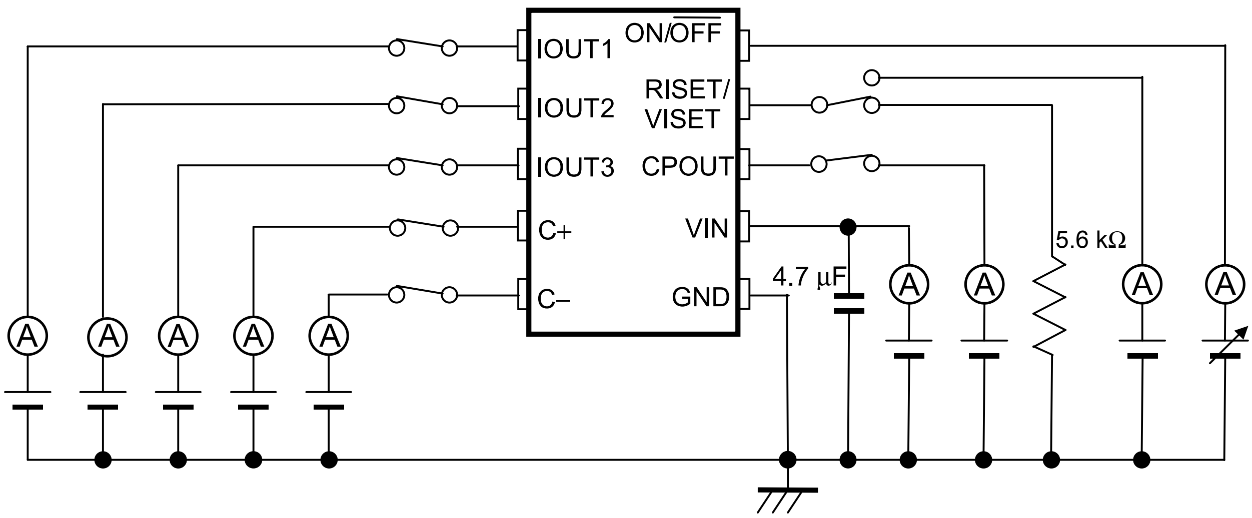
The ideal efficiency including the constant current circuit is expressed as following expression.

Efficiency =[$(V_{IOUT1} \times I_{OUT1}) + (V_{IOUT2} \times I_{OUT2}) + (V_{IOUT3} \times I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

Remark: The numbers in the "test circuit" column correspond to the circuit numbers in the **Measurement Circuits** section.

■ Measurement Circuits

1



2

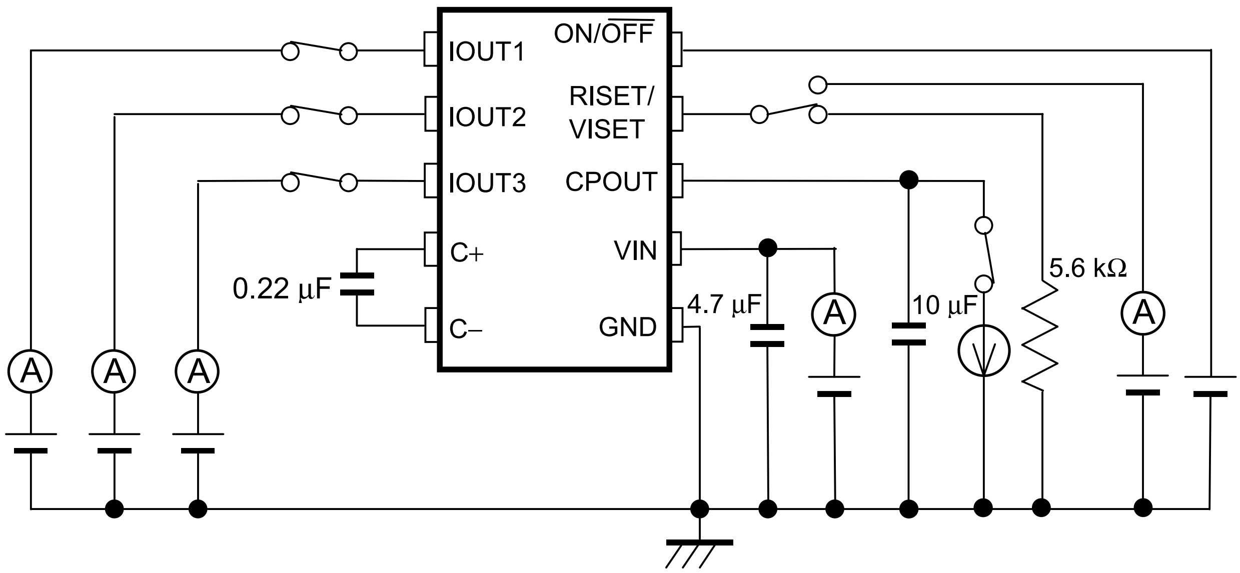


Figure 3 Measurement Circuits

■ Operation

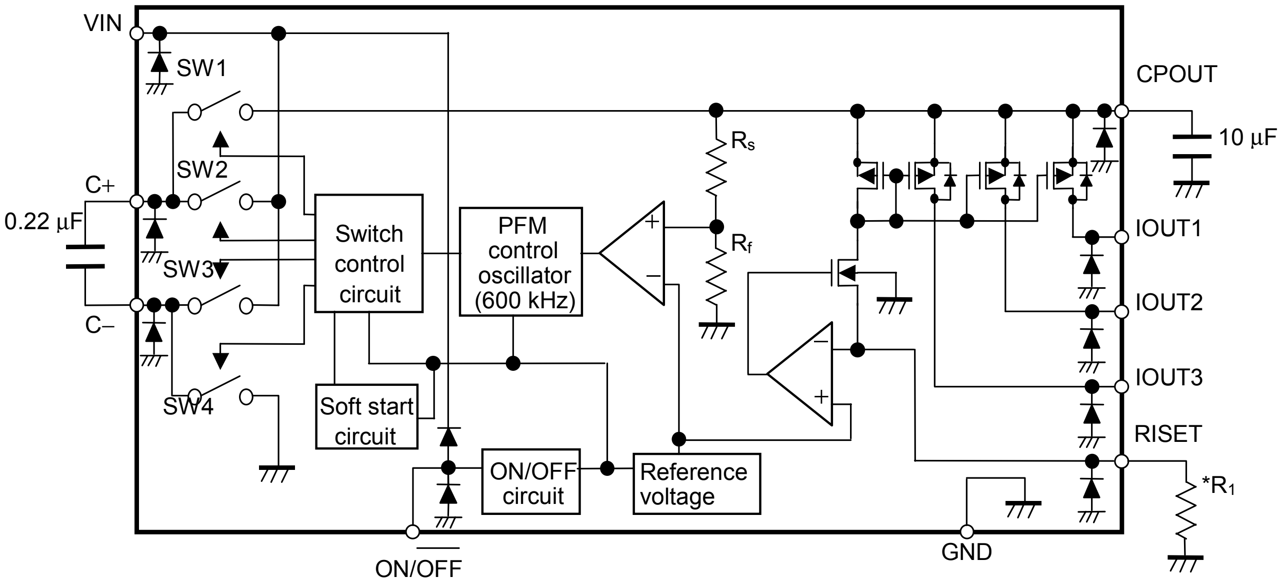
1. Basic Operation

The S-8813 Series controls by using the pulse frequency modulation (PFM) method. The SW1 to SW4 switching transistors are switched ON/OFF with the clock generated by the internal oscillator (OSC), and operates the step-up charge pump.

The output voltage is feed back and the voltage split by feedback resistances R_s and R_f and reference voltage (V_{ref}) are compared by a comparator. This comparator signal is used to modulate the oscillation pulse frequency in order to keep the output voltage constant.

Using this constant output voltage as the voltage source, a constant current is created using V_{ref} and the external resistance value applied to the RISET pin, and this constant current is supplied as the current output to the three channels of output pins (IOUT1 to IOUT3). Therefore, even if the white LED V_F (forward voltage) varies between 3 V and 4 V, a constant current can be supplied, making it possible to reduce fluctuations in brightness and keep white LEDs shining at a constant brightness.

S-881300CPE



*R1: Current setting resistance

Figure 4 Block Diagram

2. Step-up Charge Pump

The step-up charge pump steps up the voltage by switching ON/OFF the SW1 to SW4 switching transistors.

First, in order to charge the pump capacitance (C_{PUMP}), set SW1 to OFF, SW2 to ON, SW3 to OFF, and SW4 to ON (charge cycle). Following charging the electricity, in order to discharge the charged electricity to the output capacitance (C_{OUT}), SW1 set the switches as to ON, SW2 to OFF, SW3 to ON, and SW4 to OFF(discharge cycle).

The input voltage can be stepped up to a constant voltage value by repeating this charge cycle and discharge cycle.

In the S-8813 Series, the V_{IN} voltage range of 2.7 V to 4.5 V is stepped up to V_{CPOUT} = 5 V.

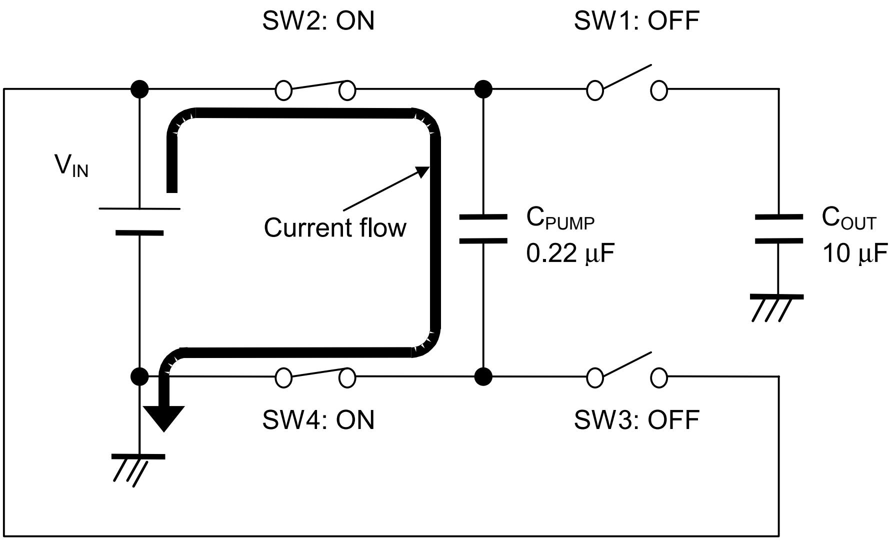


Figure 5 Charge Cycle

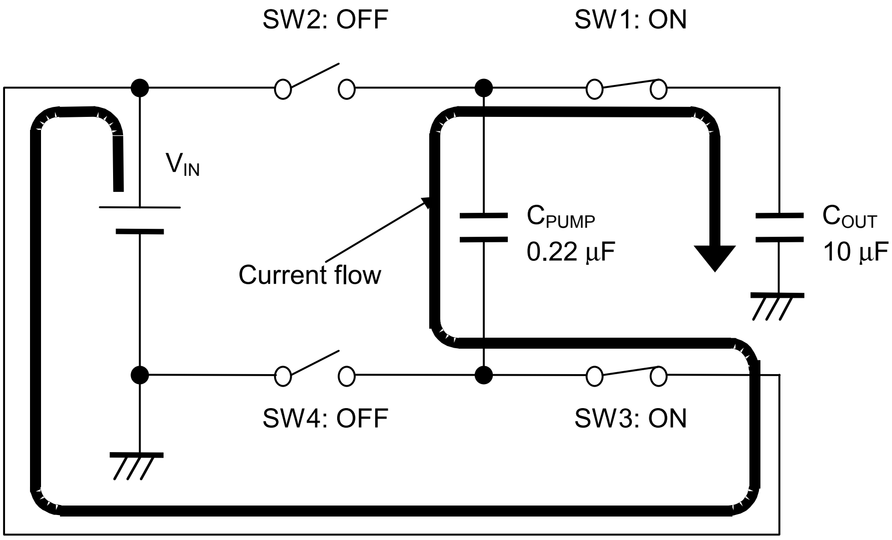


Figure 6 Discharge Cycle

3. Constant current output circuit

The S-8813 Series features a three-channel constant current output circuit and enables driving of white LEDs in the current mode.

In the case of the S-8813 Series, the constant current value can be controlled using one of the two following methods according to the product.

In the case of the S-881300CPE, the desired constant current can be obtained with an external resistance value. Since a reference voltage of 1 V ±2% is output to the RISET pin, application of a resistance

R1 of 5.6 kΩ to 20 kΩ between the RISET pin and GND results in the flow of a constant current of 50 µA to 178 µA in the current setting resistance (R_1) due to the I = V/R relationship. A constant current of between 5 mA to 17.8 mA/channel can be obtained by amplifying this constant current 100 times and outputting it to I_{OUT1}, I_{OUT2}, and I_{OUT3}.

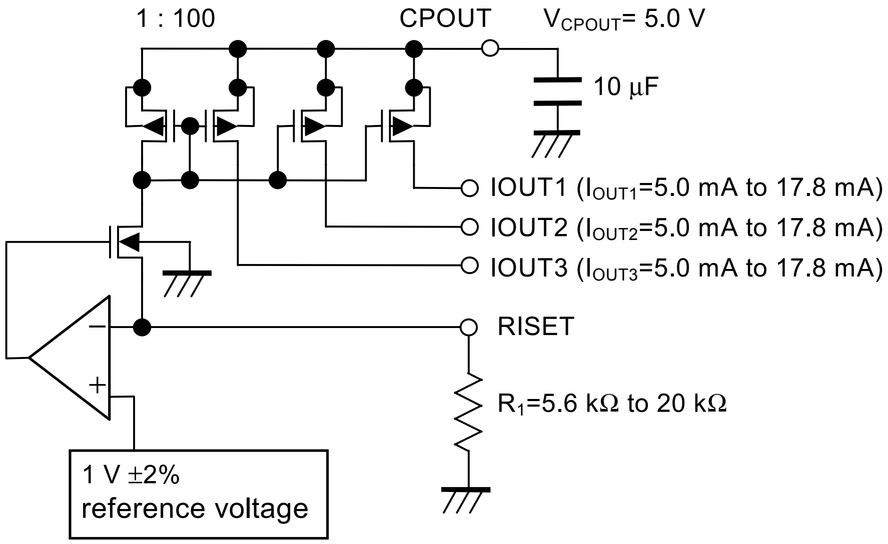


Figure 7 Constant Current Circuit of S-881300CPE

On the other hand, a constant current of the desired value can also be obtained for the S-881300BPE by supplying the reference voltage to the VISET pin externally. Within the IC, a resistance of 10 kΩ is applied between the VISET pin and GND. The application of a reference voltage of between 0.5 V and 1.8 V to the VISET pin results in the flow of a current between 50 µA and 180 µA in the internal resistor (R_2) due to the I = V/R relationship. A constant current of between 5 mA to 18 mA/channel can be obtained by amplifying this constant current 100 times and outputting it to I_{OUT1}, I_{OUT2}, and I_{OUT3}.

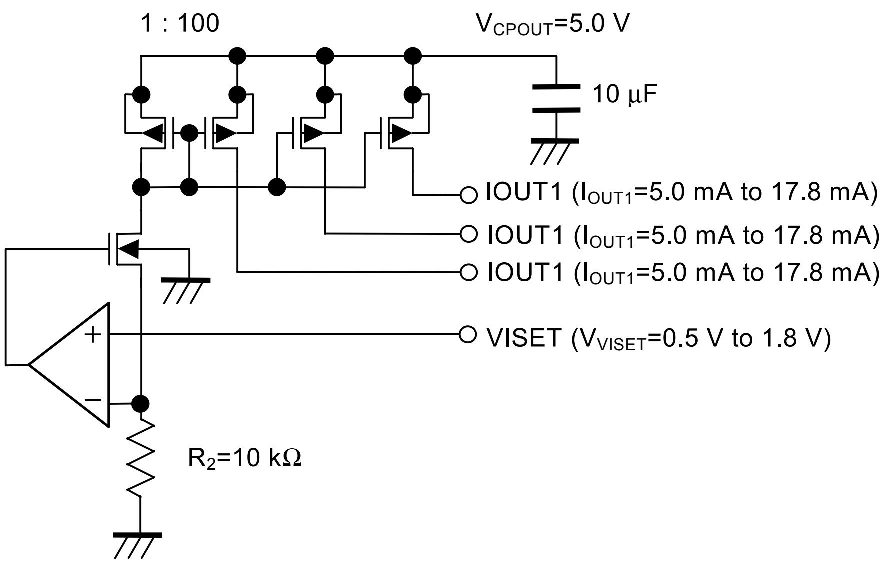


Figure 8 Constant Current Circuit S-881300BPE

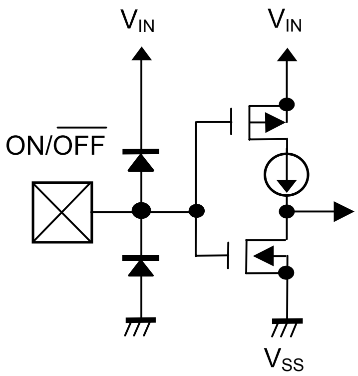
4. ON/$\overline{\text{OFF}}$ Pin (Power Off Pin)

Setting the ON/$\overline{\text{OFF}}$ pin to the Low level ("L") causes the voltage of the CPOUT pin to change to the GND potential and simultaneously the operation of all the internal circuit to stop. At this time, the consumption current is largely reduced, to a level of approximately 0.3 μA.

The ON/$\overline{\text{OFF}}$ pin is configured as shown in Figure 9 and is neither pulled up or down internally, so do not use this pin in a floating state.

When not using the ON/$\overline{\text{OFF}}$ pin, connect it to the VIN pin.

Moreover, please do not impress voltage higher than V_{IN}+0.3 V to an ON/$\overline{\text{OFF}}$ terminal. Current flows for a VIN terminal through the protection diode inside IC.



ON/$\overline{\text{OFF}}$ Pin	Oscillator	V_{CPOUT}	Output Current
High level ("H")	Operating	5.0 V	Setting value
Low level ("L")	Stopped	V_{SS}	0 mA

Figure 9 Equivalent Circuit of ON/$\overline{\text{OFF}}$ Pin

5. Soft Start Function

The S-8813 Series features an built-in soft start circuit. Upon power application or when the ON/$\overline{\text{OFF}}$ pin is switched from "L" to "H", the output voltage gradually rises over the soft start time, and the output current is gradually output as a result. This soft start function reduces the input current rush.

6. External Capacitor Selection

6.1 Input and Output Capacitors (C_{IN}, C_{OUT})

The input capacitor (C_{IN}) lowers the power supply impedance and averages the input current, resulting in improved efficiency.

The C_{IN} value is selected according to the impedance of the power supply that is used. Select a ceramic capacitor with a small equivalent series resistance (ESR). Although this figure varies according to the impedance of the power supply that is used as well as the load current value, it is generally in the range of 4.7 μF to 10 μF.

For the output capacitor (C_{OUT}), select a ceramic capacitor with a small ESR for smoothing the ripple voltage. A value of 10 μF is recommended for the capacitance value. Use of a capacitor with a capacitance lower than 10 μF results in a larger ripple voltage as well as a larger ripple current for the output current.

Conversely, use of a capacitor with a capacitance greater than 10 μF results in the output voltage not being able to rise up to 5.0 V and the impossibility to obtain the desired output current.

6.2 Pump Capacitor (C_{PUMP})

The pump capacitor (C_{PUMP}) is required for stepping up the voltage. Select a ceramic capacitor with a small ESR. A capacitance value of 0.22 μF is recommended. Use of a capacitor with a capacitance greater than 0.22 μF results in a larger ripple voltage as well as a larger ripple current for the output current.

Conversely, use of a capacitor with a capacitance lower than 0.22 μF results in the output voltage not being
able to rise up to 5.0 V and the impossibility to obtain the desired output current.

■ Application Circuit Examples

1. Variable Current Setting Resistance Type

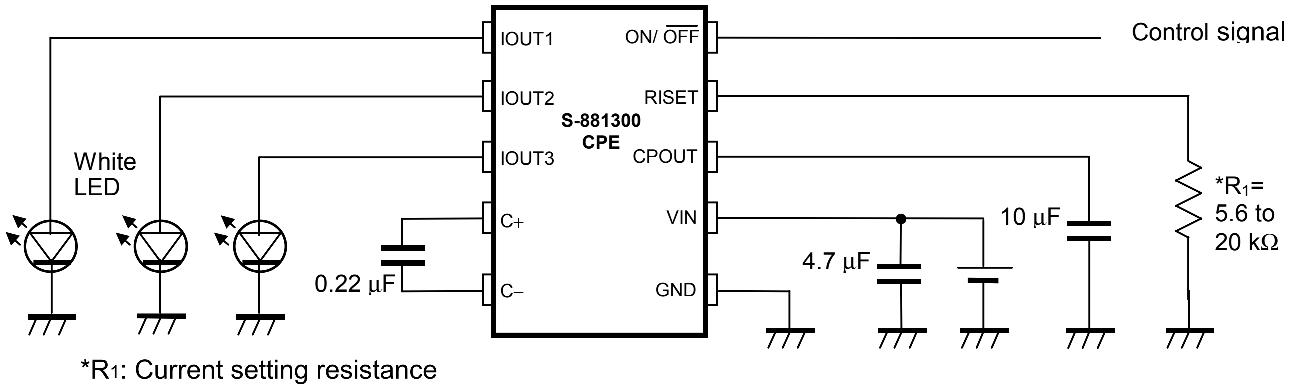


Figure 10 Application Circuit 1 (S-881300CPE)

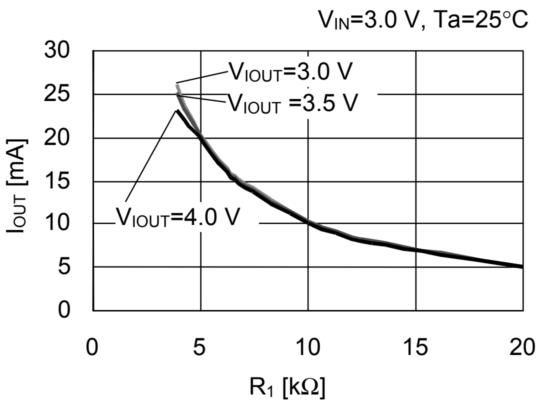


Figure 11 R_1 Dependence (S-881300CPE)

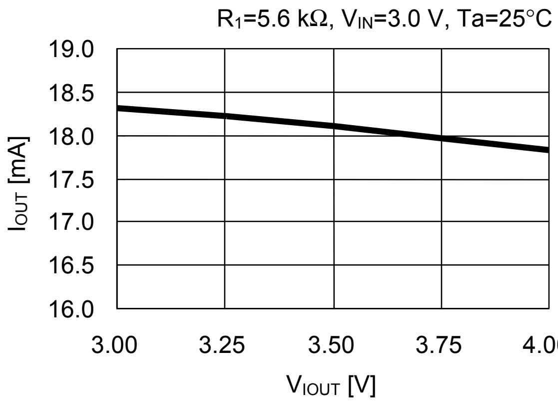


Figure 12 V_{IOUT} Dependence (S-881300CPE)

2. Variable Voltage Type

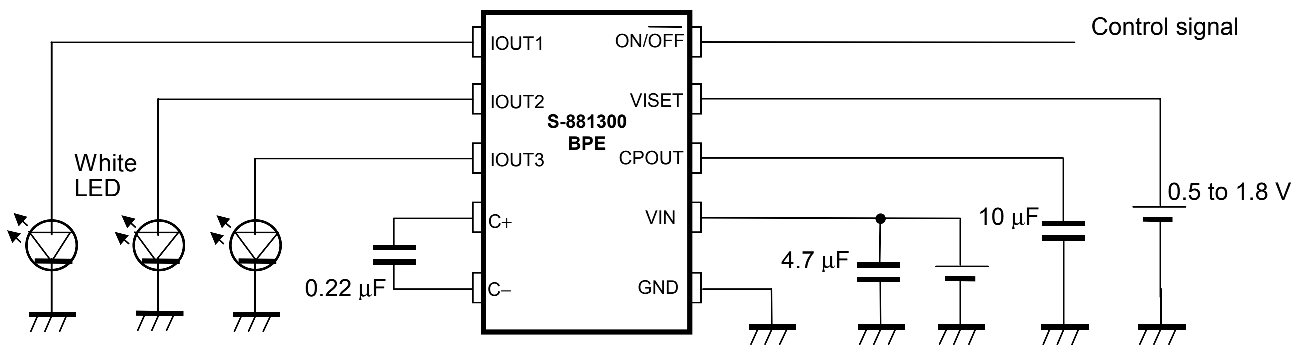


Figure 13 Application Circuit 2 (S-881300BPE)

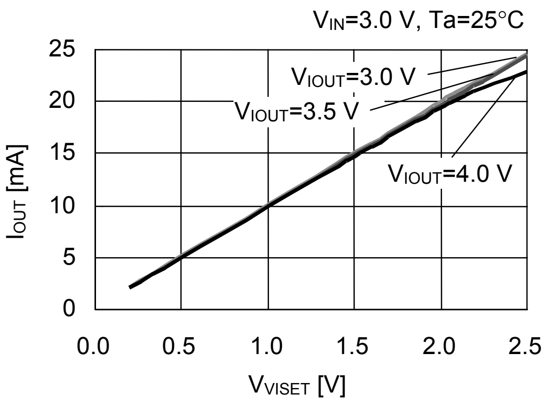


Figure 14 V_{VISET} Dependence (S-881300BPE)

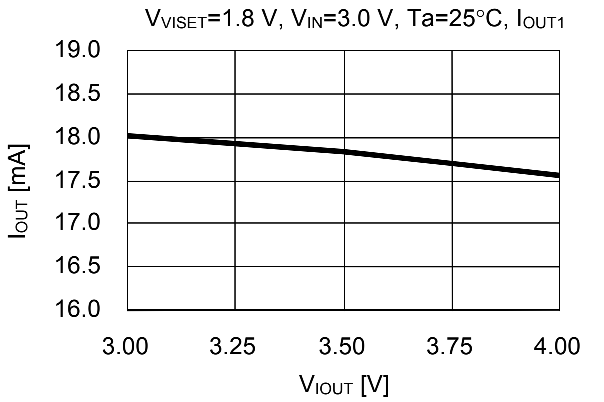


Figure 15 V_{IOUT} Dependence (S-881300BPE)

■ Precautions

- Regarding VIN, CPOUT, C+, C– and GND wiring, be careful to perform pattern wiring so as to obtain a low impedance.
- Always connect a capacitor to the CPOUT, C+, and C– pins.
- Connect C_{IN} and C_{OUT} in the vicinity of the IC and sufficiently strengthen the wiring for GND and VIN in order to lower the impedance of the wiring resistance, etc. A high impedance may cause unstable operation. Moreover, in selecting C_{IN} and C_{OUT}, perform a full evaluation of the actual usage conditions.
- Connect C_{PUMP} in the vicinity of the IC and sufficiently strengthen the wiring for the C+ and C– pins in order to lower the impedance of the wiring resistance, etc. A high impedance may cause instable operation. Moreover, in selecting C_{PUMP}, perform a full evaluation of the actual usage conditions.
- The Oscillation pulse width may be small with a light load, however, this causes problems in the IC operation.
- Be careful about the usage conditions for the input/output voltages and output current to make sure that dissipation within the IC does not exceed the allowable power dissipation of the package.
  For reference, the calculation of the power consumption in this IC is shown below.

  $P_D = (V_{IN} \times 2.0 - V_{IOUT1,2,3}) \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$

  Reference: V_{IN}=4.2 V, $V_{IOUT1,2,3}$=3.6 V, $I_{OUT1,2,3}$=18 mA
  $P_D = (4.2 \times 2.0 - 3.6) \times 0.054 = 259$ mW

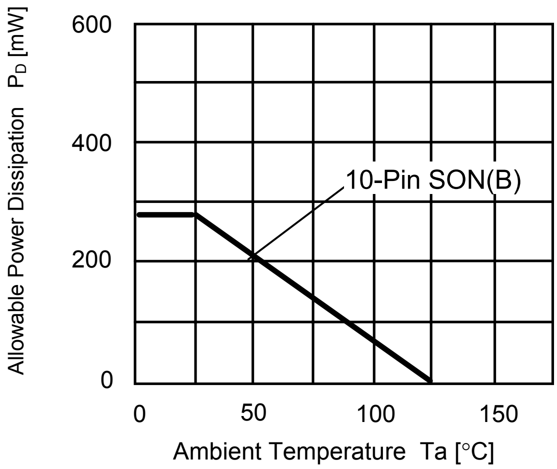
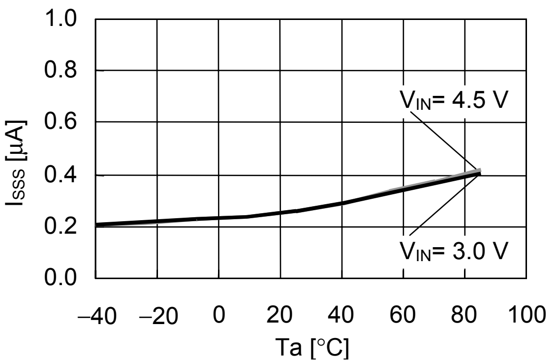


Figure 22 Allowable Power Dissipation of Package (Before Mounting)

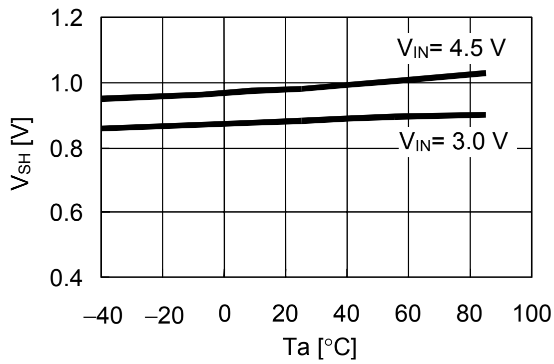
- The contents of this document are subject to change in order to reflect improvements made to the IC therein, so be sure to use the latest version of this document.
- Seiko Instruments Inc. shall not be responsible for any patent infringements caused by products using the S-8813 Series in connection with the method in which the S-8813 Series is used in such products, the product specifications, or the country of destination.

■ Major Temperature Characteristics Examples

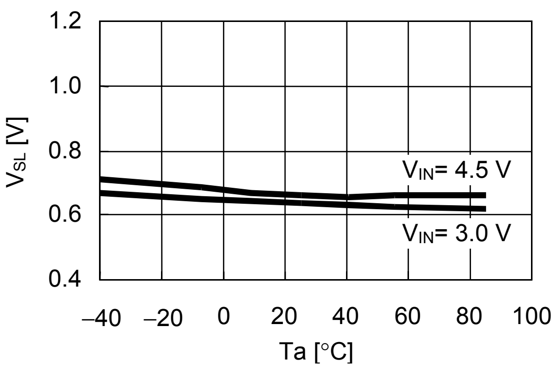
1. Standby Consumption Current (I_{SSS}) vs. Ambient Temperature (Ta) Characteristics



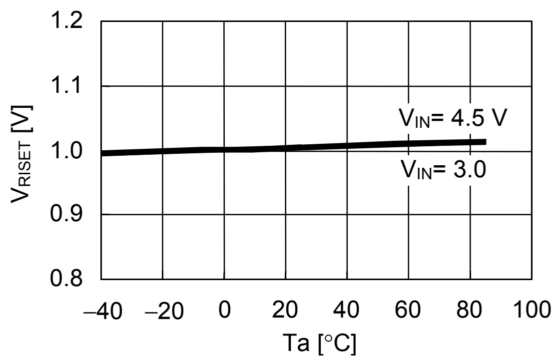
2. Power Off Pin Input Voltage "H" (V_{SH}) vs. Ambient Temperature (Ta) Characteristics



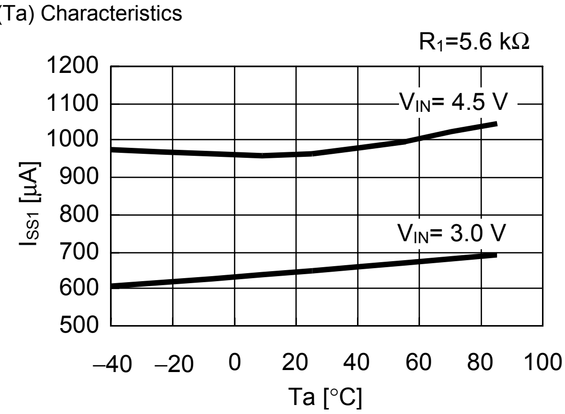
3. Power Off Pin Input Voltage "L" (V_{SL}) vs. Ambient Temperature (Ta) Characteristics



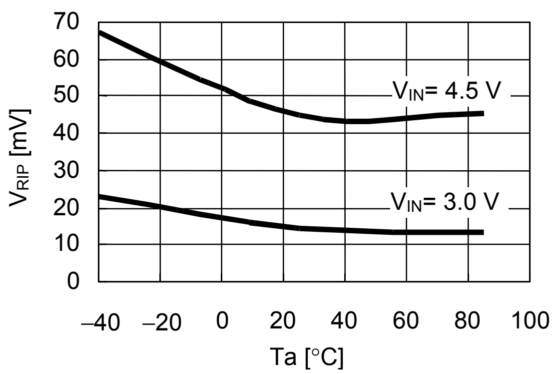
4. RISET Pin Voltage (V_{RISET}) vs. Ambient Temperature (Ta) Characteristics



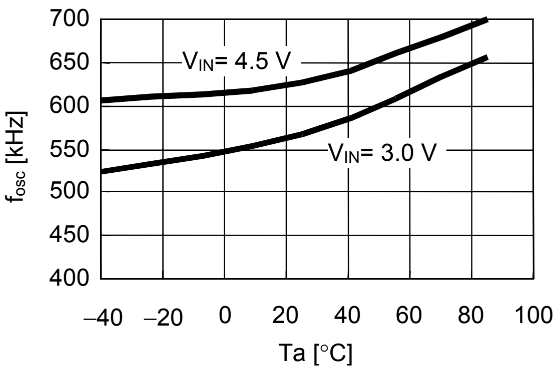
5. Operation Consumption Current (I_{SS1}) vs. Ambient Temperature (Ta) Characteristics



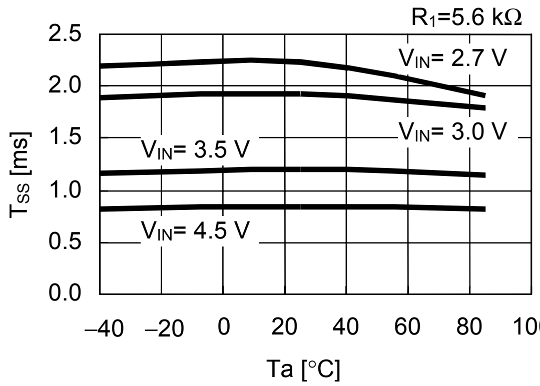
6. Ripple Voltage (V_{RIP}) vs. Ambient Temperature (Ta) Characteristics



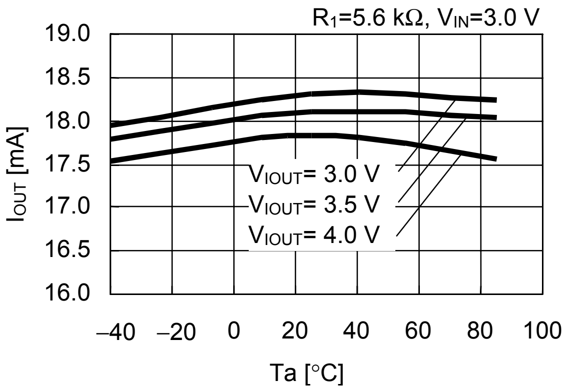
7. Maximum Oscillation Frequency (f_{OSC}) vs. Ambient Temperature (Ta) Characteristics



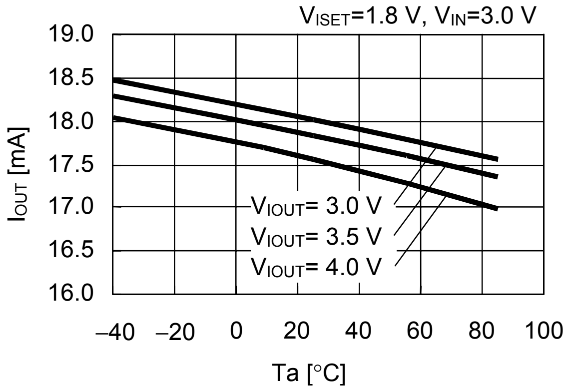
8. Soft Start Time (T_{SS}) vs. Ambient Temperature (Ta) Characteristics



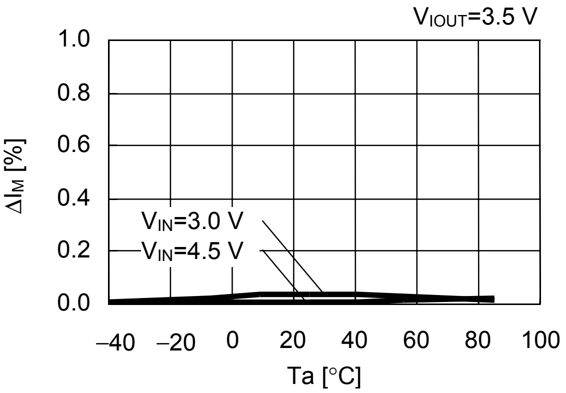
9. Stabilized Output Current (I_{OUT}) vs. Ambient Temperature (Ta) Characteristics



10. Stabilized Output Current (I_{OUT}) vs. Ambient Temperature (Ta) Characteristics

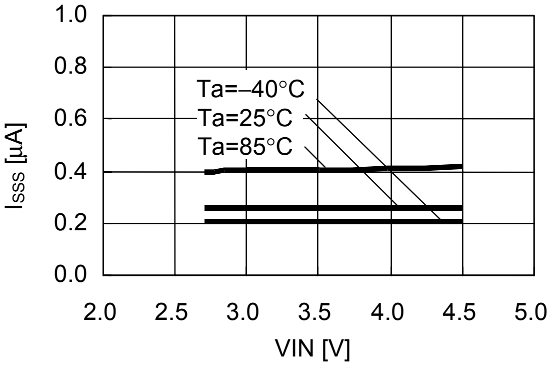


11. Inter-Pin Output Current Variation (ΔI_M) vs. Ambient Temperature (Ta) Characteristics

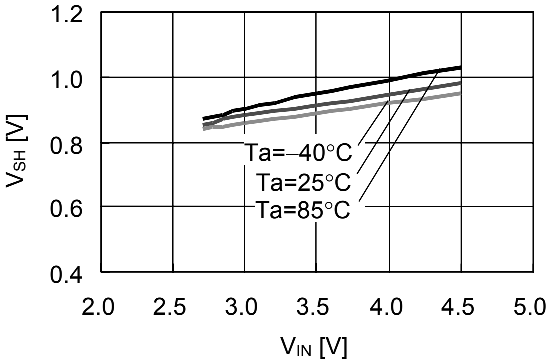


■ Major Power Supply Dependence Characteristics Examples

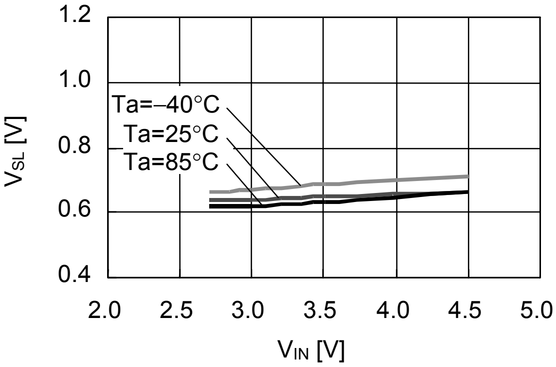
1. Standby Consumption Current (I_{SSS}) vs. Operation Input Voltage (V_{IN}) Characteristics



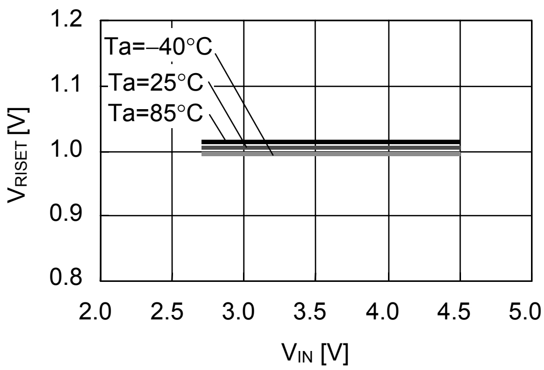
2. Power-Off Pin Input Voltage "H" (V_{SH}) vs. Operation Input Voltage (V_{IN}) Characteristics



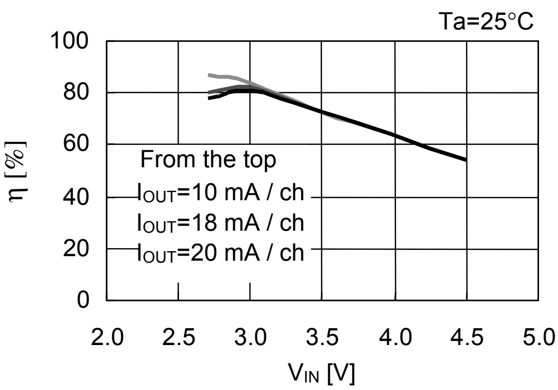
3. Power-Off Pin Input Voltage "L" (V_{SL}) vs. Operation Input Voltage (V_{IN}) Characteristics



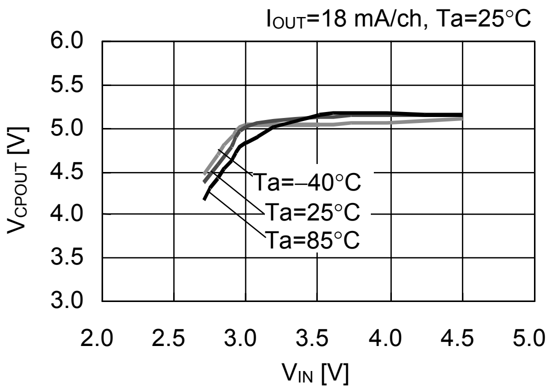
4. RISET Pin Voltage (V_{RISET}) vs. Operation Input Voltage (V_{IN}) Characteristics



5. Efficiency[*1] (η) vs. Operation Input Voltage (V_{IN}) Characteristics



6. CPOUT Pin Voltage (V_{CPOUT}) vs. Operation Input Voltage (V_{IN}) Characteristics



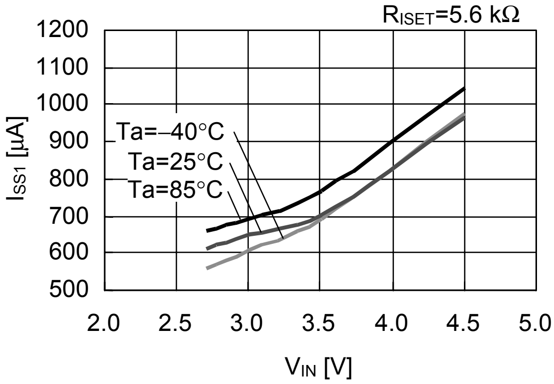
***1.** "Efficiency" in the electrical characteristics means the efficiency of the charge pump circuit block. The ideal efficiency is indicated by the following expression.

Efficiency =[$V_{CPOUT} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

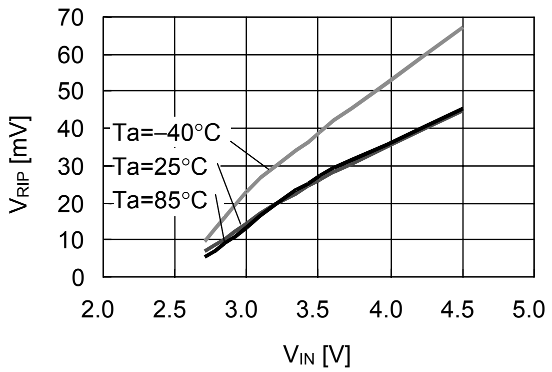
The ideal efficiency including the constant current circuit is expressed as following expression.

Efficiency =[$(V_{IOUT1} \times I_{OUT1}) + (V_{IOUT2} \times I_{OUT2}) + (V_{IOUT3} \times I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

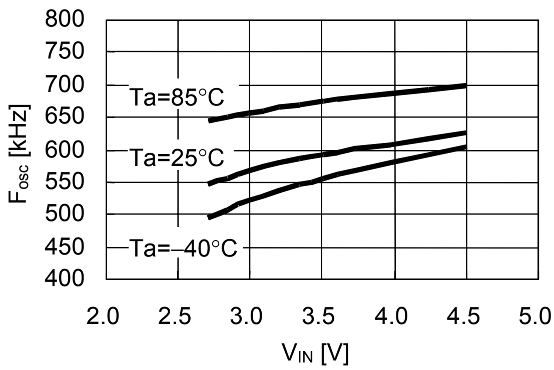
7. Operation Consumption Current (I_{SS1}) vs. Operation Input Voltage (V_{IN}) Characteristics



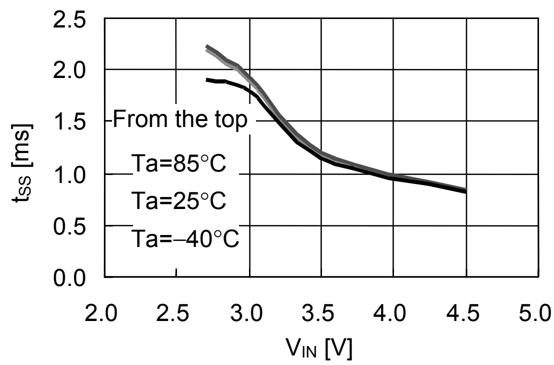
8. Ripple Voltage (V_{RIP}) vs. Operation Input Voltage (V_{IN}) Characteristics



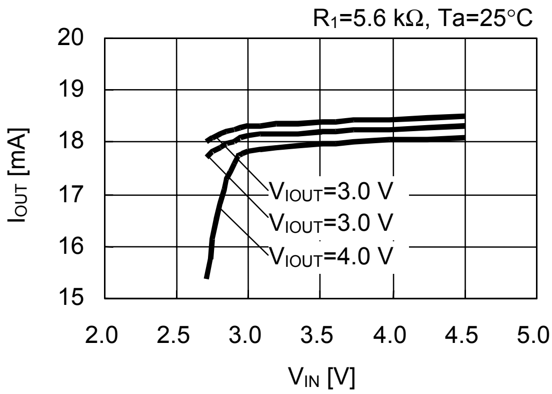
9. Maximum Oscillation Frequency (f_{OSC}) vs. Operation Input Voltage (V_{IN}) Characteristics



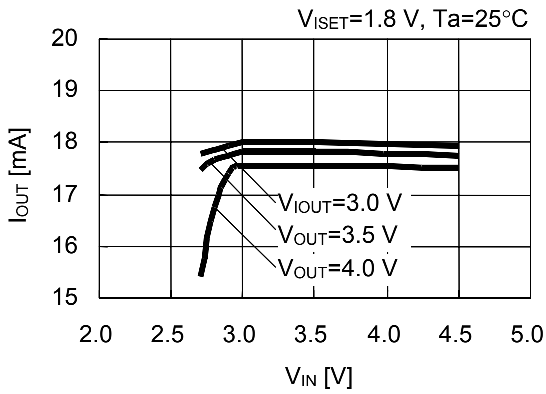
10. Soft Start Time (t_{SS}) vs. Operation Input Voltage (V_{IN}) Characteristics



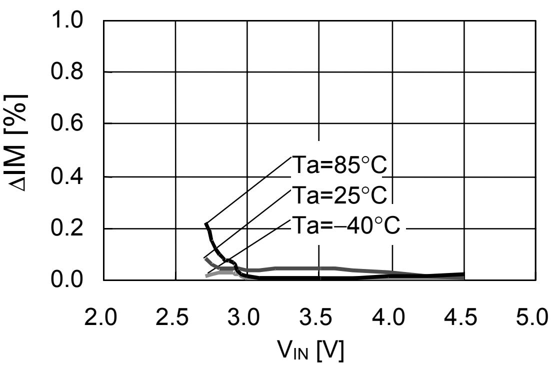
11. Stabilized Output Current (I_{OUT}) vs. Operation Input Voltage (V_{IN}) Characteristics



12. Stabilized Output Current (I_{OUT}) vs. Operation Input Voltage (V_{IN}) Characteristics

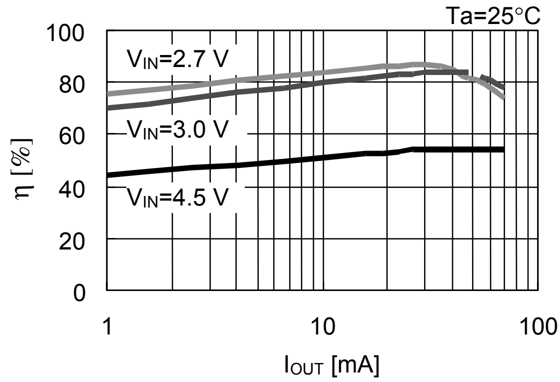


13. Inter-Pin Output Current Variation (ΔI_M) vs. Operation Input Voltage (V_{IN}) Characteristics

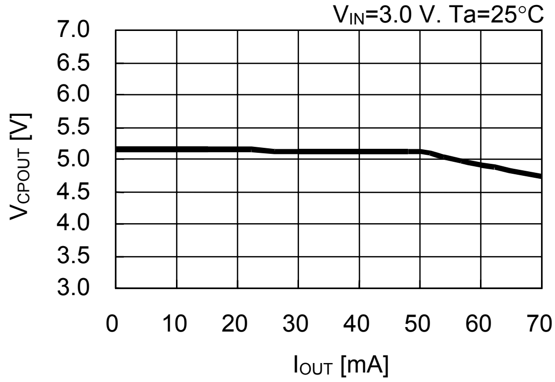


■ Major Load Characteristics Examples

1. Efficiency[*1] (η) vs. Stabilized Output Current (I_{OUT}) Characteristics



2. CPOUT Pin Voltage (V_{CPOUT}) vs. Stabilized Output Current (I_{OUT}) Characteristics



***1.** "Efficiency" in the electrical characteristics means the efficiency of the charge pump circuit block. The ideal efficiency is indicated by the following expression.

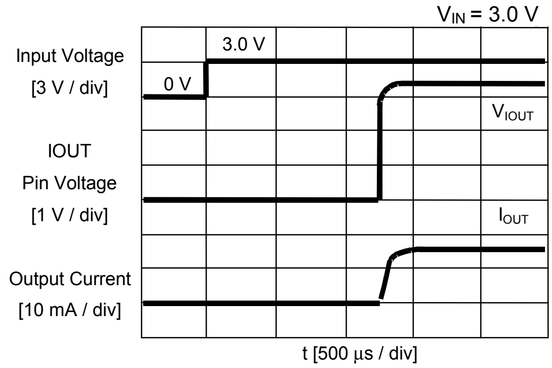
Efficiency =[$V_{CPOUT} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

The ideal efficiency including the constant current circuit is expressed as following expression.

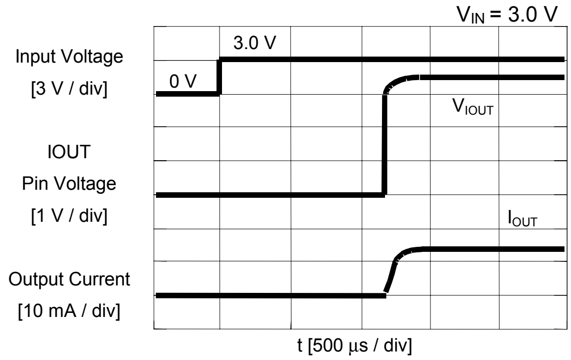
Efficiency =[$(V_{IOUT1} \times I_{OUT1}) + (V_{IOUT2} \times I_{OUT2}) + (V_{IOUT3} \times I_{OUT3})$] / [$2.0 \times V_{IN} \times (I_{OUT1} + I_{OUT2} + I_{OUT3})$]

■ Transient Response Characteristics Examples

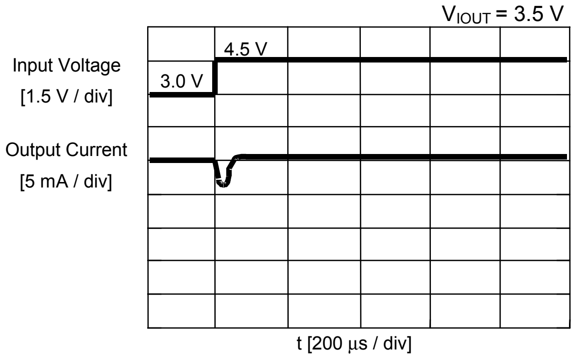
1. Power-Off Pin Response



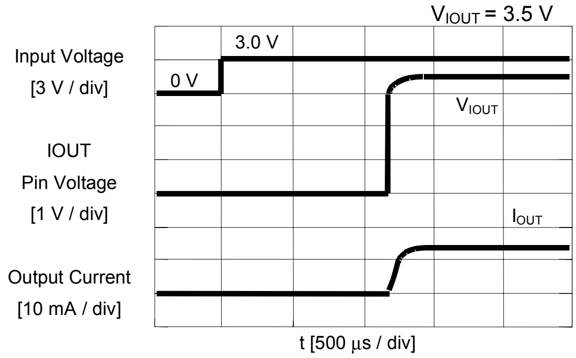
2. Power Supply Application



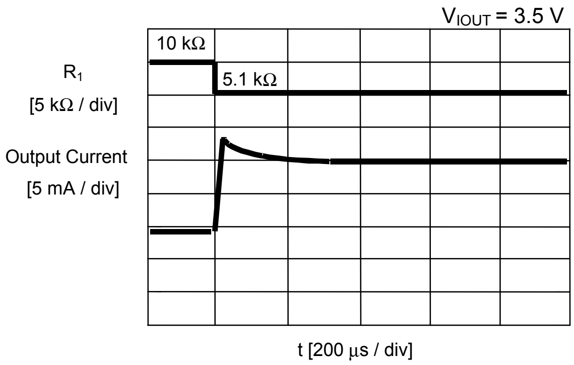
3. Power Supply Voltage Transition



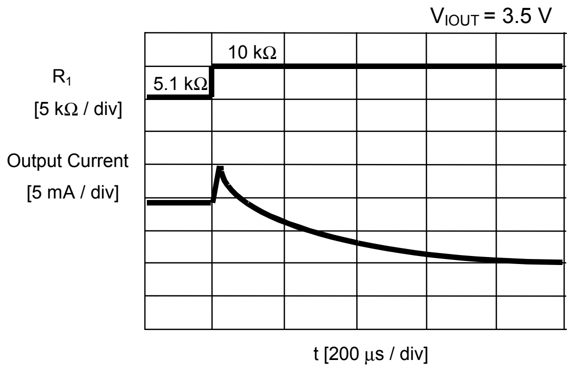
4. Power Supply Voltage Transition



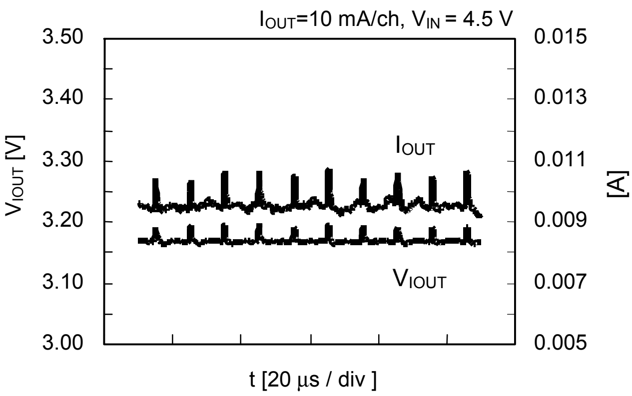
5. Current Setting Switching



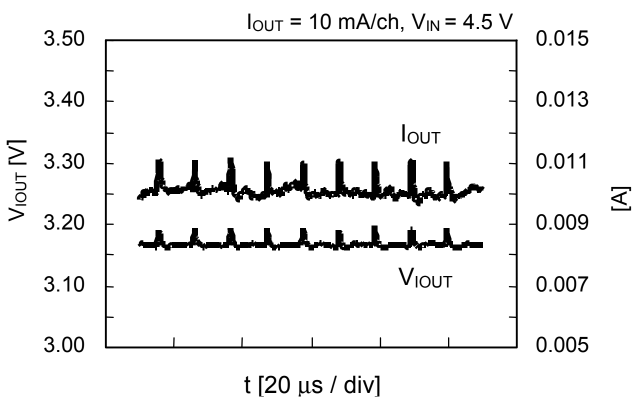
6. Current Setting Switching



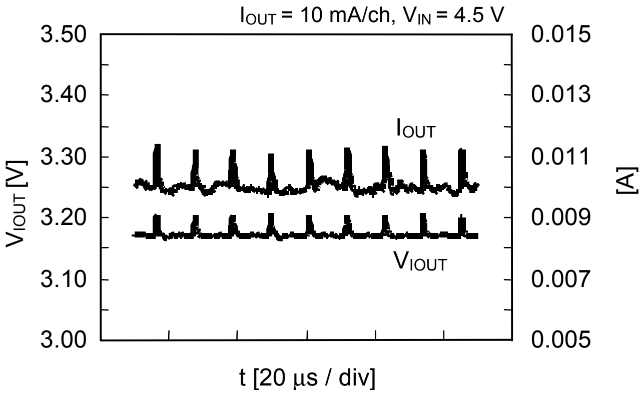
7. Ripple Characteristics (COUT 10 µF)



8. Ripple Characteristics (COUT 4.7 µF)



9. Ripple Characteristics (C_{OUT} 10 μF)

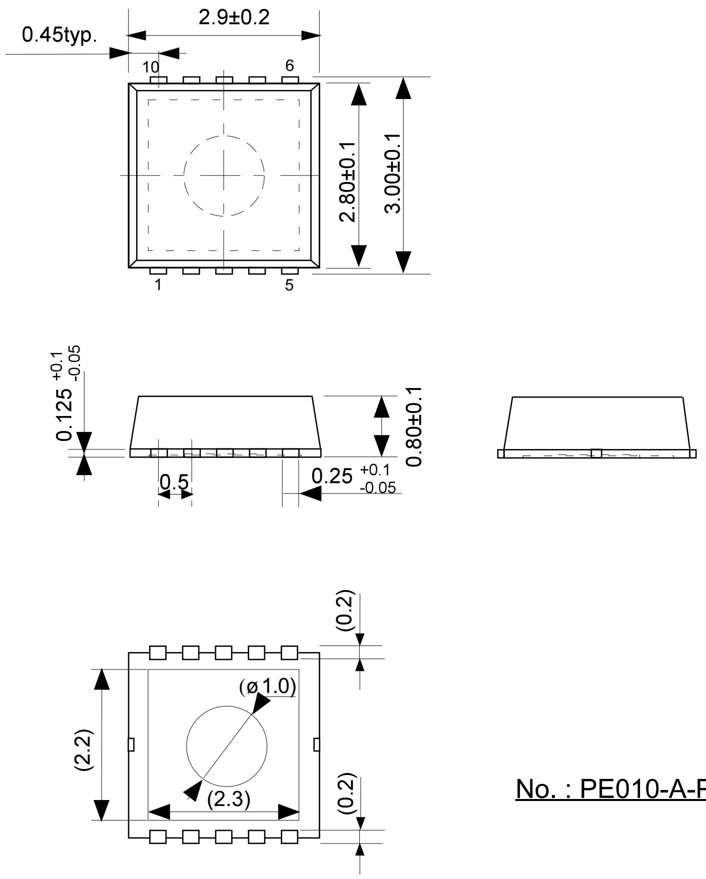


■ SON10B-A

PE010-A Rev.1.0 020128

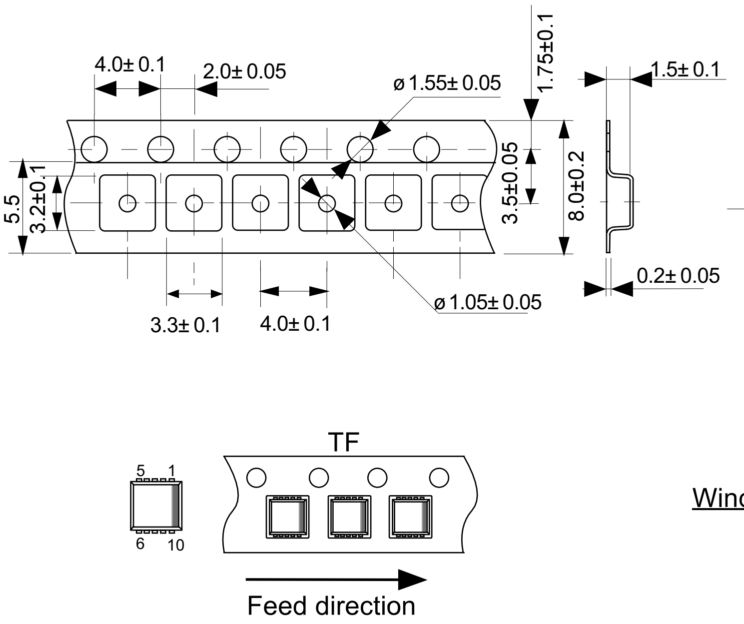
●Dimensions

Unit:mm



No. : PE010-A-P-SD-1.0

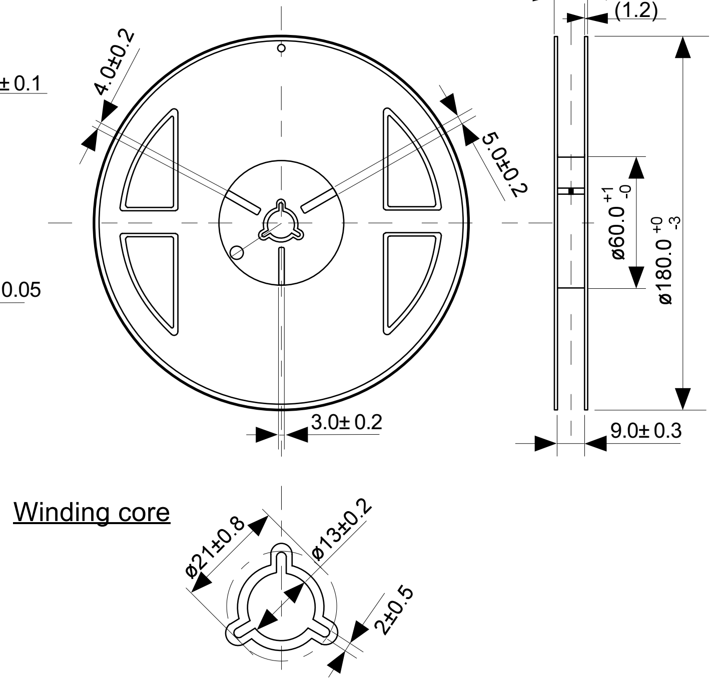
●Taping Specifications



No. : PE010-A-C-SD-1.0

●Reel Specifications

1 reel holds 3000 ICs.



No. : PE010-A-R-SD-1.0