Step-Up DC_DC Converter with voltage regulator and detector

NO.EA-237-160330

OUTLINE

RP600K series are high efficiency, current mode step-up DC-DC converter ICs with a voltage regulator and a voltage detector. This converter starts up of low voltage (typ. 0.8V) operation from one or two alkaline or nickel-metal-hydride (NiMH) batteries, or a single Li+ battery.
This IC consists of a reference voltage unit with soft start, error amplifiers, PWM comparator, protection circuits such as a current limit circuit, an internal switch transistor, an oscillator, and PWM/VFM mode control circuit. A low ripple high efficiency step-up DC/DC converter can be composed of RP600K series with only an inductor, a diode, divider resistors and capacitors. In terms of output voltage setting, fixed type and adjustable with external divider resisters type are available. Output voltage is from 2.3V to 5.5V.

The built-in LDO Regulator(VR) consists of a reference voltage unit, an error amplifier, output voltage setting resister net, a short current limit circuit, an output transistor, and so on. To prevent the inrush current at start-up, soft-start function is included. The Soft-start time is typically 200μs. The output voltage is fixed internally and the output range is from 1.5V to 5.0V.
This IC has an MODE pin. When the MODE pin is set as "H", the DC/DC converter control becomes fixed PWM control, and the LDO becomes the fast mode. When the MODE pin is set as "L", the DC/DC converter is automatic PWM/VFM control and the LDO becomes low power mode*.
The voltage detector always turns on. The output is Nch open drain type. Since the package is DFN(PLP)2527-10, so high density mounting on board is possible. If the internal chip temperature is beyond the certain level, system reset will work, or thermal shutdown circuit is included in the IC.

*) The switch-over point is fixed internally. As for A/D version, regardless the MODE pin signal, LDO mode is always set at fast mode. As for B/C version, regardless the MODE pin signal, when the DC/DC converter is active, LDO becomes fast mode.

Functions

A version: The input power supply of the built-in voltage regulator (LDO) is the output of the built-in DC/DC converter. After the soft-start function of the DC/DC converter, the LDO starts up. The built-in voltage detector outputs "L" when the supervised level becomes lower than the set detector threshold level. The output delay circuit for release the voltage detector is also built-in and the delay time is set at typically 10ms.

B version: The input power supply of the built-in voltage regulator (LDO) and the DC/DC converter is VDD pin. Each channel is individual. The minimum operating voltage of the LDO is 2.0V. The output of the DC/DC converter is fixed internally. If the DC/DC is active, the LDO mode becomes fixed fast mode. The built-in voltage detector outputs "L" when the supervised level becomes lower than the set detector threshold level. The output delay circuit for release the voltage detector is also built-in and the delay time is set at typically 10ms.

C version: The input power supply of the built-in voltage regulator (LDO) is the output of the built-in DC/DC converter. The voltage regulator is always active. The output of the DC/DC converter is fixed internally.
The built-in voltage detector outputs "L" when the supervised level becomes lower than the set detector threshold level. The output delay circuit for release the voltage detector is not included. The hysteresis range can be selected from 30% of the set voltage detector threshold to 80% of the detector threshold.

D version: The input power supply of the built-in voltage regulator (LDO) and the DC/DC converter is VDD pin. The output of the DC/DC converter is adjustable with external divider resisters. The built-in voltage detector outputs "L" when the supervised level becomes lower than the set detector threshold level. The output delay circuit for release the voltage detector is also built-in and the delay time is set at typically 10ms.

FEATURES

Step-up DC/DC converter part

- Input Voltage Range ………… 0.8V~5.5V
- High Efficiency ………… 87% (100mA/3.3V, V_{IN}=1.5V, 25°C)
- Output current ………… 500mA/4.2V(V_{IN}=2.5V)
- Internal Switch ………… NMOS=0.16Ω, (if V_{OUT1}=3.3V)
- Output Voltage Tolerance ………… ±2.0%
- Frequency ………… Typ. 1.2MHz
- Output Voltage Range ………… Fixed: Standard voltage in the range from 2.3V to 5.5V
  Adjustable: 2.3V~5.5V (Recommendation range of output voltage)
- Lx peak current control function ………… Typ. 1.4A

LDO regulator part

*Input Voltage Range (Applied to B version only) ………… from 2.0V to 5.5V

- Output Voltage Range ………… Fixed: Standard voltage in the range from 1.5V to 5.0V
- Output Voltage Tolerance ………… ±1.0%
- Turn-on Speed ………… Typ. 100μs
- Maximum Output Current ………… Min. 500mA guaranteed (A/D version)

………… Min. 300mA guaranteed (B version)

………… Min. 150mA guaranteed (C version)

Voltage Detector Part

- Detector Threshold Range ………… Fixed: Standard voltage in the range from 1.0V to 4.5V
- Released Output Delay Time ………… Typ. 10ms (A/B/D version)

………… Typ. 0ms (C version)

- Detector Threshold Hysteresis ………… Typ. 5% of the detector threshold voltage (A/B/D version)
  Selectable in the range from 30% to 80% of the detector threshold voltage (C version)

Others

- Small Package ………… DFN(PLP)2527-10
- Thermal shutdown temperature threshold ………… Tj=125°C (A/B/D version only)
- External components ………… C_{IN}=10μF, C_{OUT1}=10μFx2, L=3.3μH(If the output of the DC/DC is 3.6V or more, 4.7uH is our recommendation value.)

………… C_{OUT2}=2.2μF(B/C version LDO)

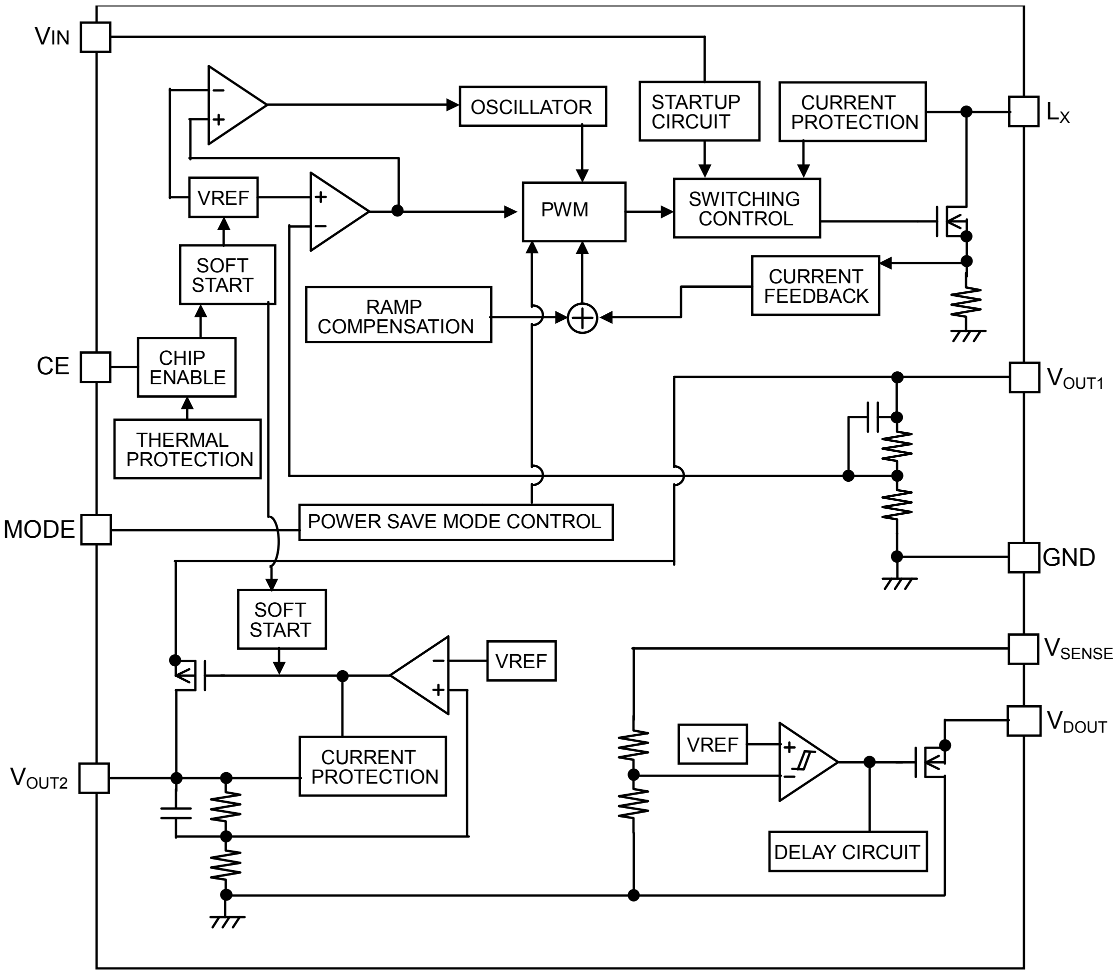
………… C_{OUT2}=10uF(A/D version LDO)

APPLICATIONS

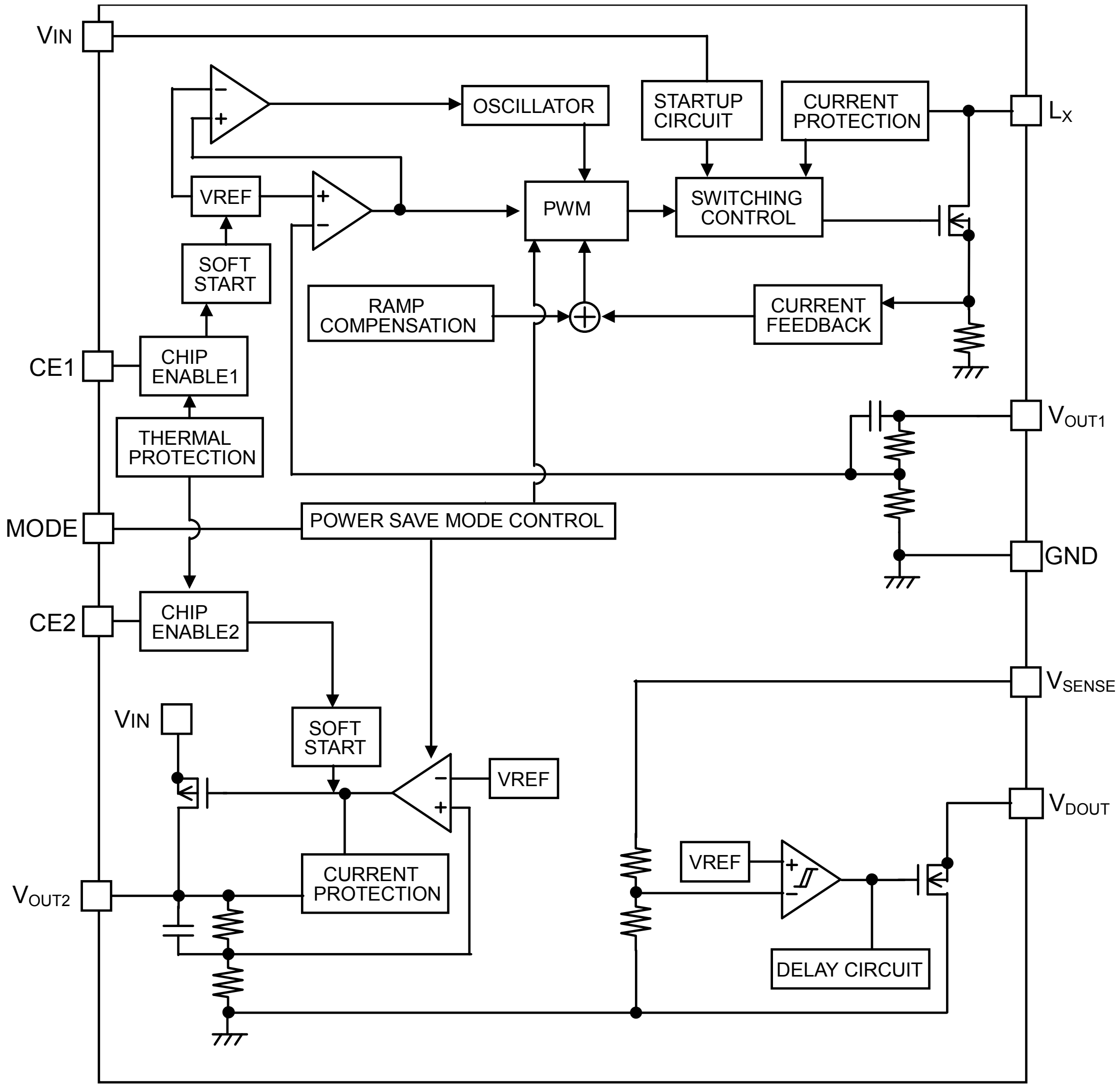
- Portable equipment such as DSC, cellular phones, electrical dictionaries, IC recorders
- Blood pressure meter
- Smoke Detector

BLOCK DIAGRAMS

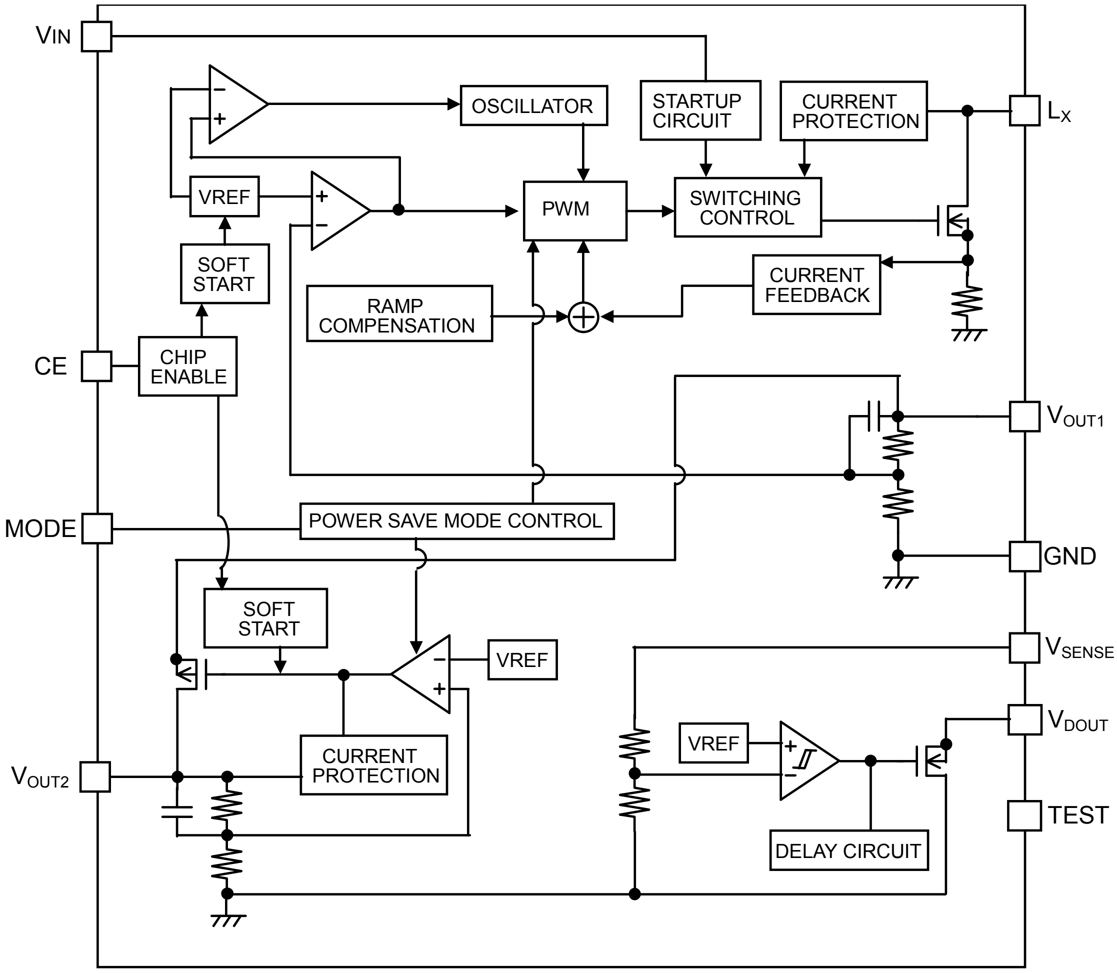
RP600K0xxA



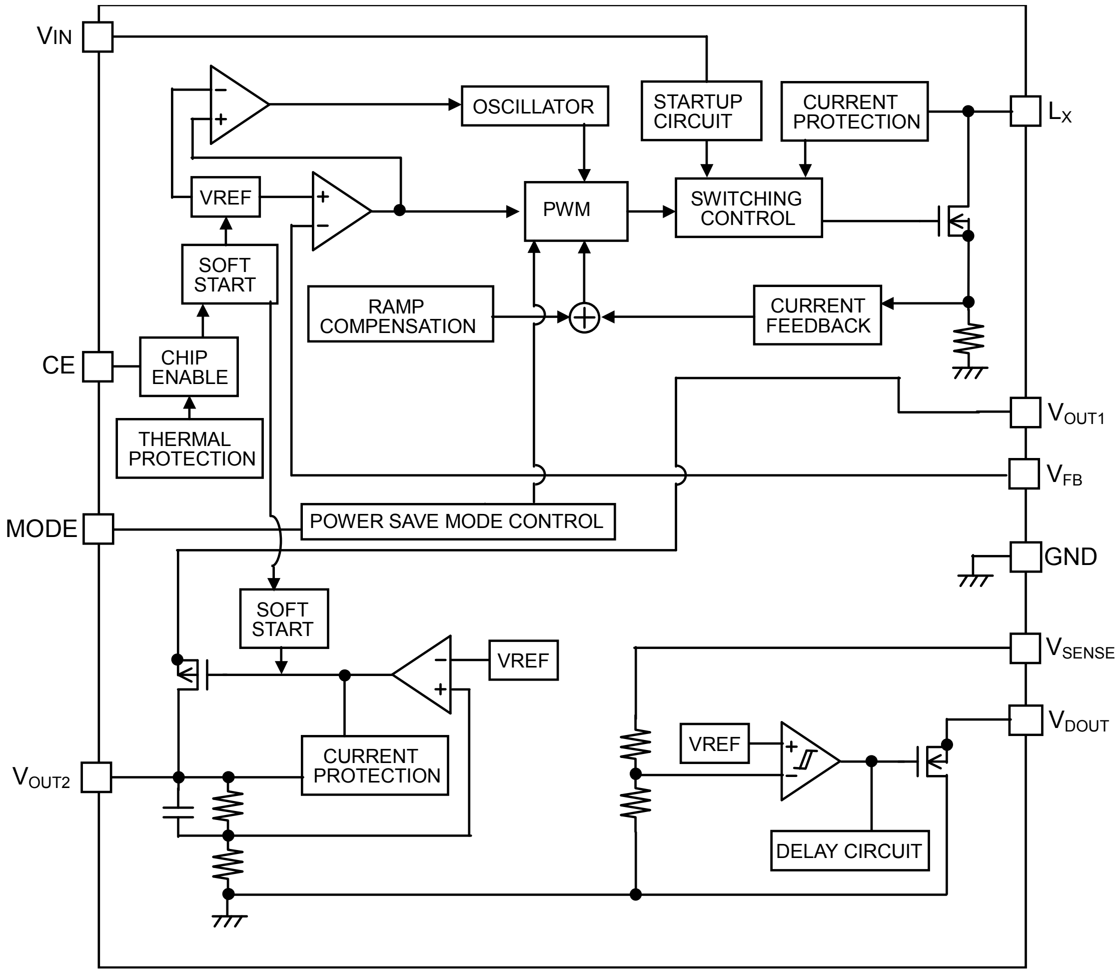
RP600K0xxB


VIN
OSCILLATOR
STARTUP CIRCUIT
CURRENT PROTECTION
LX
VREF
PWM
SWITCHING CONTROL
SOFT START
RAMP COMPENSATION
CURRENT FEEDBACK
CE1
CHIP ENABLE1
THERMAL PROTECTION
VOUT1
MODE
POWER SAVE MODE CONTROL
GND
CE2
CHIP ENABLE2
VSENSE
VIN
SOFT START
VREF
VDOUT
VREF
VOUT2
CURRENT PROTECTION
DELAY CIRCUIT

RP600K2xxC


VIN
OSCILLATOR
STARTUP CIRCUIT
CURRENT PROTECTION
LX
VREF
PWM
SWITCHING CONTROL
SOFT START
CURRENT FEEDBACK
RAMP COMPENSATION
CE
CHIP ENABLE
VOUT1
MODE
POWER SAVE MODE CONTROL
GND
SOFT START
VREF
VSENSE
VDOUT
VREF
VOUT2
CURRENT PROTECTION
TEST
DELAY CIRCUIT

RP600K1xxD


VIN
OSCILLATOR
STARTUP CIRCUIT
CURRENT PROTECTION
LX
VREF
PWM
SWITCHING CONTROL
SOFT START
RAMP COMPENSATION
CURRENT FEEDBACK
CE
CHIP ENABLE
THERMAL PROTECTION
VOUT1
VFB
MODE
POWER SAVE MODE CONTROL
GND
SOFT START
VREF
VSENSE
VDOUT
CURRENT PROTECTION
VREF
VOUT2
DELAY CIRCUIT

SELECTION GUIDE

In the RP600, the output voltage and function type can be selected at the user's request. The selection can be made with designating the part number as shown below:

Product Code	Package	pcs/reel	Pb free	Halogen free
RP600K0xxA-TR	DFN (PLP)2527-10	5,000 pcs	Yes	Yes
RP600K0xxB-TR		5,000 pcs	Yes	Yes
RP600K2xxC-TR		5,000 pcs	Yes	Yes
RP600K1xxD-TR		5,000 pcs	Yes	Yes

xx: Output voltage (DC/DC, LDO, Voltage detector) setting serial number *as for C version, the hysteresis range of the voltage detector setting is included. Further, refer to the voltage combination list.

Function by version

A version: DC/DC converter; Fixed output voltage.
Voltage Regulator; Power supply is the output of the DC/DC converter. Fast MODE only
Voltage Detector; "L" output at the detector threshold. With a released output delay time, the hysteresis is fixed 5% of the detector threshold.

B version: DC/DC converter; Fixed output voltage.
Voltage Regulator; Power supply is V_{IN} of this IC. When the DC/DC converter is active, regardless of the MODE signal, the mode is fixed as fast mode.
Voltage Detector; "L" output at the detector threshold. With a released output delay time, the hysteresis is fixed 5% of the detector threshold.

C version: DC/DC converter; Fixed output voltage.
Voltage Regulator; Power supply is the output of the DC/DC converter. Regardless of the CE signal, always turns on. When the DC/DC converter is active, regardless of the MODE signal, the mode is fixed as fast mode.
Voltage Detector; "L" output at the detector threshold. Without a released output delay time, the hysteresis can be set in the range from 30% to 80% of the detector threshold.
No thermal protection circuit.

D version: DC/DC converter; Adjustable output voltage.
Voltage Regulator; Power supply is the output of the DC/DC converter. Fast Mode only.
Voltage Detector; "L" output at the detector threshold. With released output delay time, the hysteresis is fixed 5% of the detector threshold.

Function version table

	DC/DC		LDO				VD	
Ver.	Output Voltage	EN pin	Output Current	Input	EN	Mode	Output Delay	Hysteresis
A	Fixed	CE	500mA (depends)	DC/DC output	CE*2	Fixed fast mode	Yes	5%
B	Fixed	CE1	300mA	VIN	CE2	DC/DC active: fast mode DC/DC off: controlled by MODE*3	Yes	5%
C*1	Fixed	CE	150mA	DC/DC output	Ever ON	DC/DC active: fast mode DC/DC off: controlled by MODE*3	No	30 ~ 80% with a step of 10%
D	Adjust	CE	500mA	DC/DC output	CE*2	Fixed fast mode	Yes	5%

*1) C version: No thermal protection circuit.

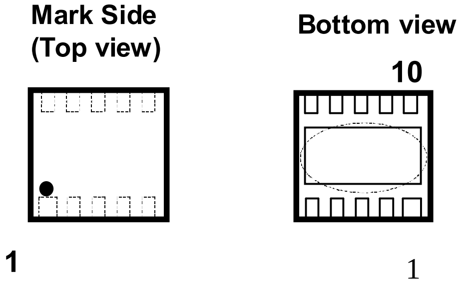
*2) Start-up sequence: LDO starts the operation after the soft-start of DC/DC.

*3) Mode pin "L": automatic shift (Iout2≤0.7mA: low power mode, Iout2≥5.0mA: fast mode)

Mode pin "H": fast mode

PIN CONFIGURATION

DFN(PLP)2527-10



PIN DESCRIPTIONS

- **RP600K0xxA**

Pin Number	Symbol	Descriptions
1	V_{SENSE}	SENSE pin (for Voltage Detector)
2	V_{DOUT}	Output pin of the voltage detector, Nch open drain output
3	NC	No Connection
4	MODE	MODE pin
5	GND	Ground pin
6	Lx	DC/DC switching pin
7	CE	Chip enable pin (active-high)
8	V_{IN}	Power input pin
9	V_{OUT1}	DC/DC converter output pin
10	V_{OUT2}	LDO output pin

Tab of the backside of the package is GND level. (They are connected to the reverse side of this IC.)
It should be connected to the GND pin (Recommendation case) or make it open.

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• **RP600K0xxB**

Pin Number	Symbol	Descriptions
1	V_{SENSE}	SENSE pin (for Voltage Detector)
2	V_{DOUT}	Output pin of the voltage detector, Nch open drain output
3	CE2	Chip enable pin for voltage regulator (active-high)
4	MODE	MODE pin
5	GND	Ground pin
6	Lx	DC/DC switching pin
7	CE1	Chip enable pin for DC/DC converter (active-high)
8	V_{IN}	Power input pin
9	V_{OUT1}	DC/DC converter output pin
10	V_{OUT2}	Voltage regulator output pin

Tab of the backside of the package is GND level. (They are connected to the reverse side of this IC.)
It should be connected to the GND pin (Recommendation case) or make it open.

• **RP600K2xxC**

Pin Number	Symbol	Descriptions
1	V_{SENSE}	SENSE pin (for Voltage Detector)
2	V_{DOUT}	Output pin of the voltage detector, Nch open drain output
3	TEST	TEST pin
4	MODE	Auto ECO pin ("H" fast mode, "L" Low power mode)
5	GND	Ground pin
6	Lx	DC/DC switching pin
7	CE	Chip enable pin for DC/DC converter (active-high)
8	V_{IN}	Power input pin
9	V_{OUT1}	DC/DC converter output pin
10	V_{OUT2}	Voltage regulator output pin

Tab of the backside of the package is GND level. (They are connected to the reverse side of this IC.)
It should be connected to the GND pin (Recommendation case) or make it open.
LDO is always active.
TEST pin should be connected to the GND pin. If the TEST pin is open or "H", the voltage regulator may turn off.

• **RP600K1xxD**

Pin Number	Symbol	Descriptions
1	V_{SENSE}	SENSE pin (for Voltage Detector)
2	V_{DOUT}	Output pin of the voltage detector, Nch open drain output
3	V_{FB}	Feedback pin for setting DC/DC converter output voltage
4	MODE	MODE pin ("H" fast mode, "L" Low power mode)
5	GND	Ground pin
6	Lx	DC/DC switching pin
7	CE	Chip enable pin for DC/DC converter (active-high)
8	V_{IN}	Power input pin
9	V_{OUT1}	DC/DC converter output pin
10	V_{OUT2}	Voltage regulator output pin

Tab of the backside of the package is GND level. (They are connected to the reverse side of this IC.)
It should be connected to the GND pin (Recommendation case) or make it open.

ABSOLUTE MAXIMAM RATINGS

Symbol	Items	Ratings		Unit
V_{IN}	V_{IN} Supply Voltage	-0.3~6.0		V
V_{OUT1}	V_{OUT1} Pin Voltage	-0.3~6.0		V
V_{CE}	CE pin Voltage (other than B version)	-0.3~6.0		V
V_{OUT2}	V_{OUT2} Pin Voltage	-0.3~V_{OUT1}+0.3		V
V_{LX}	V_{LX} Pin Voltage	-0.3~6.0		V
V_{DOUT}	V_{DOUT} Pin Voltage	-0.3~6.0		V
V_{SENSE}	V_{SENSE} Pin Voltage	-0.3~6.0		V
V_{CE1}	CE1 Pin Input Voltage (B version)	-0.3~6.0		V
V_{CE2}	CE2 Pin Input Voltage (B version)	-0.3~6.0		V
V_{MODE}	MODE Pin Input Voltage	-0.3~6.0		V
V_{FB}	V_{FB} Pin Voltage (D version)	-0.3~V_{OUT1}+0.3		V
P_D	Power Dissipation	Standard Land Pattern	910	mW
		High Wattage Land Pattern	1400	
Ta	Operating Temp Range	-40~+85		°C
Tstg	Storage Temp Range	-55~+125		°C

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

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ELECTRICAL CHARACTERISTICS

RP600K0xxA

Unless otherwise specified, open loop measurement is applied to guarantee the specifications. (Ta=25°C)

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Quiescent Current 1 (LDO operating DC/DC with heavy load PWM operation)	I_{SS1}	$V_{IN} = V_{OUT1} = V_{CE} = V_{SET} \times 0.95V$		V_{OUT1} x 260+50	V_{OUT1} x 350+90	μA
Quiescent Current 2 (LDO operating DC/DC with light load VFM operation)	I_{SS2}	$V_{IN} = V_{OUT1} = V_{CE} = 5.5V$, $V_{MODE} = 0V$		170	260	μA
Standby Current	$I_{standby}$	$V_{IN} = V_{OUT1} = 5.5V$, $V_{CE} = 0V$		1.0	6.0	μA
CE "H" Input Current	I_{CEH}	$V_{IN} = V_{OUT1} = V_{CE} = 5.5V$			0.5	μA
CE "L" Input Current	I_{CEL}	$V_{IN} = V_{OUT1} = 5.5V$, $V_{CE} = 0V$	-0.5			μA
MODE "H" Input Current	I_{MODEH}	$V_{IN} = V_{MODE} = 5.5V$			0.5	μA
MODE "L" Input Current	I_{MODEL}	$V_{IN} = 5.5V$, $V_{MODE} = 0V$	-0.5			μA
CE input "H" level Voltage	V_{CEH}		0.7			V
CE input "L" level Voltage	V_{CEL}				0.3	V
MODE input "H" level Voltage	V_{MODEH}		1.1			V
MODE input "L" level Voltage	V_{MODEL}				0.4	V

DC/DC SECTION Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}				5.5	V
Start-up Voltage	V_{START}	load current = 1mA, $V_{CE} = V_{OUT1}$			0.8	V
Hold-on Voltage (after start-up)	V_{HOLD}	load current = 1mA, $V_{CE} = V_{OUT1}$	0.7			V
Output Voltage1	V_{OUT1}		x0.98		x1.02	V
Output Voltage Range1	V_{OUT1}		2.3		5.5	V
Output Voltage1 Temperature Coefficient	$\Delta V_{OUT1}/\Delta Ta$	-40°C≤Ta≤85°C		±50		ppm/°C
Switching Frequency	f_{OSC}	$V_{IN} = V_{OUT1} = V_{SET} \times 0.7$	1020	1200	1380	kHz
Switching Frequency Temperature Coefficient	$\Delta f_{OSC}/\Delta Ta$	-40°C≤Ta≤85°C		±0.27		kHz/°C
Lx Switch ON Resistance *1	R_{ONN}	$V_{OUT1} = 3.3V$		0.16		Ω
Lx Leakage Current	I_{LX}	$V_{IN} = V_{OUT1} = V_{LX} = 6.0V$, $V_{CE} = 0V$			2.0	μA
Lx Current Limit	I_{LXPEAK}	$V_{IN} = V_{SET} \times 0.5$	1.2	1.4		A
Maximum Duty Cycle	Maxdty	$V_{IN} = V_{OUT1} = V_{SET} \times 0.7$	80	88	95	%
Soft start time 1	t_{START1}	$V_{IN} = V_{SET} \times 0.5$, $V_{CE} = 0V$ to $1.5V$	0.08	0.70	3.00	ms

*1) This item is guaranteed by design, not mass production tested. Lx switch On resistance depends on the voltage of V_{OUT1}.

VD SECTION

Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		0.8		5.5	V
Voltage Detector Threshold	$-V_{DET}$	V_{IN} = 3.0V	x0.98*2		x1.02*2	V
Voltage Detector Threshold Range	$-V_{DET}$		1.0		4.5	V
Voltage Detector Threshold Temperature Coefficient	$\Delta V_{DET}/\Delta Ta$	-40°C≤Ta≤85°C		±100		ppm/°C
Detector Threshold Hysteresis	V_{HYS}	V_{IN} = 3.0V		$-V_{DET}$x0.05		
Sense Resistance	R_{SENSE}	V_{IN} = 6.0V, V_{SENSE} = 6.0V	0.2		20	MΩ
Voltage Detector Released Output Delay Time	t_{DELAY}	V_{IN} = 3.0V		10		ms
V_{DOUT} "L" Output Current	I_{DOUTL}	V_{IN} = 2.0V, V_{DOUT} = 0.1V, V_{SENSE} = 6.0V	0.1	0.3		mA
V_{DOUT} Leakage Current	I_{DOUTH}	V_{IN} = 6.0V, V_{DOUT} = 6.0V, V_{SENSE} = 6.0V			0.5	μA

*2) This item is guaranteed under the condition of V_{IN} range from 1.0V to 5.0V and guaranteed by design, not mass production tested.

LDO SECTION

Ta=25°C

Description	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}			2.0		5.5	V
Output Voltage 2 (Fast Mode)	V_{OUT2}	I_{OUT2} = 5mA	V_{OUT2} > 2.0V	x0.99		x1.01	V
			V_{OUT2} ≤ 2.0V	-20		20	mV
Output Voltage Range	V_{OUT2}			1.5		5.0	V
Output Voltage2 Temperature Coefficient	$\Delta V_{OUT2}/\Delta Ta$	-40°C ≤ Ta ≤ 85°C			±100		ppm/°C
Output Current2	I_{OUT2}			500			mA
Load Regulation	$\Delta V_{OUT2}/\Delta I_{OUT2}$	10mA ≤ I_{OUT2} ≤ 500mA			50	100	mV
Dropout Voltage	V_{DIF}	Please refer to "Dropout Voltage".					
Line Regulation	$\Delta V_{OUT2}/\Delta V_{IN}$	V_{OUT2}+0.5V≤V_{IN}≤5.5V *V_{OUT2}<4.5V I_{OUT2}=10mA (Fast Mode)		-0.1	±0.02	0.1	%/V
Ripple Rejection	RR	f=1kHz, Ripple 0.2Vp-p, V_{IN} = V_{OUT2}+1.0V, I_{OUT2}=30mA			70		dB
Short Current Limit	I_{LIM}	V_{OUT2}=0V			200		mA
Soft-start Time 2*3	t_{START2}	after the DC/DC soft-start			200		μs

*3) This item is guaranteed by design, not mass production tested.

Thermal Shutdown Section

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		1.4		5.5	V
Thermal Shutdown temperature threshold	T_{TSD}	Junction Temperature		140		°C
Thermal Shutdown release temperature	T_{TSR}	Junction Temperature		95		°C

RP600K0xxB

Unless otherwise specified, open loop measurement is applied to guarantee the specifications. (Ta=25°C)

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Quiescent Current 1 (LDO active, DCDC with heavy load PWM operation)	I_{SS1}	$V_{IN} = V_{OUT1} = V_{SET} \times 0.95V$ $V_{CE1}=V_{CE2}=5.5V$		V_{OUT1} x 260+50	V_{OUT1} x 350+90	μA
Quiescent Current 2 (LDO active, DCDC with light load VFM operation)	I_{SS2}	$V_{IN}=V_{OUT1}=5.5V$, $V_{MODE}=0V$ $V_{CE1}=V_{CE2}=5.5V$		170	260	μA
Quiescent Current 3 (LDO off, DCDC with heavy load PWM operation)	I_{SS3}	$V_{IN}=V_{OUT1}=V_{SET} \times 0.95$ $V_{MODE}=0V$, $V_{CE1}=5.5V$, $V_{CE2}=0V$		V_{OUT1} x 260	V_{OUT1} x 350	μA
Quiescent Current 4 (LDO off, DCDC with light load VFM operation)	I_{SS4}	$V_{IN}=V_{OUT1}=5.5V$, $V_{MODE}=0V$ $V_{CE1}=5.5V$, $V_{CE2}=0V$		120	170	μA
Quiescent Current 5 (LDO fast mode, DCDC off)	I_{SS5}	$I_{OUT2}=0mA$, $V_{MODE}=5.5V$ $V_{CE1}=0V$, $V_{CE2}=5.5V$		50	90	μA
Quiescent Current 6 (LDO low power mode, DCDC off)	I_{SS6}	$I_{OUT2}=0mA$, $V_{MODE}=0V$ $V_{CE1}=0V$, $V_{CE2}=5.5V$		6.0	15.0	μA
Standby Current	$I_{standby}$	$V_{IN} = V_{OUT1}=5.5V$, $V_{CE1}=V_{CE2}=0V$		1.0	6.0	μA
CE1 "H" Input Current	I_{CE1H}	$V_{IN} = V_{OUT1} = V_{CE1}=5.5V$			0.5	μA
CE1 "L" Input Current	I_{CE1L}	$V_{IN} = V_{OUT1}=5.5V$, $V_{CE1}=0V$	-0.5			μA
CE2 "H" Input Current	I_{CE2H}	$V_{IN} = V_{CE2}=5.5V$			0.5	μA
CE2 "L" Input Current	I_{CE2L}	$V_{IN} =5.5V$, $V_{CE2}=0V$	-0.5			μA
MODE "H" Input Current	I_{MODEH}	$V_{IN} = V_{MODE}=5.5V$			0.5	μA
MODE "L" Input Current	I_{MODEL}	$V_{IN} =5.5V$, $V_{MODE} =0V$	-0.5			μA
CE1 input "H" level Voltage	V_{CE1H}		0.7			V
CE1 input "L" level Voltage	V_{CE1L}				0.3	V
CE2 input "H" level Voltage	V_{CE2H}		1.0			V
CE2 input "L" level Voltage	V_{CE2L}				0.4	V
MODE input "H" level Voltage	V_{MODEH}		1.1			V
MODE input "L" level Voltage	V_{MODEL}				0.4	V

DC/DC SECTION

Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}				5.5	V
Start-up Voltage	V_{START}	I_{OUT1} = 1mA, V_{CE1}=V_{OUT1}			0.8	V
Hold-on Voltage(after start-up)	V_{HOLD}	I_{OUT1} = 1mA, V_{CE1}=V_{OUT1}	0.7			V
Output Voltage1	V_{OUT1}		x0.98		x1.02	V
Output Voltage Range1	V_{OUT1}		2.3		5.5	V
Output Voltage1 Temperature Coefficient	$\Delta V_{OUT1}/\Delta Ta$	-40°C≤Ta≤85°C		±50		ppm/°C
Switching Frequency	f_{OSC}	V_{IN}=V_{OUT1}=V_{SET}x0.7	1020	1200	1380	kHz
Switching Frequency Temperature Coefficient	$\Delta f_{OSC}/\Delta Ta$	-40°C≤Ta≤85°C		±0.27		kHz/°C
Lx Switch ON Resistance *1	R_{ONN}	V_{OUT1}=3.3V		0.16		Ω
Lx Leakage Current	I_{LX}	V_{IN} =V_{OUT1}=V_{LX}=6.0V, V_{CE1}=0V			2.0	μA
Lx Current Limit	I_{LXPEAK}	V_{IN}=V_{SET}x0.5	1.2	1.4		A
Maximum Duty Cycle	Maxdty	V_{IN} =V_{OUT1}=V_{SET}x0.7	80	88	95	%
Soft start time 1	t_{START1}	V_{IN}=V_{SET}x0.5, V_{CE}=0V to 1.5V	0.08	0.70	3.00	ms

*1) This item is guaranteed by design, not mass production tested. Lx switch On resistance depends on the voltage of V_{OUT1}.

VD SECTION

Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		0.8		5.5	V
Voltage Detector Threshold	$-V_{DET}$	V_{IN} =3.0V	x0.98*2		x1.02*2	V
Detector Threshold Range	$-V_{DET}$		1.0		4.5	V
Voltage Detector Threshold Temperature Coefficient	$\Delta V_{DET}/\Delta Ta$	-40°C≤Ta≤85°C		±100		ppm/°C
Detector Threshold Hysteresis	V_{HYS}	V_{IN}=3.0V		$-V_{DET}$x0.05		
Sense Resistance	R_{SENSE}	V_{IN} =6.0V, V_{SENSE} =6.0V	0.2		20	MΩ
Voltage Detector Released Output Delay Time	t_{DELAY}	V_{IN} =3.0V		10		ms
V_{DOUT} "L" Output Current	I_{DOUTL}	V_{IN}=2.0V, V_{DOUT} =0.1V, V_{SENSE}=0V	0.1	0.3		mA
V_{DOUT} Leakage Current	I_{DOUTH}	V_{IN} =6.0V, V_{DOUT}=6.0V, V_{SENSE}=6.0V			0.5	μA

*2) This item is guaranteed under the condition of VIN range from 1.0V to 5.0V and guaranteed by design, not mass production tested.

LDO SECTION Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		2.0		5.5	V
Output Voltage 2 (Fast Mode)	V_{OUT2}	I_{OUT2}=5mA, V_{OUT2}>2.0V	x0.99		x1.01	%
		I_{OUT2}=5mA, V_{OUT2}≤2.0V	-20		20	mV
Output Voltage Range	V_{OUT2}		1.5		5.0	V
Output Voltage2 Temperature Coefficient	$\Delta V_{OUT2}/\Delta Ta$	-40°C≤Ta≤85°C		±100		ppm/°C
Output Current2	I_{OUT2}		300			mA
Fast Mode Switch-over Current	I_{OUTH}	I_{OUT2}=Light load to Heavy Load		3.2	5.0	mA
Low Power Mode Switch-over Current	I_{OUTL}	I_{OUT2}=Heavy load to Light Load	0.7	1.5		mA
Load Regulation	$\Delta V_{OUT2}/\Delta I_{OUT2}$	0.5mA≤ I_{OUT2}≤10mA, V_{CE1}=V_{MODE}=0V, V_{OUT2}>2.0V	-1.2		1.2	%
		0.5mA≤ I_{OUT2}≤10mA, V_{CE1}=V_{MODE}=0V, V_{OUT2}≤2.0V	-24		24	mV
		10mA≤ I_{OUT2}≤300mA		30	60	mV
Dropout Voltage	V_{DIF}	Please refer to "Dropout Voltage".				
Line Regulation	$\Delta V_{OUT2}/\Delta V_{IN}$	V_{OUT2}+0.5V≤ V_{IN}≤5.5V, V_{MODE}=0V *V_{OUT2}<4.5V; I_{OUT2}=0.5mA (Low Power Mode)	-0.2		0.2	%/V
		V_{OUT2}+0.5V≤ V_{IN}≤5.5V, V_{MODE}=0V *V_{OUT2}<4.5V; I_{OUT2}=10mA (Fast Mode)	-0.1	±0.02	0.1	%/V
Ripple Rejection	RR	f=1kHz, Ripple 0.2Vp-p, V_{IN} = V_{OUT2}+1.0V, I_{OUT2}=30mA		70		dB
Short Current Limit	I_{LIM}	V_{OUT2}=0V		150		mA
Soft-start Time 2*3	t_{START2}	after the DC/DC soft-start		200		μs

*3) This item is guaranteed by design, not mass production tested.

Thermal Shutdown Section

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		1.4		5.5	V
Thermal Shutdown temperature threshold	T_{TSD}	Junction Temperature		140		°C
Thermal Shutdown release temperature	T_{TSR}	Junction Temperature		95		°C

RP600K2xxC

Unless otherwise specified, open loop measurement is applied to guarantee the specifications. (Ta=25°C)

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Quiescent Current 1 (LDO on, DC/DC with heavy load PWM operation	I_{SS1}	V_{IN} = V_{OUT1}=V_{CE}=V_{SET} x 0.95V		V_{OUT1} x 260+50	V_{OUT1} x 350+90	μA
Quiescent Current 2 (LDO on, DC/DC with light load VFM operation	I_{SS2}	V_{IN}=V_{OUT1}=5.5V, V_{CE}=V_{MODE}=0V,		170	260	μA
Quiescent Current 3 (LDO with low power mode)	I_{SS3}	V_{IN}= V_{OUT1}=5.5V, V_{CE} =V_{MODE}=0V, I_{OUT2}=0mA		2.0	7.0	μA
Quiescent Current 4 (LDO with fast mode)	I_{SS4}	V_{IN}=V_{OUT1}=V_{MODE}=5.5V, V_{CE}=0V		50	90	μA
CE "H" Input Current	I_{CEH}	V_{IN} = V_{OUT1}= V_{CE} =5.5V			0.5	μA
CE "L" Input Current	I_{CEL}	V_{IN} = V_{OUT1}=5.5V, V_{CE} =0V	-0.5			μA
MODE "H" Input Current	I_{MODEH}	V_{IN} = V_{MODE}=5.5V			0.5	μA
MODE "L" Input Current	I_{MODEL}	V_{IN} =5.5V, V_{MODE} =0V	-0.5			μA
CE input "H" level Voltage	V_{CEH}		0.7			V
CE input "L" level Voltage	V_{CEL}				0.3	V
MODE input "H" level Voltage	V_{MODEH}		1.1			V
MODE input "L" level Voltage	V_{MODEL}				0.4	V

DC/DC SECTION Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}				5.5	V
Start-up Voltage	V_{START}	I_{OUT} = 1mA, V_{CE}=V_{OUT1}			0.8	V
Hold-on Voltage (After start-up)	V_{HOLD}	I_{OUT} = 1mA, V_{CE}=V_{OUT1}	0.7			V
Output Voltage1	V_{OUT1}		x0.98		x1.02	V
Output Voltage Range1	V_{OUT1}		2.3		5.5	V
Output Voltage1 Temperature Coefficient	$\Delta V_{OUT1}/\Delta Ta$	-40°C≤Ta≤85°C		±50		ppm/°C
Switching Frequency	f_{OSC}	V_{IN}=V_{OUT1}=V_{SET}x0.95	1020	1200	1380	kHz
Switching Frequency Temperature Coefficient	$\Delta f_{OSC}/\Delta Ta$	-40°C≤Ta≤85°C		±0.27		kHz/°C
Lx Switch ON Resistance *1	R_{ONN}	V_{OUT1}=3.3V		0.16		Ω
Lx Leakage Current	I_{LX}	V_{IN}=V_{OUT1}=V_{LX}=6.0V, V_{CE}=0V			2.0	μA
Lx Current Limit	I_{LXPEAK}	V_{IN}=V_{SET}x0.5	1.2	1.4		A
Maximum Duty Cycle	Maxdty	V_{IN}=V_{OUT1}=V_{SET}x0.7	80	88	95	%
Soft start time 1	t_{START1}	V_{IN}=V_{SET}x0.5, V_{CE}=0V to 1.5V	0.08	0.7	3.0	ms

*1) This item is guaranteed by design, not mass production tested. Lx switch On resistance depends on the voltage of V_{OUT1}.

VD SECTION

Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		0.8		5.5	V
Voltage Detector Threshold	$-V_{DET}$	V_{IN} =3.0V	x0.98[*2]		x1.02[*2]	V
Voltage Detector Threshold Range	$-V_{DET}$		1.0		4.5	V
Voltage Detector Threshold Temperature Coefficient	$\Delta V_{DET}/\Delta Ta$	-40°C≤Ta≤85°C		±100		ppm/°C
Detector Threshold Hysteresis	V_{HYS}	V_{IN}=3.0V		$-V_{DET}$x0.3 to $-V_{DET}$x0.8		
Sense Resistance	R_{SENSE}	V_{IN} =6.0V, V_{SENSE} =6.0V	0.2		20.0	MΩ
Voltage Detector Released Output Delay Time	t_{DELAY}	V_{IN} =3.0V		0	200	μs
V_{DOUT} "L" Output Current	I_{DOUTL}	V_{IN}=2.0V, V_{DOUT} =0.1V, V_{SENSE}=6.0V	0.1	0.3		mA
V_{DOUT} Leakage Current	I_{DOUTH}	V_{IN} =6.0V, V_{DOUT}=6.0V, V_{SENSE}=0V			0.5	μA

*2) This item is guaranteed under the condition of VIN range from 1.0V to 5.0V and guaranteed by design, not mass production tested.

LDO SECTION

Ta=25°C

Description	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}			2.0		5.5	V
Output Voltage 2 (Fast Mode)	V_{OUT2}	I_{OUT2}=5mA	V_{OUT2}>2.0V	x0.99		x1.01	%
			V_{OUT2}≤2.0V	-20		20	mV
Output Voltage Range	V_{OUT2}			1.5		5.0	V
Output Voltage2 Temperature Coefficient	$\Delta V_{OUT2}/\Delta Ta$	-40°C≤Ta≤85°C			±100		ppm/°C
Output Current2	I_{OUT2}			150			mA
Fast Mode Switch-over Current	I_{OUTH}	I_{OUT2}=Light load to Heavy Load			3.2	5.0	mA
Low Power Mode Switch-over Current	I_{OUTL}	I_{OUT2}=Heavy load to Light Load		0.7	1.5		mA
Load Regulation	$\Delta V_{OUT2}/\Delta I_{OUT2}$	0.5mA≤ I_{OUT2}≤10mA	V_{OUT2}>2.0V	-1.2		1.2	%
			V_{OUT2}≤2.0V	-24		24	mV
		10mA≤ I_{OUT2}≤150mA			15	40	mV
Dropout Voltage	V_{DIF}	Please refer to "Dropout Voltage".					
Line Regulation	$\Delta V_{OUT2}/\Delta V_{IN}$	V_{OUT2}+0.5V≤ V_{IN}≤5.5V *V_{OUT2}<4.5V	I_{OUT2}=0.5mA (Low Power Mode)	-0.2		0.2	%/V
			I_{OUT2}=10mA (Fast Mode)	-0.1	±0.02	0.1	
Ripple Rejection	RR	f=1kHz, Ripple 0.2Vp-p, V_{IN} = V_{OUT2}+1.0V, I_{OUT2}=30mA			70		dB
Short Current Limit	I_{LIM}	V_{OUT2}=0V			60		mA
Soft-start Time 2[*3]	t_{START2}				200		μs

*3) This item is guaranteed by design, not mass production tested.

RP600K1xxD

Unless otherwise specified, open loop measurement is applied to guarantee the specifications. (Ta=25°C)

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Quiescent Current 1 (LDO operating DC/DC with heavy load PWM operation)	I_{SS1}	V_{IN}=2.0V, V_{OUT1}=V_{CE}=2.5V, V_{FB}=0V		700	950	μA
Quiescent Current 2 (LDO operating DC/DC with light load VFM operation)	I_{SS2}	V_{IN}=V_{OUT1}=V_{CE}=5.5V, V_{MODE}=0V, V_{FB}=1.0V		170	260	μA
Standby Current	$I_{standby}$	V_{IN}=V_{OUT1}=5.5V, V_{CE} =0V		1.0	6.0	μA
CE ”H” Input Current	I_{CEH}	V_{IN}=V_{OUT1}= V_{CE} =5.5V			0.5	μA
CE ”L” Input Current	I_{CEL}	V_{IN}=V_{OUT1}=5.5V, V_{CE} =0V	-0.5			μA
MODE ”H” Input Current	I_{MODEH}	V_{IN} = V_{MODE} =5.5V			0.5	μA
MODE ”L” Input Current	I_{MODEL}	V_{IN} =5.5V, V_{MODE} =0V	-0.5			μA
CE input ”H” level Voltage	V_{CEH}		0.7			V
CE input “L” level Voltage	V_{CEL}				0.3	V
MODE input ”H” level Voltage	V_{MODEH}		1.1			V
MODE input “L” level Voltage	V_{MODEL}				0.4	V

DC/DC SECTION Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}				5.5	V
Start-up Voltage	V_{START}	I_{OUT1} = 1mA, V_{CE1}=V_{OUT1}			0.8	V
Hold-on Voltage (after start-up)	V_{HOLD}	I_{OUT1} = 1mA, V_{CE1}=V_{OUT1}	0.7			V
Feedback Voltage	V_{FB}		0.588	0.600	0.612	V
Output Voltage Range1	V_{OUT1}		2.3		5.5	V
Output Voltage1 Temperature Coefficient	$\Delta V_{OUT1}/\Delta Ta$	-40°C≤Ta≤85°C		±50		ppm/°C
Switching Frequency	fosc	V_{IN}=V_{OUT1}=V_{SET}x0.7	1020	1200	1380	kHz
Switching Frequency Temperature Coefficient	$\Delta fosc/\Delta Ta$	-40°C≤Ta≤85°C		±0.27		kHz/°C
Lx Switch ON Resistance *1	R_{ONN}	V_{OUT1}=3.3V		0.16		Ω
FB Input Current "H"	I_{FBH}	V_{IN}=V_{OUT1}=V_{FB}=5.5V, V_{CE}=0V			0.5	μA
FB Input Current "L"	I_{FBL}	V_{IN}=V_{OUT1}=5.5V V_{FB}=V_{CE}=0V	-0.5			μA
Lx Leakage Current	I_{LX}	V_{IN} =V_{OUT1}=V_{LX}=6.0V, V_{CE1}=0V			2.0	μA
Lx Current Limit	I_{LXPEAK}	V_{IN}=V_{SET}x0.5	1.2	1.4		A
Maximum Duty Cycle	Maxdty	V_{IN} =V_{OUT1}=V_{SET}x0.7	80	88	95	%
Soft start time 1	t_{START1}	V_{IN}=V_{SET}x0.5, V_{CE}=0V to 1.5V	0.08	0.70	3.00	ms

*1) This item is guaranteed by design, not mass production tested. Lx switch On resistance depends on the voltage of V_{OUT1}.

VD SECTION

Ta=25°C

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		0.8		5.5	V
Voltage Detector Threshold	$-V_{DET}$	V_{IN} =3.0V	x0.98[*2]		x1.02[*2]	V
Detector Threshold Range	$-V_{DET}$		1.0		4.5	V
Voltage Detector Threshold Temperature Coefficient	$\Delta V_{DET}/\Delta Ta$	-40°C≤Ta≤85°C		±100		ppm/°C
Detector Threshold Hysteresis	V_{HYS}	V_{IN}=3.0V		$-V_{DET}$x0.05		
Sense Resistance	R_{SENSE}	V_{IN} =6.0V, V_{SENSE} =6.0V	0.2		20.0	MΩ
Voltage Detector Released Output Delay Time	t_{DELAY}	V_{IN} =3.0V		10		ms
VDOUT "L" Output Current	I_{DOUTL}	V_{IN}=2.0V, V_{DOUT} =0.1V, V_{SENSE}=0V	0.1	0.3		mA
V_{DOUT} Leakage Current	I_{DOUTH}	V_{IN} =6.0V, V_{DOUT}=6.0V, V_{SENSE}=6.0V			0.5	μA

*2) This item is guaranteed under the condition of V_{IN} range from 1.0V to 5.0V and guaranteed by design, not mass production tested.

LDO SECTION

Ta=25°C

Description	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}			2.0		5.5	V
Output Voltage 2 (Fast Mode)	V_{OUT2}	I_{OUT2}=5mA	V_{OUT2}>2.0V	x0.99		x1.01	V
			V_{OUT2}≤2.0V	-20		20	mV
Output Voltage Range	V_{OUT2}			1.5		5.0	V
Output Voltage2 Temperature Coefficient	$\Delta V_{OUT2}/\Delta Ta$	-40°C≤Ta≤85°C			±100		ppm/°C
Output Current2	I_{OUT2}			500			mA
Load Regulation	$\Delta V_{OUT2}/\Delta I_{OUT2}$	10mA≤ I_{OUT2}≤500mA			50	100	mV
Dropout Voltage	V_{DIF}	Please refer to "Dropout Voltage".					
Line Regulation	$\Delta V_{OUT2}/\Delta V_{IN}$	V_{OUT2}+0.5V≤V_{IN}≤5.5V *V_{OUT2}<4.5V I_{OUT2}=10mA (Fast Mode)		-0.1	±0.02	0.1	%/V
Ripple Rejection	RR	f=1kHz, Ripple 0.2Vp-p, V_{IN} = V_{OUT2}+1.0V, I_{OUT2}=30mA			70		dB
Short Current Limit	I_{LIM}	V_{OUT2}=0V			200		mA
Soft-start Time 2[*3]	t_{START2}	after the DC/DC soft-start			200		μs

*3) Refer to the Timing Chart. This item is guaranteed by design, not mass production tested.

Thermal Shutdown Section

Description	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Voltage	V_{IN}		1.4		5.5	V
Thermal Shutdown temperature threshold	T_{TSD}	Junction Temperature		140		°C
Thermal Shutdown release temperature	T_{TSR}	Junction Temperature		95		°C

●LDO Dropout Voltage

・A&D_Ver.

Output Voltage V_{OUT2} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
1.5≦V_{OUT}2＜1.8	I_{OUT}2=500mA	0.45	0.60
1.8≦V_{OUT}2＜2.1		0.40	0.53
2.1≦V_{OUT}2＜3.3		0.36	0.48
3.3≦V_{OUT}2≦5.0		0.28	0.38

・B_Ver.

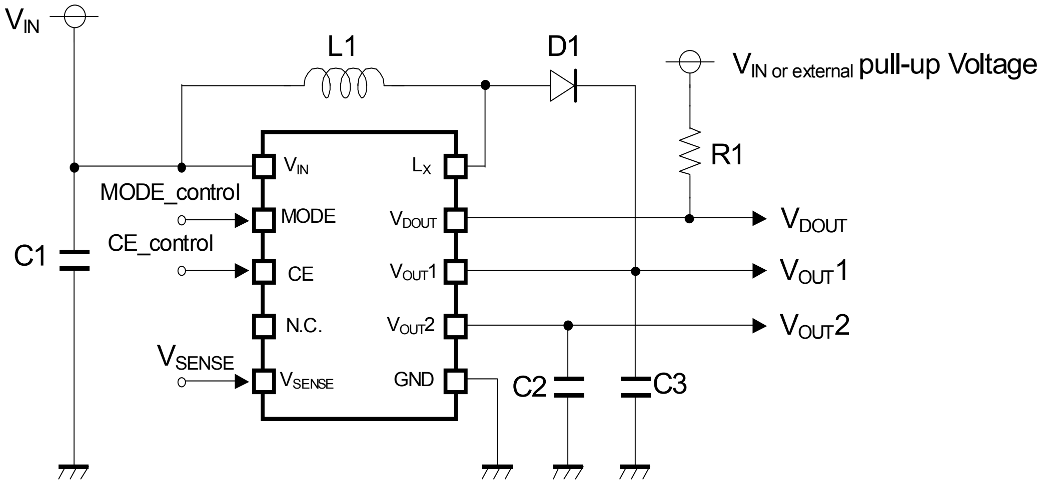
Output Voltage V_{OUT2} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
1.5≦V_{OUT}2＜1.8	I_{OUT}2=300mA	0.26	0.37
1.8≦V_{OUT}2＜2.1		0.24	0.32
2.1≦V_{OUT}2＜3.3		0.22	0.29
3.3≦V_{OUT}2≦5.0		0.17	0.20

・C_Ver.

Output Voltage V_{OUT2} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
1.5≦V_{OUT}2＜1.8	I_{OUT}2=150mA	0.14	0.19
1.8≦V_{OUT}2＜2.1		0.12	0.16
2.1≦V_{OUT}2＜3.3		0.11	0.15
3.3≦V_{OUT}2≦5.0		0.09	0.11

TYPICAL APPLICATION

A_Version



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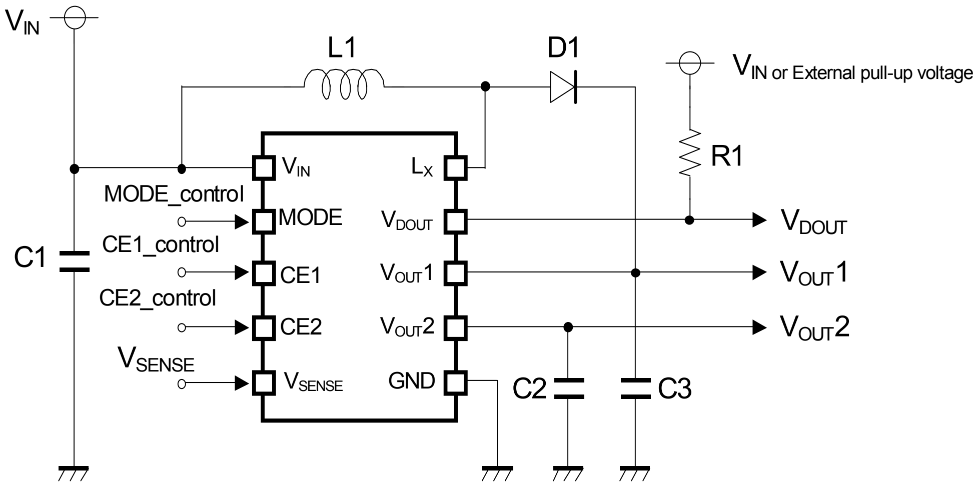

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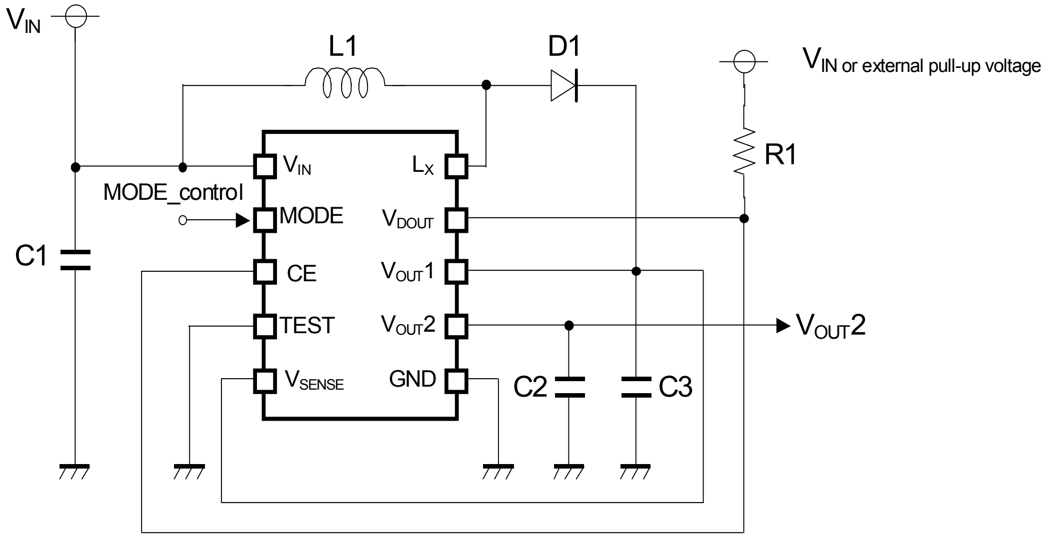
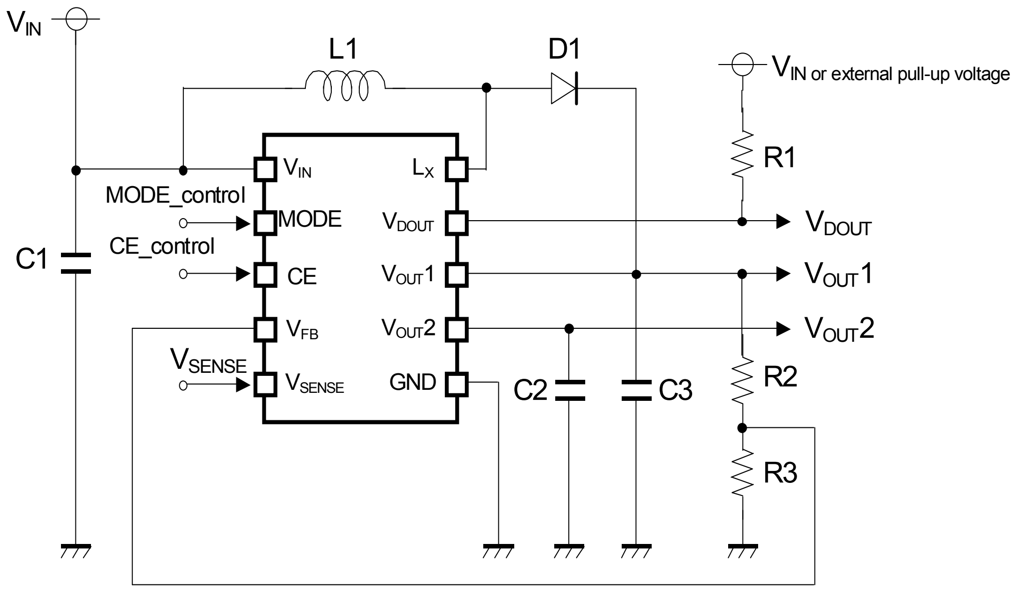


D_Version



■ External Components Recommendation

● Inductor L1 $V_{OUT}1 < 3.6V$, SLF7028T-3R3M1R6-PF, (3.3μH, TDK)
$V_{OUT}1 \geqq 3.6V$, SLF7028T-4R7M1R5-PF, (4.7μH, TDK)

● Diode D1

[A/B/D_Version]
$I_{LXPEAK} < 1.0A$, CRS10I30A, (TOSHIBA)
$I_{LXPEAK} \geqq 1.0A$, CMS06, (TOSHIBA)

[C_Version]
RB550VA-30, (ROHM)

● Capacitor C1 C1608JB0J106M, (10μF, TDK)
Capacitor C2 C1608JB0J106M, (10μF, TDK)
Capacitor C3 C1608JB0J106M x 2, (10μF x 2, TDK)

●Pull-up Resistance R1 100kΩ

◆Capacitor C2 Small Components example

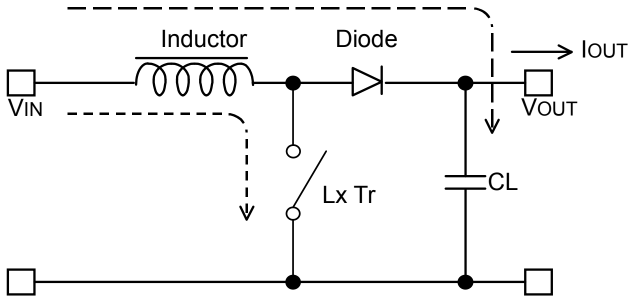
* If the small capacitors such as shown below are selected, the operation of the RP600 is stable, however, to reduce the output ripple, C1608JB0J106M (10μF, TDK) is better than items below.

[B/C_Version]
$V_{OUT}2 \leq 3.3V$, C1005JB0J225M, (2.2μF, TDK)
$V_{OUT}2 > 3.3V$, C1608JB0J225M, (2.2μF, TDK)

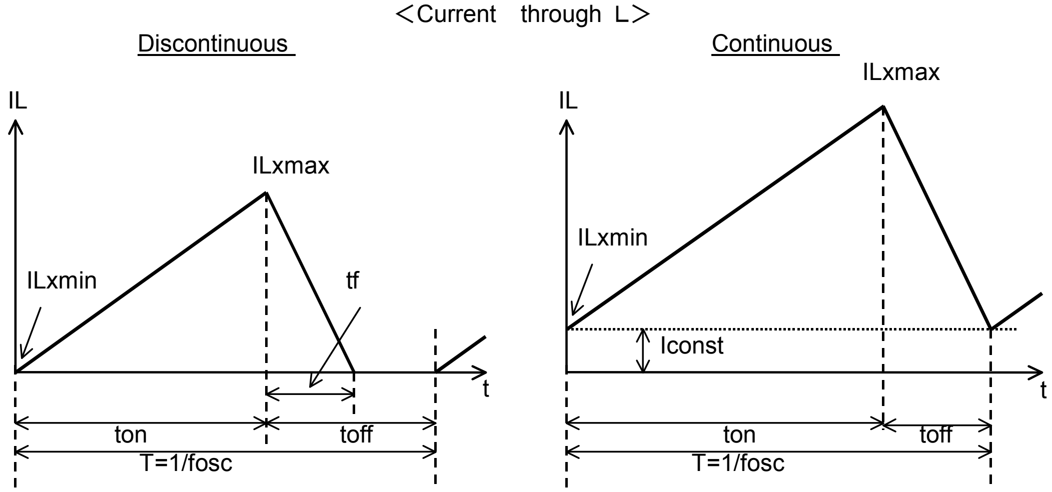
[A/D_Version]
$V_{OUT}2 \leq 3.3V$, C1005JB0J475M x 2, (4.7μF, TDK)
$V_{OUT}2 > 3.3V$, C1608JB0J475M, (4.7μF, TDK)

OUTPUT CURRENT OF STEP-UP CIRCUIT

<Basic Circuit>



<Current through L>



There are two modes, or discontinuous mode and continuous mode for the PWM step-up switching regulator depending on the continuous characteristic of inductor current. During on time of the transistor, when the voltage added on to the inductor is described as V_{IN}, the current is $V_{IN} \times t/L$.
Therefore, the electric power, P_{ON}, which is supplied with input side, can be described as in next formula.

$$P_{ON} = \int_0^{ton} V_{IN}^2 \times t/L \, dt \quad \cdots\cdots \text{Formula 1}$$

With the step-up circuit, electric power is supplied from power source also during off time. In this case, input current is described as$(V_{OUT} - V_{IN}) \times t/L$, therefore electric power, P_{OFF} is described as in next formula.

$$P_{OFF} = \int_0^{tf} V_{IN} \times (V_{OUT} - V_{IN}) t/L \, dt \quad \cdots\cdots \text{Formula 2}$$

In this formula, tf means the time of which the energy saved in the inductance is being emitted. Thus average electric power, P_{AV} is described as in the next formula.

$$P_{AV} = 1/(ton + toff) \times \{\int_0^{ton} V_{IN}^2 \times t/L \, dt + \int_0^{tf} V_{IN} \times (V_{OUT} - V_{IN}) t/L \, dt\} \quad \cdots\cdots \text{Formula 3}$$

In PWM control, when tf=toff is true, the inductor current becomes continuous, then the operation of switching regulator becomes continuous mode. In the continuous mode, the deviation of the current is equal between on time and off time.

$V_{IN}\times ton/L = (V_{OUT} - V_{IN})\times toff/L$ ························· Formula 4

Further, the electric power, PAV is equal to output electric power, $V_{OUT} \times I_{OUT}$, thus,

$I_{OUT} = fosc\times V_{IN}^2\times ton^2/\{2\times L(V_{OUT} - V_{IN})\} = V_{IN}^2\times ton/(2\times L\times V_{OUT})$ ························· Formula 5

When I_{OUT} becomes more than $V_{IN}\times ton\times toff/(2\times L\times(ton + toff))$,the current flows through the inductor, then the mode becomes continuous. The continuous current through the inductor is described as Iconst, then,

$I_{OUT} = fosc\times V_{IN}^2\times ton^2/(2\times L\times(V_{OUT} - V_{IN})) + V_{IN}\times Iconst/V_{OUT}$ ························· Formula 6

In this moment, the peak current, Ilxmax flowing through the inductor and the driver Tr. is described as follows:

$ILxmax = Iconst + V_{IN}\times ton/L$ ························· Formula 7

With the formula 4 , 6 and Ilxmax is

$ILxmax = V_{OUT}/V_{IN}\times I_{OUT} + V_{IN}\times ton/(2\times L)$ ························· Formula 8

However, $ton=(1-V_{IN}/V_{OUT})/fosc$

Therefore, peak current is more than I_{OUT}. Considering the value of ILxmax, the condition of input and output, and external components should be selected.
In the formula 7, peak current ILxmax at discontinuous mode can be calculated. Put Iconst＝0 in the formula.
The explanation above is based on the ideal calculation, and the loss caused by Lx switch and external components is not included. Please select the inductor and the diode with current peak to the standard(Formula 8).

EXTERNAL COMPONENTS and TECHNICAL NOTES

*Make enforce both V_{IN} and GND lines sufficient. Large current by switching may flow through the V_{IN} line and GND line. If their impedance is high, the internal voltage of the IC may shift by the switching current and the operation may unstable. When the built-in Lx switch turns off, a spike noise may be generated caused by the inductor, therefore recommendation range of the voltage rating of capacitor C3 and the shottky barrier diode is 1.5 or more times as much as the set output voltage.

*Select a diode with low Vf (Shottky barrier diode), low reverse current, fast switching speed.

*In this IC, after the step-up, V_{OUT1} voltage is used as a main power source of the IC. That means the capacitor C3 between V_{OUT1} and GND has a role of the bypass capacitor of the IC. Therefore, to select the capacitor C3 between V_{OUT1} and GND, consider the bias characteristics, and mean value must be 10μF or more. Set the capacitor as close as possible to the V_{OUT1} pin and GND pin. A capacitor C1 between V_{IN} and GND, select 10μF or more capacitance ceramic type.

*As for the capacitor C2 between V_{OUT2} and GND, consider the bias characteristics, put the 2.2μF or more ceramic capacitor as close as possible to the V_{OUT2} pin and GND pin.
-In case of A, C, and D version, V_{OUT2} operates with V_{OUT1} voltage as power supply. Therefore, the capacitor C3 between V_{OUT1} and GND has a role of the bypass capacitor of the V_{OUT2}. If the position of C2, C3 and GND are not close one another, put a 0.001uF capacitor between V_{OUT1} and the GND of C2.

*Select the inductance value according to the set output voltage. If $V_{OUT1} \geq 3.6V$ is true, 4.7μH is the recommendation value, and if $V_{OUT1} < 3.6V$ is true, 3.3μH is the recommendation value. Low DCR, enough permissible current, and uneasy to become magnetic saturation characteristics are preferable. If the inductance value is too small, the current of Lx transistor and inductor current or Lx peak current at maximum load may exceed the absolute maximum rating. Choose an appropriate value.

*If the spike noise of the Lx pin is large, put the snub circuit (serial CR connection) in parallel with the diode D1 and reduce the spike noise. The time constant of CR depends on the actual PCB, and efficiency may be effected, therefore fully evaluation on the actual PCB is necessary. (As much as 10Ω and 300pF is the nominal value.)

*The performance with this IC largely depends on the peripheral circuits. Do not exceed the ratings of voltage, current, and power for each external component and IC and consider the PCB layout.

DC/DC output voltage setting method (for D version)

DC/DC output voltage(V_{OUT1}) is determined by the divider resisters, R2 and R3.
$V_{OUT1}=V_{FB}x(R2+R3)/R3$ ($V_{FB}=0.6V$)
The recommendation range of R2+R3 is equal or less than 100kΩ.

GENERAL TECHNICAL NOTES

(Common for all versions:)
*If the built-in detector is not used, set the V_{DOUT} pin and V_{SENSE} pin to the GND.

*If the output of the DC/DC (V_{OUT1}) is under the condition of the output short ($V_{OUT1} < 0.5V$), to protect the IC itself, the switching will stop. However, an external path remains between Vin and GND and large current flows.

*When the LDO start-up, inrush current suppression function operates and until the output voltage reaches to the set output voltage, the maximum current is limited around the short current limit. Start-up load current must be low.

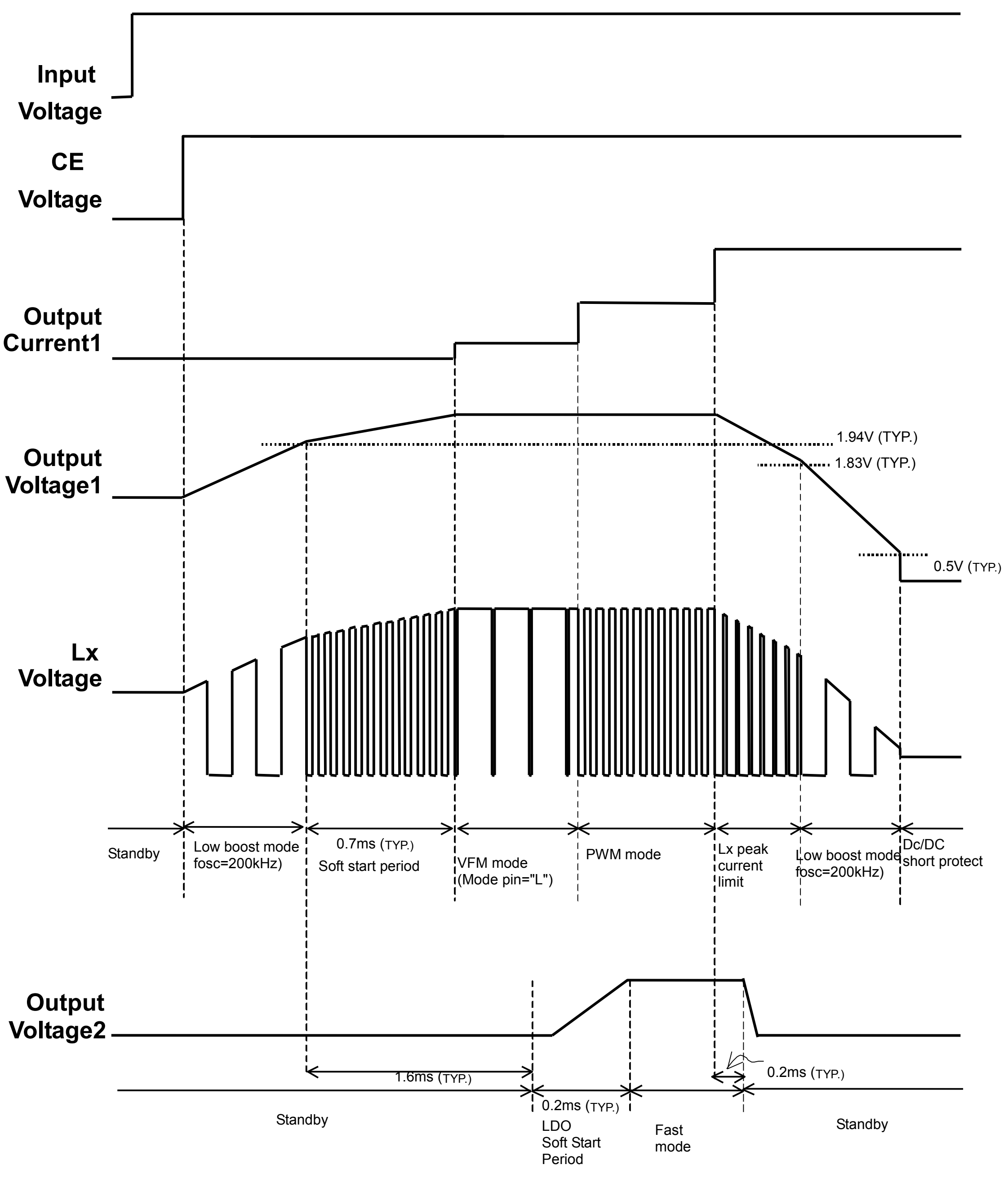
(A, C, and D version)
The output of the DC/DC(V_{OUT1}) is input voltage for LDO (V_{OUT2}), therefore V_{OUT1}-V_{OUT2} is dropout voltage for LDO, therefore, the decide the voltage of V_{OUT1} with considering the load current of V_{OUT2} and output characteristics of V_{OUT1} and V_{OUT2}.

If the DC/DC converter must limit the current, to protect the IC, LDO turns off. When the DC/DC starts up, if a heavy load is forced, or the capacitor, C3 between V_{OUT1} and GND is large, current limit may operate and start-up of the LDO may be slow. Especially, the step-up ratio is high, this phenomenon is likely to happen, and fully evaluation is necessary.

When the LDO starts-up, inrush current limit operates, and DC/DC converter can avoid the heavy load, however, if the DC/DC converter's load current is large, LDO may turn off.

TIMING CHART (A/D version)

Soft-start operation, DC/DC short circuit limit

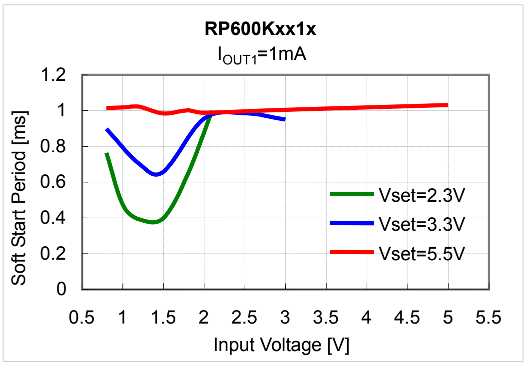


(1) DC/DC Converter

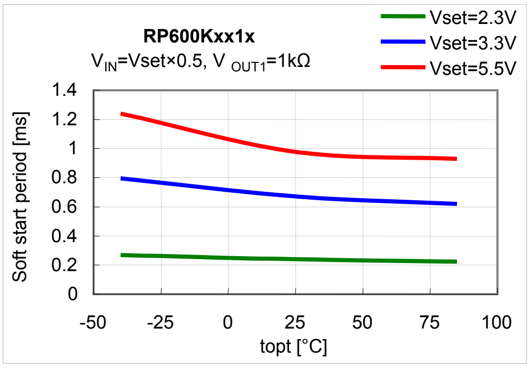
(Start-up) When the CE signal changes from "L" to "H", the DC/DC converter starts up.
The DC/DC converter of the RP600 can start up with the low input voltage such as 0.8V. To realize this, the RP600 has a low-boost mode. Until the output voltage 1 reaches 1.94V (Typ.), the operation mode is low-boost mode. When the output voltage becomes equal or more than 1.94V, then to suppress the inrush current, soft-start operation starts until the output voltage 1 becomes set output voltage.
*At the low-boost mode, the oscillator frequency becomes low, 200kHz (Typ.) Therefore, compared with the normal operation mode at 1.2MHz, the boost ability will worse.

Soft-start time depends on the set output voltage, the input voltage, the ambient temperature, and the load current.

Soft start period vs. Input Voltage



Soft start period vs. Temperature

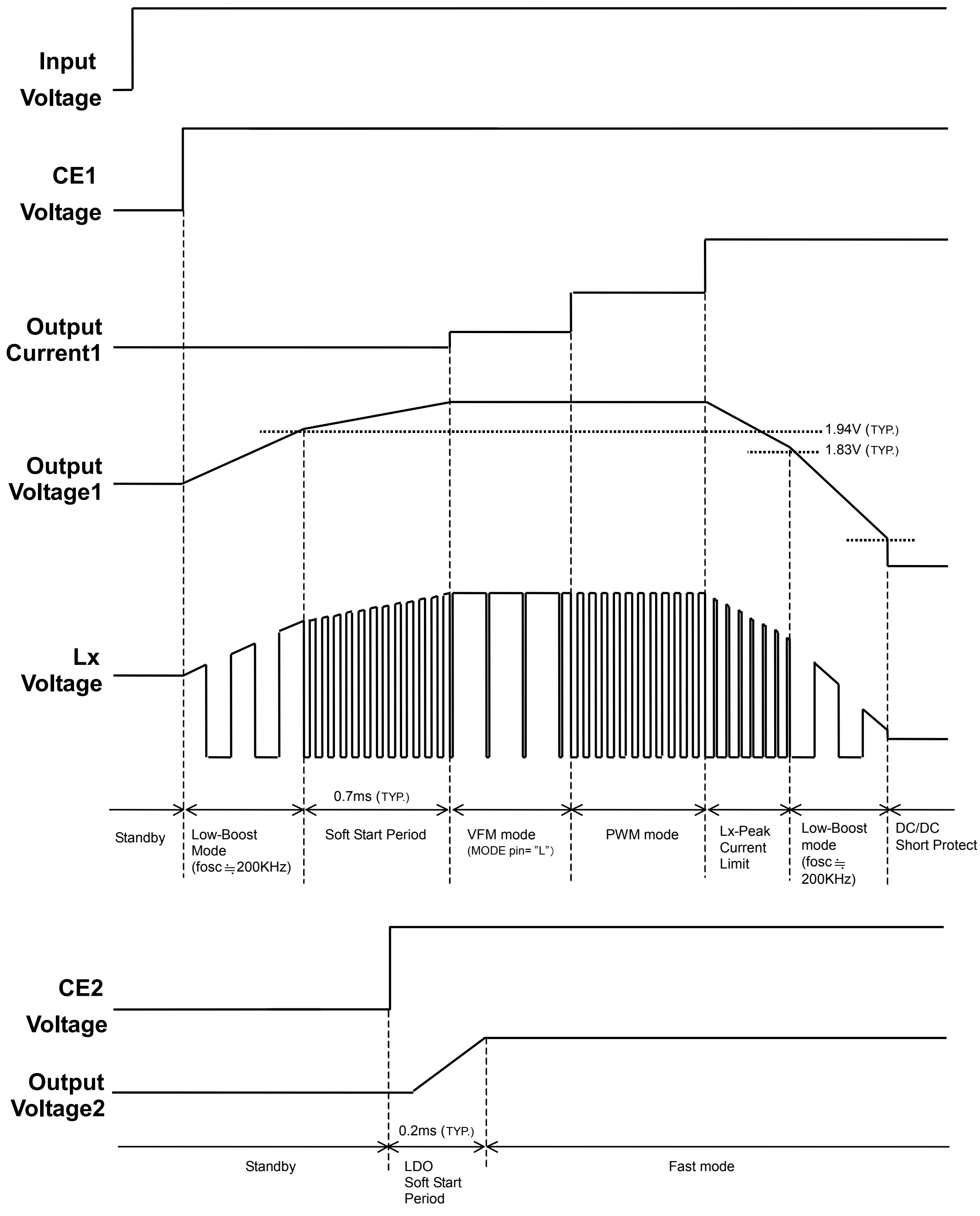


(Over-current protection operation)
If the Lx peak current may reach 1.4A (typ.), Lx peak current limit circuit may operate and control the duty ratio. If the output voltage becomes down to typically 0.5V or less, the switching stops to protect the IC. However, large current flows between Vin and GND via an external component.

(2) LDO
Typically 1.6ms from starting the soft-start operation of the DC/DC converter, LDO starts up its operation. When the LDO starts up, to suppress the inrush current, LDO operation will start with soft-start and typically 0.2ms, reaches the set output voltage.
Until the output voltage reaches to set output voltage, the maximum current limits around the short current limit. Depending on the load condition and the capacity of the capacitor, C2, the start-up time will be long.

(Over current protection operation)
The LDO has an over-current limit circuit, and if the DCDC converter limits the over current typically 0.2ms or longer than 0.2ms, then LDO will be into standby mode.
After that, when the DC/DC converter becomes VFM mode, or normal PWM mode again, then restart with soft-start operation.
If DC/DC converter becomes low-boost mode, or short protect condition, then 1.6ms from the soft-start of DC/DC converter, LDO also restarts with soft-start operation.

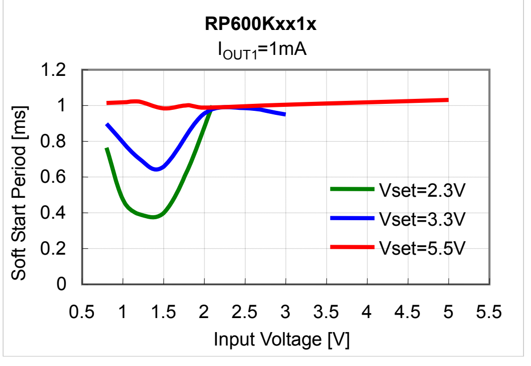
TIMING CHART (B version)



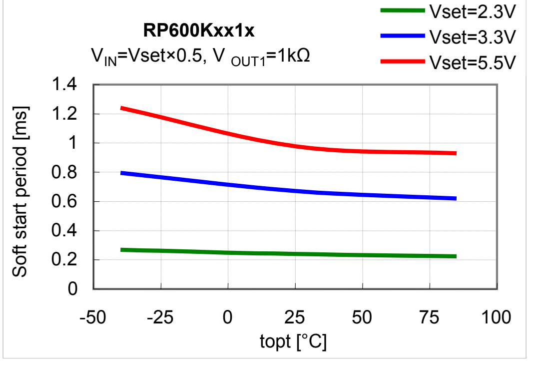
(1) DC/DC Converter
(Start-up) When the CE signal changes from "L" to "H", the DC/DC converter starts up.
The DC/DC converter of the RP600K can start up with the low input voltage such as 0.8V. To realize this, the RP600 has a low-boost mode. Until the output voltage 1 reaches 1.94V (Typ.), the operation mode is low-boost mode. When the output voltage becomes equal or more than 1.94V, then to suppress the inrush current, soft-start operation starts until the output voltage 1 becomes set output voltage.
*At the low-boost mode, the oscillator frequency becomes low, 200kHz (Typ.) Therefore, compared with the normal operation mode at 1.2MHz, the boost ability will worse.

Soft-start time depends on the set output voltage, the input voltage, the ambient temperature, and the load current.

Soft start period vs. Input Voltage



Soft start period vs. Temperature



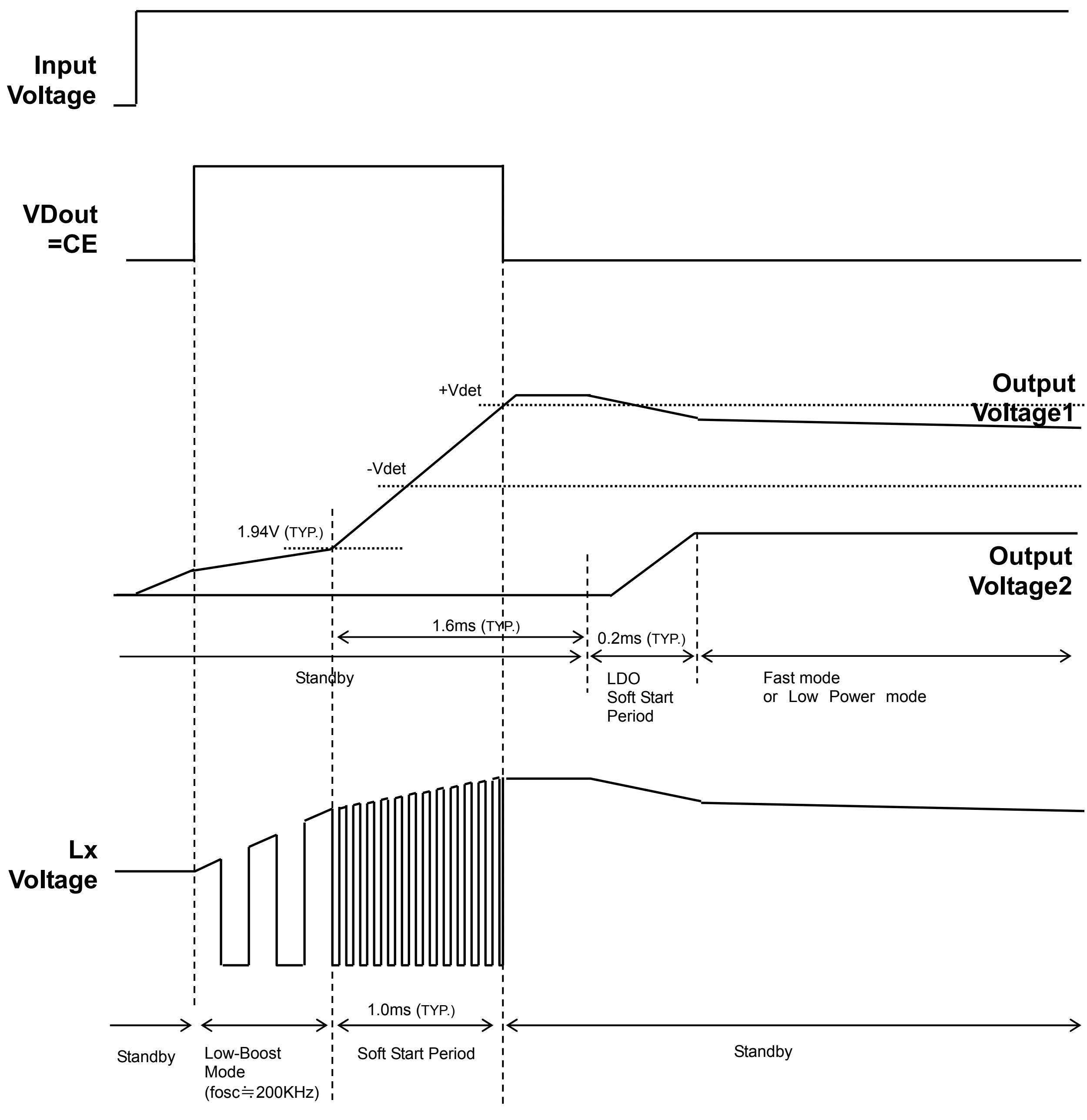
(Over-current protection operation)
If the Lx peak current may reach 1.4A (typ.), Lx peak current limit circuit may operate and control the duty ratio. If the output voltage1 becomes down to typically 0.5V or less, the switching stops to protect the IC. However, large current flows between Vin and GND via an external component.

(2) LDO
When the CE2 signal changes from "L" to "H", LDO starts up.
When the LDO starts up, to suppress the inrush current, LDO operation will start with soft-start and typically 0.2ms, reaches the set output voltage.
Until the output voltage reaches to set output voltage, the maximum current limits around the short current limit. Depending on the load condition and the capacity of the capacitor, C2, the start-up time will be long.

(Over current protection operation)
The LDO has an over-current limit circuit, and if the DCDC converter limits the over current typically 0.2ms or longer than 0.2ms, then LDO will be into standby mode.
After that, when the DC/DC converter becomes VFM mode, or normal PWM mode again, then restart with soft-start operation.
If DC/DC converter becomes low-boost mode, or short protect condition, then 1.6ms from the soft-start of DC/DC converter, LDO also restarts with soft-start operation.

TIMING CHART (C version)

Start-up Operation



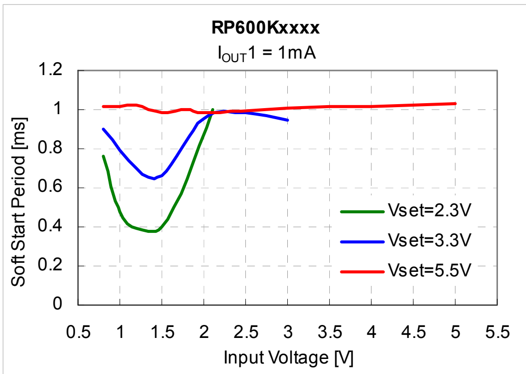
(1) DC/DC Converter and VD

(Start-up) The V_{SENSE} pin is connected to the DC/DC output (V_{OUT1}), and the VD output (V_{DOUT}) is connected to the CE pin.

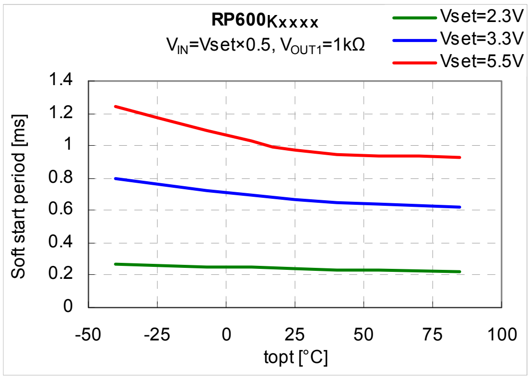
The V_{OUT1} pin voltage starts up from less than the VD detector threshold ($-V_{DET}$), therefore the V_{DOUT} outputs “H” signal and DC/DC converter becomes active mode. The DC/DC converter of the RP600 can start up with the low input voltage such as 0.8V. To realize this, the RP600 has a low-boost mode. Until the output voltage 1 reaches 1.94V (Typ.), the operation mode is low-boost mode. When the output voltage becomes equal or more than 1.94V, then to suppress the inrush current, soft-start operation starts until the output voltage 1 becomes set output voltage.

*At the low-boost mode, the oscillator frequency becomes low, 200kHz (Typ.) Therefore, compared with the normal operation mode at 1.2MHz, the boost ability will worse.
*Soft-start time depends on the set output voltage, the input voltage, the ambient temperature, and the load current.

Soft start period vs. Input Voltage



Soft start period vs. Temperature



The output voltage 1 continually rises until it reaches to the set output voltage. When it reaches to the VD released voltage* ($+V_{DET}$), V_{DOUT} outputs “L” signal and DC/DC converter becomes standby mode.

*Set $+V_{DET} < V_{OUT1}$

(2) LDO

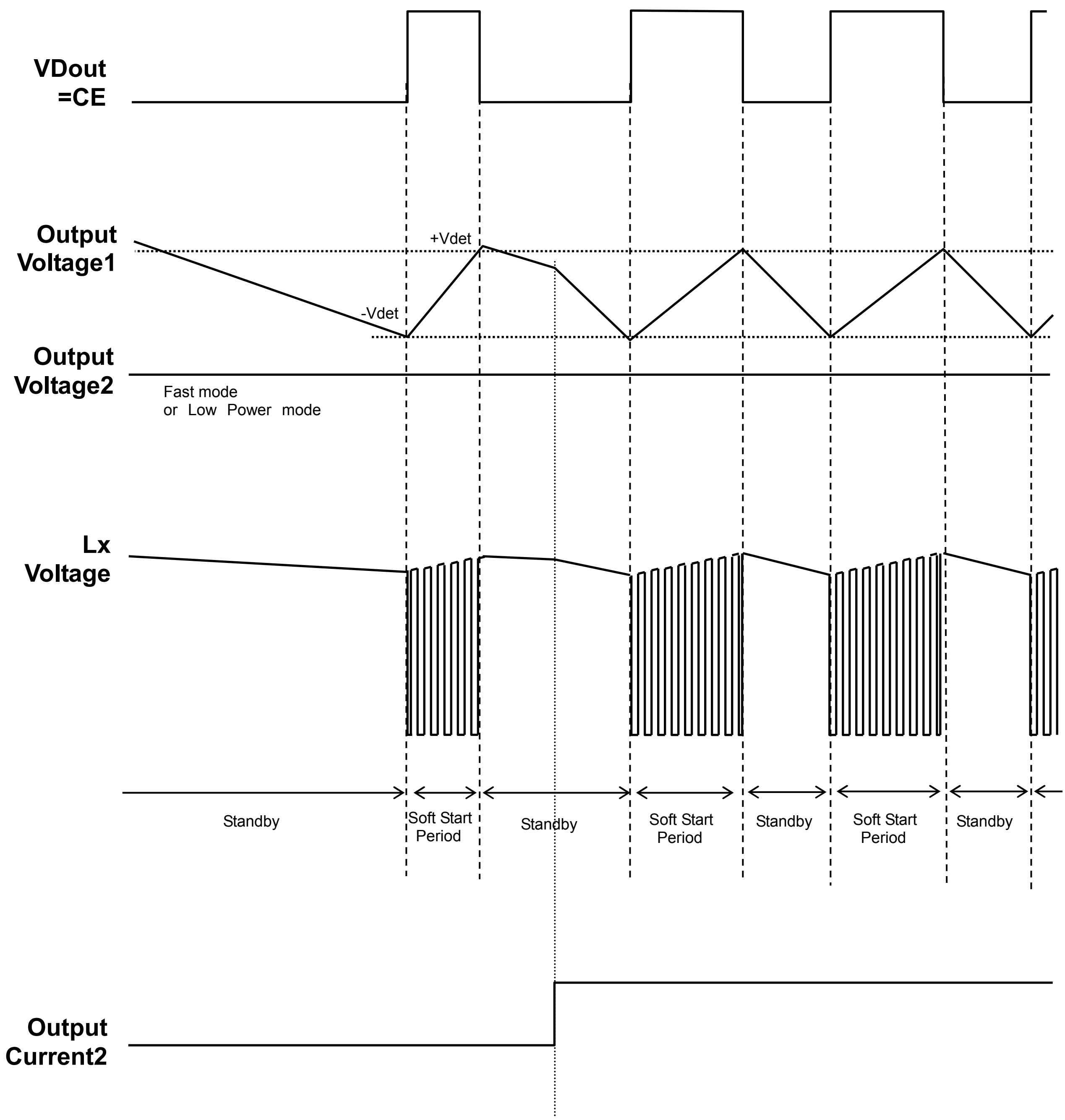
LDO is always in active mode, however, only at the start-up, LDO starts its operation after 1.6ms (TYP) counting from the beginning of soft-start operation of the DC/DC converter.

When the LDO starts up, to suppress the inrush current, LDO operation will start with soft-start and typically 0.2ms, reaches the set output voltage.

Until the output voltage reaches to set output voltage, the maximum current limits around the short current limit. Depending on the load condition and the capacity of the capacitor, C2, the start-up time will be long.

TIMING CHART (C version)

After Start-up Operation

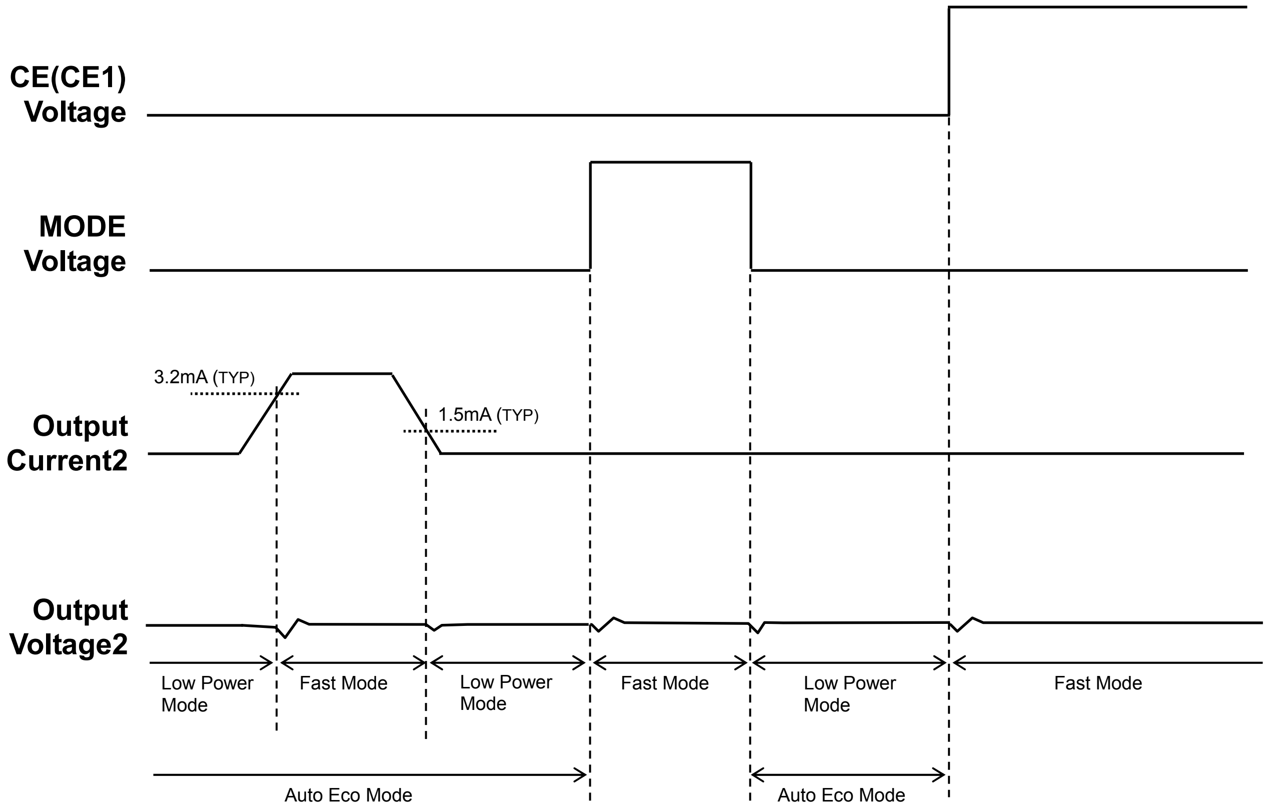


(After Start-up) V_{OUT1} is controlled by the signals sent by V_{DOUT}. When the V_{OUT1} becomes less than V_{DET} ($-V_{DET}$), the V_{DOUT} outputs "H" signal and the DC/DC converter becomes active mode. When the V_{OUT1} becomes more than V_{DET} ($+V_{DET}$), the DC/DC converter outputs "L" signal and the DC/DC converter becomes standby mode. LDO is using V_{OUT1} as a power-supply voltage, therefore it can maintain a desired V_{OUT2}*. If the LDO load is increased, this switching operation interval will be shorter.

*Set $-V_{DET} > V_{OUT2}$

TIMING CHART (B/C version)

LDO mode shift operation



*In the case of CE(1) pin "L" and Mode pin "L"
LDO operates at auto ECO mode, by the load current, the low power mode and the fast mode switch over automatically.
The switchover point is internally fixed.

From the low power mode to the fast mode: switchover current 3.2mA (typ.)
From the fast mode to low power mode: switchover current 1.5mA(typ.)

*In the case of CE(1) pin "L" and Mode pin "H"
LDO always operates at the fast mode regardless of the load current.

*In the case of CE(1) pin "H",
LDO always operates at the fast mode regardless of the condition of MODE pin.

Power Dissipation (DFN(PLP)2527-10)

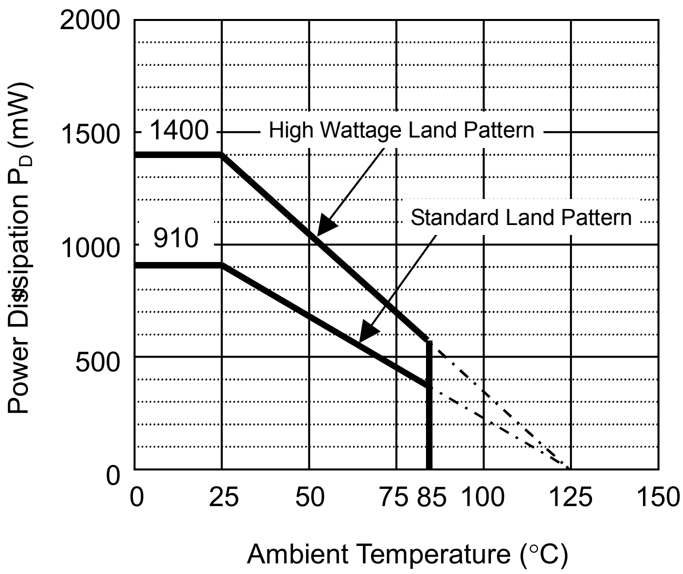
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

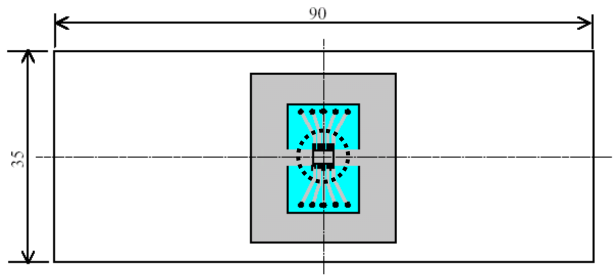
	High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (4-Layers)	Glass cloth epoxy plastic (Double sided)
Board Dimensions	35mm * 90mm * 0.8mm	40mm*40mm*1.6mm
Copper Ratio	Each layers: Approx. 15%	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	φ 0.30mm * 9pcs φ 0.50mm * 10pcs	φ 0.54mm * 30pcs

Measurement Result: (Ta=25°C, Tjmax=125°C)

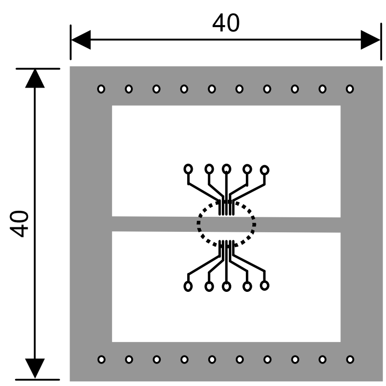
	High Wattage Land Pattern	Standard Land Pattern
Power Dissipation	1400mW (Tjmax=125°C)	910mW(Tjmax=125°C)
Thermal Resistance	θja = (125-25°C)/1.4W = 71°C/W	θja = (125-25°C)/0.91W = 110°C/W



Power Dissipation



High Wattage



Standard

Measurement Board Pattern

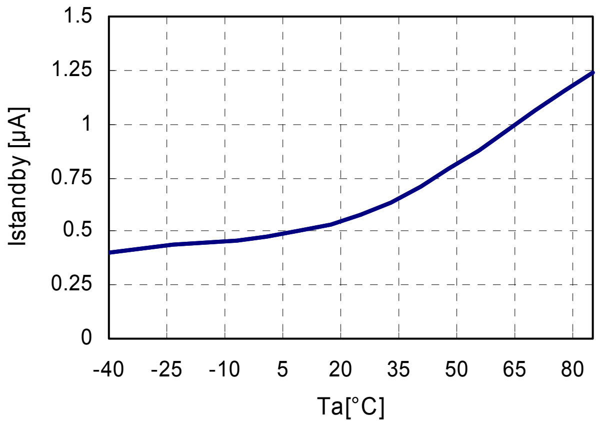
IC Mount Area (Unit : mm)

TYPICAL CHARACTERISTICS

1) Standby Current vs. Temperature

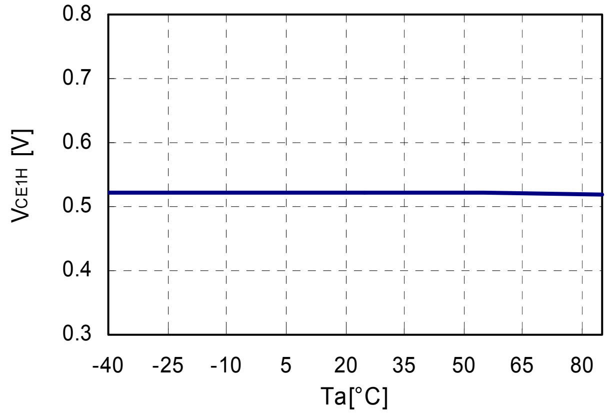
RP600KxxxA/B/D

V_{IN}=V_{OUT1}=5.5V, CE(CE1&CE2)=0V



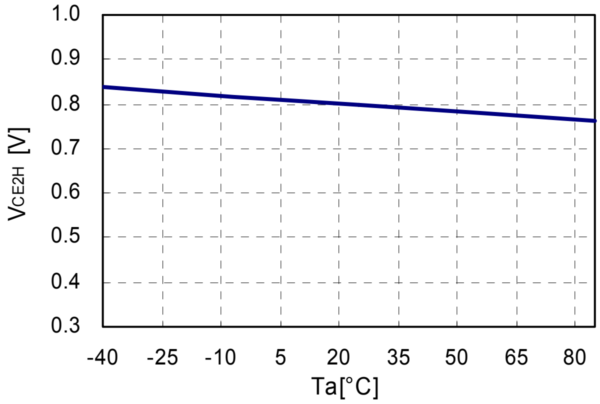
2) CE (or CE1) Input "H" Voltage vs. Temperature

RP600Kxxxx



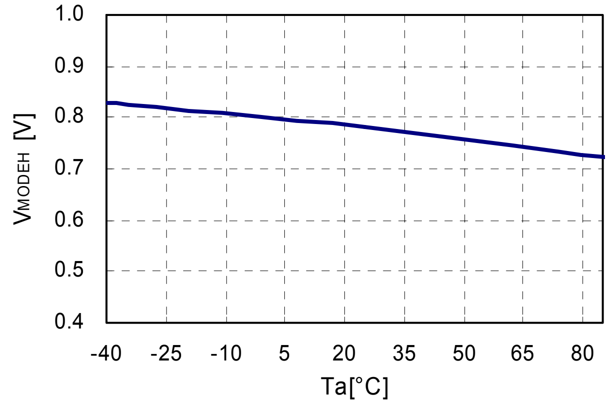
3) CE2 Input "H" Voltage vs. Temperature

RP600K0xxB



4) MODE Input "H" Voltage vs. Temperature

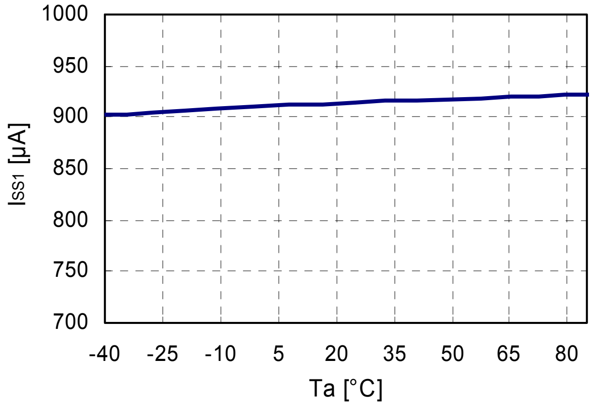
RP600Kxxxx



5) Quiescent Current 1 vs. Temperature

RP600Kxxxx

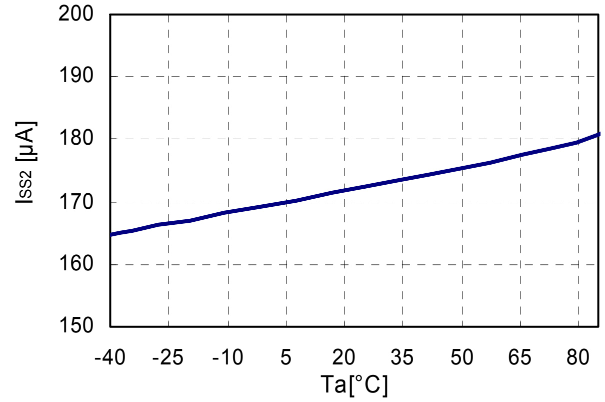
DC/DC=3.3V, CE(CE1)=(CE2)=5.5V, MODE="H"



6) Quiescent Current 2 vs. Temperature

RP600Kxxxx

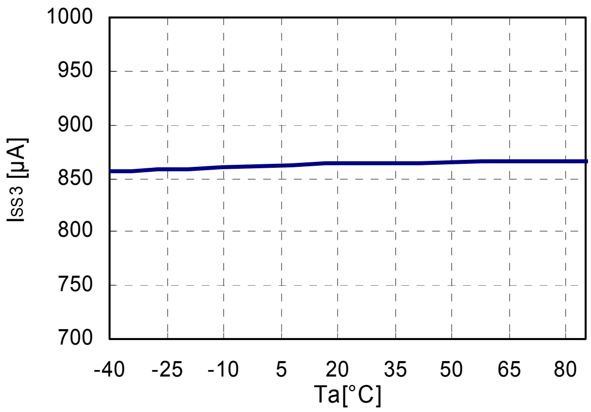
DC/DC=3.3V, CE(CE1)=(CE2)=5.5V, MODE="L"



7) Quiescent Current 3 vs. Temperature

RP600K0xxB

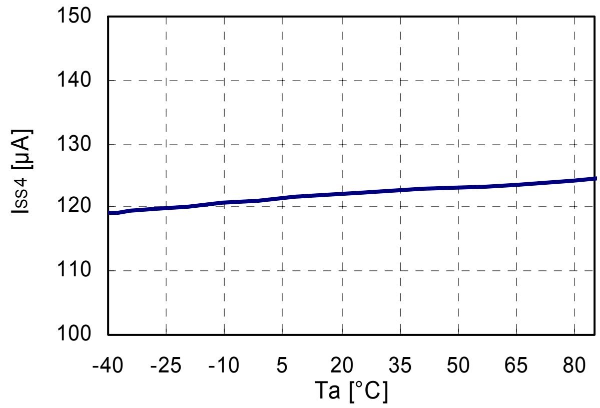
DC/DC=3.3V, CE1=5.5V, CE2=0V



8) Quiescent Current 4 vs. Temperature

RP600K0xxB

DC/DC=3.3V, MODE=0V, CE1=5.5V, CE2=0V

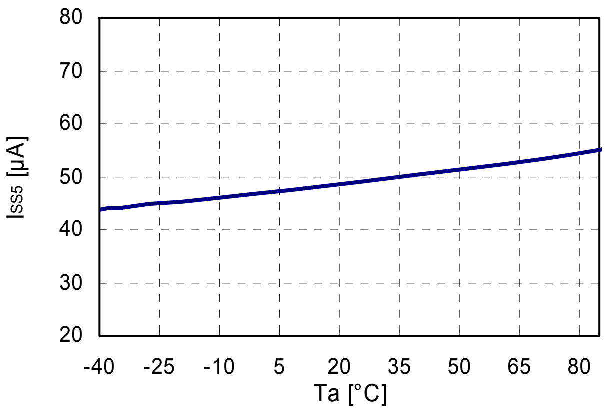


9) Quiescent Current 5 vs. Temperature

RP600K0xxB

LDO=3.3V, MODE="H",

CE1=0V, I_{OUT2}=0mA,CE2=5.5V

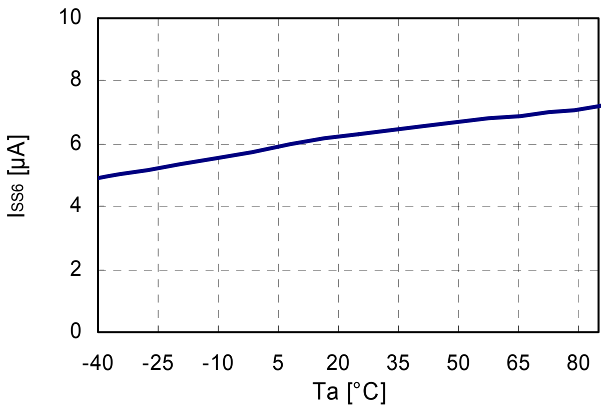


10) Quiescent Current 6 vs. Temperature

RP600K0xxB

LDO=3.3V, MODE="L",

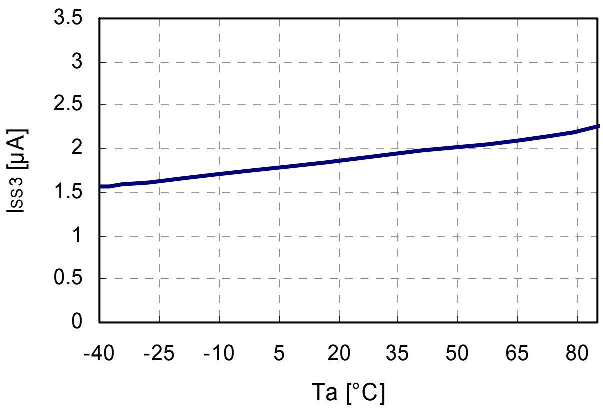
CE1=0V, CE2=5.5V, I_{OUT2}=0mA



11) Quiescent Current 3 vs. Temperature

RP600K2xxC

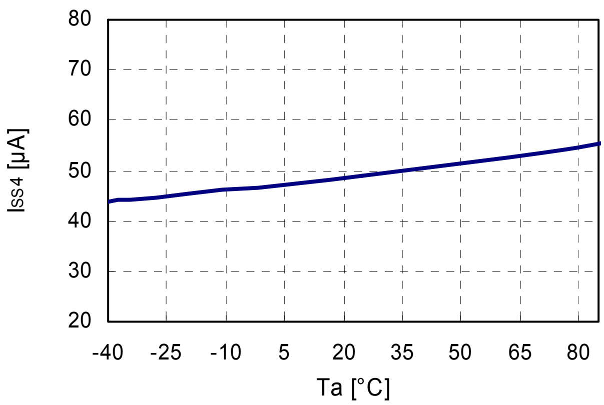
LDO=3.3V, MODE="L", CE=0V, I_{OUT2}=0mA



12) Quiescent Current 4 vs. Temperature

RP600K2xxC

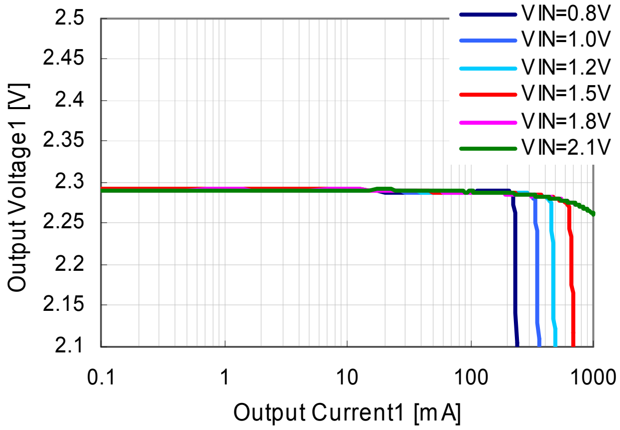
LDO=3.3V, MODE="H", CE=0V, I_{OUT2}=0mA



13) Output Voltage 1 vs. Output Current 1

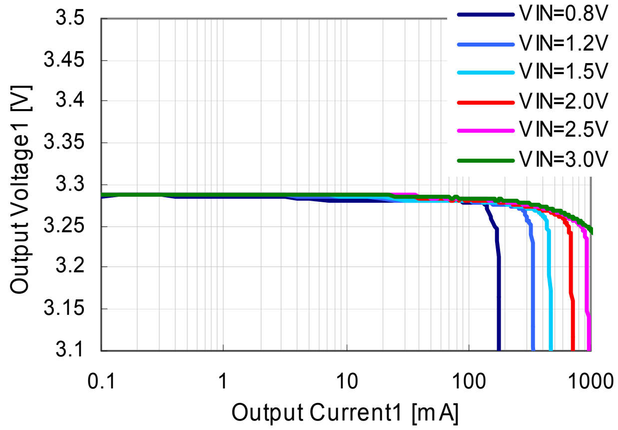
RP600Kxxxx

DC/DC=2.3V, MODE=H/L, Ta=25°C, I_{OUT2}=0mA



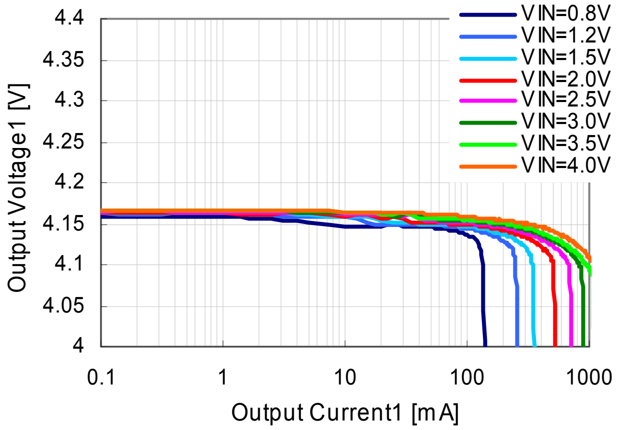
RP600Kxxxx

DC/DC=3.3V, MODE=H/L, Ta=25°C, I_{OUT2}=0mA



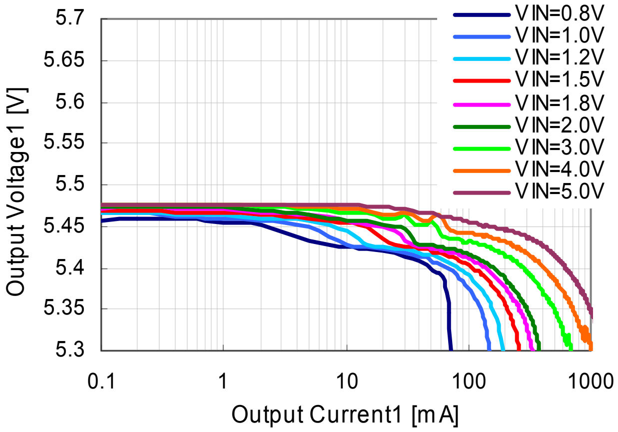
RP600Kxxxx

DC/DC=4.2V, MODE=H/L, Ta=25°C, I_{OUT2}=0mA



RP600Kxxxx

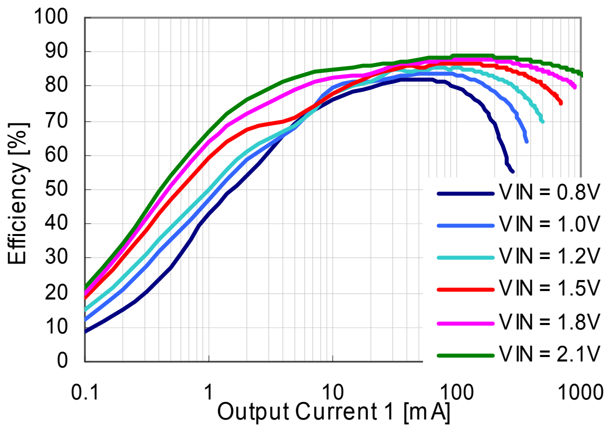
DC/DC=5.5V, MODE=H/L, Ta=25°C, I_{OUT2}=0mA



14) Efficiency vs. Output Current 1

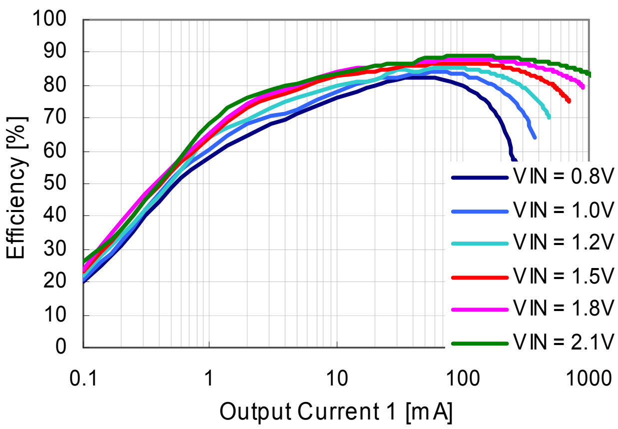
RP600Kxxxx

DC/DC=2.3V, MODE="H", Ta=25°C, I_{OUT2}=0mA

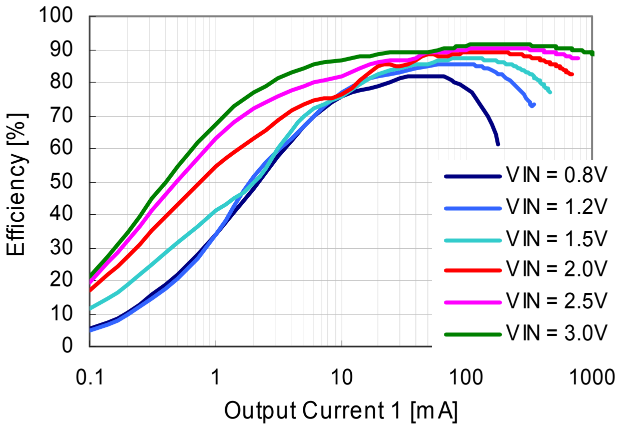


RP600Kxxxx

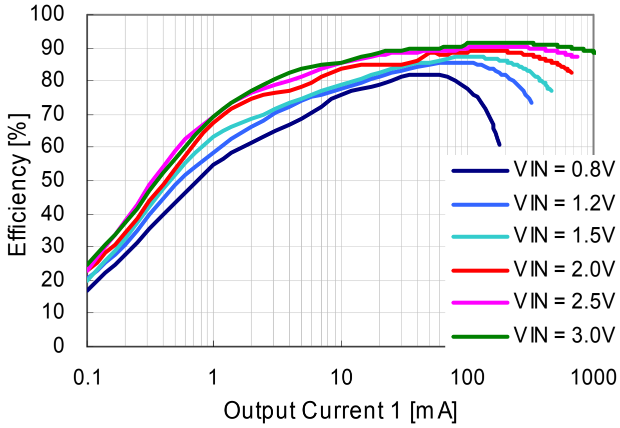
DC/DC=2.3V, MODE="L", Ta=25°C, I_{OUT2}=0mA



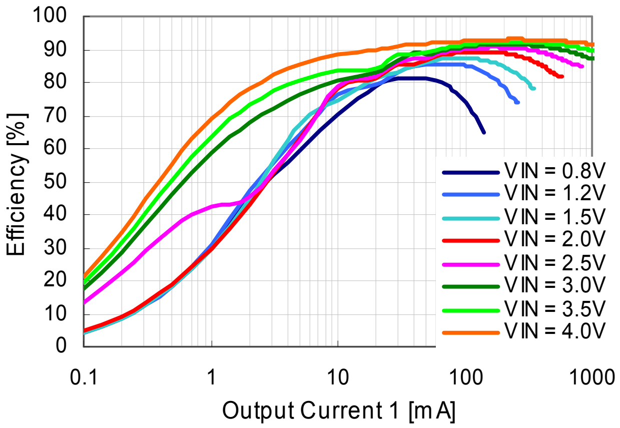
RP600Kxxxx
DC/DC=3.3V, MODE="H", Ta=25°C, I_{OUT2}=0mA



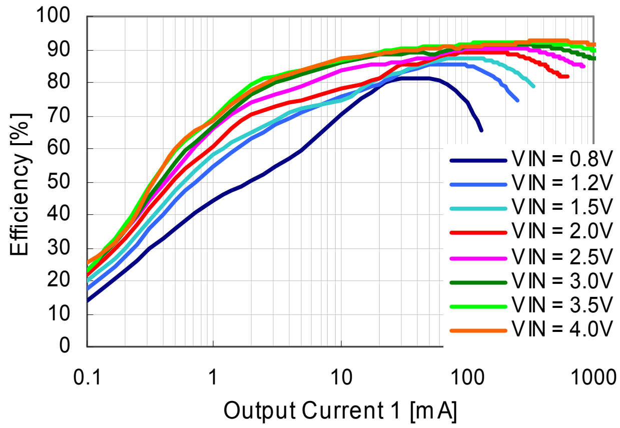
RP600Kxxxx
DC/DC=3.3V, MODE="L", Ta=25°C, I_{OUT2}=0mA



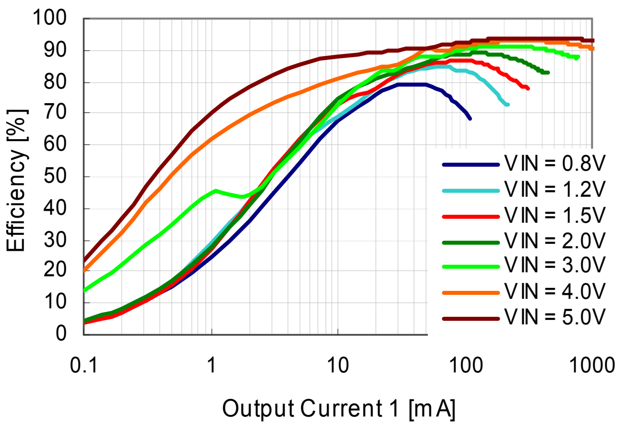
RP600Kxxxx
DC/DC=4.2V, MODE="H", Ta=25°C, I_{OUT2}=0mA



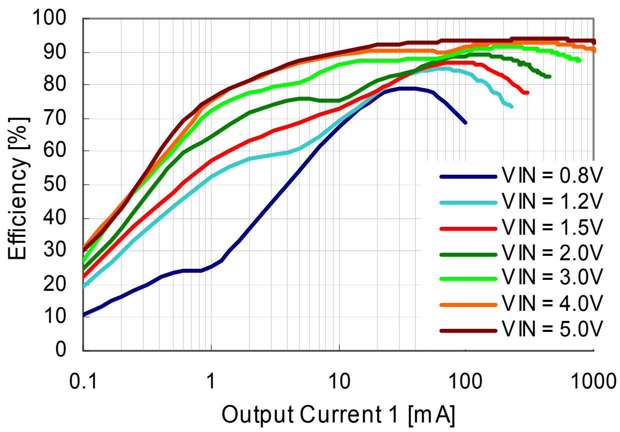
RP600Kxxxx
DC/DC=4.2V, MODE="L", Ta=25°C, I_{OUT2}=0mA



RP600Kxxxx
DC/DC=5.5, MODE="H", Ta=25°C, I_{OUT2}=0mA



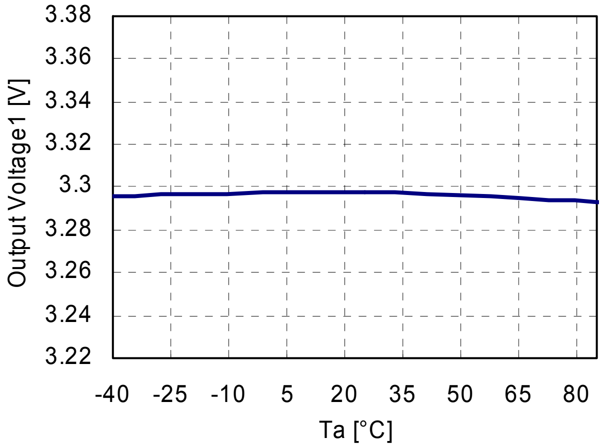
RP600Kxxxx
DC/DC=5.5V, MODE="L", Ta=25°C, I_{OUT2}=0mA



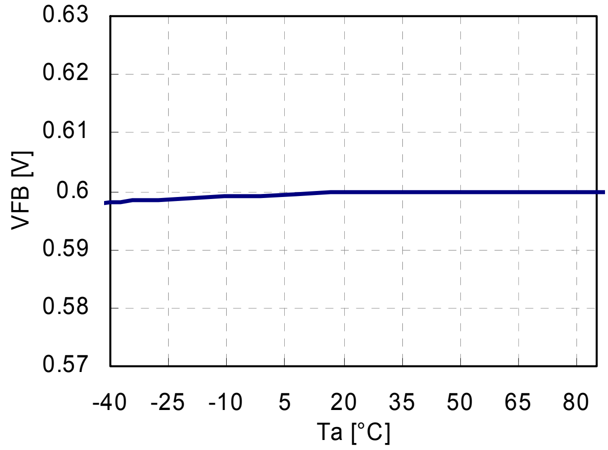
15) Output Voltage 1 (or VFB) vs. Temperature

RP600KxxxA/B/C

DC/DC=3.3V

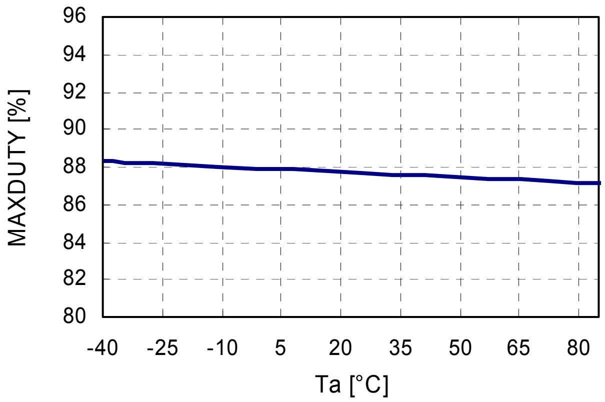


RP600K1xxD



16) Maximum Duty Cycle vs. Temperature

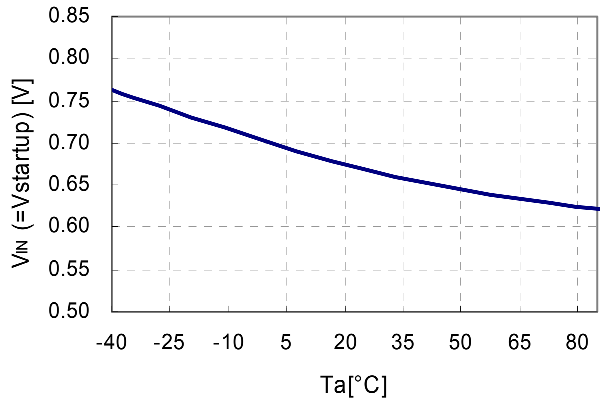
RP600Kxxxx



17) Start-up Voltage vs. Temperature

RP600Kxxxx

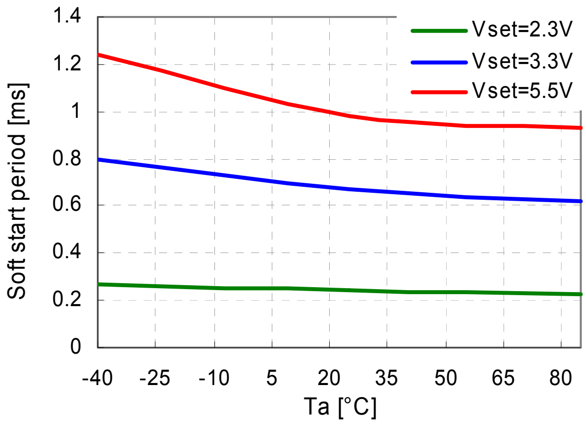
DC/DC=5.5V, I_{OUT1}=-1mA, CE(CE1)=V_{OUT1}



18) DC/DC Soft start time vs. Temperature

RP600Kxxxx

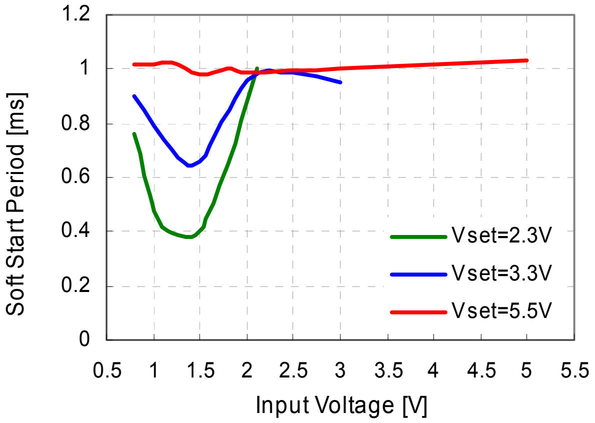
V_{IN}=Vset×0.5, V_{OUT}=1kΩ, I_{OUT2}=0mA



19) DC/DC Soft start time vs. Input Voltage

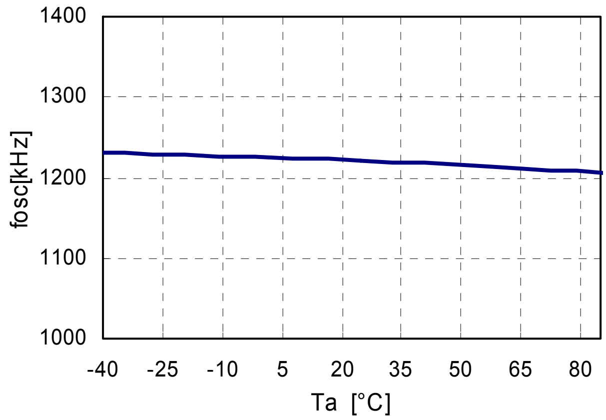
RP600Kxxxx

I_{OUT1}=−1mA, I_{OUT2}=0mA



20) Switching Frequency vs. Temperature

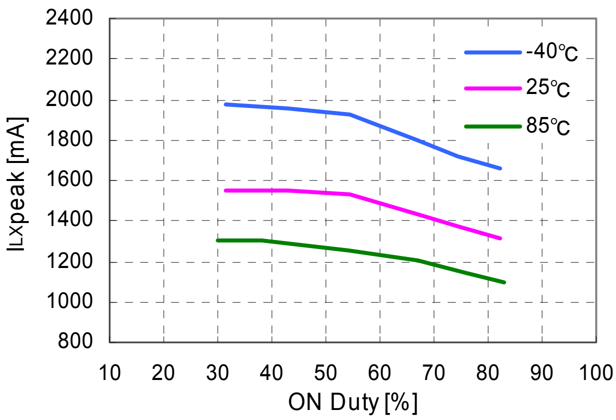
RP600Kxxxx



21) Lx Current Limit vs. ON Duty

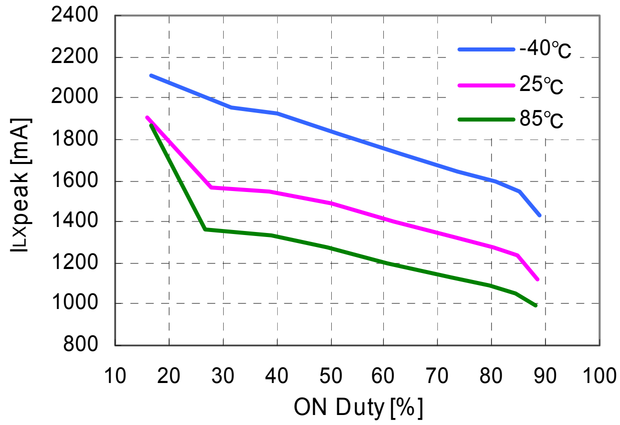
RP600Kxxxx

DC/DC=2.3V



RP600Kxxxx

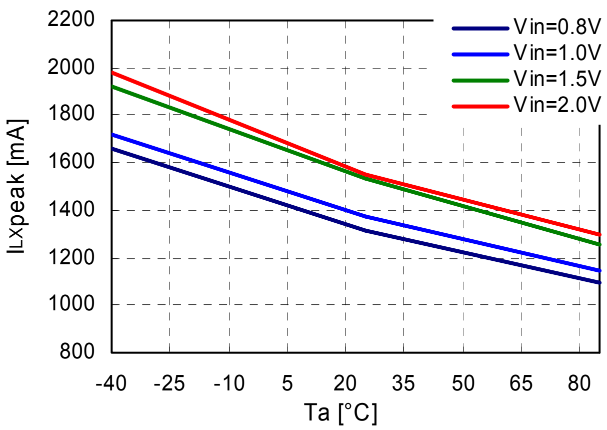
DC/DC=4.2V



22) Lx Current Limit vs. Temperature

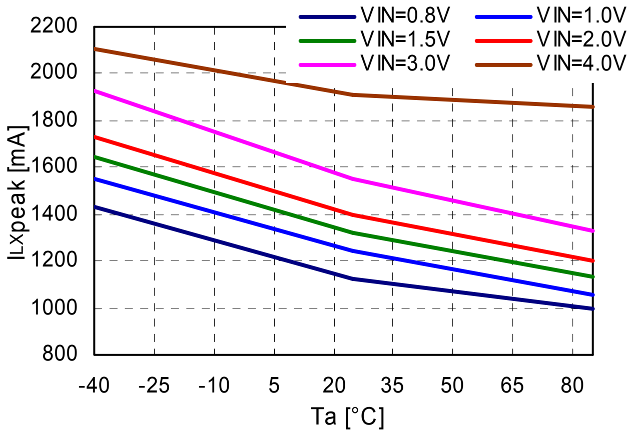
RP600Kxxxx

DC/DC=2.3V



RP600Kxxxx

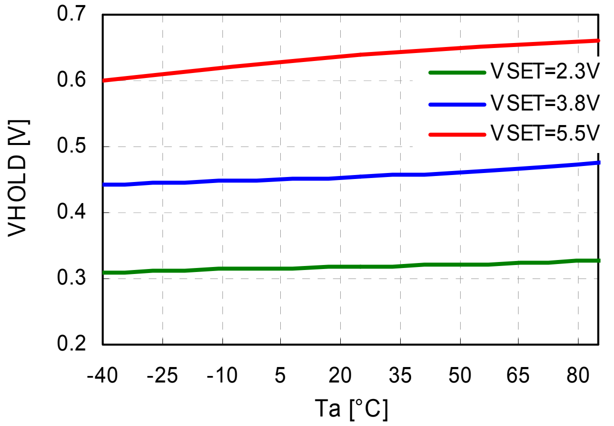
DC/DC=4.2V



23) Hold-on Voltage vs. Temperature

RP600Kxxxx

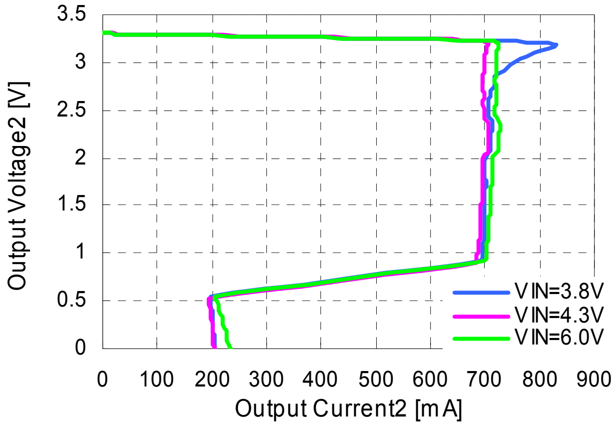
I_{OUT1}=−1mA, I_{OUT2}=0mA



24) Output Voltage vs. Output Current 2

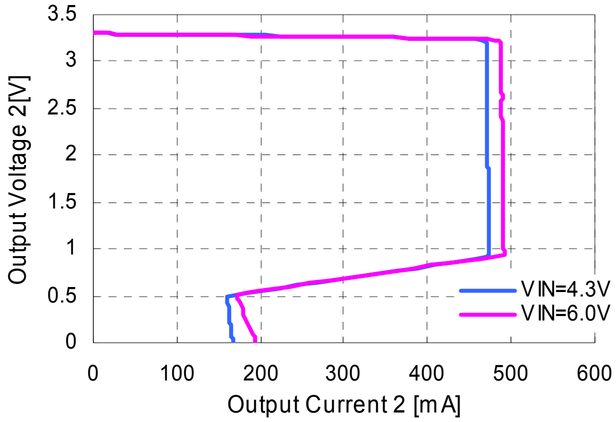
RP600KxxxA/D

LDO=3.3V, Ta=25°C



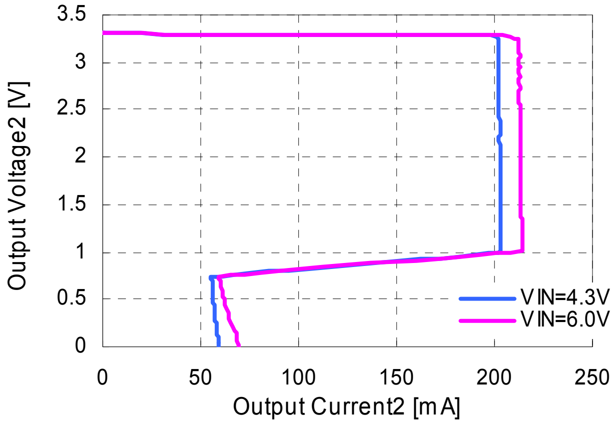
RP600K0xxB

LDO=3.3V, Ta=25°C



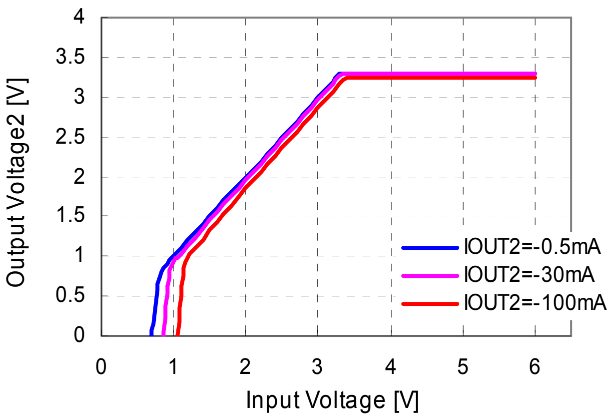
RP600K2xxC

LDO=3.3V, Ta=25°C

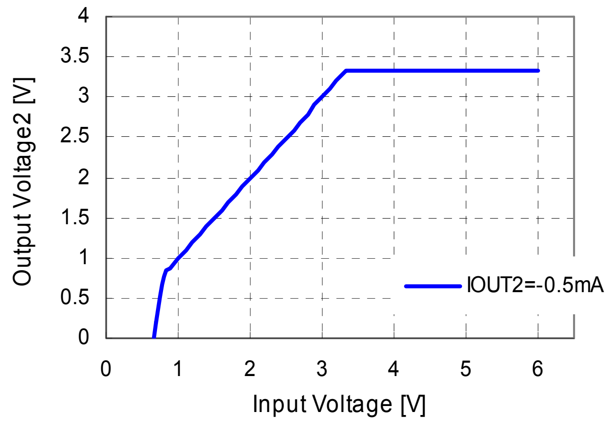


25) Output Voltage 2 vs. Input Voltage

RP600Kxxxx
LDO=3.3V, MODE="H", Ta=25°C

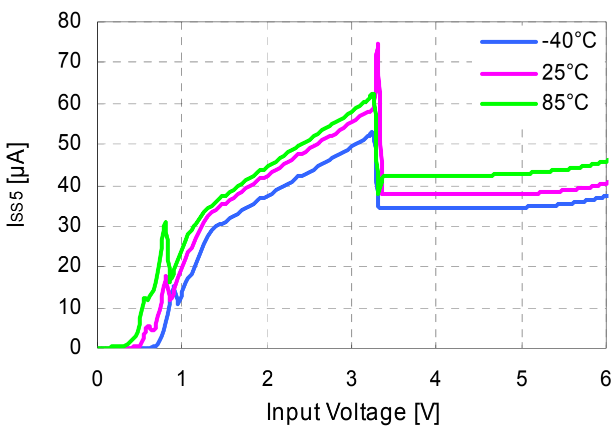


RP600KxxxB/C
LDO=3.3V, MODE="L", Ta=25°C



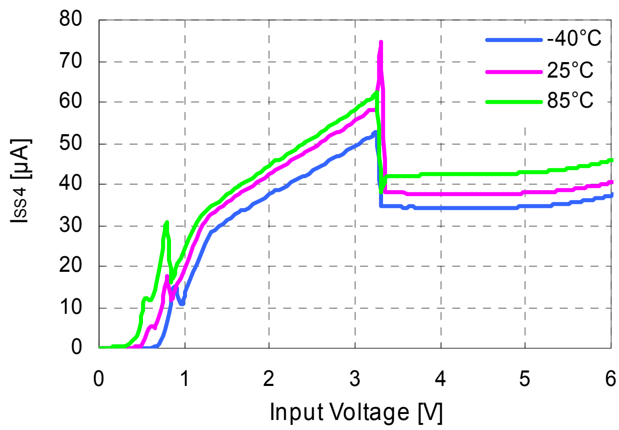
26) Quiescent Current 5 vs. Input Voltage

RP600K0xxB
LDO=3.3V, MODE="H", CE1=L, I_{OUT2}=0mA



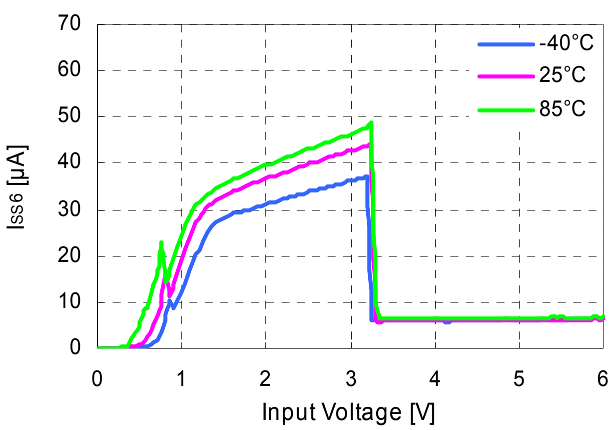
27) Quiescent Current 4 vs. Input Voltage

RP600K2xxC
LDO=3.3V, MODE="H", CE=L, I_{OUT2}=0mA



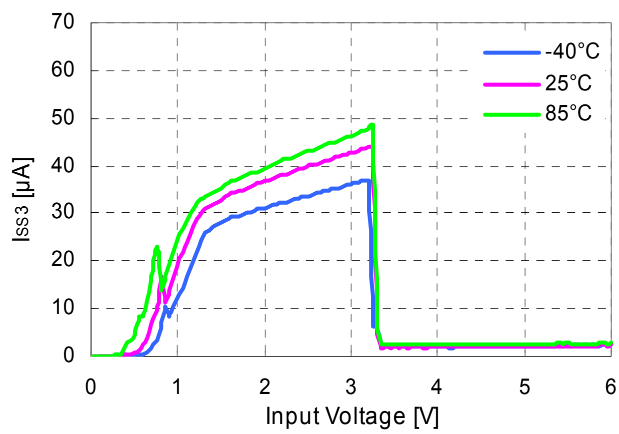
28) Quiescent Current 6 vs. Input Voltage

RP600K0xxB
LDO=3.3V, MODE="L", CE1=L, I_{OUT2}=0mA



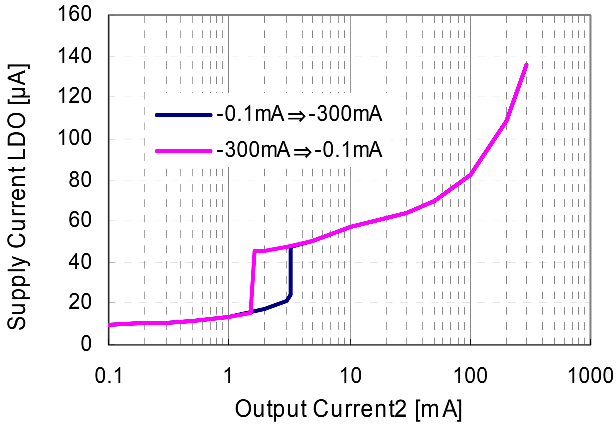
29) Quiescent 3 vs. Input Voltage

RP600K2xxC
LDO=3.3V, MODE="L", CE=L, I_{OUT2}=0mA

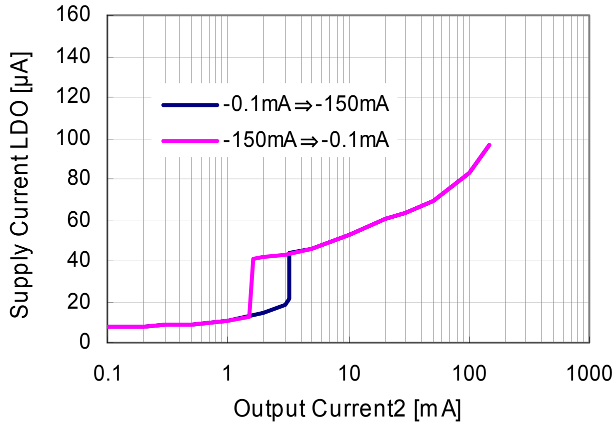


30) Supply Current LDO vs. Output Current

RP600K0xxB
LDO=3.3V, MODE=“L”, CE1=L, Ta=25°C

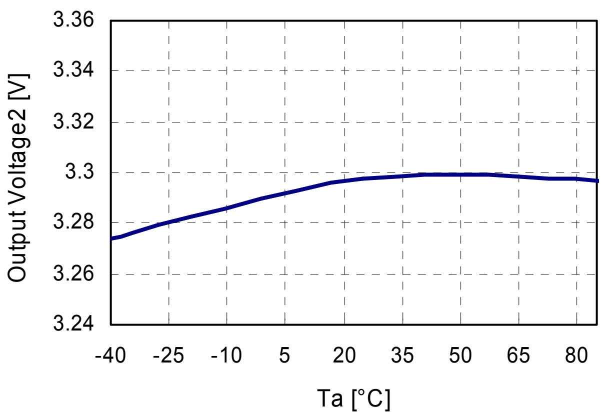


RP600K2xxC
LDO=3.3V, MODE=“L”, CE=L, Ta=25°C

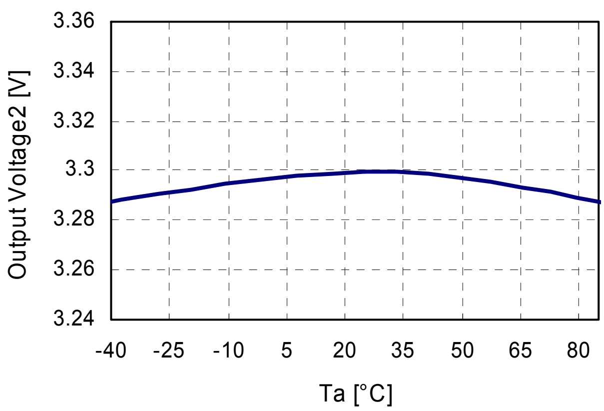


31) Output Voltage 2 vs. Temperature

RP600Kxxxx
LDO=3.3V, MODE=“H”, I_{OUT2}=-1mA

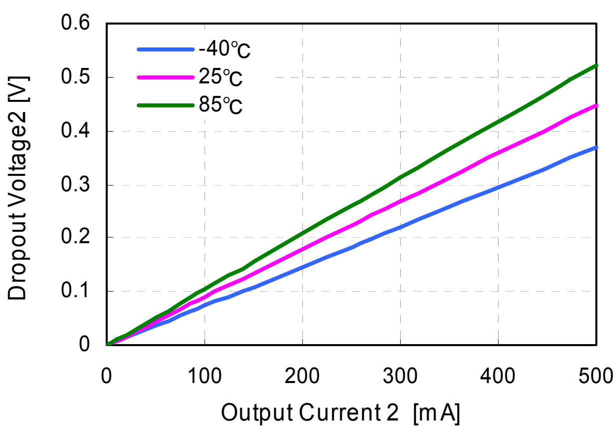


RP600Kxxxx
LDO=3.3V, MODE=“L”, I_{OUT2}=-0.5mA

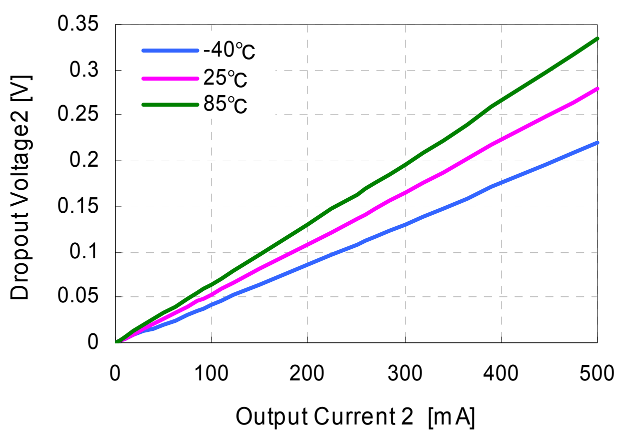


32) Dropout Voltage 2 vs. Output Current 2

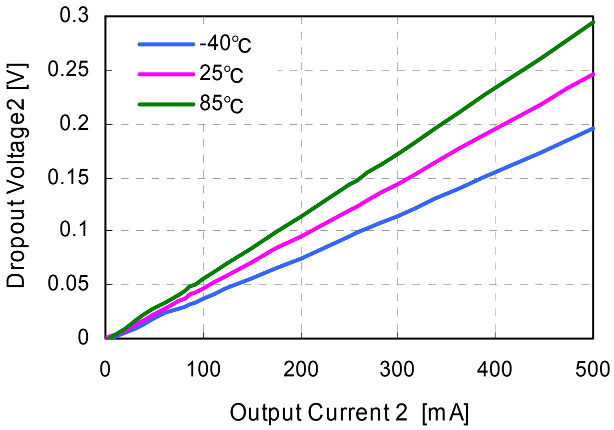
RP600KxxxA/D
LDO=1.5V



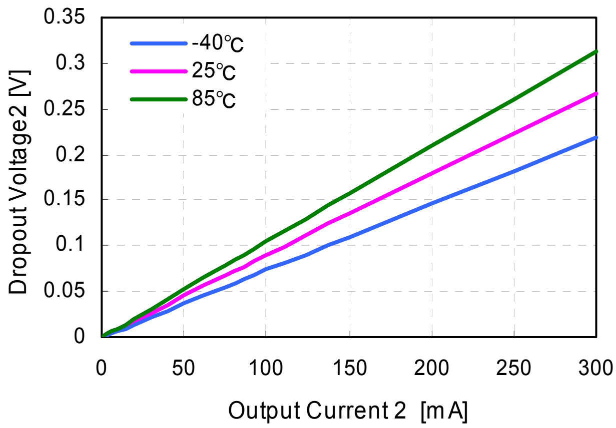
RP600KxxxA/D
LDO=3.3V



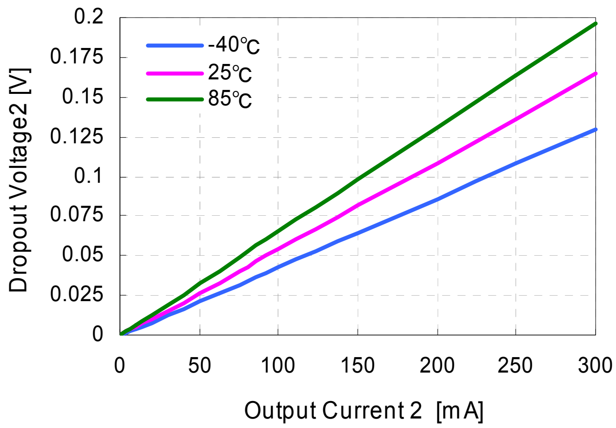
RP600KxxxA/D
LDO=5.0V



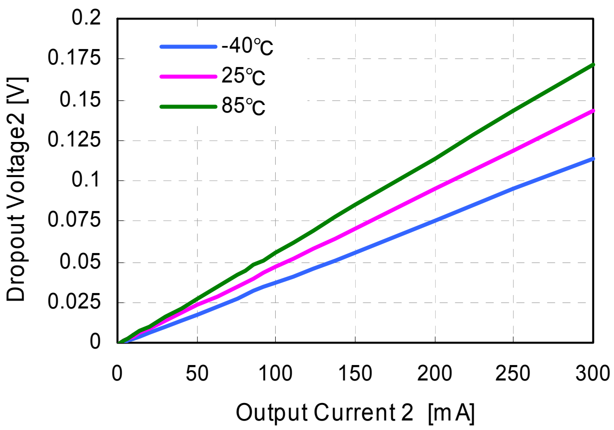
RP600K0xxB
LDO=1.5V



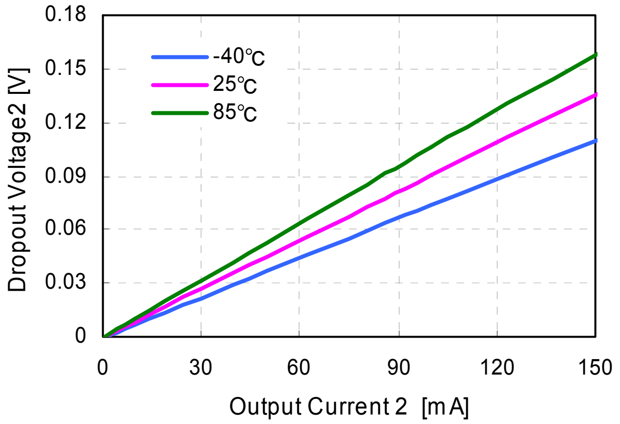
RP600K0xxB
LDO=3.3V



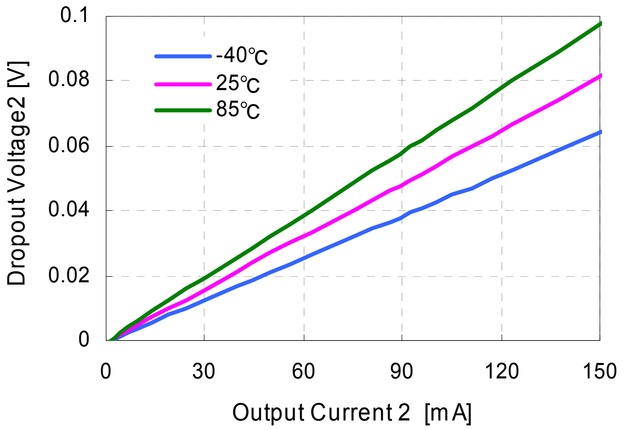
RP600K0xxB
LDO=5.0V



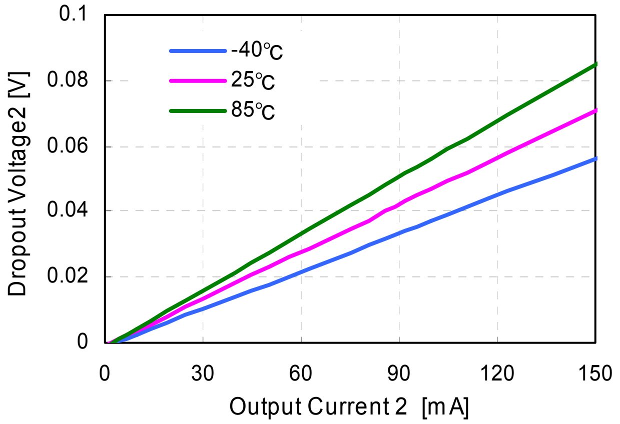
RP600K2xxC
LDO=1.5V



RP600K2xxC
LDO=3.3V

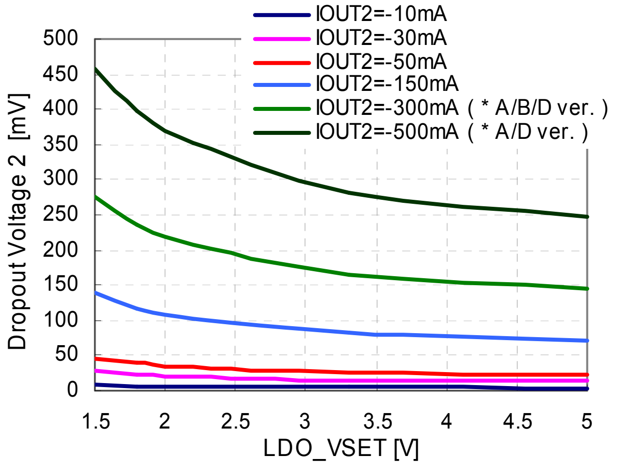


RP600K2xxC
LDO=5.0V



33) Dropout Voltage 2 vs. LDO_Vset

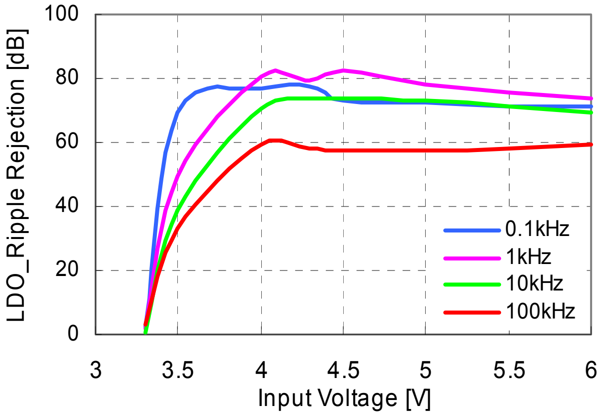
RP600Kxxxx, Ta=25°C



34) LDO Ripple Rejection vs. Input Voltage

RP600Kxxxxx

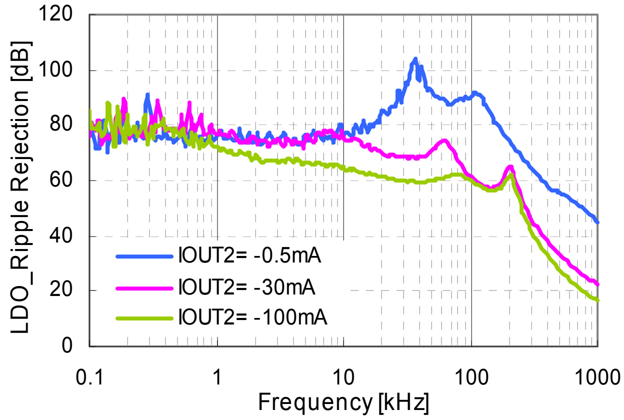
LDO=3.3V, MODE="H", Ta=25°C, I_{OUT2}=-30mA



35) LDO Ripple Rejection vs. Frequency

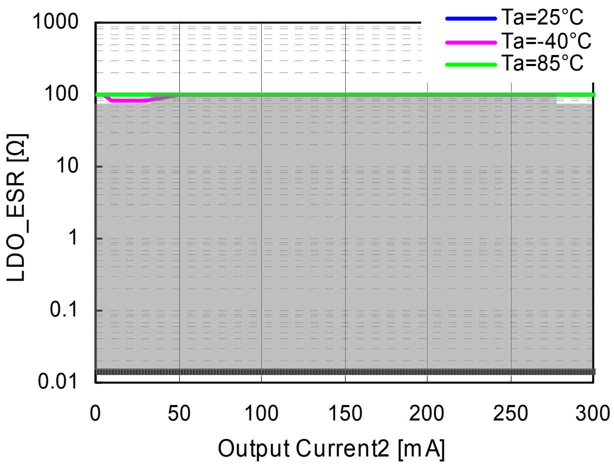
RP600Kxxxxx

LDO=3.3V, MODE="H", Ta=25°C, V_{IN}=4.3V+0.2Vp-p



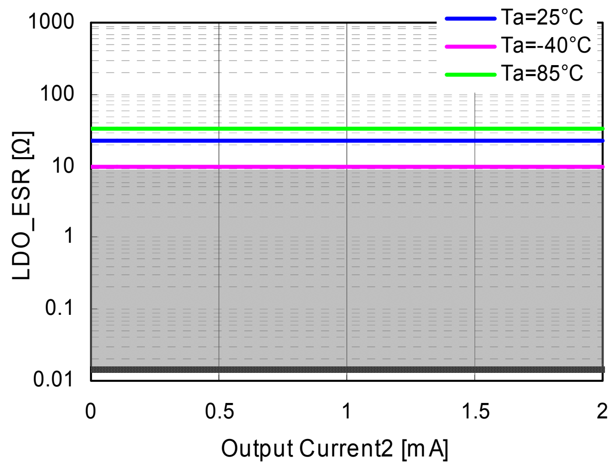
36) LDO ESR vs. Output Current 2

RP600Kxxxxx (MODE="H")



37) LDO ESR vs. Output Current 2

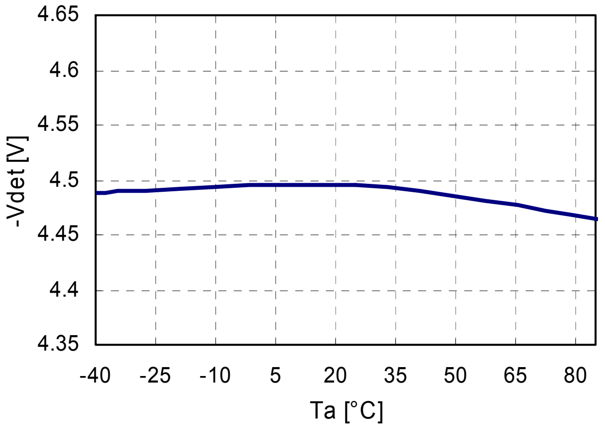
RP600Kxxxxx (MODE="L")



38) Detector Threshold Range vs. Temperature

RP600Kxxxxx

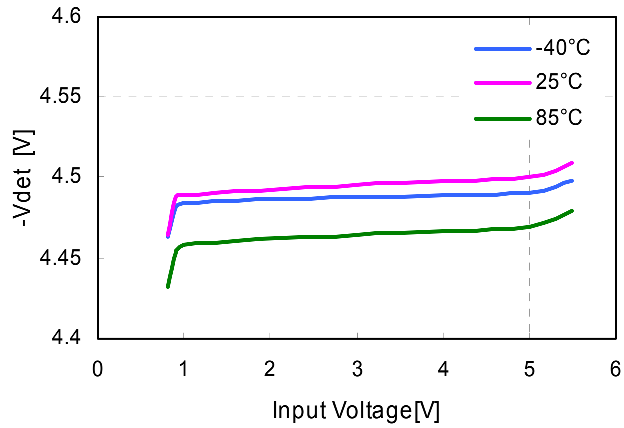
-Vdet=4.5V



39) Detector Threshold Range vs. Input Voltage

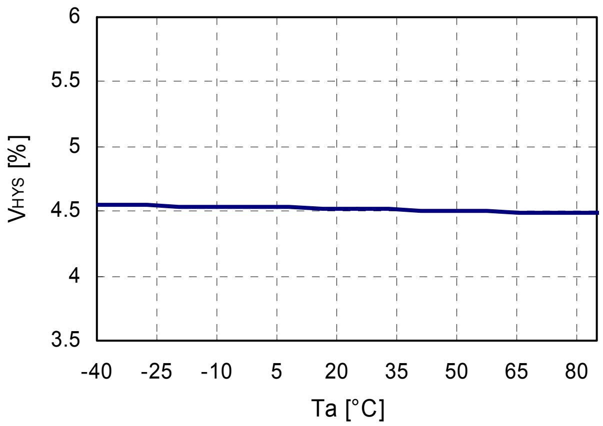
RP600Kxxxxx

-Vdet=4.5V

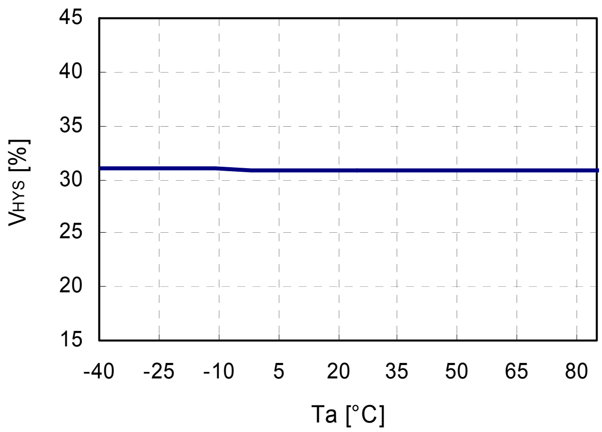


40) Detector Threshold Hysteresis vs. Temperature

RP600KxxxA/B/D
V_{IN}=3.0V

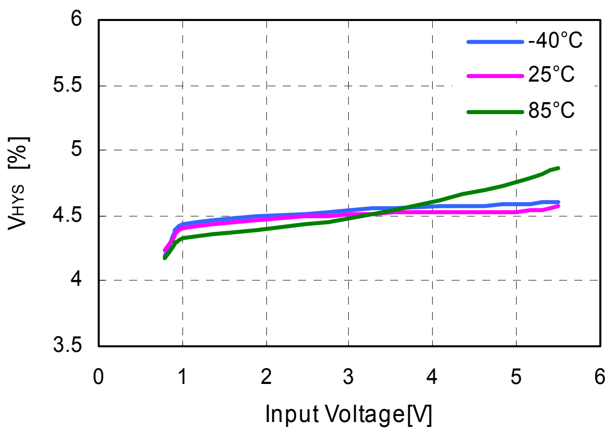


RP600K2xxC
V_{IN}=3.0V, HYS=30%

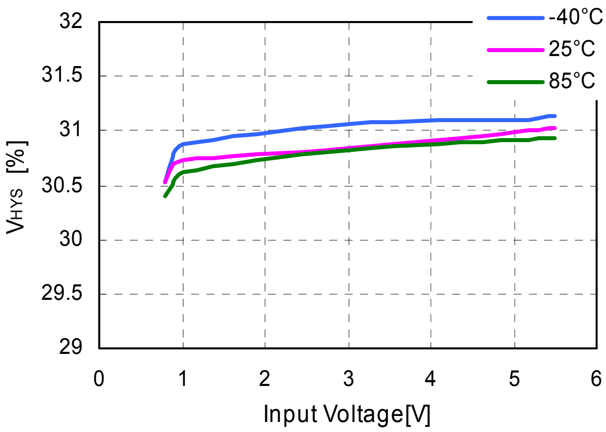


41) Detector Threshold Hysteresis vs. Input Voltage

RP600KxxxA/B/D

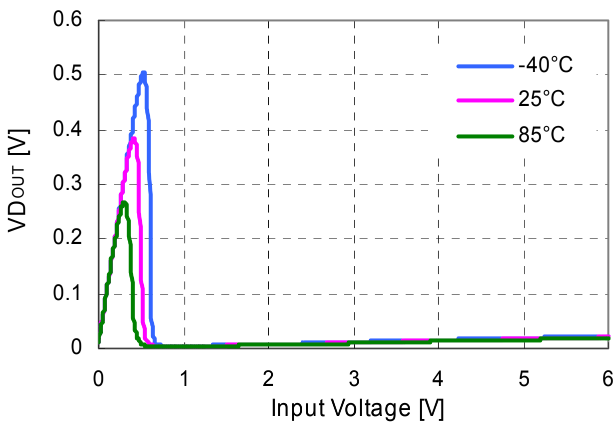


RP600K2xxC
HYS=30%



42) VDOUT vs. Input Voltage

RP600Kxxxx
-Vdet=4.5V, V_{SENSE}=0V(A/B/D) or 5V(C), VD_{OUT}=100kΩ_V_{IN}pullup

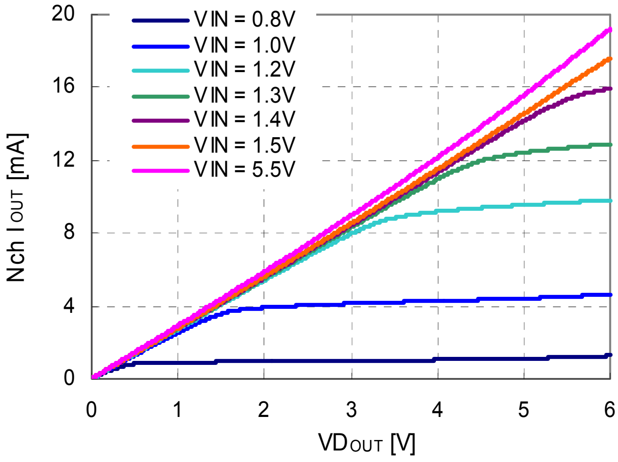


RICOH

43) Nch Driver Output Current vs. VDOUT

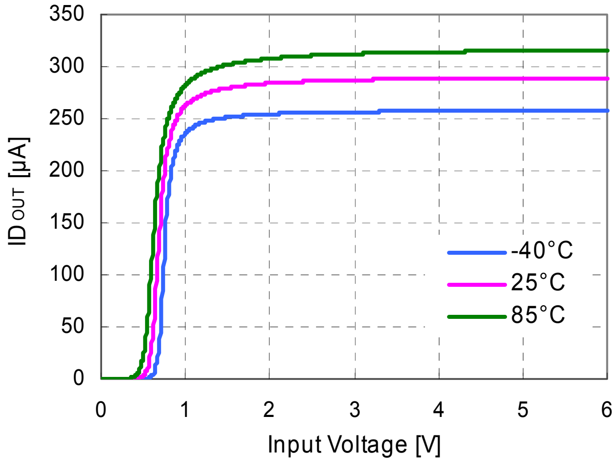
RP600Kxxxx

-Vdet=4.5V, Ta=25°C, VSENSE=0V(A/B/D) or 5V(C)



44) Nch Driver Output Current vs. Input Voltage

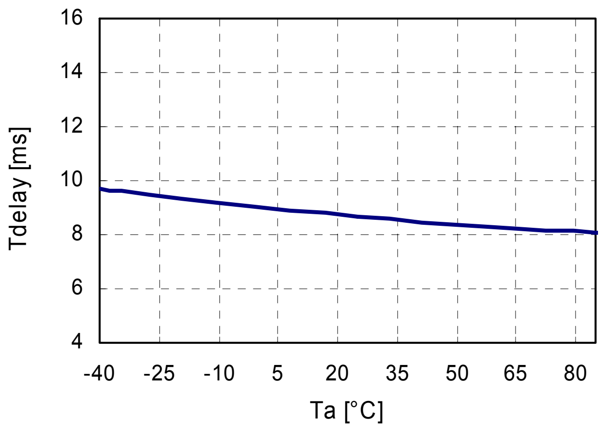
-Vdet=4.5V, VDOOUT=0.1V, VSENSE=0V(A/B/D) or 5V(C)



45) Voltage Detector Released Output Delay Time vs. Temperature

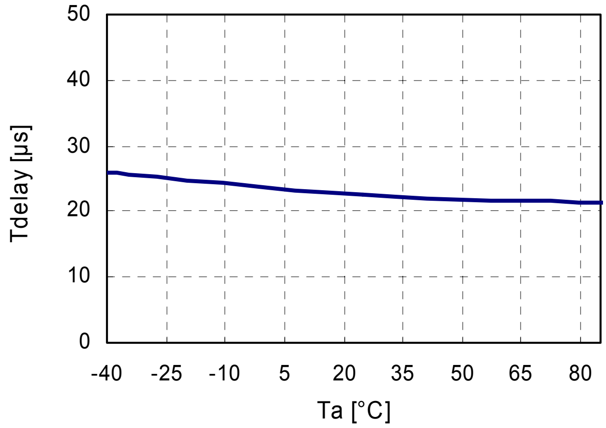
RP600KxxxA/B/D

VIN=3.0V



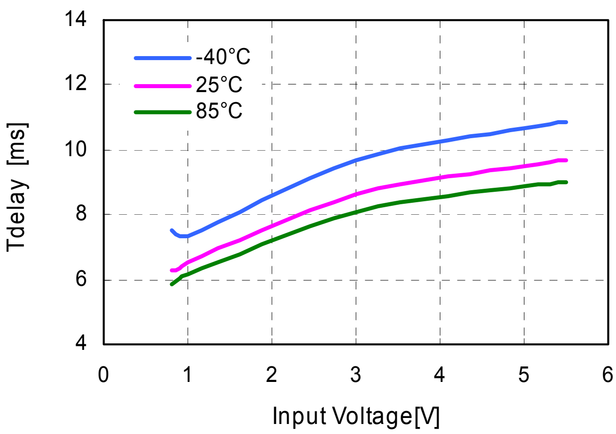
RP600K2xxC

VIN=3.0V



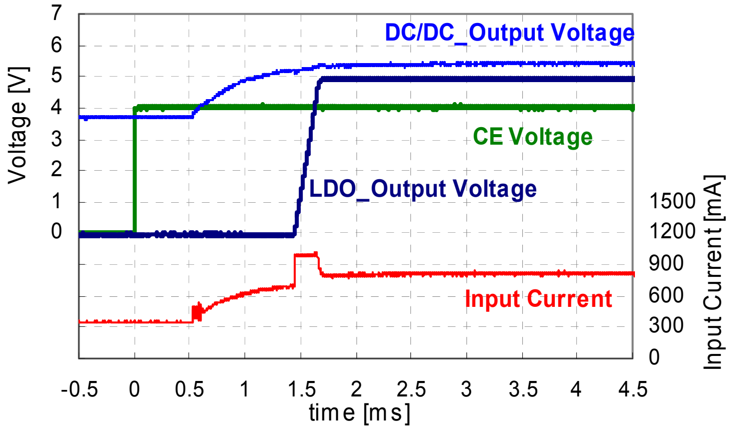
46) Voltage Detector Released Output Delay Time vs. Input Voltage

RP600KxxxA/B/D



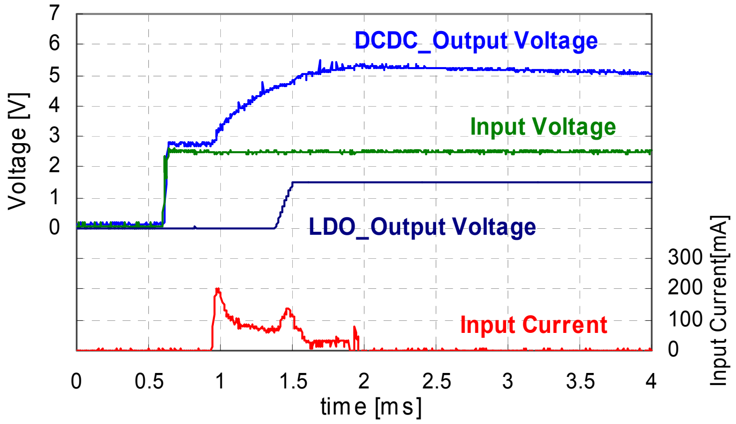
47) Turn On Speed with CE pin

RP600KxxxA/D
DC/DC=5.5V, LDO=5.0V, MODE="L", V_{IN}=4.0V,
I_{OUT1}=-500mA, I_{OUT2}=-50mA, Ta=25°C



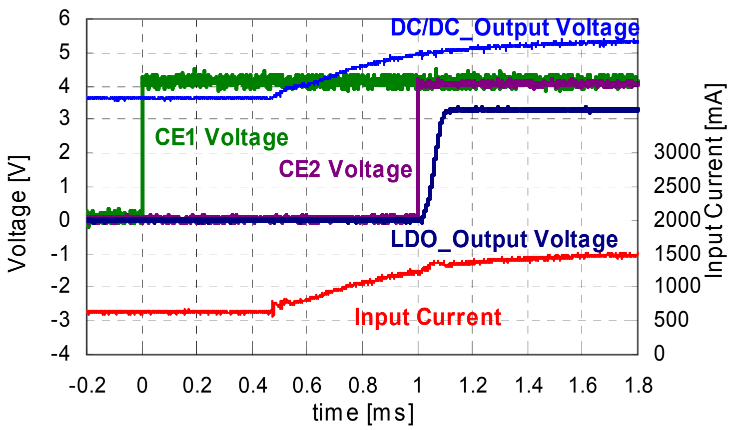
48) Turn On Speed with VDD

RP600K2xxC
DC/DC=5.5V, LDO=1.5V, -Vdet=2.8V, HYS=80%, MODE="L",
V_{IN}=0V→2.5V, I_{OUT1}=0mA, I_{OUT2}=-1mA, Ta=25°C



49) Turn On Speed with CE1, CE2

RP600K0xxB
DC/DC=5.5V, LDO=3.3V, MODE="L", V_{IN}=4.0V,
I_{OUT1}=-1000mA, I_{OUT2}=-0.1mA, Ta=25°C



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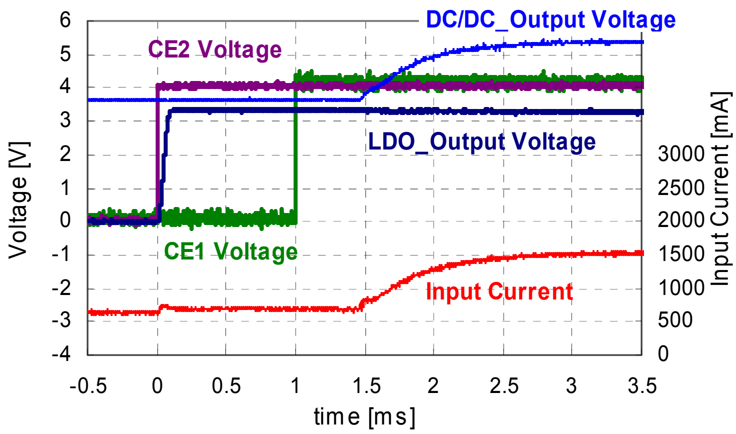
50) Turn On Speed with CE2, CE1

RP600K0xxB

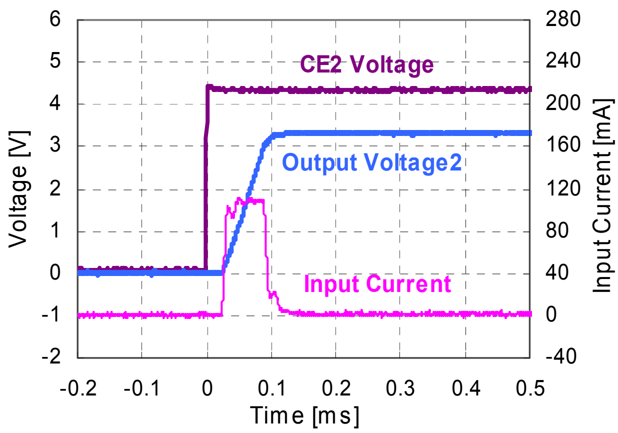
DC/DC=5.5V, LDO=3.3V, MODE="L", V_{IN}=4.0V, I_{OUT1}=-1000mA, I_{OUT2}=-0.1mA, Ta=25°C



51) LDO Start-up Waveform (DC/DC=standby)

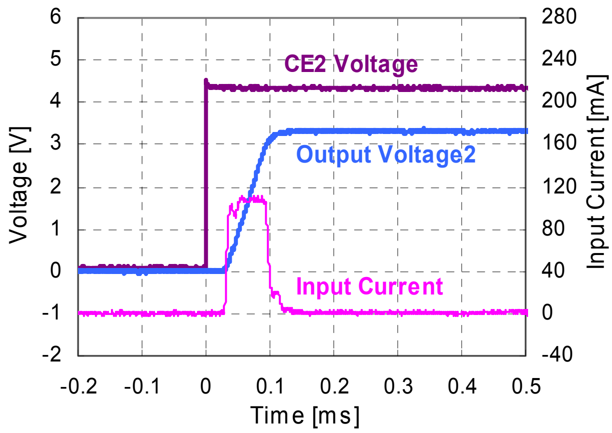
RP600KxxxB/C

LDO=3.3V, V_{IN}=4.3V, CE(CE1)=L, I_{OUT2}=-1mA, Ta=25°C, MODE="L"



RP600KxxxB/C

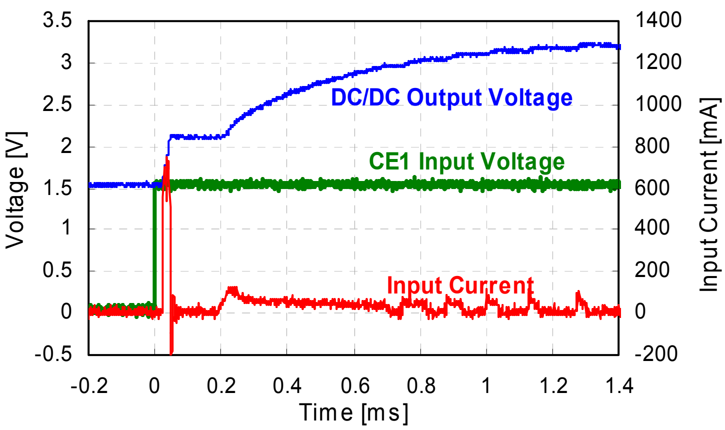
LDO=3.3V, V_{IN}=4.3V, CE(CE1)=L, I_{OUT2}=-1mA,Ta=25°C, MODE="H"



52) DC/DC Start-up Waveform (LDO=standby)

RP600K0xxB

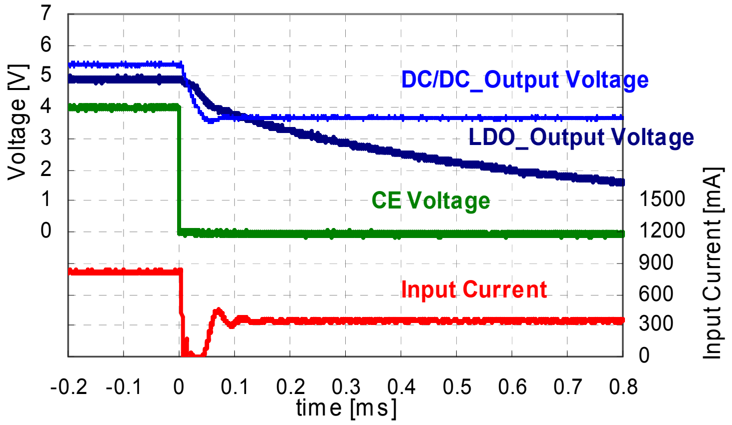
DC/DC=3.3V, V_{IN}=1.65V, I_{OUT1}=-1mA, MODE="L", Ta=25°C, CE2=0V



53) Turn Off Speed with CE

RP600KxxxA/D

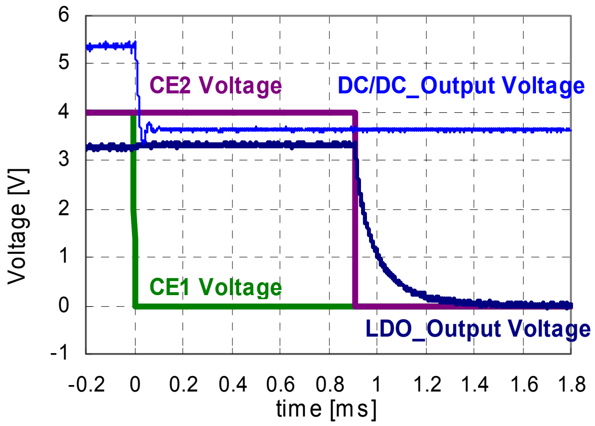
DC/DC=5.5V, LDO=5.0V, MODE="L", V_{IN}=4.0V, I_{OUT1}=-500mA, I_{OUT2}=-50mA, Ta=25°C



54) Turn Off Speed with CE1, CE2

RP600K0xxB

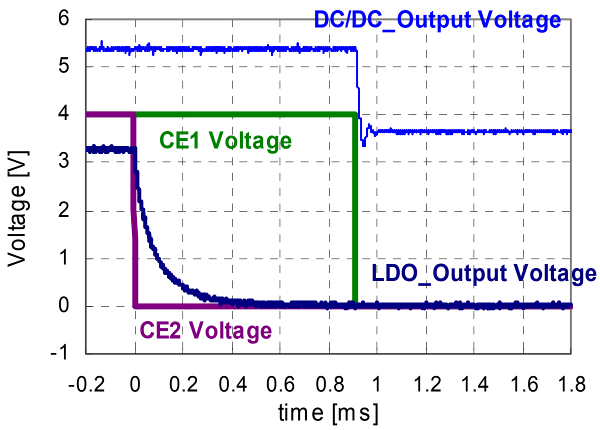
DC/DC=5.5V, LDO=3.3V, MODE="L", V_{IN}=4.0V, I_{OUT1}=-1000mA, I_{OUT2}=-50mA, Ta=25°C



55) Turn Off Speed with CE2, CE1

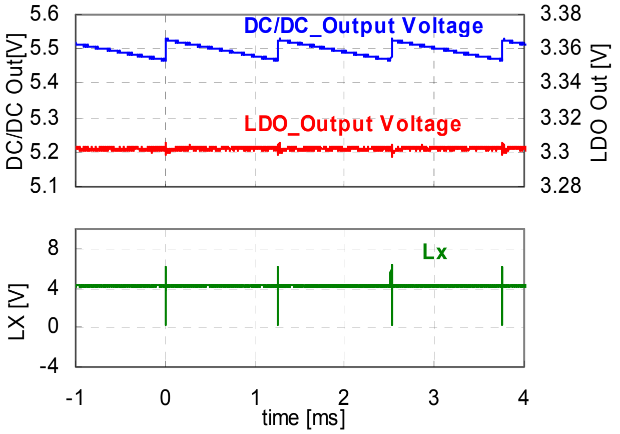
RP600K0xxB

DC/DC=5.5V, LDO=3.3V, MODE="L", V_{IN}=4.0V, I_{OUT1}=-1000mA, I_{OUT2}=-50mA, Ta=25°C

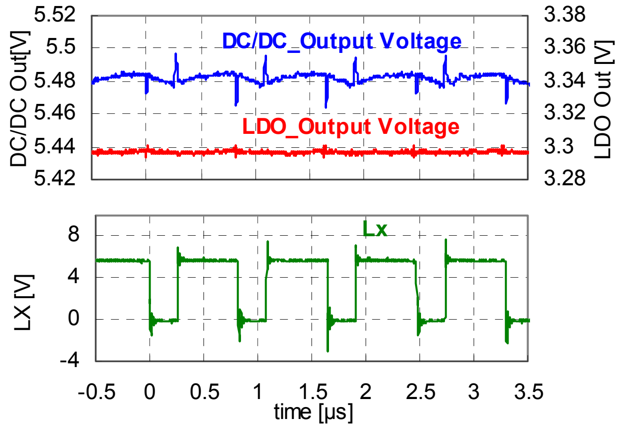


56) Output Voltage 1, Output Voltage 2, Lx Waveform

RP600KxxxA/B/D
DC/DC=5.5V, LDO=3.3V, V_{IN}=4.0V,
I_{OUT1}=-0.1mA, I_{OUT2}=-0.1mA, Ta=25°C, MODE="L"

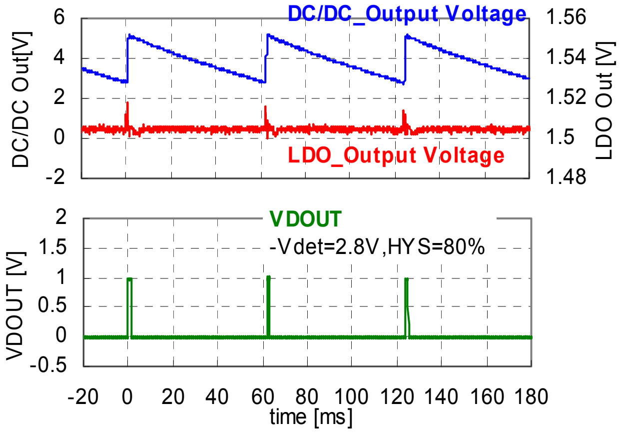


RP600KxxxA/B/D
DC/DC=5.5V, LDO=3.3V, V_{IN}=4.0V
I_{OUT1}=-100mA, I_{OUT2}=-100mA, Ta=25°C, MODE="L"

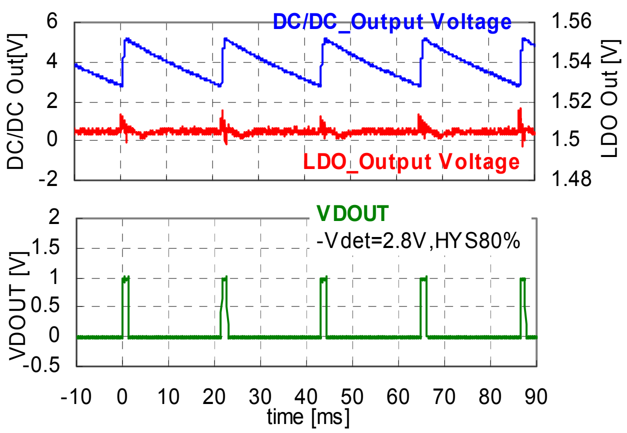


57) Output Voltage 1, Output Voltage 2, VDout Waveform (RP600K2xxC)

DC/DC=5.5V, LDO=1.5V, V_{IN}=1.0V,
I_{OUT1}=0mA, I_{OUT2}=-0.1mA, Ta=25°C, MODE="L"

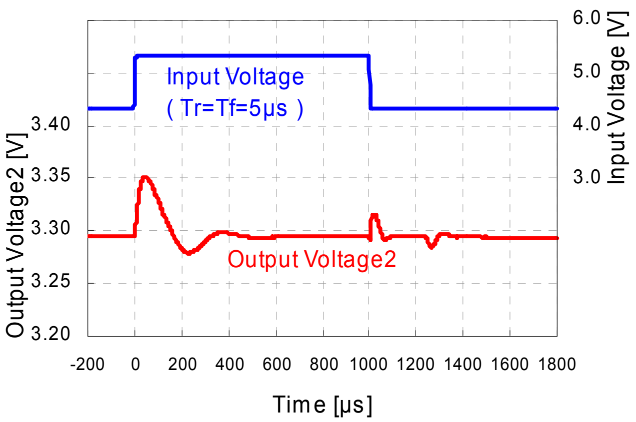


DC/DC=5.5V, LDO=1.5V, V_{IN}=1.0V
I_{OUT1}=0mA, I_{OUT2}=-1mA, Ta=25°C, MODE="L"

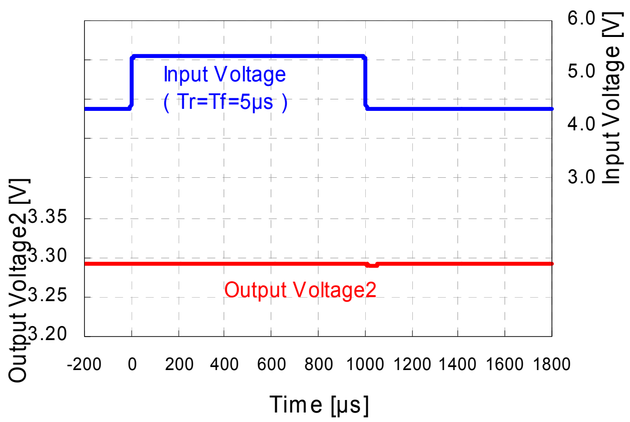


58) Input Transient Response_LDO (DC/DC=Standby)(RP600KxxxB/C)

LDO=3.3V, I_{OUT2}=-0.5mA, CE(CE1)=L,
Ta=25°C, V_{IN}=4.3V～5.3V, MODE="L"



LDO=3.3V, I_{OUT2}=-30mA, CE(CE1)=L,
Ta=25°C, V_{IN}=4.3V～5.3V, MODE="H"

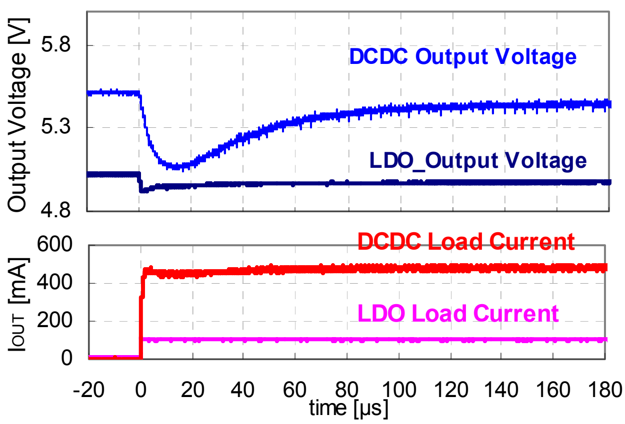


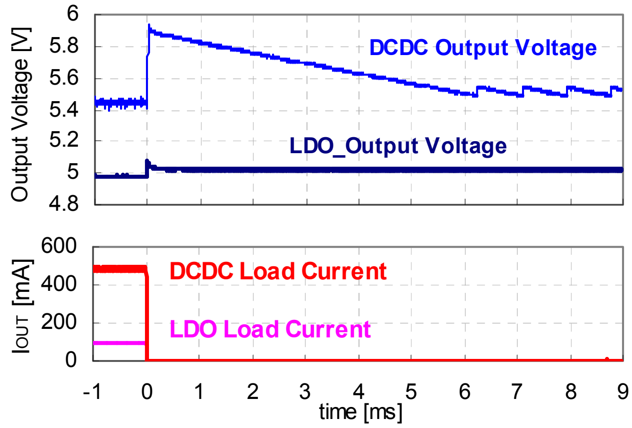
59) Load Transient Response (DC/DC&LDO)

RP600KxxxA/D

DC/DC=5.5V, LDO=5.0V, V_{IN}=4.0V, MODE="L",

DC/DC_I_{OUT}=-0.1mA⇔-500mA, LDO_ I_{OUT}=0mA⇔-50mA, Ta=25°C,



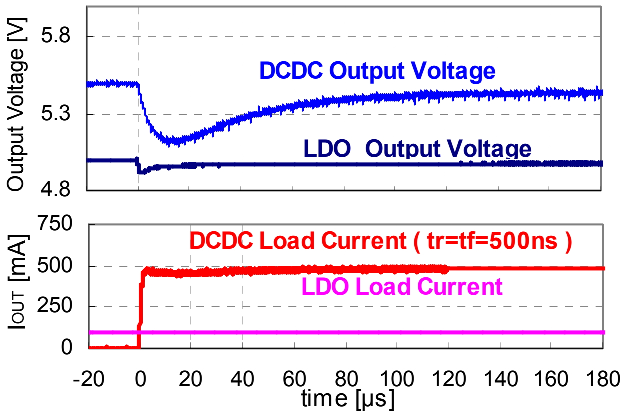


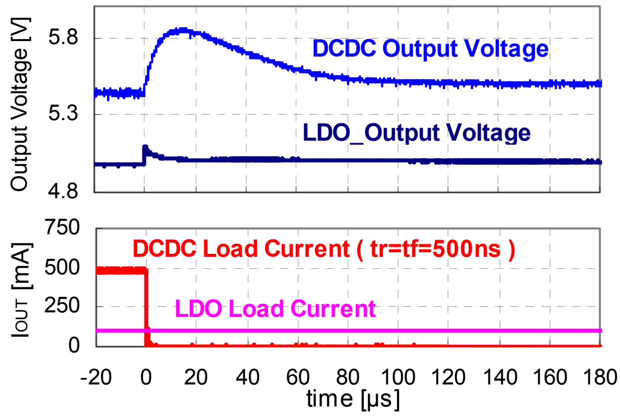
60) DC/DC Load Transient Response, LDO Output Voltage

RP600KxxxA/D

DC/DC=5.5V, LDO=5.0V, V_{IN}=4.0V, MODE="L",

DC/DC_I_{OUT}=-0.1mA⇔-500mA, LDO_ I_{OUT}=-100mA, Ta=25°C,

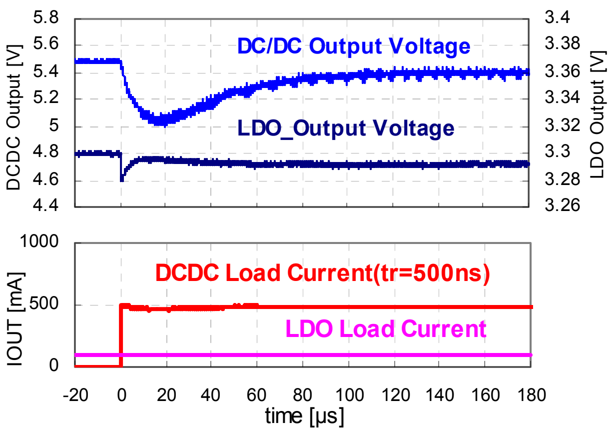


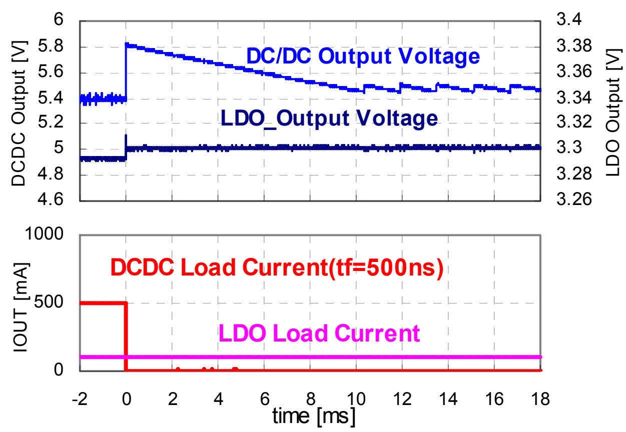


RP600K0xxB

DC/DC=5.5V, LDO=3.3V, V_{IN}=4.0V, MODE="L",

DC/DC_I_{OUT}=-0.1mA⇔-500mA, LDO_ I_{OUT}=-100mA, Ta=25°C,



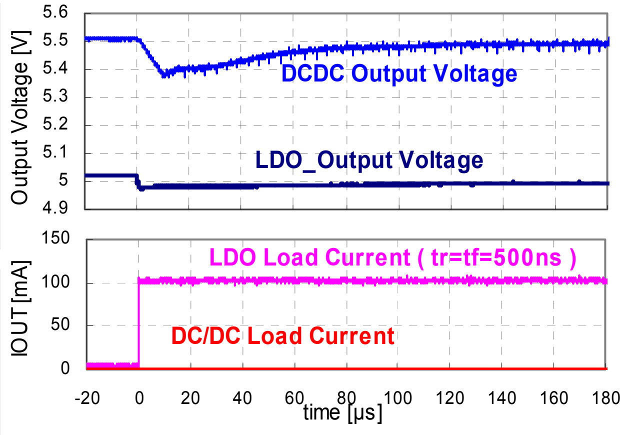


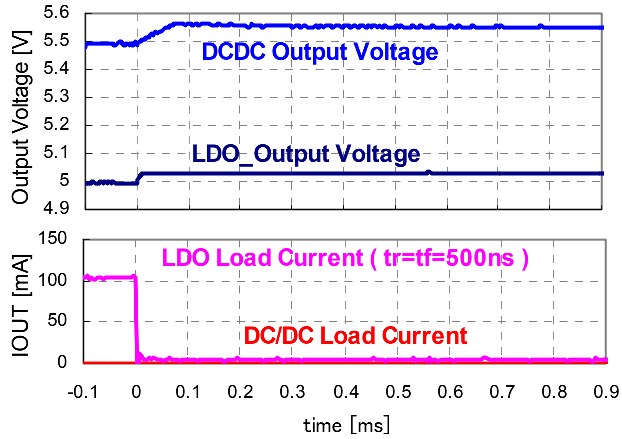
61) LDO Load Transient Response, DC/DC Output Voltage

RP600KxxxA/D

DC/DC=5.5V, LDO=5.0V, V_{IN}=4.0V, MODE=“L”,

DC/DC_I_{OUT}=-0.1mA, LDO_ I_{OUT}=0⇔-100mA, Ta=25°C,

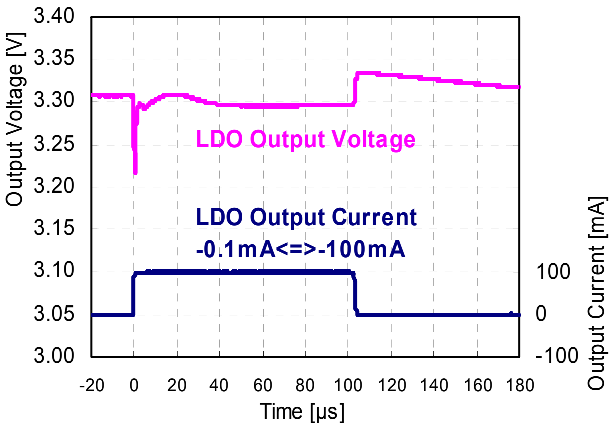




62) LDO Load Transient Response (DC/DC=Standby) (RP600K0xxB)

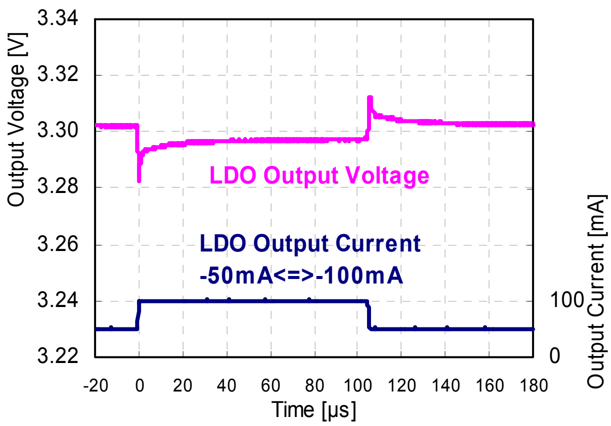
LDO=3.3V, I_{OUT2}=-0.1mA⇔-100mA,

V_{IN}=4.3V, MODE=“L”, CE1=0V, Ta=25°C



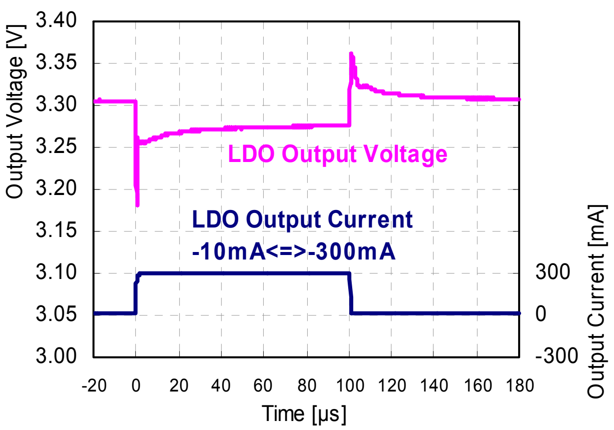
LDO=3.3V, I_{OUT2}=-50mA⇔-100mA,

V_{IN}=4.3V, MODE=“L”, CE1=0V, Ta=25°C



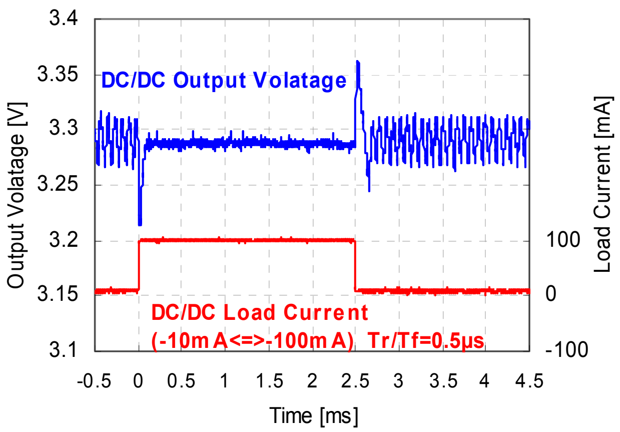
LDO=3.3V, I_{OUT2}=-10mA⇔-300mA,

V_{IN}=4.3V, MODE=“L”, CE1=0V, Ta=25°C

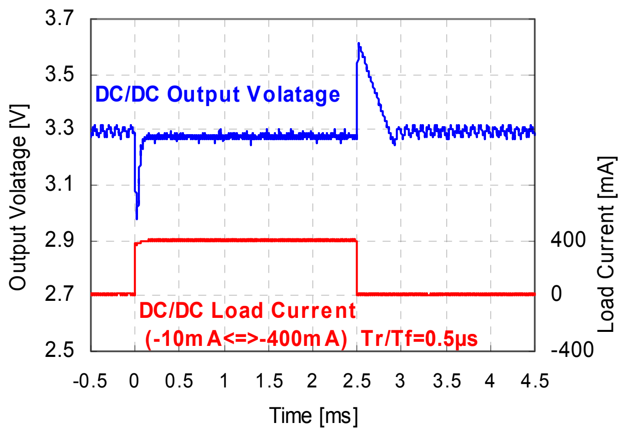


63) DC/DC Load Transient Response (LDO=Standby)

RP600K0xxB
DC/DC=3.3V, V_{IN}=1.65V, MODE="L", CE2=L, Ta=25°C

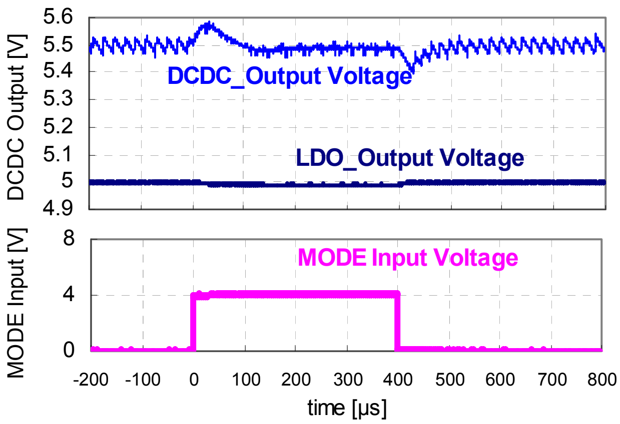


RP600K0xxB
DC/DC=3.3V, V_{IN}=1.65V, MODE="L", CE2=L, Ta=25°C



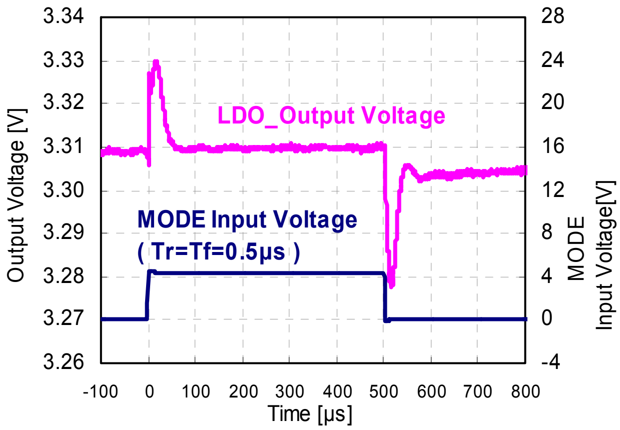
64) MODE pin Switching Response (DC/DC&LDO)

RP600KxxxA/D
DC/DC=5.5V, LDO=5.0V, V_{IN}=4.0V,DC/DC_I_{OUT}=-0.1mA, LDO_ I_{OUT}=-20mA, Ta=25°C



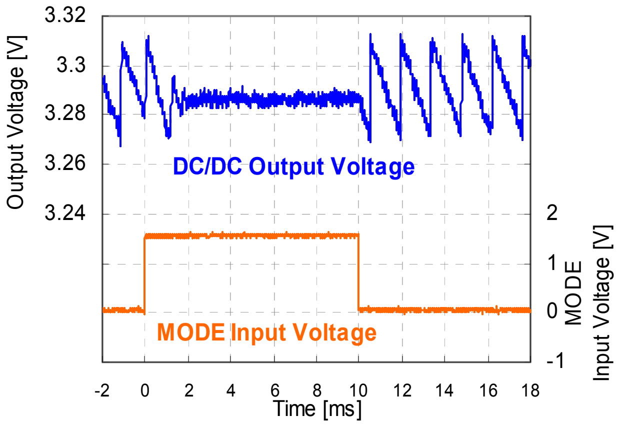
65) MODE pin Switching Response (LDO)

RP600KxxxB/C
(DC/DC=Standby), LDO=3.3V, I_{OUT}2=-2.5mA V_{IN}=4.3V, CE(CE1)=0V, Ta=25°C



66) MODE pin Switching Response (DC/DC)

RP600K0xxB
(LDO=Standby), DC/DC=3.3V, V_{IN}=1.5V, I_{OUT1}=-0.1mA, CE2=L, Ta=25°C



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