2A*1 PWM/VFM Step-down DC/ DC Converter with Synchronous Rectifier

NO.EA-296-120525

OUTLINE

The RP506K Series are low supply current CMOS-based PWM/VFM step-down DC/ DC converters with synchronous rectifier featuring 2A*1 output current. Internally, a single IC consists of an oscillator, a reference voltage unit, an error amplifier, a switching control circuit, a mode control circuit, a soft start circuit, a latch protection circuit, an under-voltage lockout (UVLO) circuit, a thermal shutdown circuit, and switching transistors.

By simply using an inductor and capacitors as external components, without connecting any diode, a low ripple and high efficiency synchronous rectifier step-down DC/ DC converter can be easily configured.

RP506K is available in DFN(PLP)2527-10 package which achieves high-density mounting on boards. RP506K is available in the fixed output voltage type (RP506Kxx1A/ B/ D/ E) which can be set by 0.1 V step and the output voltage accuracy is as high as ±1.5% or ±18mV, or the adjustable output voltage type (RP506K001C/ F) which can be set by using the external resistors.

The oscillator frequency can be selected from 2.25MHz (RP506Kxx1A/ B/ C) or 1.2MHz (RP506K001C/ F). By inputting a signal to MODE pin, RP506K can choose PWM/VFM auto switching control or forced PWM control. In low output current, PWM/VFM auto switching control automatically switches from PWM mode to VFM mode in order to achieve high efficiency. Likewise, in low output current, fixed PWM control switches at fixed frequency in order to reduce noise.

RP506K contains a latch type protection circuit which latches the built-in driver to the OFF state during high load or if the output is short-circuited for a specified time (protection delay time). The latch protection circuit can be released by once setting the IC into the standby mode with the CE pin and then setting it back to the active mode, or, by turning the power off and back on. Setting the supply voltage lower than the UVLO detector threshold can also release the latch protection circuit. RP506K also contains a thermal shutdown circuit which detects overheating of the regulator if the output pin (V_{OUT}) is shorted to the ground pin (GND) etc. and stops regulator operation to protect it from damage.

The soft-start time is fixed within the IC (Typ. 150μs), but it is also adjustable by using external capacitors. RP506K includes a power good (PG) function which monitors the V_{OUT} pin voltage or the feedback pin voltage (V_{FB}), and switches the PG pin to low if any abnormal condition is detected.

*1 This is an approximate value. The output current depends on conditions and external components.

FEATURES

- Supply Current ··· Typ. 48μA (VFM mode, Lx at no load)
- Standby Current ··· Max. 5μA
- Input Voltage Range ··· 2.5V to 5.5V (Absolute Maximum Ratings: 6.5V)
- Output Voltage Range ··· 0.8V to 3.3V*2 (RP506Kxx1A/ B/ C)
  0.6V to 3.3V*2 (RP506Kxx1D/ E/ F)
- Output Voltage Accuracy ··· ±1.5%(V_{SET}*3≥1.2V), ±18mV(V_{SET}<1.2V) (RP506Kxx1A/ B/ D/ E)
- Feedback Voltage Accuracy ··· ±9mV(V_{FB}=0.6V) (RP506K001C/ F)
- Output Voltage/ Feedback Voltage
  Temperature Coefficient ··· ±100ppm/ °C
- Oscillator Frequency ··· Typ. 2.25MHz (RP506Kxx1A/ B/ C)
  Typ. 1.2MHz (RP506Kxx1D/ E/ F)
- Oscillator Maximum Duty ··· Min. 100%
- Built-in Driver ON Resistance ··· Typ. Pch. 0.130Ω, Nch. 0.125Ω (V_{IN}=3.6V)
- UVLO Detector Threshold ··· Typ. 2.2V
- Inductor Current Limit Circuit ··· Current limit Typ. 2.8A
- Latch Type Protection Circuit ··· Typ. 1.5ms
- Package ··· DFN(PLP)2527−10

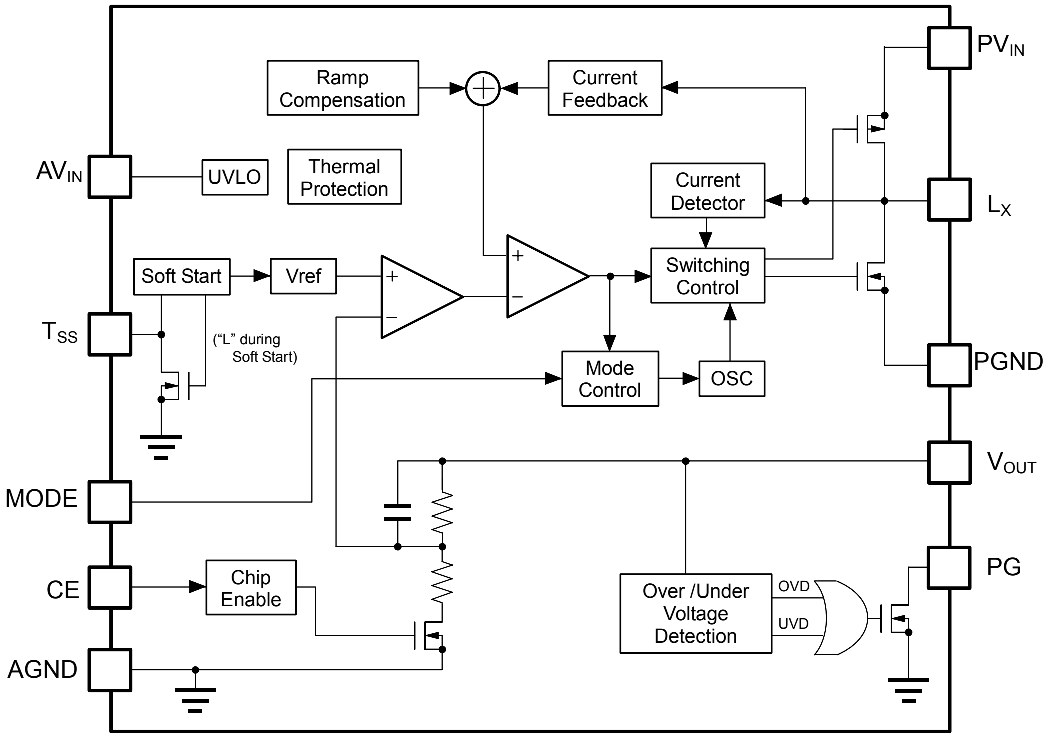
*2 Please refer to *Electrical Characteristics* for more information. Fixed output voltage type (RP506Kxx1A/ B/ D/ E) can be set by 0.1 V step.
*3 V_{SET}=Set Output Voltage

APPLICATION

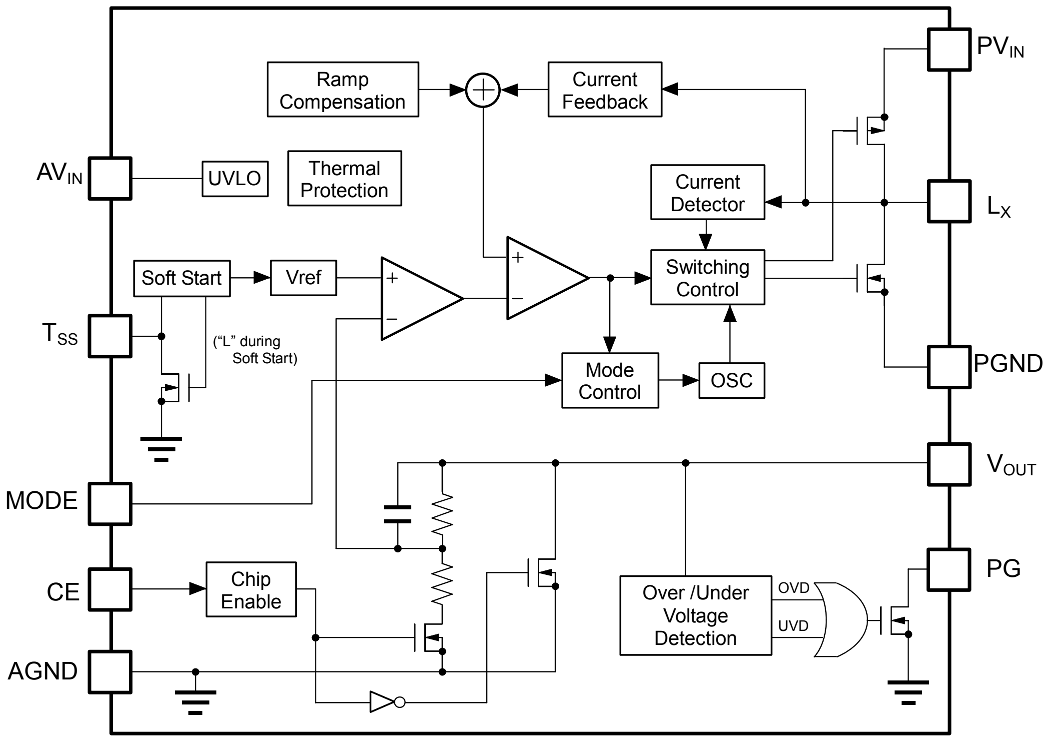
- Power source for Li-ion battery-used equipment
- Power source for portable communication equipment, camcorder, DSC, Notebook PC
- Power source for HDD, WLAN

BLOCK DIAGRAM

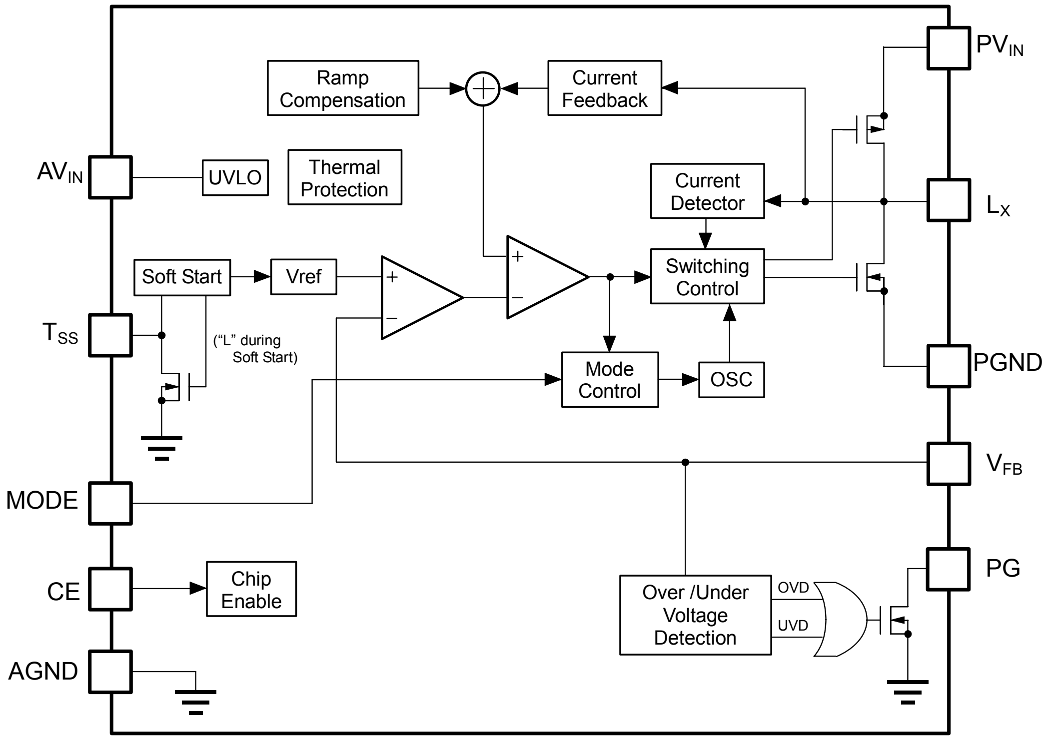
RP506Kxx1A/D



RP506Kxx1B/E



RP506K001C/F



SELECTION GUIDE

The set output voltage, the output voltage type, the auto-discharge function[*4], and the oscillator frequency for the ICs are user-selectable options.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP506Kxx1$(y)-TR	DFN(PLP)2527−10	5,000 pcs	Yes	Yes

xx: Designation of the set output voltage (V_{SET})
For Fixed Output Voltage Type: 0.6V (06)[*5] to 3.3V (33) in 0.1V steps[*6]
For Adjustable Output Voltage Type: 0.6V (001) only
(y): If V_{SET} includes the 3rd digit, indicate the digit of 0.01V.
(1.25V)
Ex. If V_{SET} is 1.25V, RP506K121$5-TR-FE.

$: Designation of version

Version	Output Voltage Type	Auto-discharge Function	Oscillator Frequency
A	Fixed	No	2.25MHz
B	Fixed	Yes	2.25MHz
C	Adjustable	No	2.25MHz
D	Fixed	No	1.2MHz
E	Fixed	Yes	1.2MHz
F	Adjustable	No	1.2MHz

[*4] Auto-discharge function quickly lowers the output voltage to 0V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.
[*5] V_{SET} can be set only within the specified range of voltage. Please refer to *Electrical Characteristics* for details.
[*6] 0.05V step is also available as a custom code.

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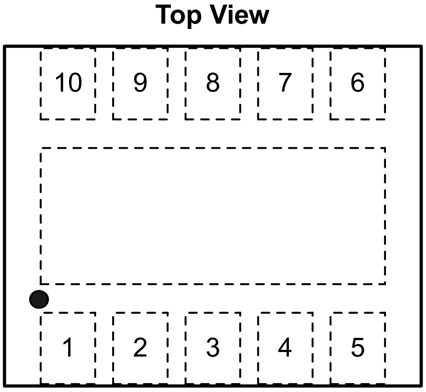
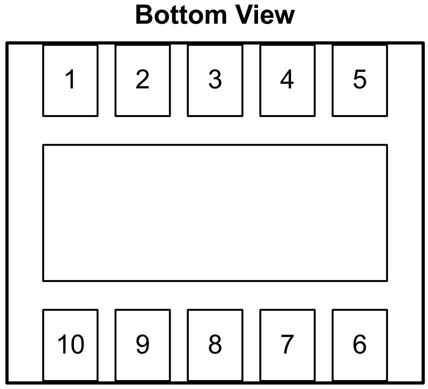
PIN CONFIGURATION





PIN DESCRIPTION

RP506K: DFN(PLP)2527-10[*7]

Pin No.	Symbol	Description
1	PV_{IN}	PV_{IN} Input Voltage Pin[*8]
2	AV_{IN}	AV_{IN} Input Voltage Pin[*8]
3	PG	Power Good Pin
4	CE	Chip Enable Pin (“H” active)
5	MODE	Mode Control Pin (“H” Forced PWM Control, “L” PWM/ VFM Auto Switching Control)
6	T_{SS}	Soft-start Pin
7	V_{OUT}/ V_{FB}	Output/ Feedback Voltage Pin
8	AGND	Analog Ground Pin[*9]
9	L_X	Switching Pin
10	PGND	Power Ground Pin[*9]

[*7] The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substarate level). It is recommended that the tab be connected to the ground plane on the board. If not, the tab can be left open.
[*8] No.1 pin and No.2 pin must be wired to the V_{IN} plane when mounting on boards.
[*9] No.8 pin and No.10 pin must wired to the GND plane when mounting on boards.

ABSOLUTE MAXIMUM RATINGS

(AGND=PGND=0V)

Symbol	Item	Rating	Unit
V_{IN}	AV_{IN}/ PV_{IN} Pin Voltage	-0.3 to 6.5	V
V_{LX}	L_X Pin Voltage	-0.3 to AV_{IN}/ PV_{IN} +0.3	V
V_{CE}	CE Pin Voltage	-0.3 to 6.5	V
V_{OUT}/ V_{FB}	V_{OUT}/ V_{FB} Pin Voltage	-0.3 to 6.5	V
V_{MODE}	MODE Pin Voltage	-0.3 to 6.5	V
V_{PG}	PG Pin Voltage	-0.3 to 6.5	V
V_{TSS}	T_{SS} Pin Voltage	-0.3 to AV_{IN}+0.3	V
I_{LX}	L_X Pin Output Current	2.8	A
P_D	Power Dissipation[*10] (DFN2527-10)	910 (Standard Land Pattern[*10])	mW
		1400 (High Wattage Land Pattern[*10])	mW
Ta	Operating Temperature Range	-40 to +85	ºC
Tstg	Storage Temperature Range	-55 to +125	ºC

*10 For more information about Power Dissipation, Standard Land Pattern and High Wattage Land Pattern, please refer to *Package Information*.

ABSOLUTE MAXIMUM RATINGS
Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime 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.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)
All of electro nic equi pment shou ld be desi gned that the mounted s emiconductor d evices o perate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

RP506Kxx1 (Ta=25ºC)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
Istandby	Standby Current	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=0V		0	5	µA
I_{CEH}	CE "H" Input Current	AV_{IN}/ PV_{IN}=V_{CE}=5.5V	-1	0	1	µA
I_{CEL}	CE "L" Input Current	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=0V	-1	0	1	µA
I_{MODEH}	MODE "H" Input Current	AV_{IN}/ PV_{IN}=V_{MODE}=5.5V, V_{CE}=0V	-1	0	1	µA
I_{MODEL}	MODE "L" Input Current	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=V_{MODE}=0V	-1	0	1	µA
$I_{LXLEAKH}$	L_X Leakage Current "H"	AV_{IN}/ PV_{IN}=V_{LX}=5.5V, V_{CE}=0V	-1	0	6	µA
$I_{LXLEAKL}$	L_X Leakage Current "L"	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=V_{LX}=0V	-6	0	1	µA
V_{CEH}	CE "H" Input Voltage	AV_{IN}/ PV_{IN}=5.5V	1.0			V
V_{CEL}	CE "L" Input Voltage	AV_{IN}/ PV_{IN}=2.5V			0.4	V
V_{MODEH}	MODE "H" Input Voltage	AV_{IN}/ PV_{IN}=5.5V	1.0			V
V_{MODEL}	MODE "L" Input Voltage	AV_{IN}/ PV_{IN}=2.5V			0.4	V
R_{ONP}	On Resistance of Pch Transistor	AV_{IN}/ PV_{IN}=3.6V, I_{LX}=-100mA		0.130		Ω
R_{ONN}	On Resistance of Nch Transistor	AV_{IN}/ PV_{IN}=3.6V, I_{LX}=-100mA		0.125		Ω
Maxduty	Oscillator Maximum Duty Cycle		100			%
tstart1	Soft-start Time 1	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V, T_{SS}=OPEN		150	300	µs
tstart2	Soft-start Time 2	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V, C_{SS}=0.1µF	15	30	45	ms
I_{LXLIM}	L_X Current Limit	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V	2300	2800		mA
tprot	Protection Delay Time	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V	0.5	1.5	5	ms
V_{UVLO1}	UVLO Detector Threshold	AV_{IN}/ PV_{IN}=V_{CE}	2.1	2.2	2.3	V
V_{UVLO2}	UVLO Released Voltage	AV_{IN}/ PV_{IN}=V_{CE}	2.2	2.3	2.4	V
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature		150		ºC
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		100		ºC
R_{PG}	On Resistance of PG Pin When Low Output	AV_{IN}/ PV_{IN}=3.6V, V_{OUT}=0V or V_{FB}=0V		45		Ω
♦RP506Kxx1A/ B/ C (Oscillator Frequency: 2.25MHz)						
V_{IN}	When MODE=H Operating Input Voltage[*11]	1.1V≤V_{SET}<1.2V	2.5		4.5	V
		1.2V≤V_{SET}	2.5		5.5	
	When MODE=L Operating Input Voltage	0.8V≤V_{SET}<1.0V	2.5		4.5	
		1.0V≤V_{SET}	2.5		5.5	
fosc	Oscillator Frequency	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V	2.00	2.25	2.50	MHz
♦RP506Kxx1D/ E/ F (Oscillator Frequency: 1.2MHz)						
V_{IN}	When MODE=H Operating Input Voltage	0.6V≤V_{SET}<0.7V	2.5		4.5	V
		0.7V≤V_{SET}	2.5		5.5	
	When MODE=L Operating Input Voltage		2.5		5.5	
f_{OSC}	Oscillator Frequency	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V	1.00	1.20	1.40	MHz

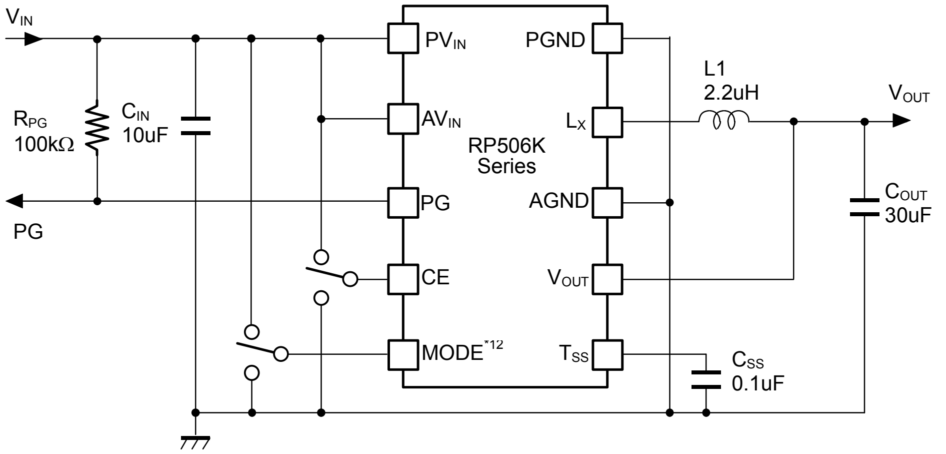
Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
	■RP506Kxx1A/ B/ D/ E (Fixed Output Voltage Type)						
V_{OUT}	Output Voltage	AV_{IN}/ PV_{IN}=V_{CE}=3.6V or V_{SET}+1V	V_{SET}≥1.2V	x -1.015		x 1.015	V
			V_{SET}<1.2V	-0.018		+0.018	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	−40°C≤Ta≤85°C			±100		ppm/ºC
I_{DD1}	Supply Current 1	AV_{IN}/ PV_{IN}=V_{CE}=5.5V, V_{OUT}=V_{SET}×0.8			600		μA
I_{DD2}	Supply Current 2	AV_{IN}/ PV_{IN}=V_{CE} =V_{OUT}=5.5V	V_{MODE}=0V		48	72	μA
			V_{MODE}=5.5V		600		μA
I_{VOUTL}	V_{OUT} "L" Current	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=V_{OUT}=0V		-1	0	1	μA
V_{OVD}	OVD Voltage	AV_{IN}/ PV_{IN}=3.6V			V_{SET}×1.2		V
V_{UVD}	UVD Voltage	AV_{IN}/ PV_{IN}=3.6V			V_{SET}×0.8		V
	□RP506Kxx1A/ D (Fixed Output Voltage Type without Auto-discharge Function)						
I_{VOUTH}	V_{OUT} "H" Current	AV_{IN}/ PV_{IN}=V_{OUT}=5.5V, V_{CE}=0V		-1	0	1	μA
	□RP506Kxx1B/ E (Fixed Output Voltage Type with Auto-discharge Function)						
R_{LOW}	On Resistance of Low Output	AV_{IN}/ PV_{IN}=3.6V, V_{CE}=0V			45		Ω
	■RP506K001C/ F (Adjustable Output Voltage Type)						
V_{FB}	Feedback Voltage	AV_{IN}/ PV_{IN}=V_{CE}=3.6V		0.591	0.600	0.609	V
$\Delta V_{FB}/\Delta T$	Feedback Voltage Temperature Coefficient	−40°C≤Ta≤85°C			±100		ppm/ºC
I_{DD1}	Supply Current 1	AV_{IN}/ PV_{IN}=V_{CE}=5.5V, V_{FB}=0.48V			600		μA
I_{DD2}	Supply Current 2	AV_{IN}/ PV_{IN}=V_{CE} =V_{FB}=5.5V	V_{MODE}=0V		48	72	μA
			V_{MODE}=5.5V		600		μA
I_{VFBH}	V_{FB} "H" Current	AV_{IN}/ PV_{IN}=V_{FB}=5.5V, V_{CE}=0V		-1	0	1	μA
I_{VFBL}	V_{FB} "L" Current	AV_{IN}/ PV_{IN}=5.5V, V_{CE}=V_{FB}=0V		-1	0	1	μA
V_{OVD}	OVD Voltage	AV_{IN}/ PV_{IN}=3.6V			0.72		V
V_{UVD}	UVD Voltage	AV_{IN}/ PV_{IN}=3.6V			0.48		V

All test items listed under *Electrical Characteristics* are done under the pulse load condition (Tj≈Ta=25ºC) except Output Voltage Temperature Coefficient and Feedback Voltage Temperature Coefficient.

[*11] As for RP506Kxx1A/ B/ C (MODE=H), V_{SET} can be set from 1.1V.

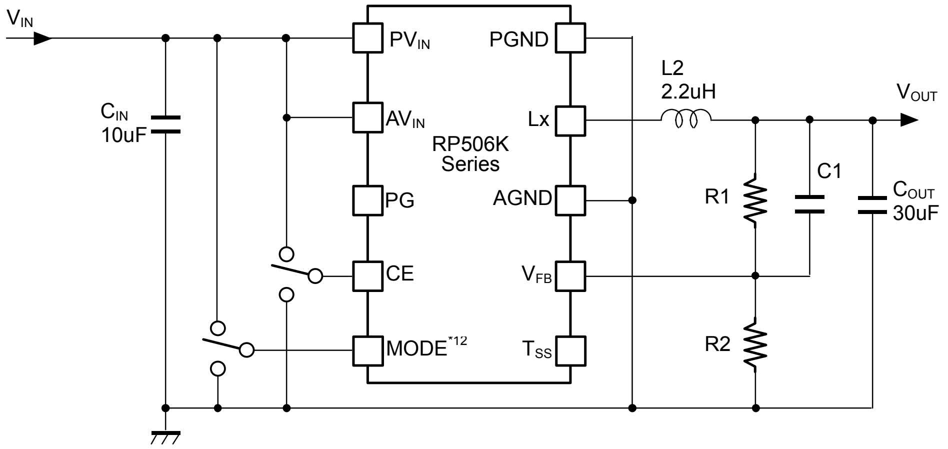
TYPICAL APPLICATION

RP506Kxx1A/ B/ D/ E (Fixed Output Voltage Type) with PG Function, 30ms Soft-start Time



***12 MODE="H" Forced PWM Control**
MODE="L" PWM/ VFM Auto Switching Control

RP506K001C/ F (Adjustable Output Voltage Type) without PG Function, 150µs Soft-start-time



***12 MODE="H" Forced PWM Control**
MODE="L" PWM/ VFM Auto Switching Control

Table 1. Recommended External Components

Symbol	Size	Part Description	Model
C_{IN}	10µF	Ceramic Capacitor	C1608JB0J106M (TDK)
			JMK107BJ106MA (Taiyo Yuden)
C_{OUT}	22µF x 2	Ceramic Capacitor	C2012JB0J226M (TDK)
	10µF x 3	Ceramic Capacitor	C1608JB0J106M (TDK)
			JMK107BJ106MA (Taiyo Yuden)
L	2.2µH	Inductor	SLF6045T-2R2N3R3 (TDK)
			CLF6045-2R2N (TDK)
			FDSD0415-2R2M (TOKO)
			RLF7030T-2R2M5R4 (TDK)

TECHNICAL NOTES

When using RP506K Series, please consider the following points.

- AGND and PGND must be wired to the GND plane when mounting on boards.
- AV_{IN} and PV_{IN} must be wired to the V_{IN} plane when mounting on boards.
- Ensure the AV_{IN}/ PV_{IN} and AGND/ PGND lines are sufficiently robust. A large switching current flows through the AGND/ PGND line, the V_{DD} line, the V_{OUT} line, an inductor, and L_X. If their impedance is too high, noise pickup or unstable operation may result. Set the external components as close as possible to the IC and minimize the wiring between the components and the IC. Especially, place a capacitor (C_{IN}) as close as possible to the PV_{IN} pin and PGND. For RP506Kxx1A/ B/ D/ E, separate the wiring between the V_{OUT} pin and an inductor (L1) from the wiring between L1 and Load. Likewise, for RP506K001C/ F, separate the wiring between a resistor for setting output voltage (R1) and an inductor (L2) from the wiring between L2 and Load.
- Choose a low ESR ceramic capacitor. The ceramic capacitance of C_{IN} should be more than or equal to 10µF. For a ceramic capacitor (C_{OUT}), it is recommended that three paralleled 10µF ceramic capacitors or two paralleled 22µF ceramic capacitors be used.
- Choose a 2.2µH inductor. The phase compensation of this IC is designed according to the C_{OUT} and L values. Choose an inductor that has small DC resistance, has enough allowable current and is hard to cause magnetic saturation. If the inductance value of an inductor is extremely small, the peak current of L_X may increase along with the load current. As a result, over current protection circuit may start to operate when the peak current of L_X reaches to "L_X limit current".
- Over current protection circuit and latch type protection circuit may be affected by self-heating or power dissipation environment.
- The output voltage (V_{OUT}) is adjustable by changing the resistance values of resistors (R1, R2) as follows.
  $V_{OUT} = V_{FB} \times (R1 + R2) / R2$ (Recommended V_{OUT} range for RP506K001F: $0.6V \le V_{SET} \le 3.3V$)
  (Recommended V_{OUT} range for RP506K001C: $0.8V \le V_{SET} \le 3.3V$)
- If R1 and R2 are too large, the impedances of V_{FB} also become large, as a result, the IC could be easily affected by noise. For this reason, R2 should be 220kΩ or less. If the operation becomes unstable dues to the high impedances, the impedances should be decreased.
- C1 can be calculated by the following equations. Please use the value close to the calculation result.
  $C1 = 4.84 \times 10^{-6} / R_2$ [F]
- The recommended resistance values for R1 and C1 when R_2=220kΩ are as follows.

V_{SET} [V]	0.6	0.7	0.8	1.2	1.8	2.5	3.3
R1 [kΩ]	0	36.7	73.3	220	440	697	990
R2 [kΩ]	220	220	220	220	220	220	220
C1 [pF]	-	22	22	22	22	22	22

- Soft-start Time (tstart) is adjustable by connecting a capacitor (C_{SS}) between the T_{SS} pin and GND. The capacitance value for C_{SS} that is suitable for tstart can be calculated by the following equation.
  C_{SS} (nF) = 3.5 × tstart (ms)

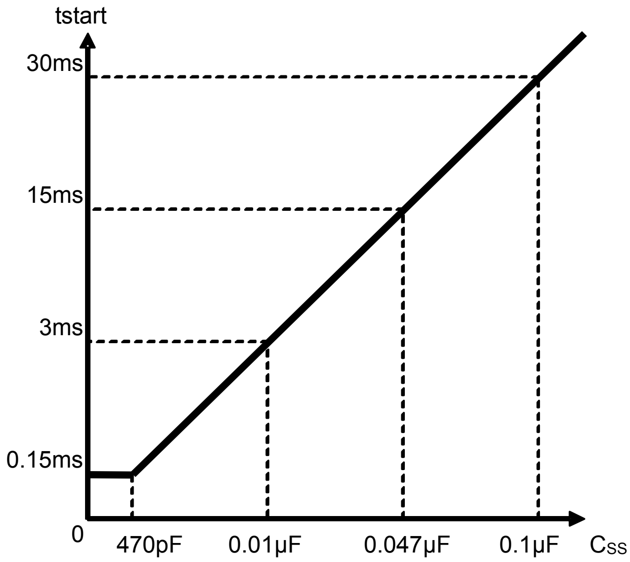
  The T_{SS} pin must be open if Soft-start time function is not used. Soft-start time is set to typically 150µs when the T_{SS} pin is open.
- When using the power good function, the resistance value of a resistor (R_{PG}) should be between 10kΩ to 100kΩ. The PG pin must be open or connected to GND if the power good function is not used.

★ For stable operation, please use recommended external components with recommended sizes indicated in *Table 1. Recommended External Components*. However, performances of power source circuits using RP506K largely depend on peripheral circuits. When selecting the peripheral components, please consider the conditions of use. Do not allow each component, PCB pattern or the IC to exceed their respected rated values (voltage, current, and power) when designing the peripheral circuits.

SOFT START TIME ADJUSTABLE FUNCTION AND POWER GOOD FUNCTION

Soft-start Time Adjustable Function

Soft-start time (tstart) of RP506K Series is adjustable by connecting a soft-start time adjustable capacitor (C_{SS}) between the T_{SS} pin and GND. tstart can be set from Typ. 0.15ms. As the diagram below shows, if 0.1μF C_{SS} is connected, tstart will be 30ms. The T_{SS} pin must be open if the soft-start time function is not used. tstart is set to 0.15ms (Typ.) when the T_{SS} pin is open.



C_{SS} vs. tstart (Typ.)

Power Good Function

RP506K Series contains a power good function using Nch open drain. If any abnormal condition is detected, the power good function turns Nch transistor on and switches the PG pin to low . If the cause of the abnormal condition is removed, the power good function turns Nch transistor off and switches the PG pin back to high. After the recovery from abnormal condition, it takes typically 0.1ms for the IC to turns Nch transistor off. The followings are the abnormal conditions that the power good function can detect.

・CE="L" (Shut down) ・UVLO (Shut down) ・Thermal Shutdown
・Over Voltage Detection: Typ . V_{SET} x 1.2V (RP506Kxx1A/ B/ D/ E) or 0.72V (RP506K001C/ F)
・Under Voltage Detection: Typ . V_{SET} x 0.8V (RP506Kxx1A/ B/ D/ E) or 0.48V (RP506K001C/ F)

When using the power good function, the resistance of PG pin (R_{PG}) should be between 10kΩ to 100kΩ. The PG pin must be open or connected to GND if the power good function is not used.

START-UP SEQUENCE USING SOFT-START TIME ADJUSTABLE FUNCTION AND POWER GOOD FUNCTION

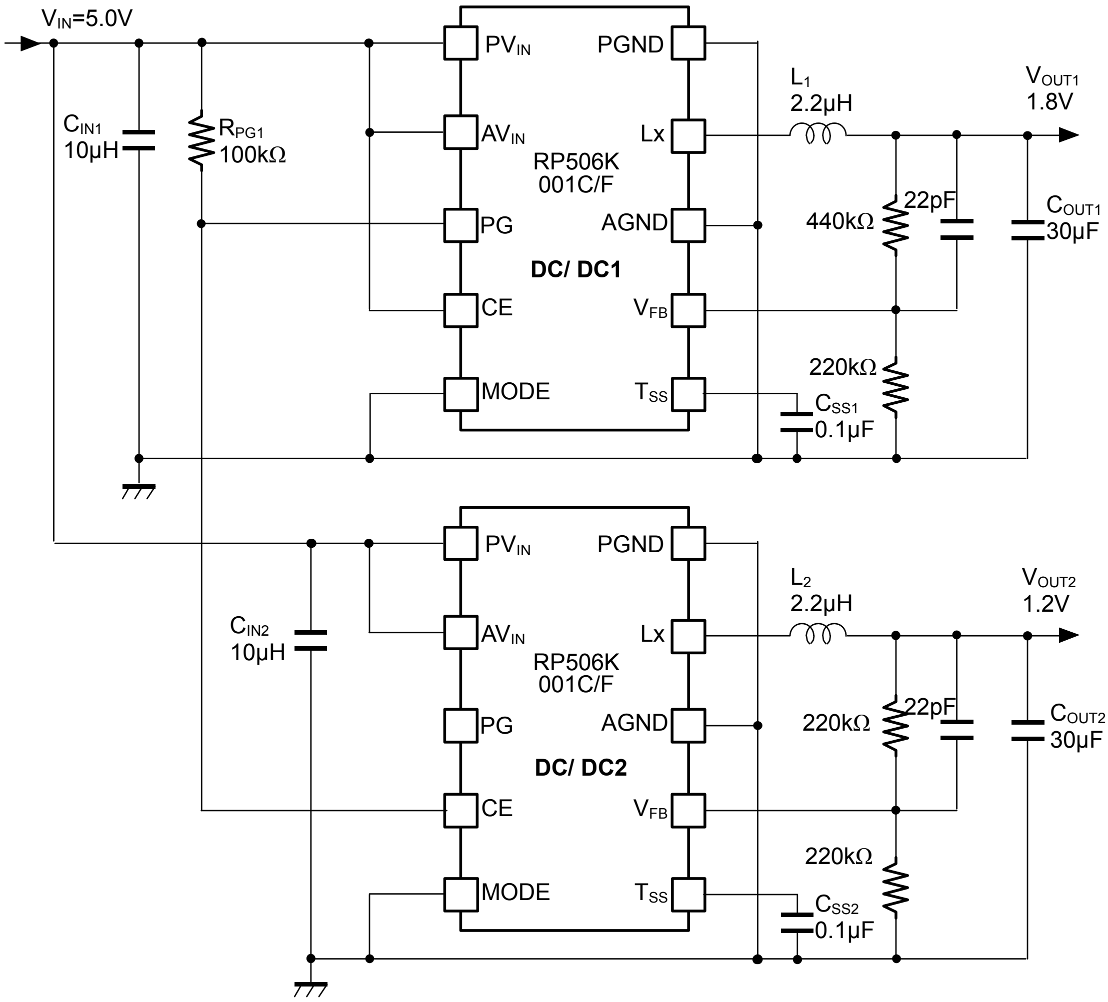
Start-up sequence of RP506K Series can be built by using soft-start time adjustable function and power good function.

The diagram below shows an example of circuits with start-up sequence using DC/ DC1 and DC/ DC2. In the circuits with start-up sequence, by sending the PG signal to the CE pin of DC/ DC2, DC/ DC1 starts up first and then DC/ DC2 starts up after.

Circuits Example with Start-up Sequence

DC/ DC1 (RP506K001C/F): V_{IN}=5.0V, V_{OUT}=1.8V, tstart=30ms (C_{SS}=0.1μF)

DC/ DC2 (RP506K001C/F): V_{IN}=5.0V, V_{OUT}=1.2V, tstart=30ms (C_{SS}=0.1μF)

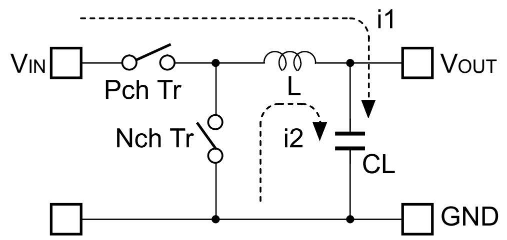


OPERATION OF STEP-DOWN DC/ DC CONVERTER AND OUTPTUT CURRENT

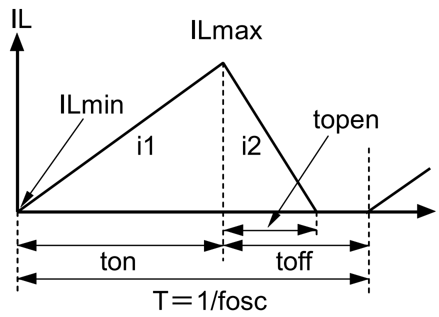
The step-down DC/ DC converter charges energy in the inductor when L_X Tr. turns "ON", and discharges the energy from the inductor when L_X Tr. turns "OFF" and operates with less energy loss, so that a lower output voltage (V_{OUT}) than the input voltage (V_{IN}) can be obtained.

The operation of the step-down DC/ DC converter is explained in the following diagrams.

Diag. 1 Basic Circuit



Diag. 2 Inductor Current (IL) Flowing through Inductor (L)



Step1. Pch Tr. turns "ON" and IL (i1) flows, L is charged with energy. At this moment, i1 increases from the minimum inductor current (ILmin), which is 0A, and reaches the maximum inductor current (ILmax) in proportion to the on-time period (ton) of Pch Tr.

Step2. When Pch Tr. turns "OFF", L tries to maintain IL at ILmax, so L turns Nch Tr. "ON" and IL (i2) flows into L.

Step3. i2 decreases gradually and reaches ILmin after the open-time period (topen) of Nch Tr., and then Nch Tr. turns "OFF". This is called discontinuous current mode.

As the output current (I_{OUT}) increases, the off-time period (toff) of Pch Tr. runs out before IL reaches ILmin. The next cycle starts, and Pch Tr. turns "ON" and Nch Tr. turns "OFF", which means IL starts increasing from ILmin. This is called continuous current mode.

In the case of PWM control system, V_{OUT} is maintained by controlling ton. During PWM control, the oscillator frequency (fosc) is being maintained constant.

As shown in Diag. 2, when the step-down DC/ DC operation is constant, ILmin and ILmax during ton of Pch Tr. would be same as during toff of Pch Tr.

The current differential between ILmax and ILmin is described as ΔI.

$$\Delta I = ILmax - ILmin = V_{OUT} \times topen / L = (V_{IN} - V_{OUT}) \times ton / L \quad \cdots\cdots \text{Equation 1}$$

However,

$T = 1 / fosc = ton + toff$

$Duty (\%) = ton / T \times 100 = ton \times fosc \times 100$

$topen \leq toff$

In Equation 1, "$V_{OUT} \times topen / L$" shows the amount of current change in "ON" state. Also, "$(V_{IN} - V_{OUT}) \times ton / L$" shows the amount of current change at "OFF" state.

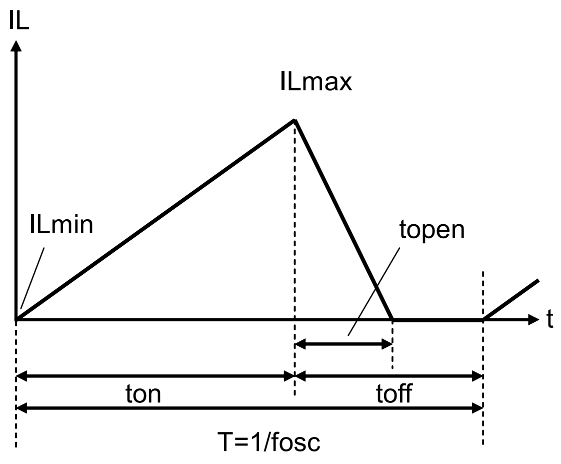
RICOH

Discontinuous Mode and Continuous Mode

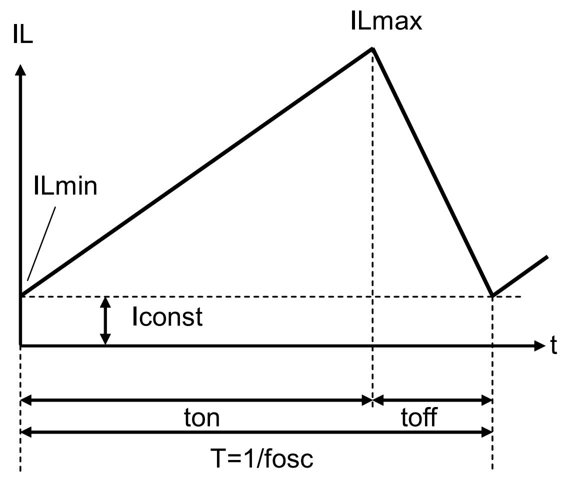
As illustrated in Diag 3., when I_{OUT} is relatively small, topen<toff. In this case, the energy charged into L during ton will be completely discharged during toff, as a result, ILmin=0. This is called discontinuous mode.

When I_{OUT} is gradually increased, eventually topen=toff and when I_{OUT} is increased further, eventually ILmin>0. This is called continuous mode.

Diag 3. Discontinuous Mode



Diag 4. Continuous Mode



In the continuous mode, the solution of Equation 1 is described as tonc.

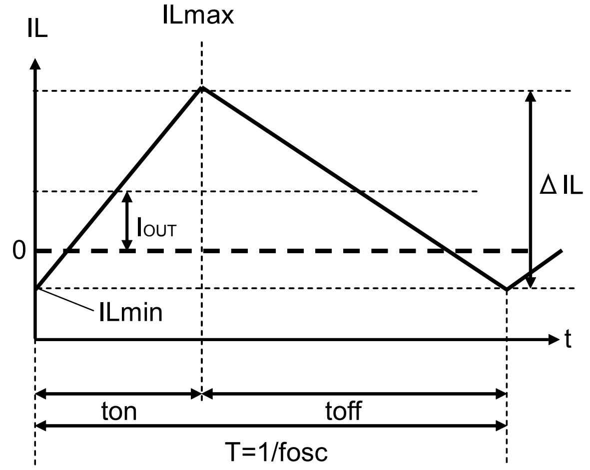
$tonc = T \times V_{OUT} / V_{IN}$ ………… Equation 2

When ton<tonc, it is discontinuous mode, and when ton≧tonc, it is continuous mode.

Forced PWM Mode

By setting the MODE pin to “H”, the IC switches the frequency at the fixed rate to reduce noise even when the output load is light. Therefore, when I_{OUT} is ΔIL/2 or less, ILmin becomes less than 0. That is, the accumulated electricity in CL is discharged through the IC side while IL is increasing from ILmin to 0 during ton, and also while IL is decreasing from 0 to ILmin during toff.

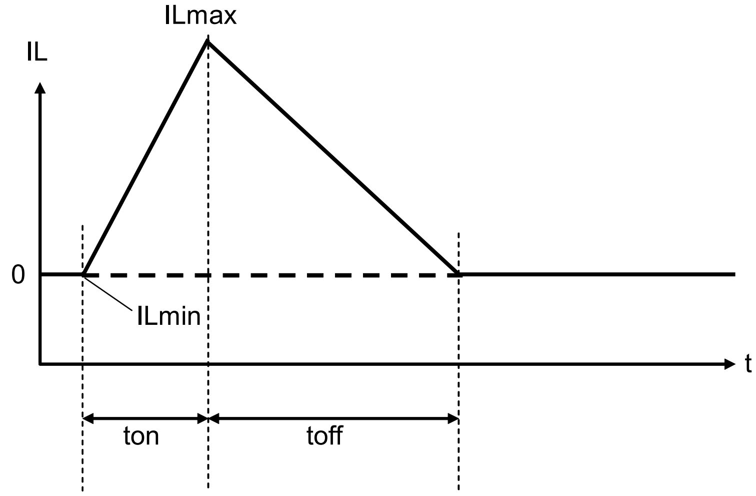
Forced PWM Mode



VFM Mode

By setting the MODE pin to “L”, in low output current, the IC automatically switches into VFM mode in order to achieve high efficiency. In VFM mode, ton is forced to end when the inductor current reaches the pre-set ILmax. In the VFM mode, ILmax is typically set to 400mA for RP506Kxx1A/ B/ C, and 550mA for RP506Kxx1D/ E/ F. When ton reaches 1.5 times of T=1/fosc, ton will be forced to end even if the inductor current is not reached ILmax.

VFM Mode



OUTPUT CURRENT AND SELECTION OF EXTERNAL COMPONENTS

The following equations explain the relationship between output current and peripheral components used in the diagram in "*TYPICAL APPLICATIONS*" (P.9).

Ripple Current P-P value is described as I_{RP}, ON resistance of Pch Tr. is described as R_{ONP}, ON resistance of Nch Tr. is described as R_{ONN}, and DC resistor of the inductor is described as R_L.

First, when Pch Tr. is "ON", the following equation is satisfied.

$$V_{IN} = V_{OUT} + (R_{ONP} + R_L) \times I_{OUT} + L \times I_{RP} / ton \quad \cdots\cdots \text{Equation 3}$$

Second, when Pch Tr. is "OFF" (Nch Tr. is "ON"), the following equation is satisfied.

$$L \times I_{RP} / toff = R_{ONN} \times I_{OUT} + V_{OUT} + R_L \times I_{OUT} \quad \cdots\cdots \text{Equation 4}$$

Put Equation 4 into Equation 3 to solve ON duty of Pch Tr. (D_{ON} = ton / (toff + ton)):

$$D_{ON} = (V_{OUT} + R_{ONN} \times I_{OUT} + R_L \times I_{OUT})/(V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT}) \quad \cdots\cdots \text{Equation 5}$$

Ripple Current is described as follows:

$$I_{RP} = (V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON} / fosc / L \quad \cdots\cdots \text{Equation 6}$$

Peak current that flows through L, and L_X Tr. is described as follows:

$$ILXmax = I_{OUT} + I_{RP} / 2 \quad \cdots\cdots \text{Equation 7}$$

★ Please consider ILxmax when setting conditions of input and output, as well as selecting the external components.

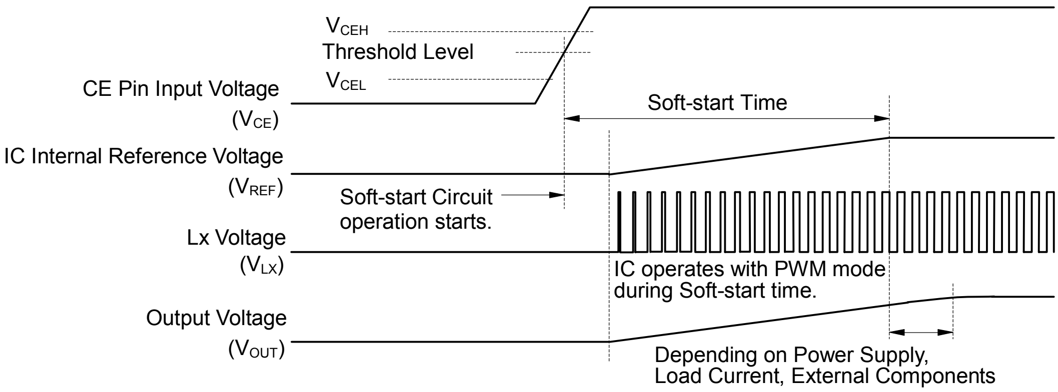
★ The above calculation formulas are based on the ideal operation of the ICs in continuous mode.

TIMING CHART

(1) Soft-start Time

Starting-up with CE Pin

The IC starts to operate when the CE pin voltage (V_{CE}) exceeds the threshold voltage. The threshold voltage is preset between CE “H” input voltage (V_{CEH}) and CE “L” input voltage (V_{CEL}).

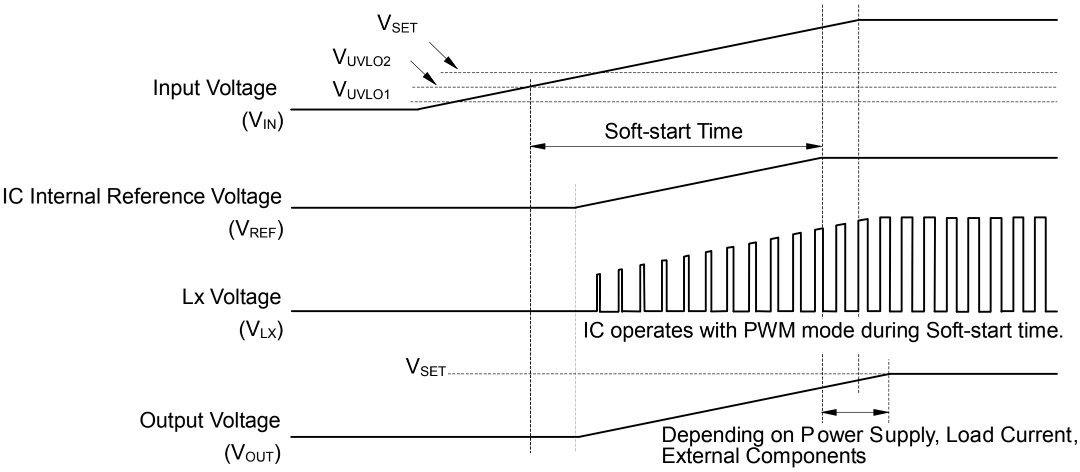


Soft-start time starts when soft-start circuit is activated, and ends when the reference voltage reaches the specified voltage.

★ Soft start time is not always equal to the turn-on speed of the step-down DC/DC converter. Please note that the turn-on speed could be affected by the power supply capacity, the output current, the inductance value and the C_{OUT} value.

Starting-up with Power Supply

After the power-on, when V_{IN} exceeds the UVLO released voltage (V_{UVLO2}), the IC starts to operate. Then, soft-start circuit starts to operate and after a certain period of time, V_{REF} gradually increases up to the specified value. Soft-start time starts when soft-start circuit is activated, and ends when V_{REF} reaches the specified voltage.



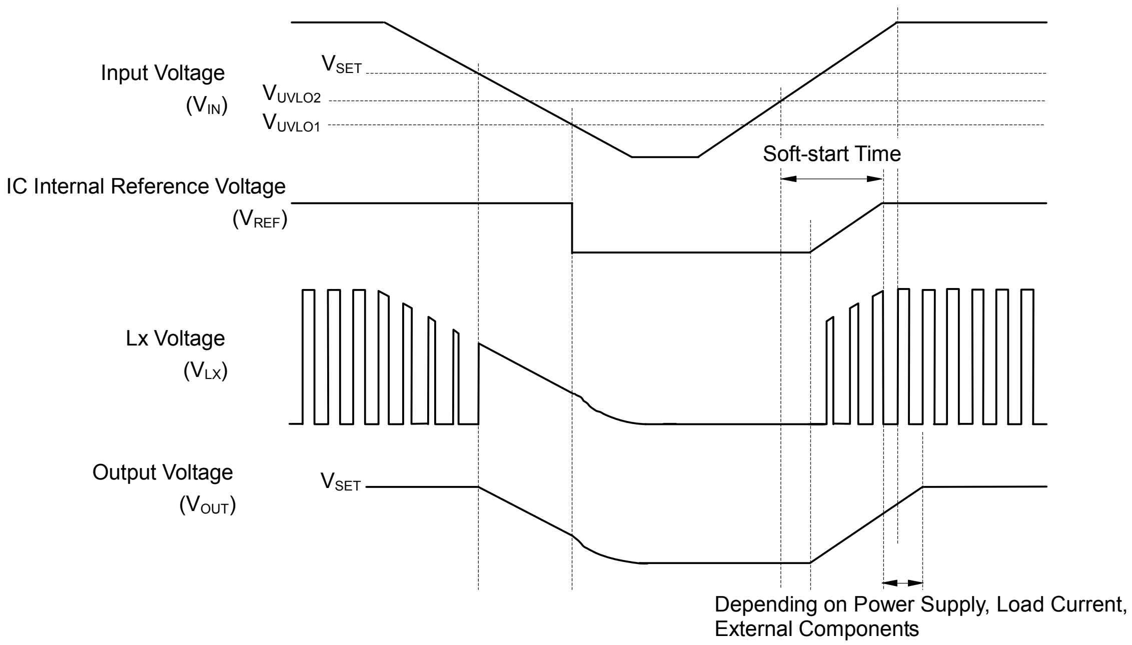
★ Please note that the turn-on speed of V_{OUT} could be affected by the power supply capacity, the output current, the inductance value, the C_{OUT} value and the turn-on speed of V_{IN} determined by C_{IN}.

(2) Under Voltage Lockout (UVLO) Circuit

If V_{IN} becomes lower than V_{SET}, the step-down DC/ DC converter stops the switching operation and ON duty becomes 100%, and then V_{OUT} gradually drops according to V_{IN}.

If the V_{IN} drops more and becomes lower than the UVLO detector threshold (V_{UVLO1}), the UVLO circuit starts to operate, V_{REF} stops, and Pch and Nch built-in switch transistors turn "OFF". As a result, V_{OUT} drops according to the C_{OUT} capacitance value and the load.

To restart the operation, V_{IN} needs to be higher than V_{UVLO2}. The timing chart below shows the voltage shifts of V_{REF}, V_{LX} and V_{OUT} when V_{IN} value is varied.



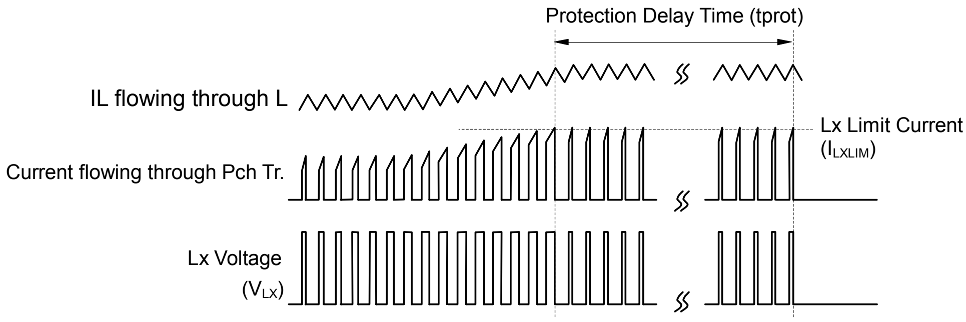
★ Falling edge (operating) and rising edge (releasing) waveforms of V_{OUT} could be affected by the initial voltage of C_{OUT} and the output current of V_{OUT}.

(3) Over Current Protection Circuit, Latch Type Protection Circuit

Over current protection circuit supervises the inductor peak current (the peak current flowing through Pch Tr.) in each switching cycle, and if the current exceeds the L_X current limit (I_{LXLIM}), it turns off Pch Tr. I_{LXLIM} of the RP506K is set to Typ.2800mA.

Latch type protection circuit latches the built-in driver to the OFF state and stops the operation of the step-down DC/ DC converter if the over current status continues or V_{OUT} continues being the half of the setting voltage for equal or longer than protection delay time (tprot).

Notes: I_{LXLIM} and tprot could be easily affected by self-heating or ambient environment. If the V_{IN} drops dramatically or becomes unstable due to short-circuit, protection operation and tprot could be affected.

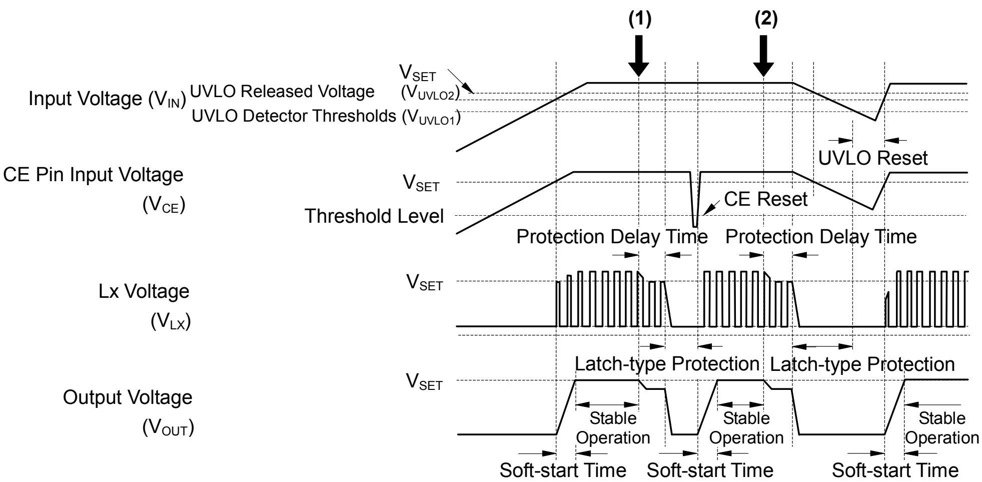


To release the latch type protection circuit, restart the IC by inputting "L" signal to the CE pin, or restart the IC with power-on or make the supply voltage lower than V_{UVLO1}.

The timing chart below shows the voltage shift of V_{CE}, V_{LX} and V_{OUT} when the IC status is changed by the following orders: V_{IN} rising → stable operation → high load → CE reset → stable operation → V_{IN} falling → V_{IN} recovering → stable operation.

(1) If the large current flows through the circuit or the IC goes into low V_{OUT} condition due to short-circuit or other reasons, the latch type protection circuit latches the built-in driver to "OFF" state after tprot. Then, V_{LX} becomes "L" and V_{OUT} turns "OFF". In this timing chart below, the latch protection circuit is released by once setting the IC into "L" with the CE pin and then setting it back to "H".

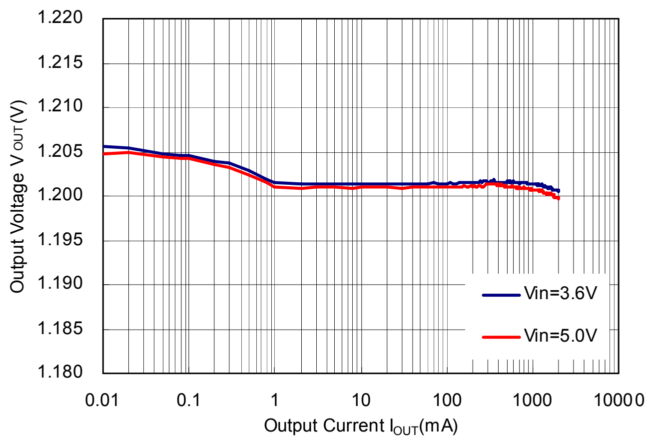
(2) The latch type protection is released by UVLO reset, which makes V_{IN} lower than V_{UVLO1}.



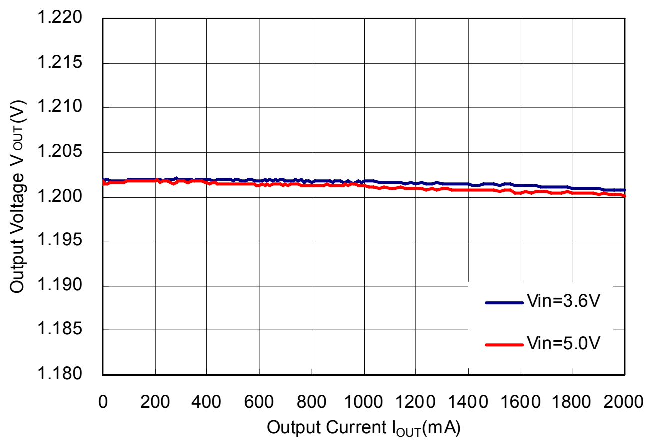
TYPICAL PERFORMANCE CHARACTERISTICS

1) Output Voltage vs. Output Current

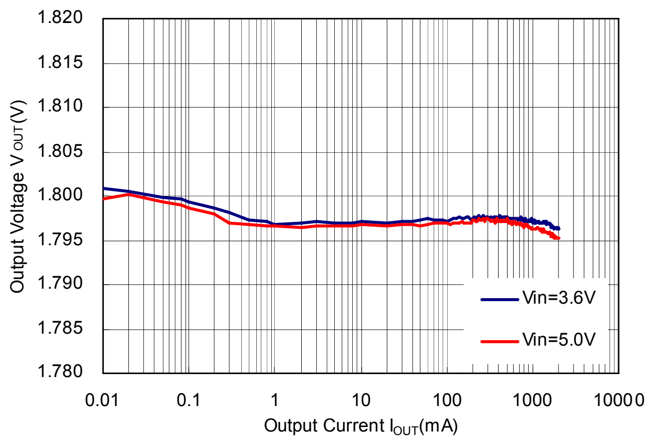
RP506Kxx1A/B/C V_{OUT}=1.2V
MODE="L"PWM/VFM Auto Switching Control



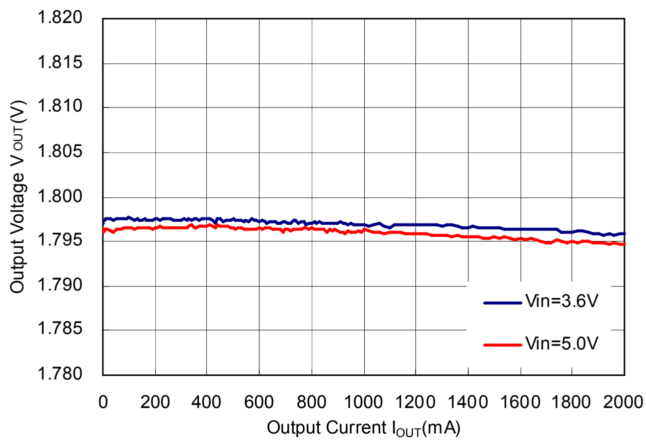
RP506Kxx1A/B/C V_{OUT}=1.2V
MODE="H" Forced PWM Control



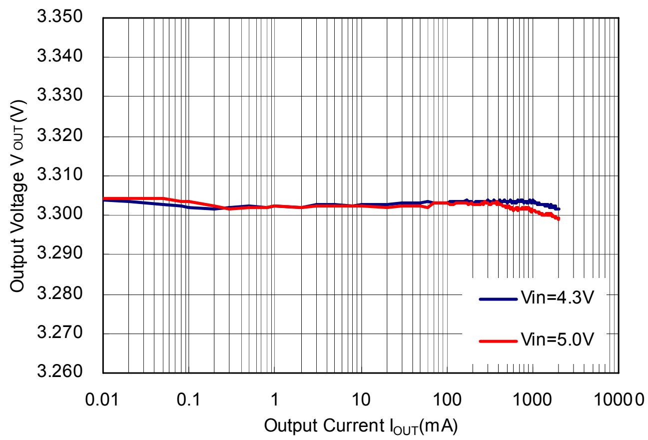
RP506Kxx1A/B/C V_{OUT}=1.8V
MODE="L"PWM/VFM Auto Switching Control



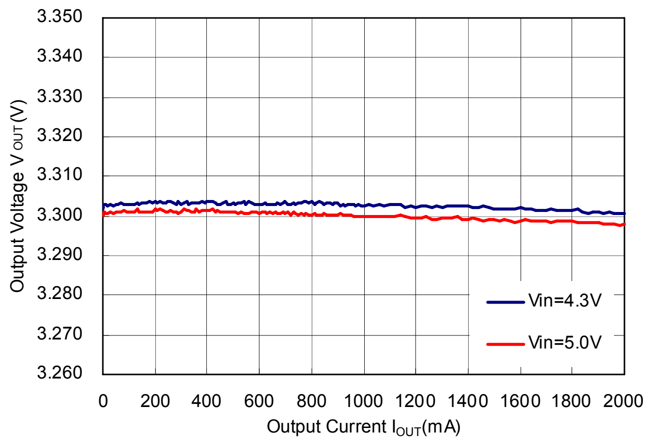
RP506Kxx1A/B/C V_{OUT}=1.8V
MODE="H" Forced PWM Control



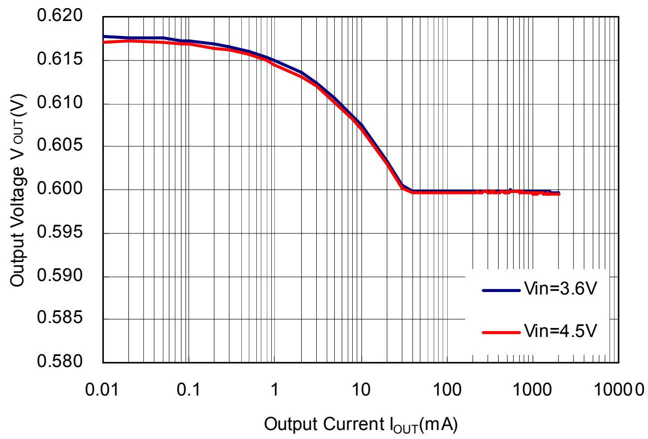
RP506Kxx1A/B/C V_{OUT}=3.3V
MODE="L"PWM/VFM Auto Switching Control



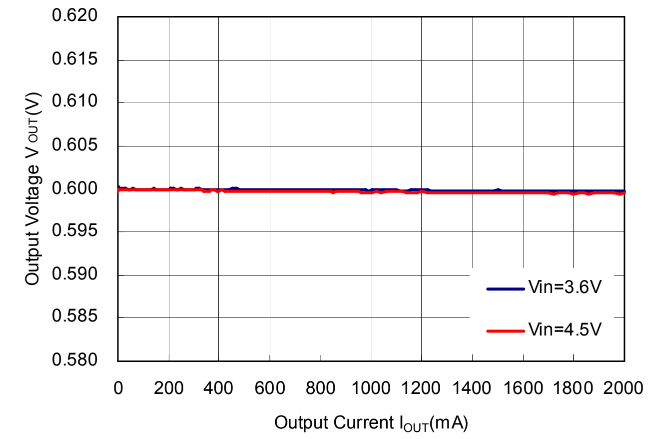
RP506Kxx1A/B/C V_{OUT}=3.3V
MODE="H" Forced PWM Control



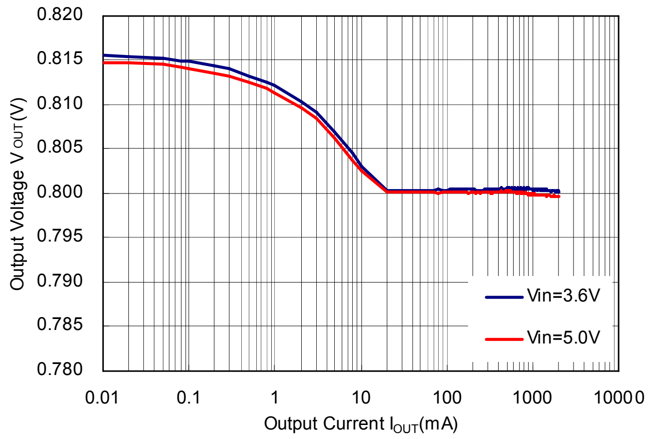
RP506Kxx1D/E/F V_{OUT}=0.6V
MODE="L"PWM/VFM Auto Switching Control



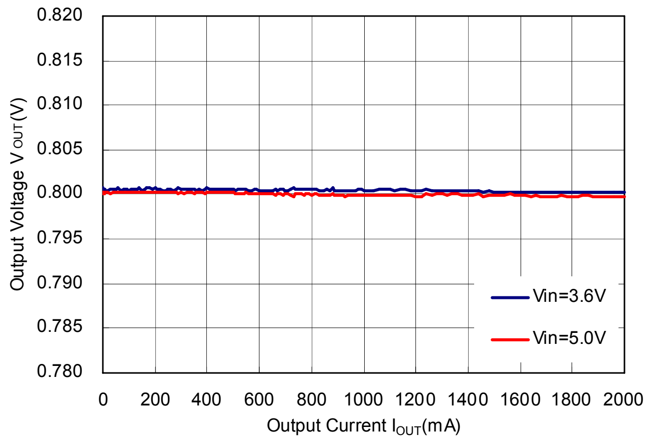
RP506Kxx1D/E/F V_{OUT}=0.6V
MODE="H" Forced PWM Control



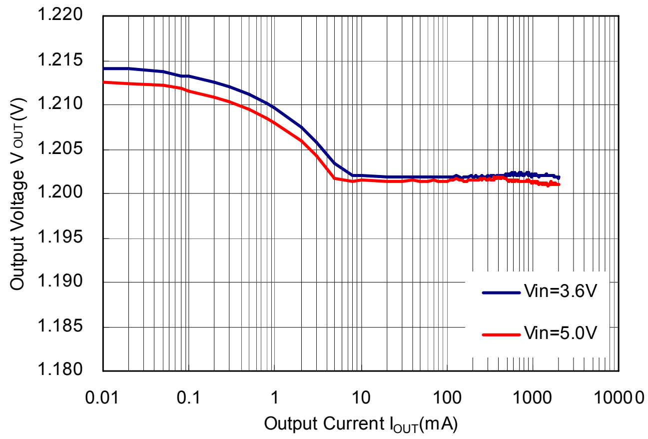
RP506 Kxx1D/E/F V_{OUT}=0.8V
MODE="L"PWM/VFM Auto Switching Control



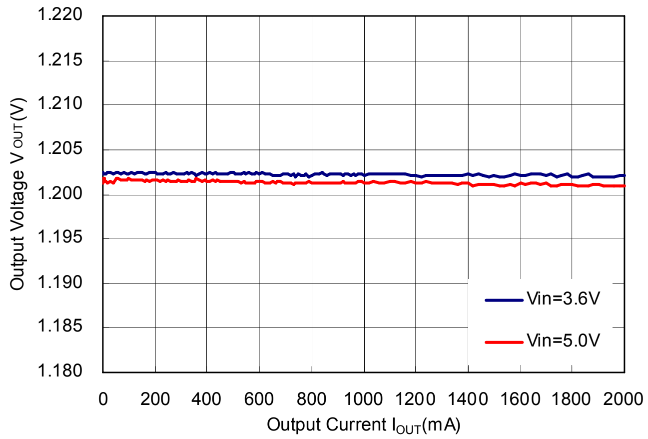
RP506 Kxx1D/E/F V_{OUT}=0.8V
MODE="H" Forced PWM Control



RP506 Kxx1D/E/F V_{OUT}=1.2V
MODE="L"PWM/VFM Auto Switching Control

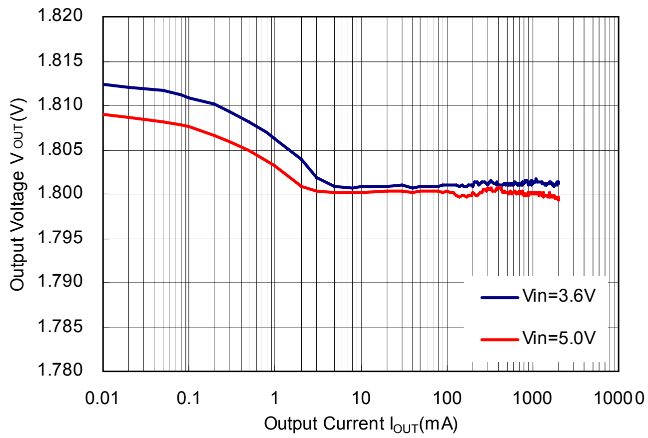


RP506 Kxx1D/E/F V_{OUT}=1.2V
MODE="H" Forced PWM Control



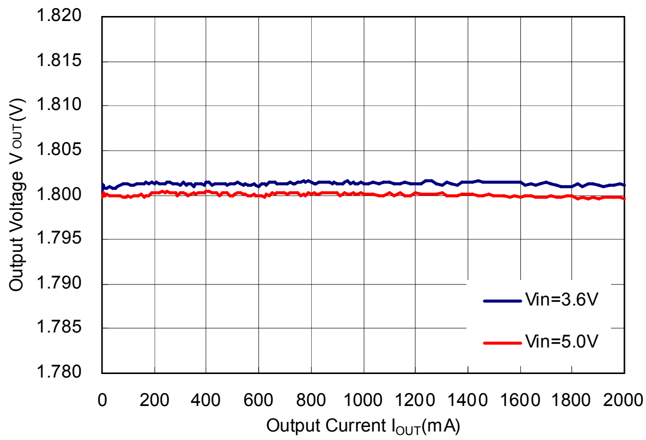
RP506 Kxx1D/E/F V_{OUT}=1.8V

MODE="L"PWM/VFM Auto Switching Control



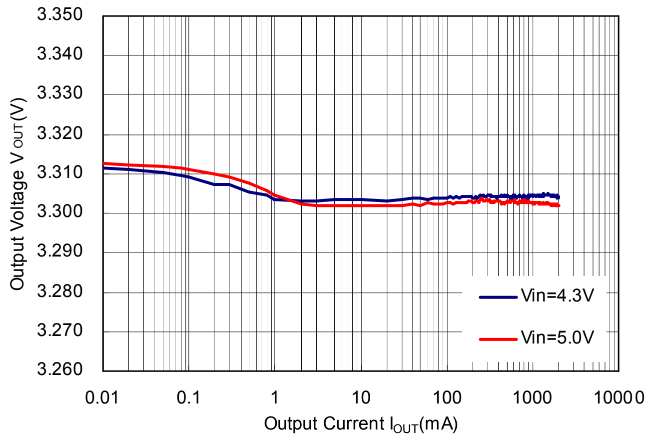
RP506 Kxx1D/E/F V_{OUT}=1.8V

MODE="H" Forced PWM Control



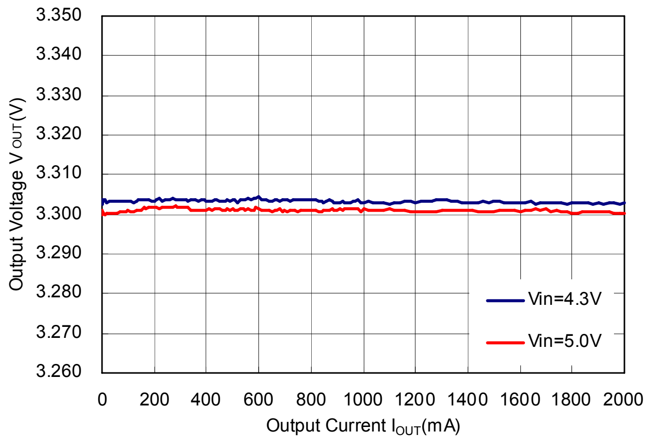
RP506 Kxx1D/E/F V_{OUT}=3.3V

MODE="L"PWM/VFM Auto Switching Control



RP506 Kxx1D/E/F V_{OUT}=3.3V

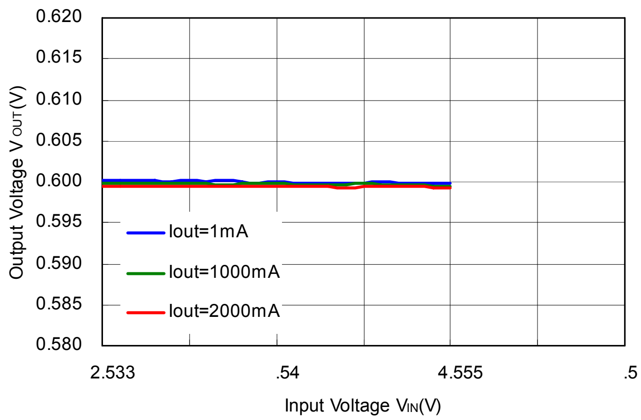
MODE="H" Forced PWM Control



2) Output Voltage vs. Input Voltage

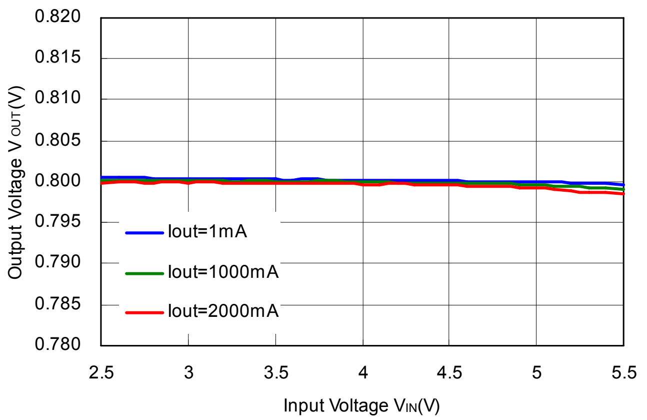
RP506 Kxx1D/E/F V_{OUT}=0.6V

MODE="H" Forced PWM Control

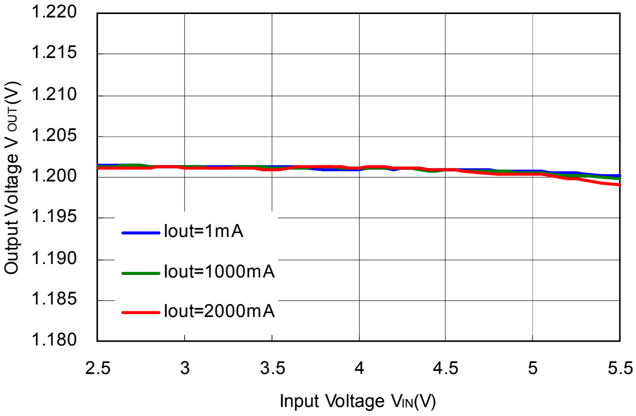


RP506 Kxx1D/E/F V_{OUT}=0.8V

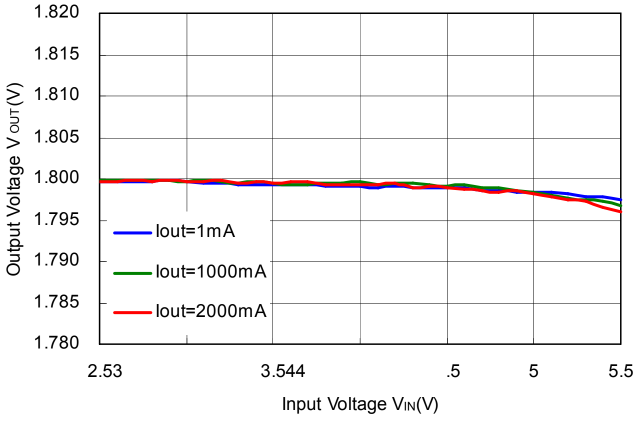
MODE="H" Forced PWM Control



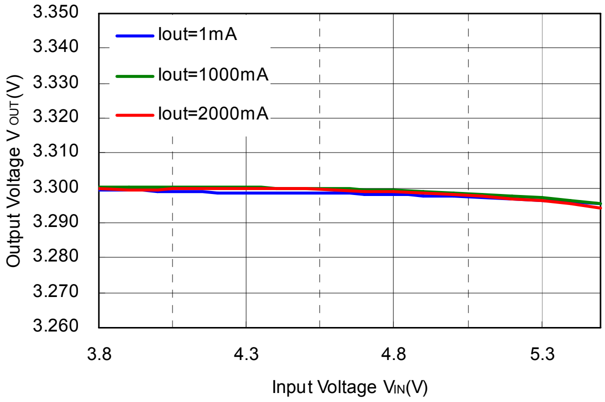
RP506K V$_{OUT}$=1.2V
MODE="H" Forced PWM Control



RP506K V$_{OUT}$=1.8V
MODE="H" Forced PWM Control

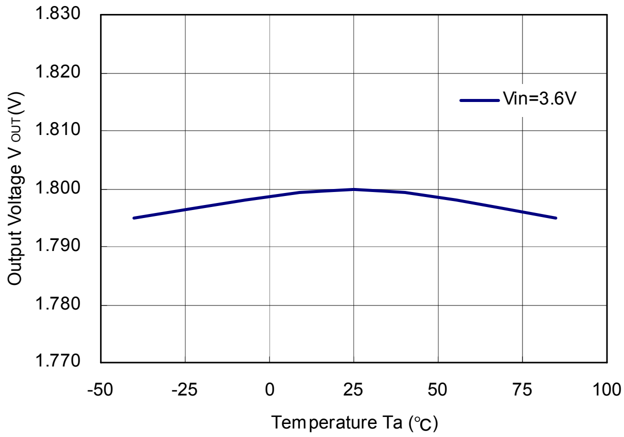


RP506K V$_{OUT}$=3.3V
MODE="H" Forced PWM Control



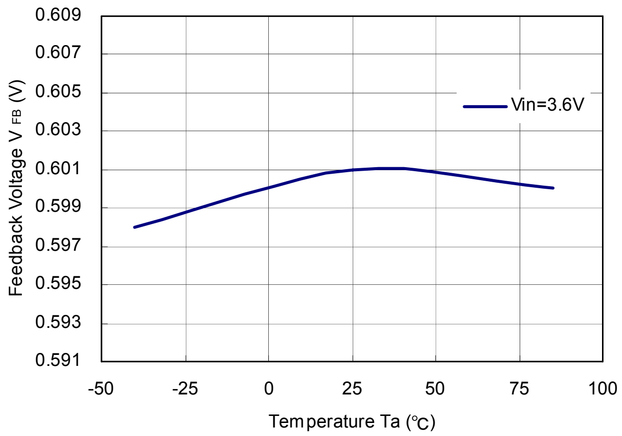
3) Output Voltage vs. Ambient Temperature

RP506 K181A/B/D/E V$_{OUT}$=1.8V



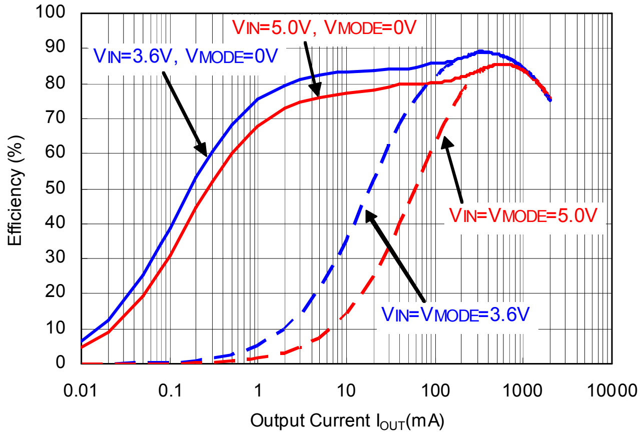
4) Feedback Voltage vs. Ambient Temperature

RP506K001C/F

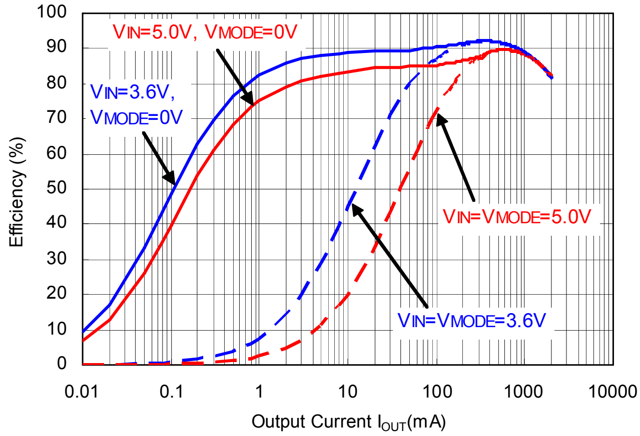


5) Efficiency vs. Output Current

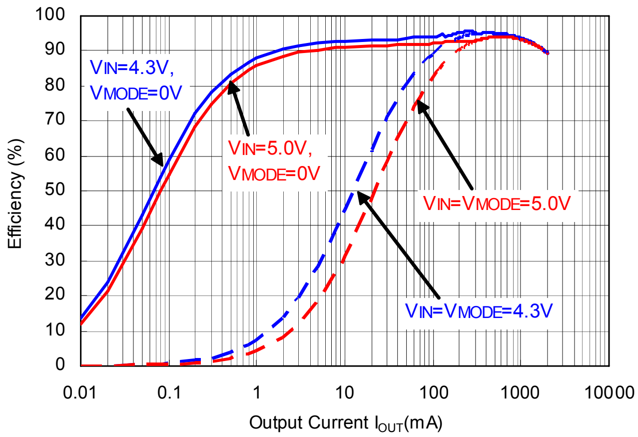
RP506 Kxx1A/B/C V_{OUT}=1.2V



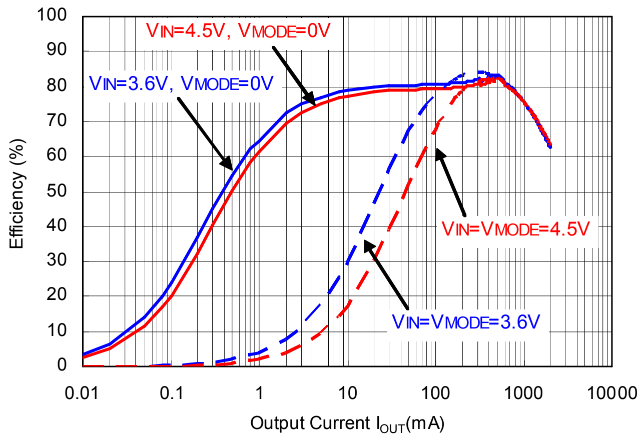
RP506 Kxx1A/B/C V_{OUT}=1.8V



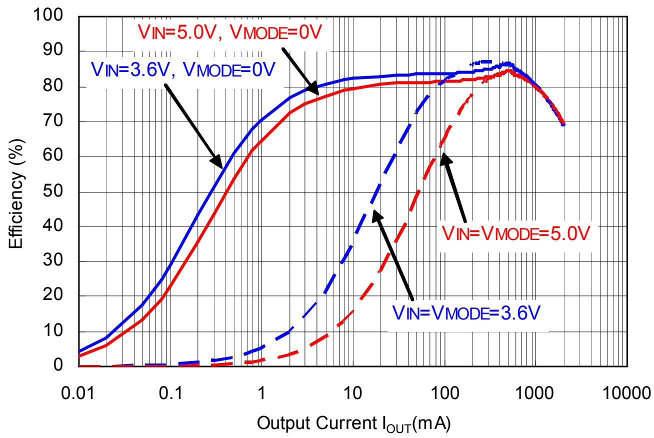
RP506 Kxx1A/B/C V_{OUT}=3.3V



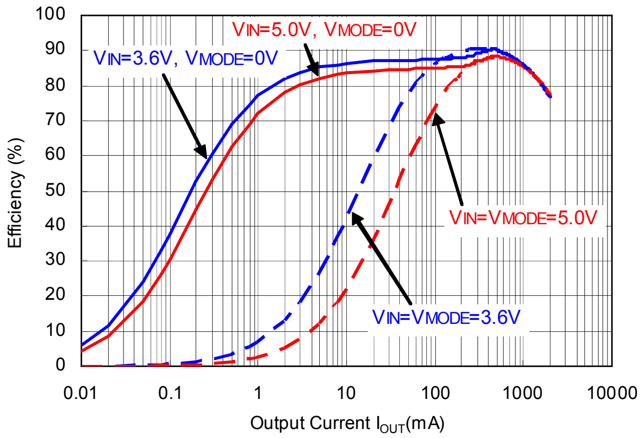
RP506 Kxx1D/E/F V_{OUT}=0.6V



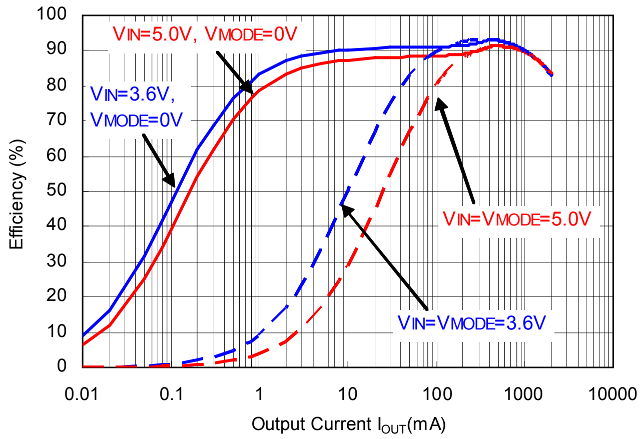
RP506 Kxx1D/E/F V_{OUT}=0.8V



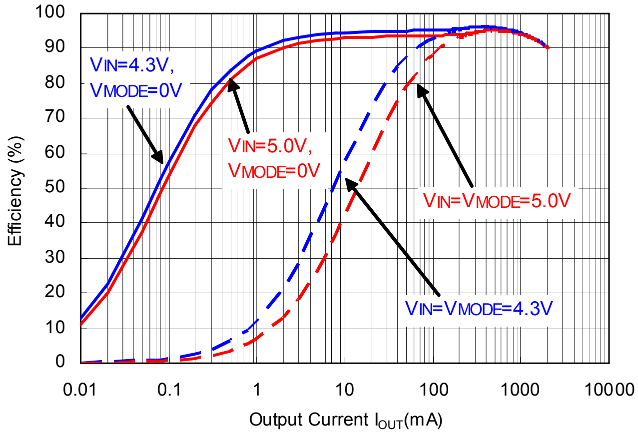
RP506 Kxx1D/E/F V_{OUT}=1.2V



RP506 Kxx1D/E/F V_{OUT}=1.8V



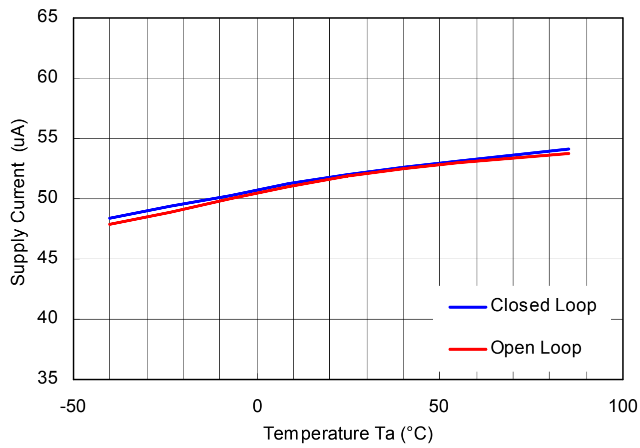
RP506Kxx1D/E/F V_{OUT}=3.3V



6) Supply Current vs. Ambient Temperature

RP506 K V_{OUT}=1.8V(V_{IN}=5.5V)

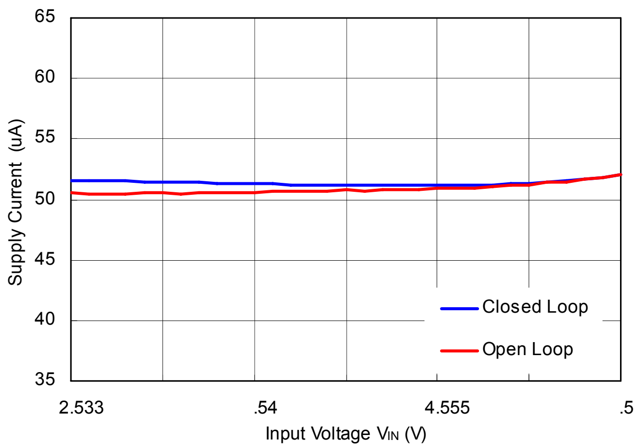
MODE="L"PWM/VFM Auto Switching Control



7) Supply Current vs. Input Voltage

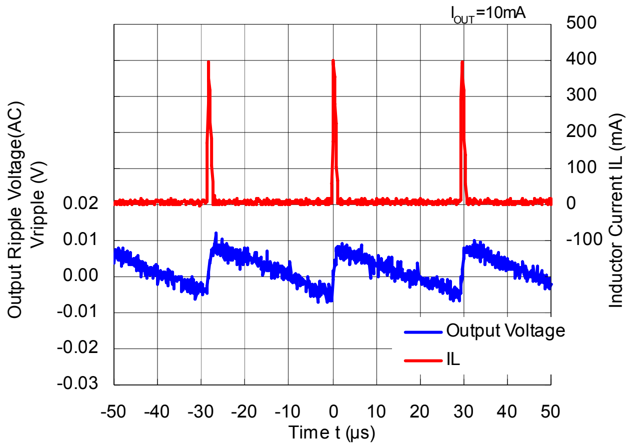
RP506 K V_{OUT}=1.8V

MODE="L"PWM/VFM Auto Switching Control

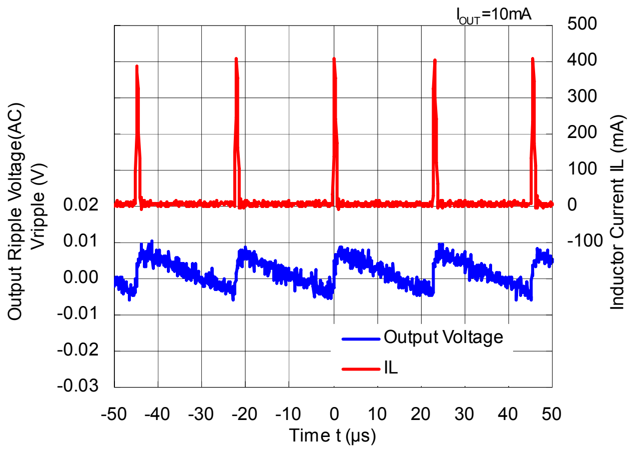


8) Output Voltage Waveform

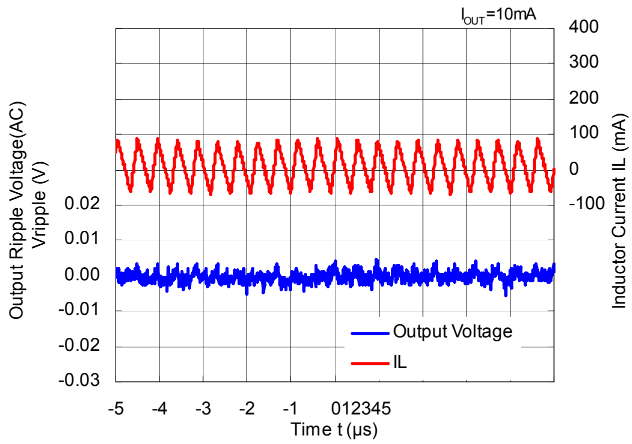
RP506 Kxx1A/B/C V_{OUT}=0.8V(V_{IN}=3.6V)
MODE ="L"PWM/VFM Auto Switching Control



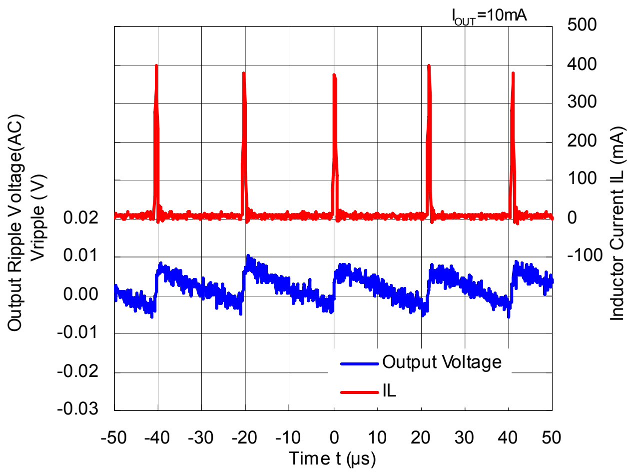
RP506Kxx1A/B/C V_{OUT}=1.2V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



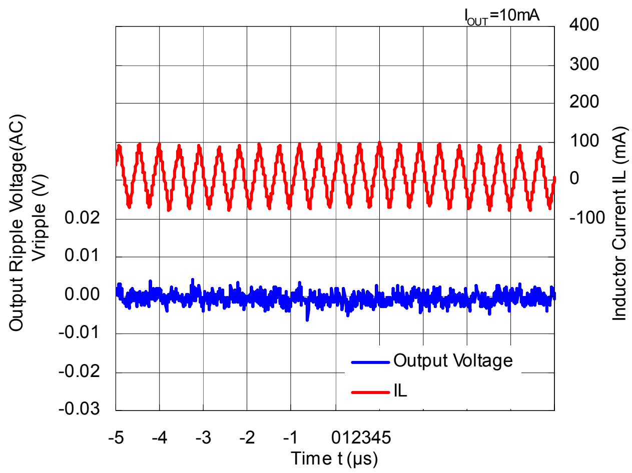
RP506Kxx1A/B/C V_{OUT}=1.2V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



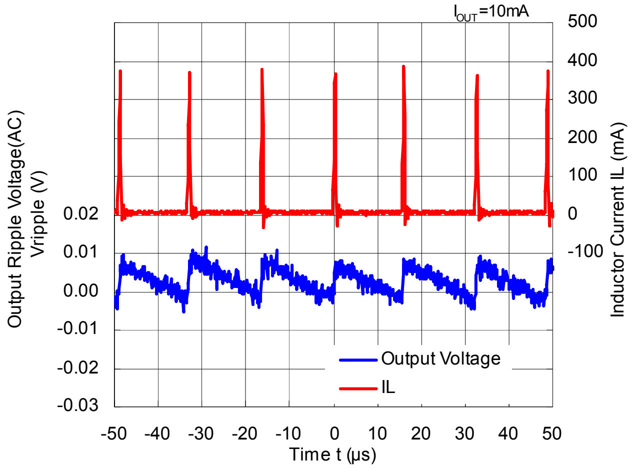
RP506Kxx1A/B/C V_{OUT}=1.8V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



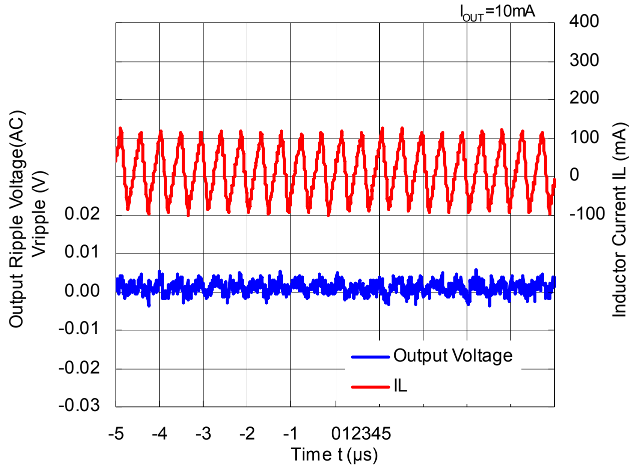
RP506 Kxx1A/B/C V_{OUT}=1.8V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



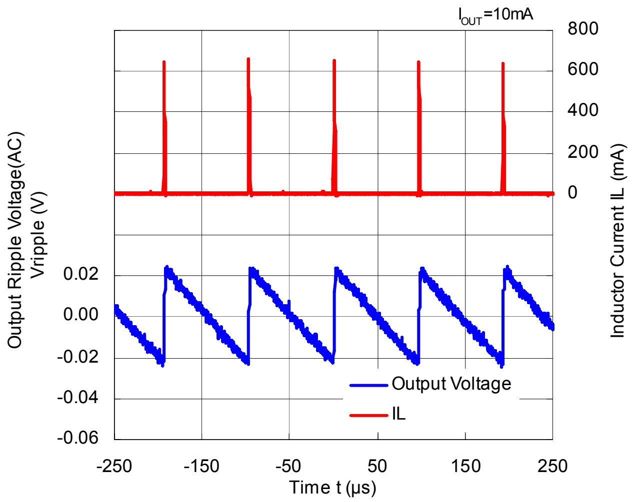
RP506Kxx1A/B/C V_{OUT}=3.3V(V_{IN}=5.0V)
MODE="L"PWM/VFM Auto Switching Control



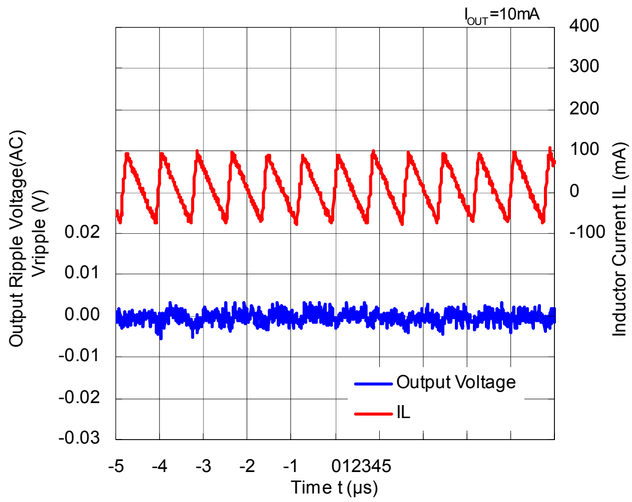
RP506Kxx1A/B/C V_{OUT}=1.8V(V_{IN}=5.0V)
MODE="H" Forced PWM Control



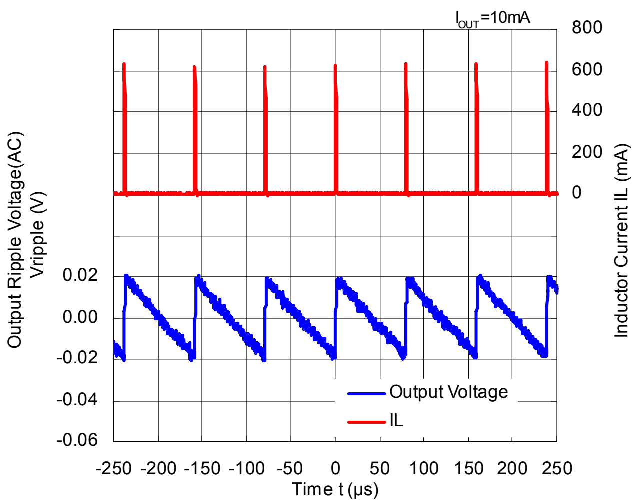
RP506Kxx1D/E/F V_{OUT}=0.6V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



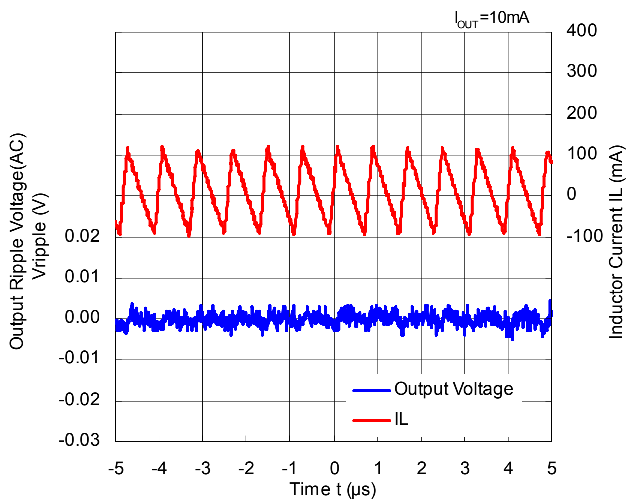
RP506Kxx1D/E/F V_{OUT}=0.6V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



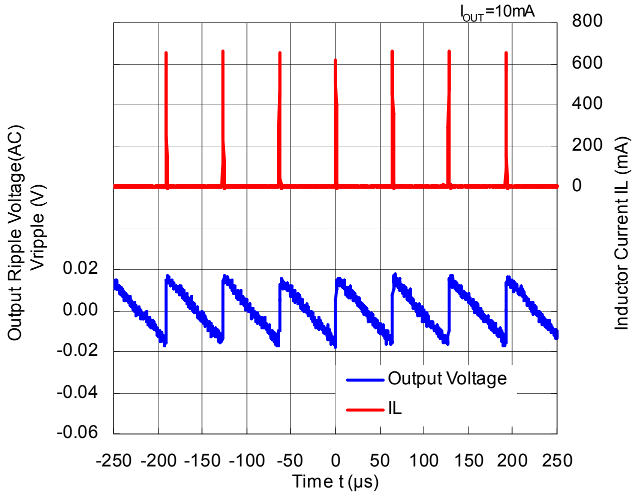
RP506Kxx1D/E/F V_{OUT}=0.8V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



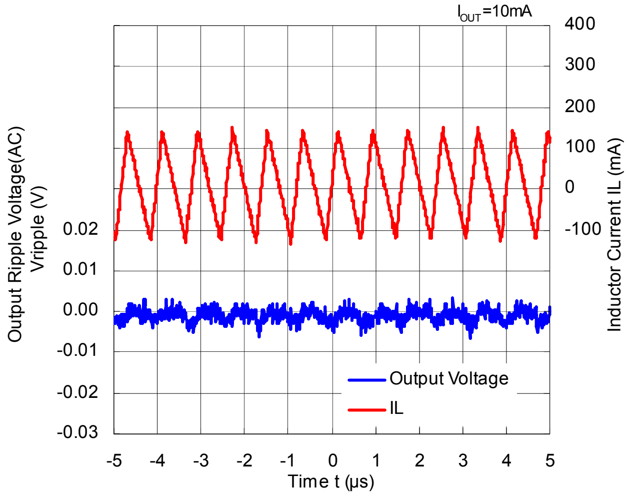
RP506Kxx1D/E/F V_{OUT}=0.8V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



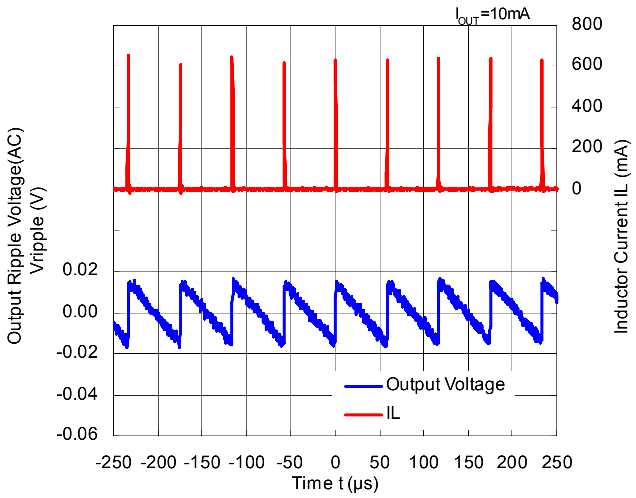
RP506Kxx1D/E/F V_{OUT}=1.2V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



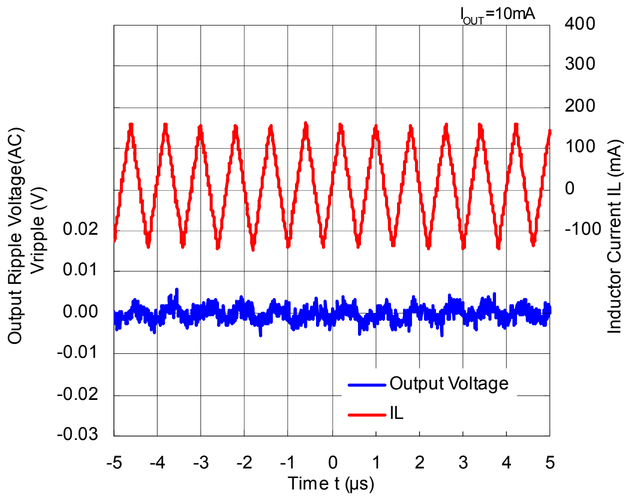
RP506Kxx1D/E/F V_{OUT}=1.2V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



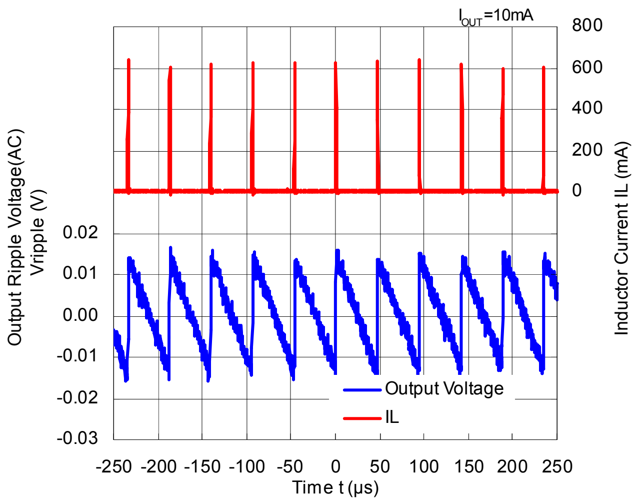
RP506Kxx1D/E/F V_{OUT}=1.8V(V_{IN}=3.6V)
MODE="L"PWM/VFM Auto Switching Control



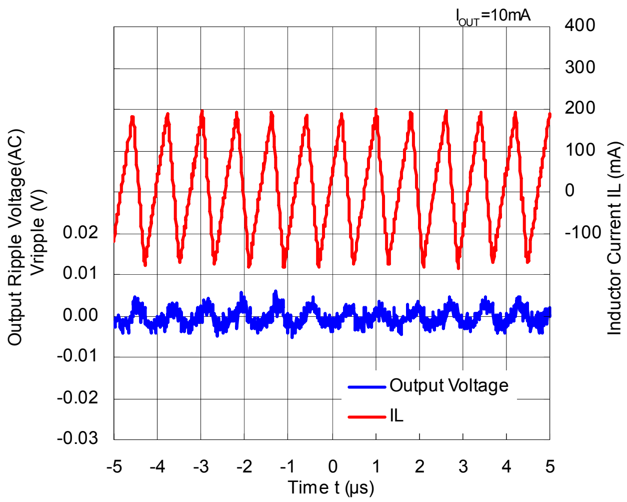
RP506Kxx1D/E/F V_{OUT}=1.8V(V_{IN}=3.6V)
MODE="H" Forced PWM Control



RP506Kxx1D/E/F V_{OUT}=3.3V(V_{IN}=5.0V)
MODE="L"PWM/VFM Auto Switching Control

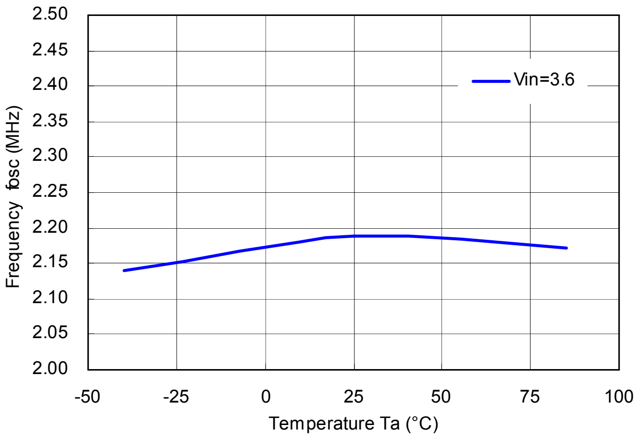


RP506Kxx1D/E/F V_{OUT}=3.3V(V_{IN}=5.0V)
MODE="H" Forced PWM Control

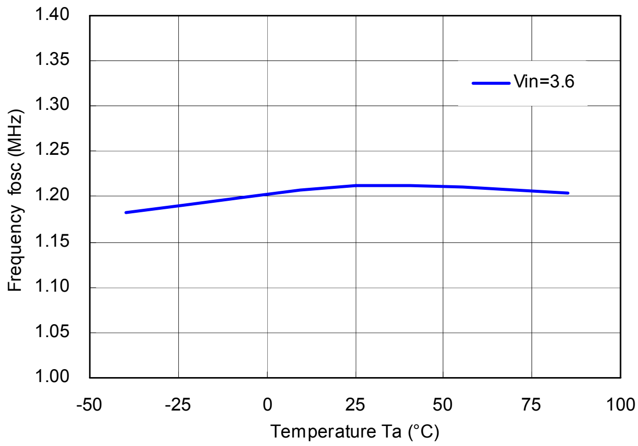


9) Oscillator Frequency vs. Ambient Temperature

RP506Kxx1A/B/C

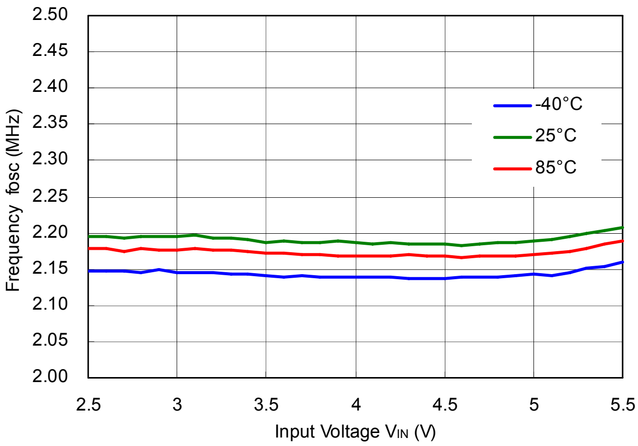


RP506Kxx1D/E/F

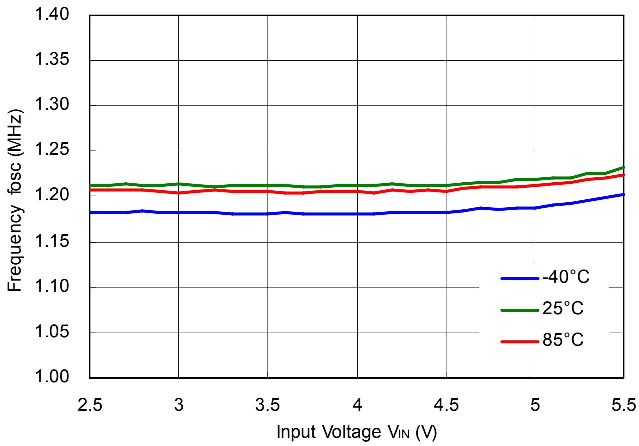


10) Oscillator Frequency vs. Input Voltage

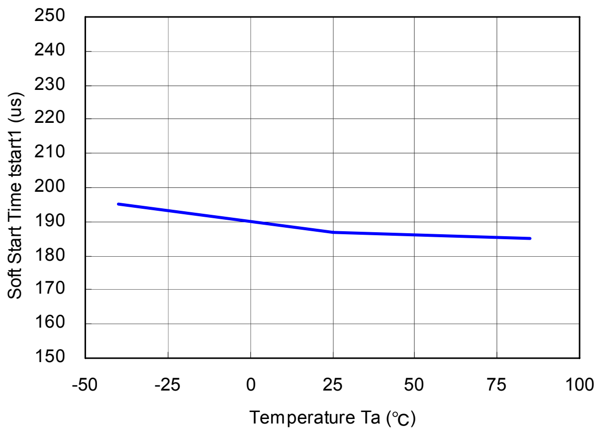
RP506Kxx1A/B/C



RP506Kxx1D/E/F

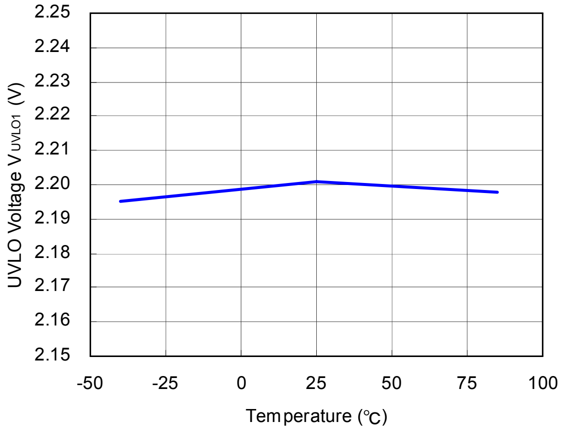


11) Soft-start Time vs. Ambient Temperature

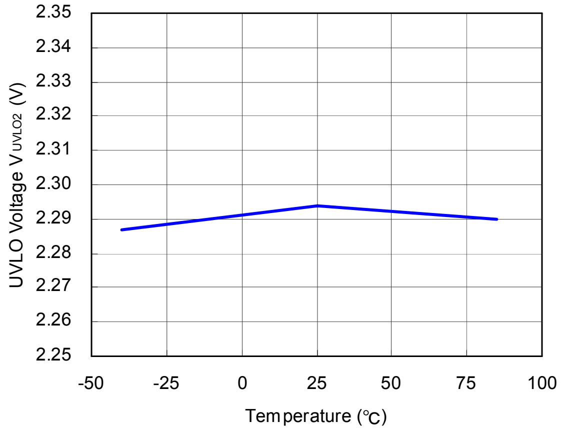


12) UVLO Detector Threshold/ Released Voltage vs. Ambient Temperature

UVLO Detector Threshold

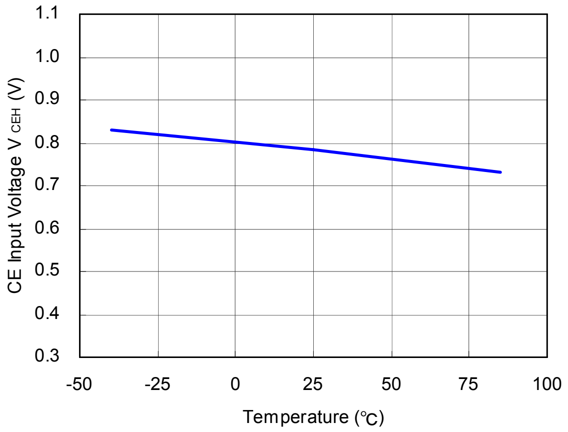


UVLO Released Voltage

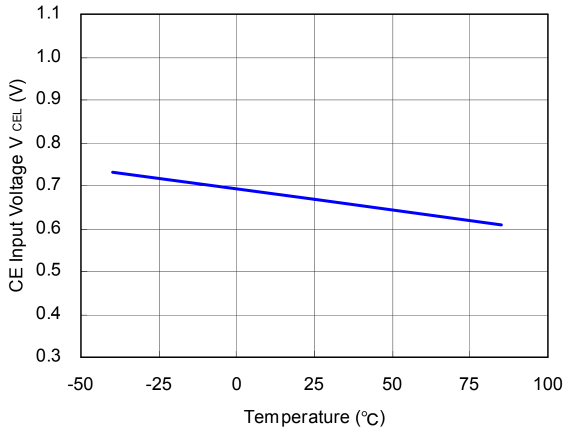


13) CE Input Voltage vs. Ambient Temperature

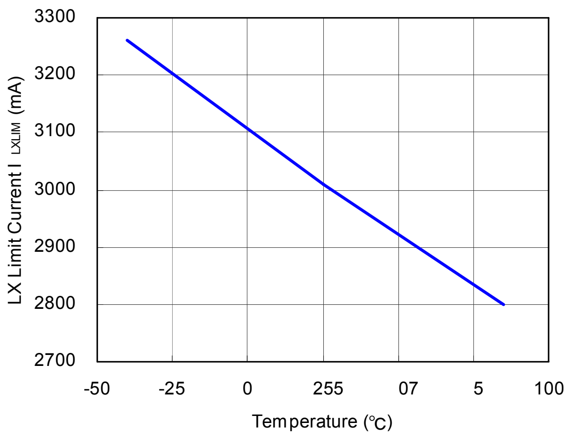
CE"H" Input Voltage (V_{IN}=5.5V)



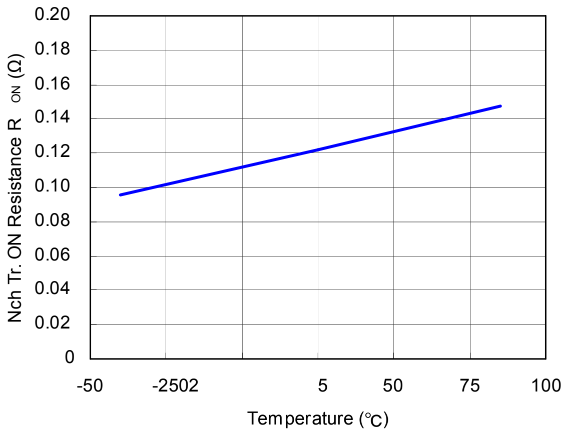
CE"L" Input Voltage (V_{IN}=2.5V)



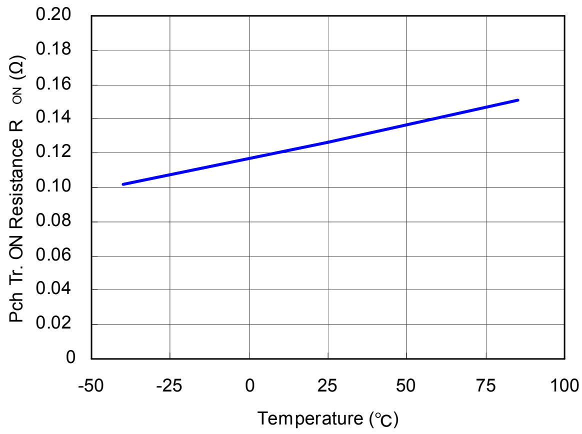
14) Lx Limit Current vs. Ambient Temperature



15) Nch Tr. On Resistance vs. Ambient Temperature

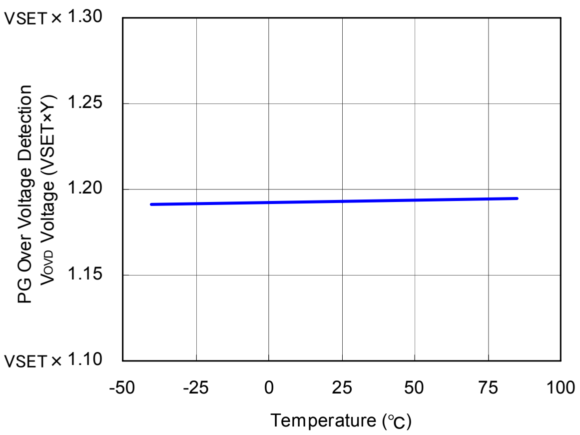


16) Pch Tr. On Resistance vs. Ambient Temperature

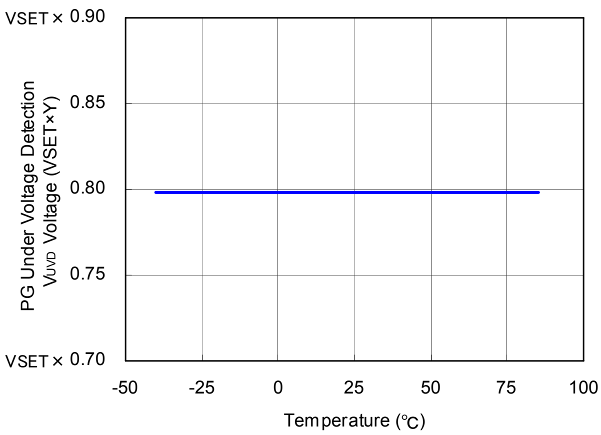


17) PG Detector Threshold vs. Ambient Temperature

Over Voltage Detection (V_{OVD})

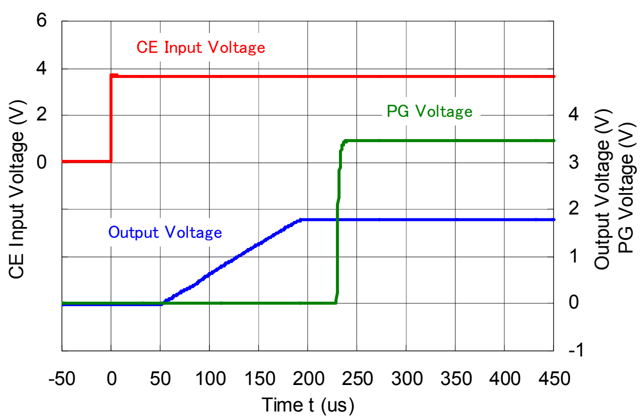


Under Voltage Detection (V_{UVD})

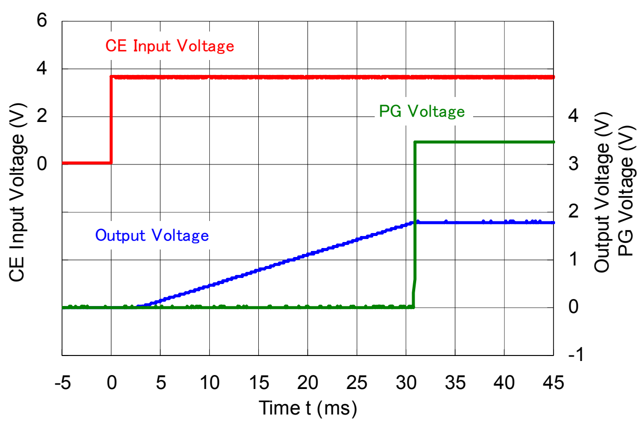


18) Soft-start Waveform

RP506K V_{OUT}=1.8V T_{SS}=Open

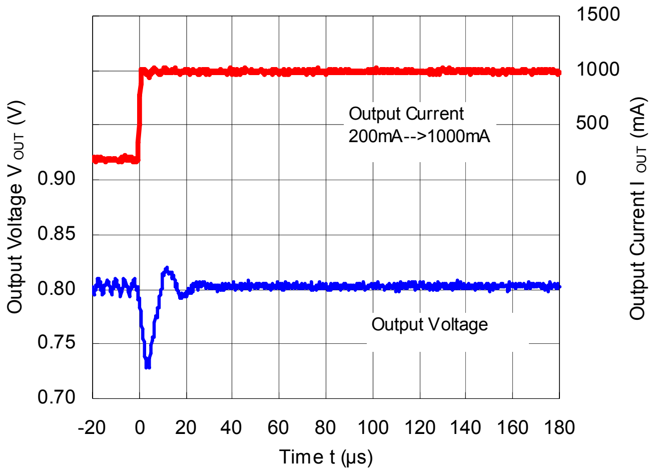


RP506K V_{OUT}=1.8V T_{SS}=0.1μF

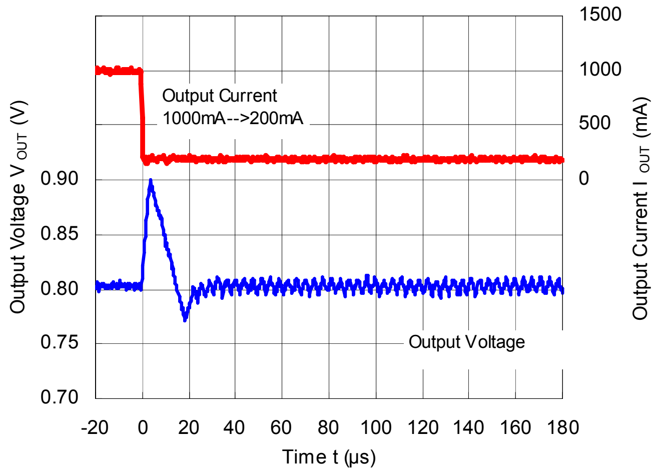


19) Load Transient Response

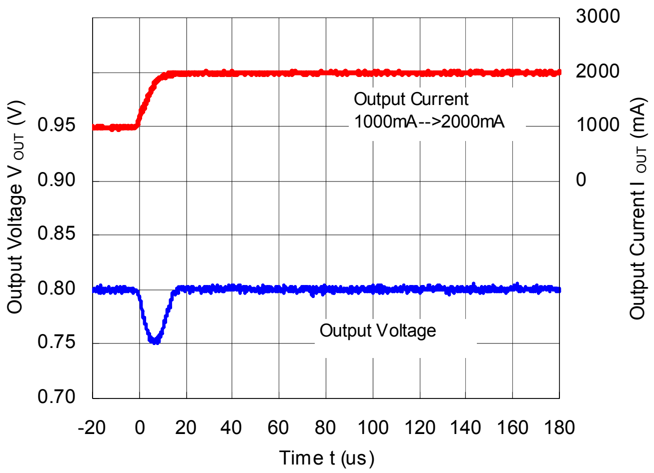
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=0.8V)
MODE="L"PWM/VFM Auto Switching Control



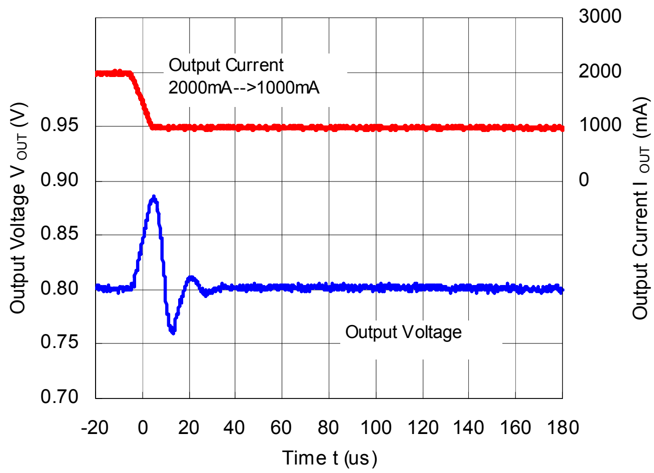
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=0.8V)
MODE="L"PWM/VFM Auto Switching Control



RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=0.8V)
MODE="L"PWM/VFM Auto Switching Control

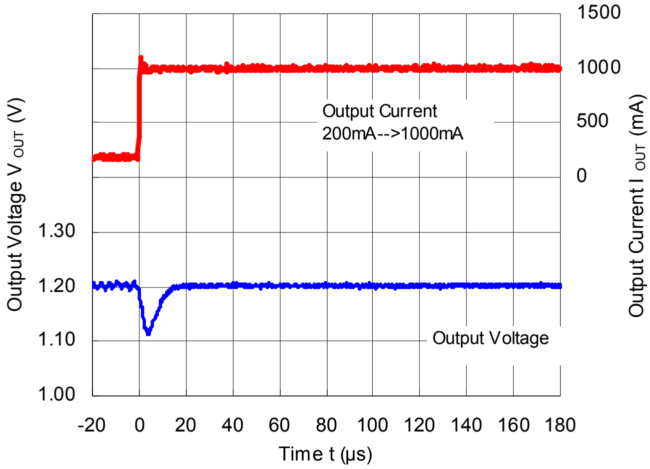


RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=0.8V)
MODE="L"PWM/VFM Auto Switching Control

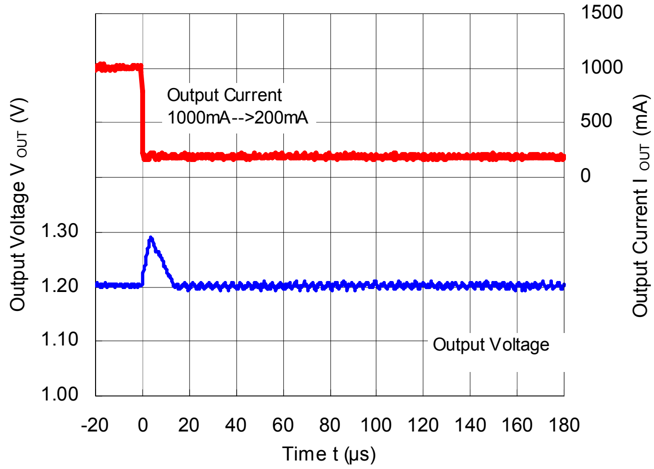


RICOH

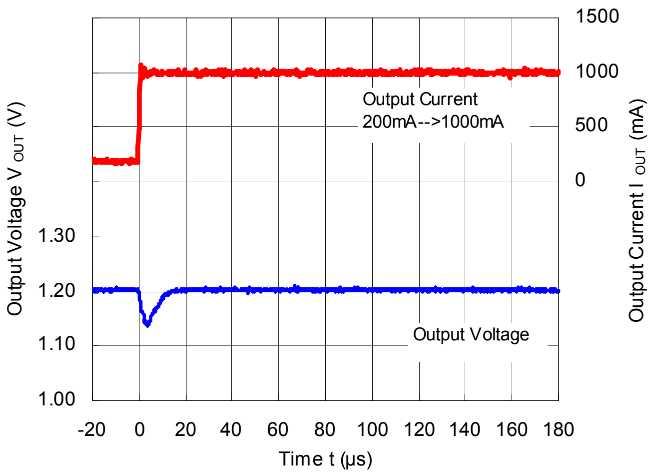
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="L"PWM/VFM Auto Switching Control



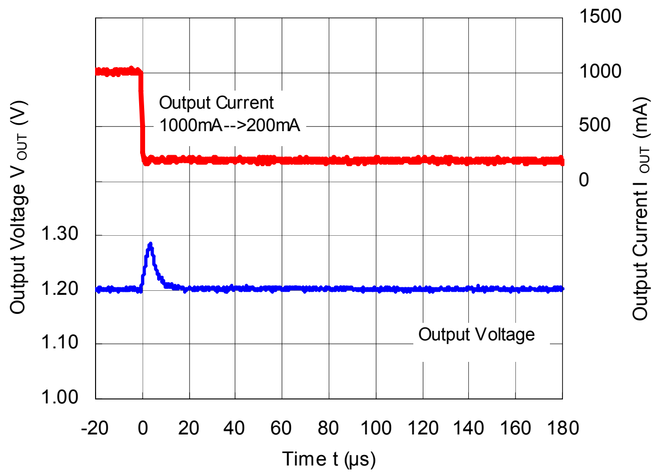
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="L"PWM/VFM Auto Switching Control



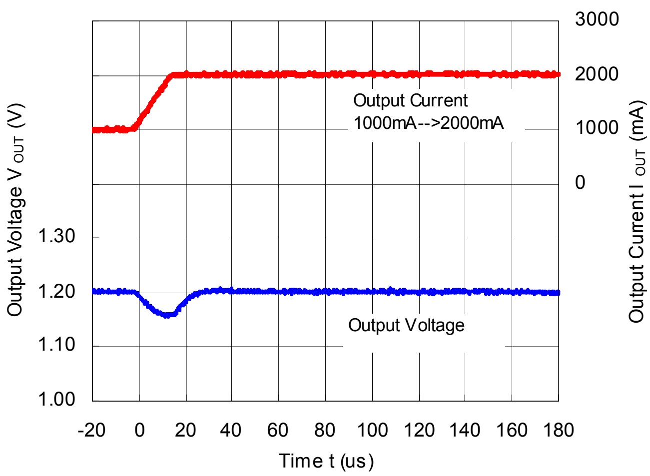
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="H" Forced PWM Control



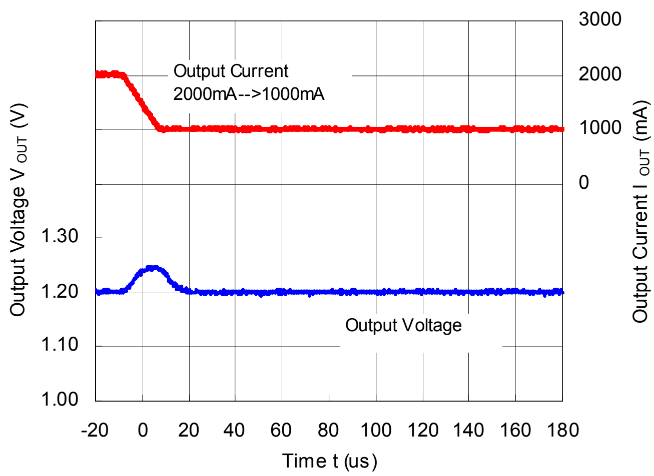
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="H" Forced PWM Control



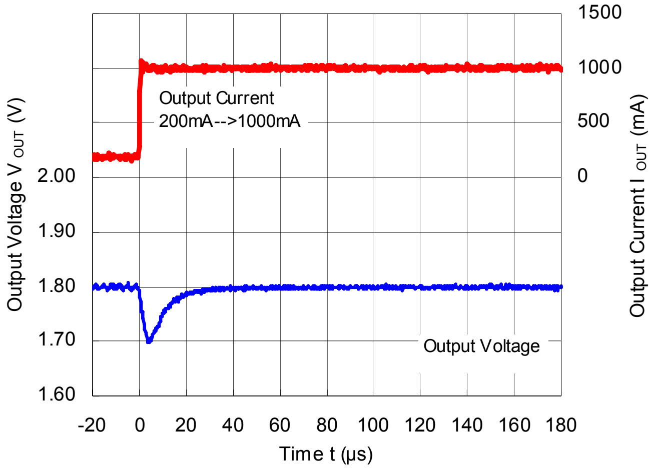
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)



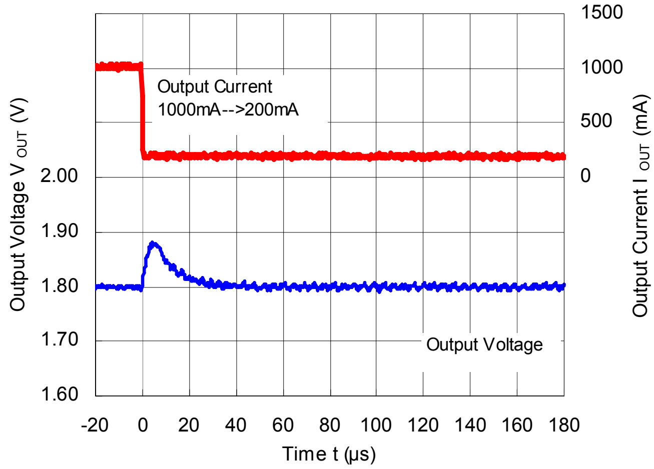
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V)



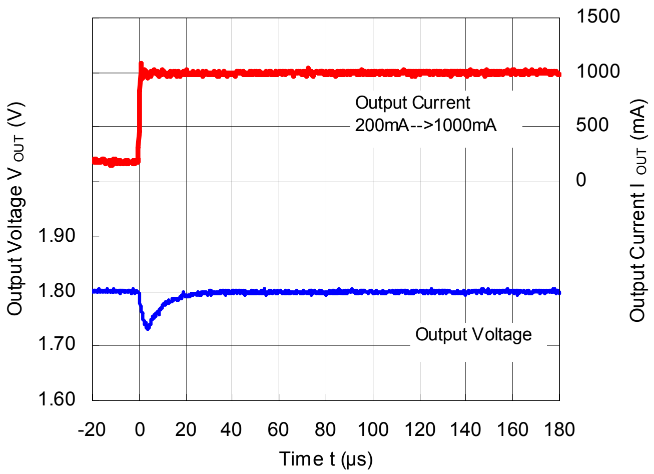
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)
MODE="L"PWM/VFM Auto Switching Control



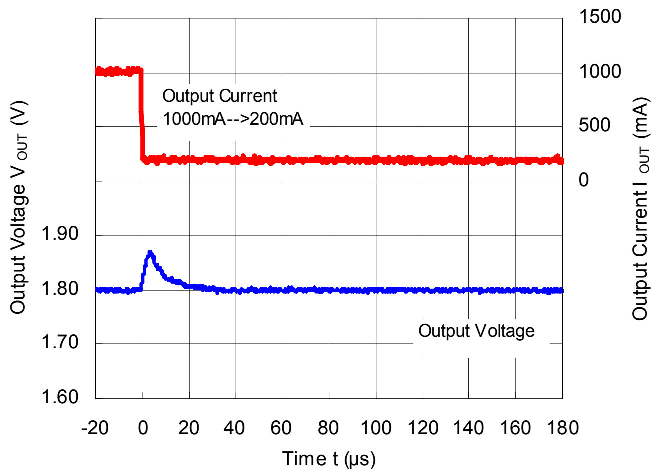
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)
MODE="L"PWM/VFM Auto Switching Control



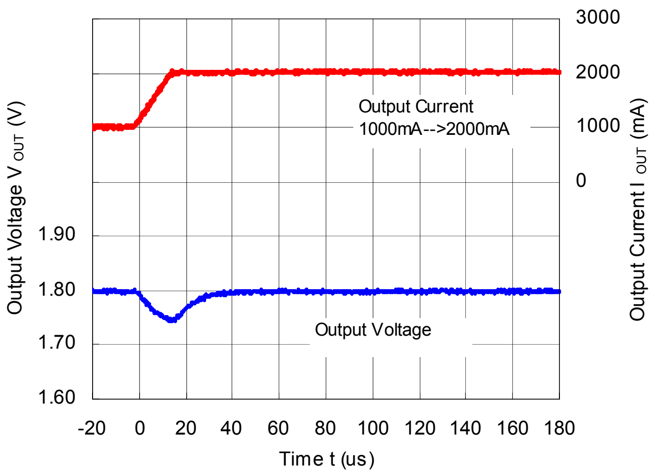
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)
MODE="H" Forced PWM Control



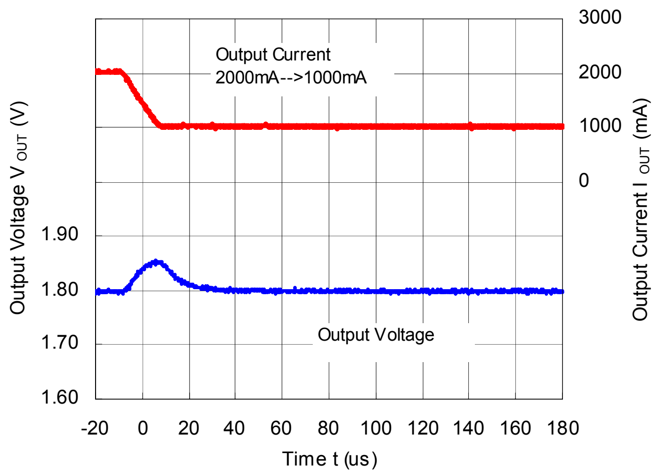
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)
MODE="H" Forced PWM Control



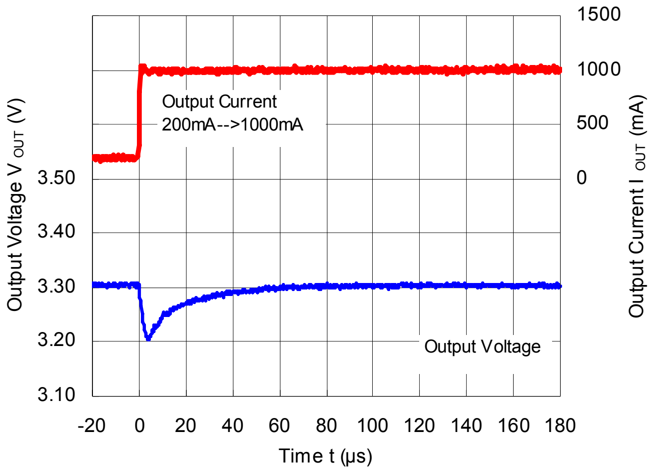
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)



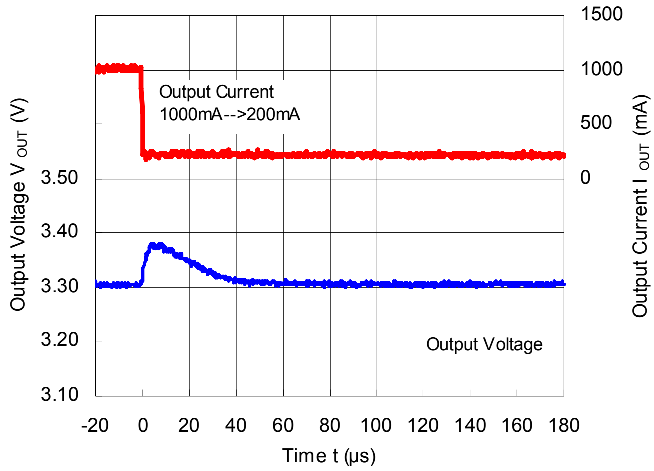
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V)



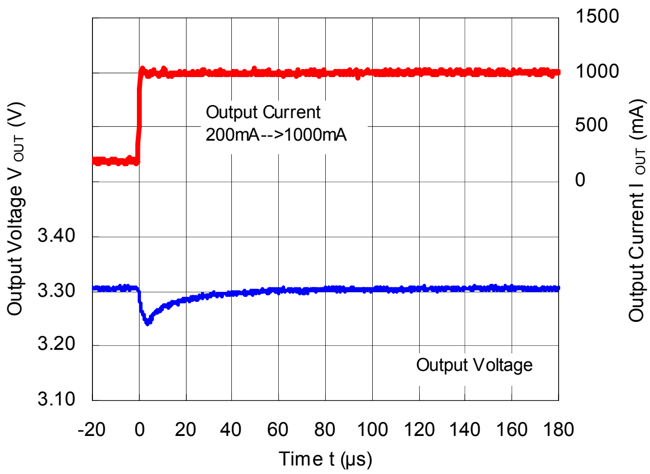
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="L"PWM/VFM Auto Switching Control



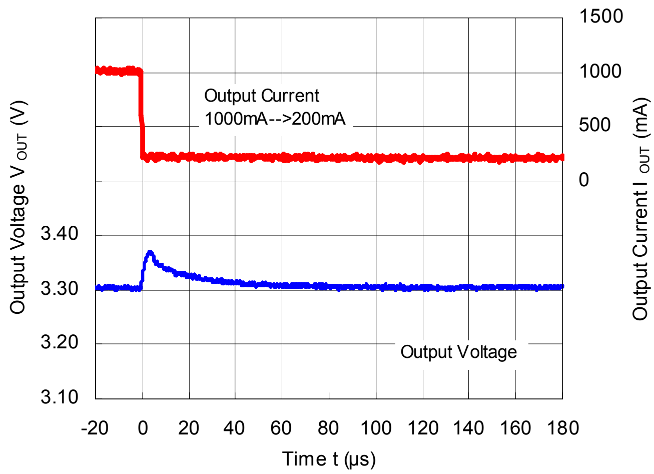
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="L"PWM/VFM Auto Switching Control



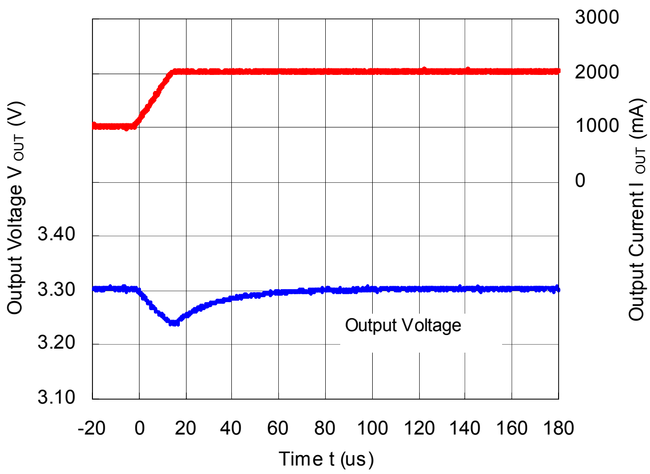
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="H" Forced PWM Control



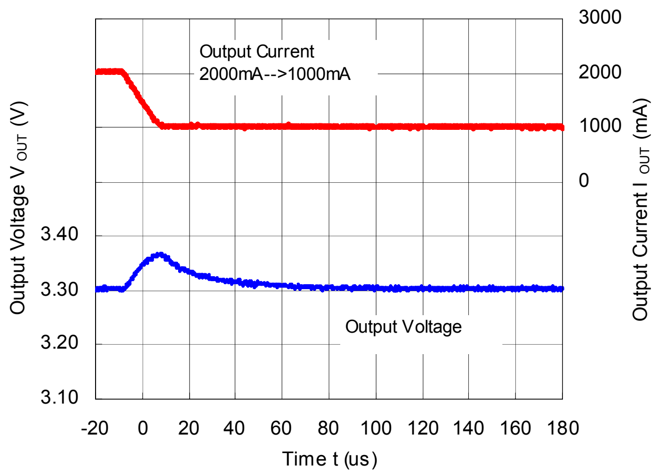
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="H" Forced PWM Control



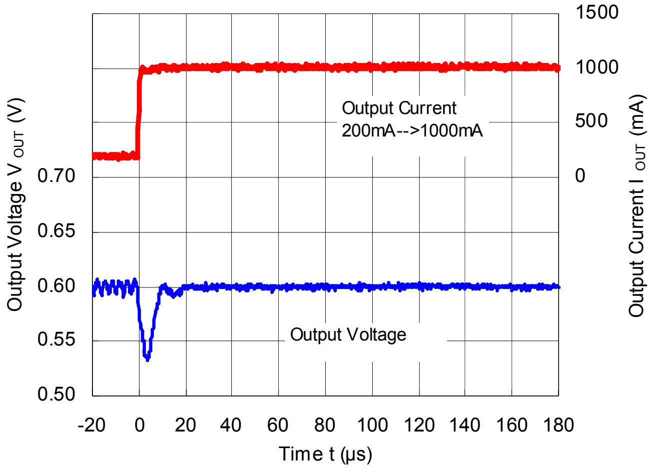
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)



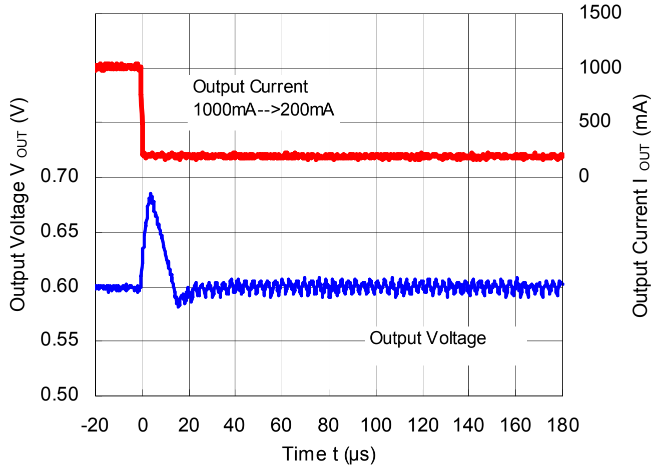
RP506Kxx1A/B/C (V_{IN}=5.0V, V_{OUT}=3.3V)



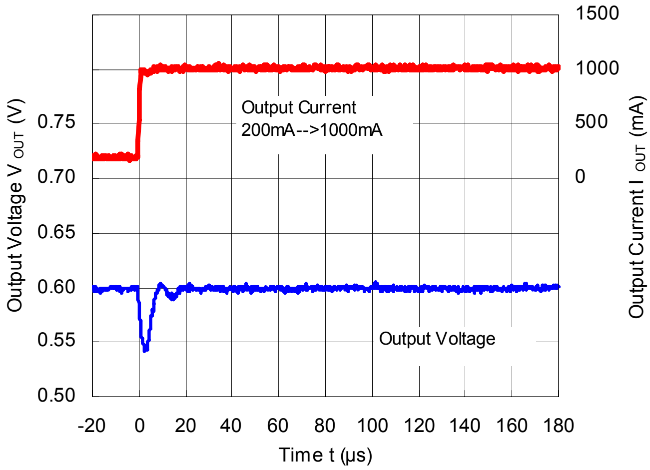
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V)
MODE="L"PWM/VFM Auto Switching Control

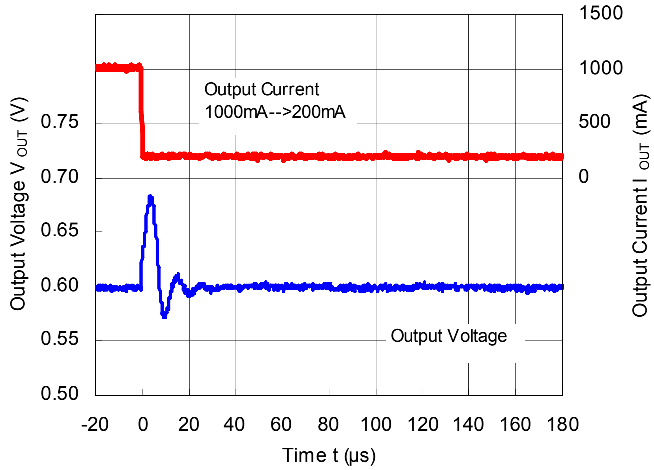


RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V)
MODE="L"PWM/VFM Auto Switching Control

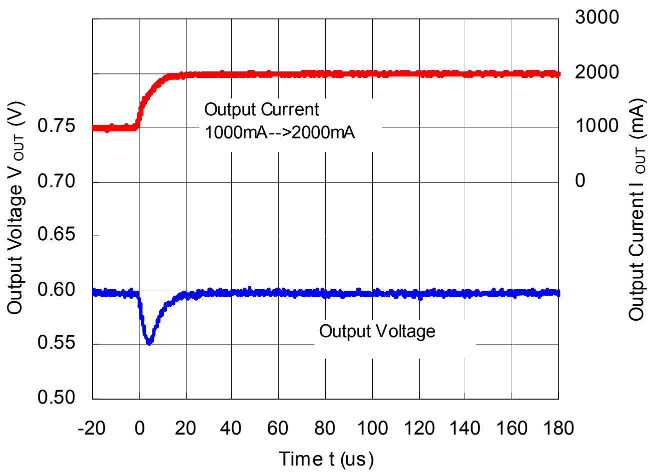


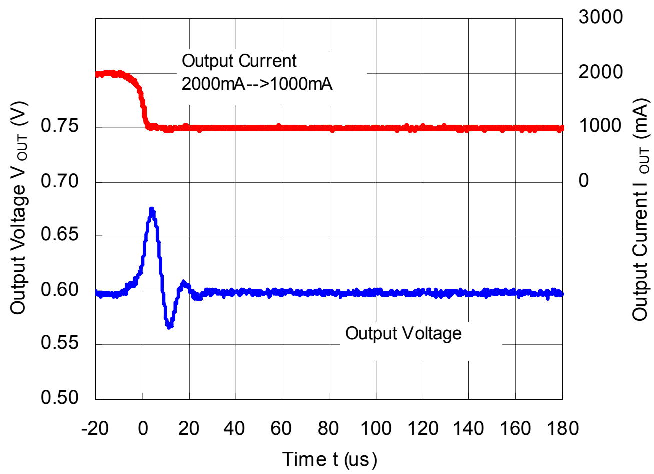
RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V) RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V)
MODE="H" Forced PWM Control MODE="H" Forced PWM Control





RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V) RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.6V)





RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.8V)
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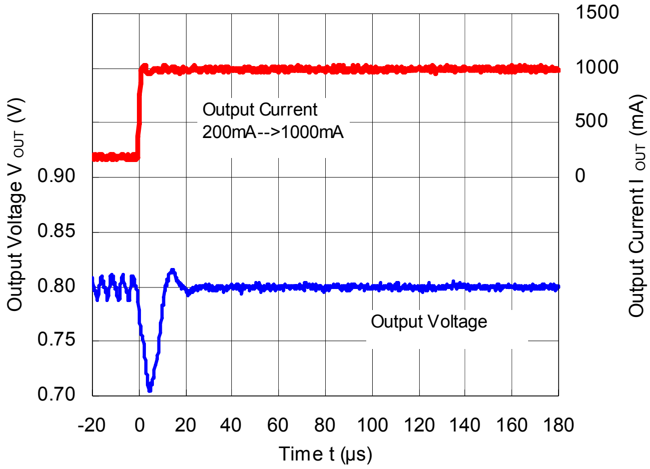

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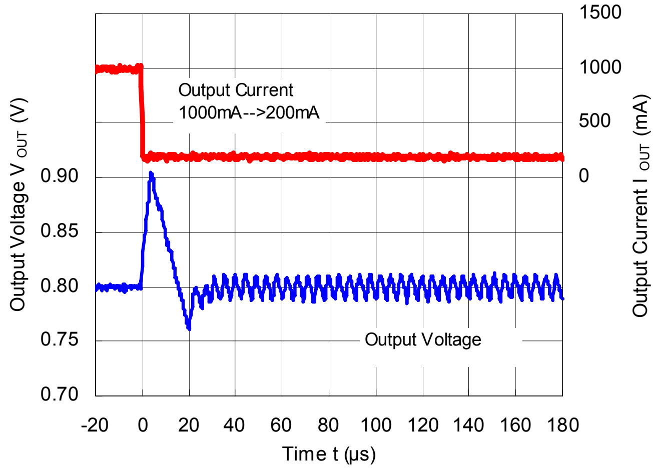

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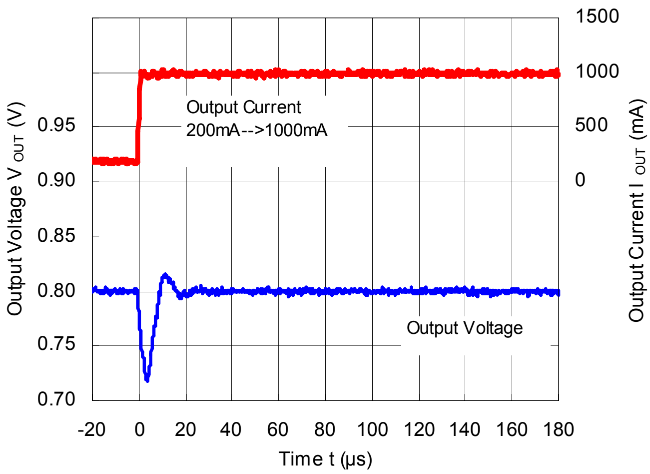

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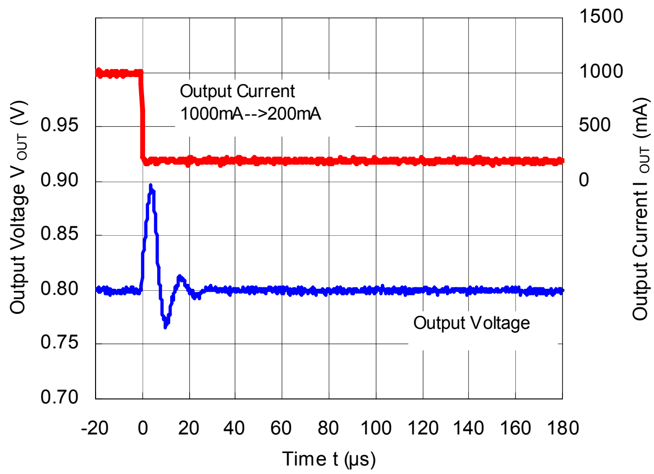
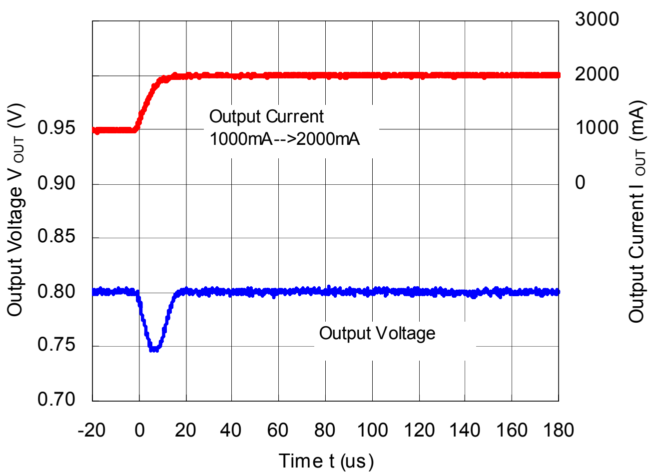
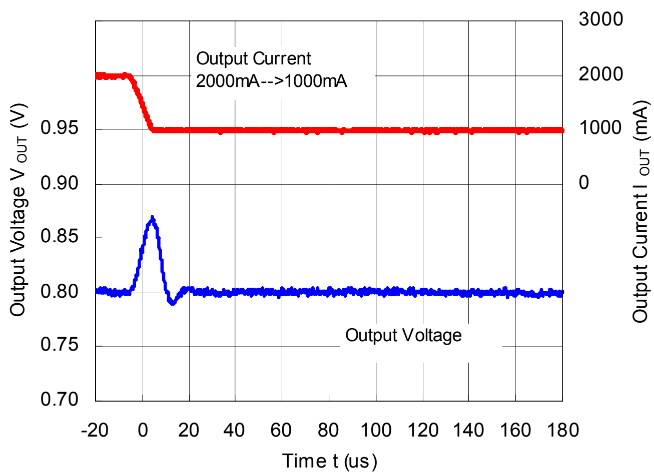
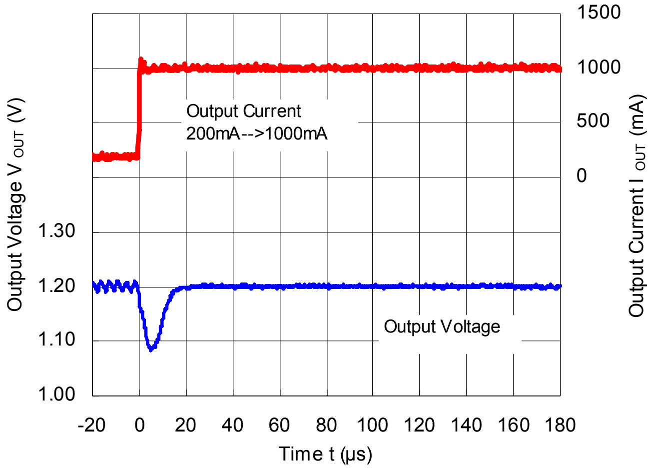


RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.8V) RP506 Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=0.8V)

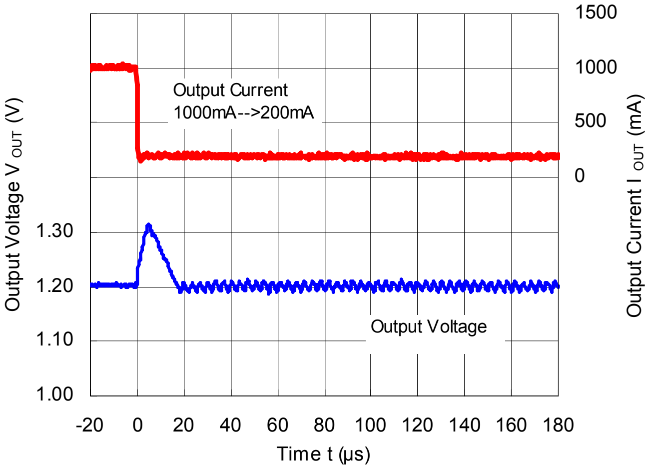




RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="L"PWM/VFM Auto Switching Control



RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V)
MODE="L"PWM/VFM Auto Switching Control



RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V)
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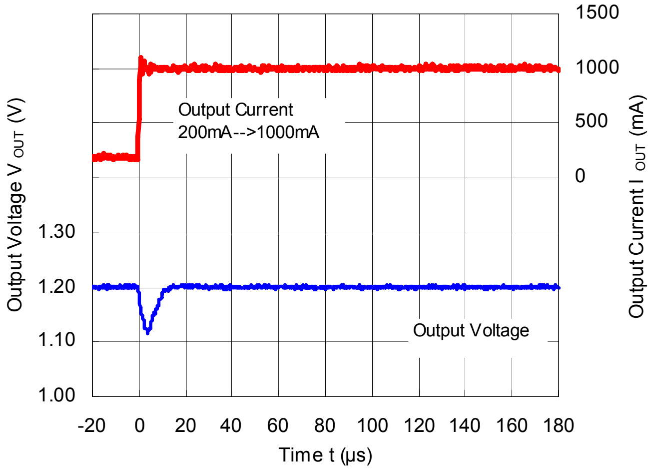

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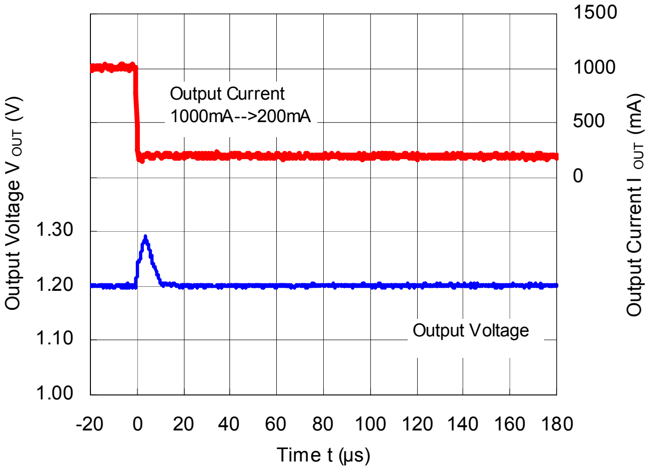

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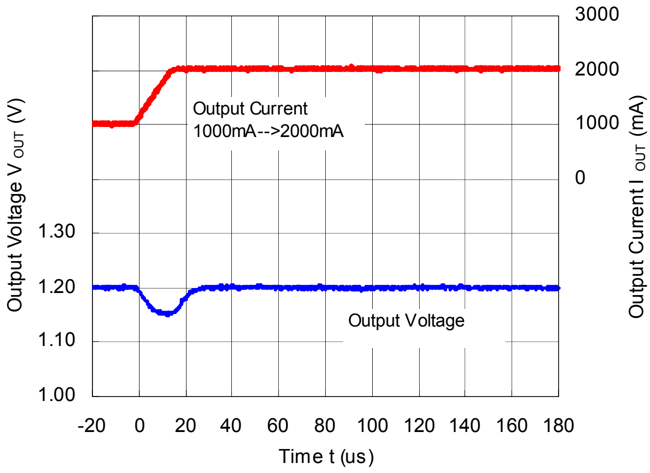
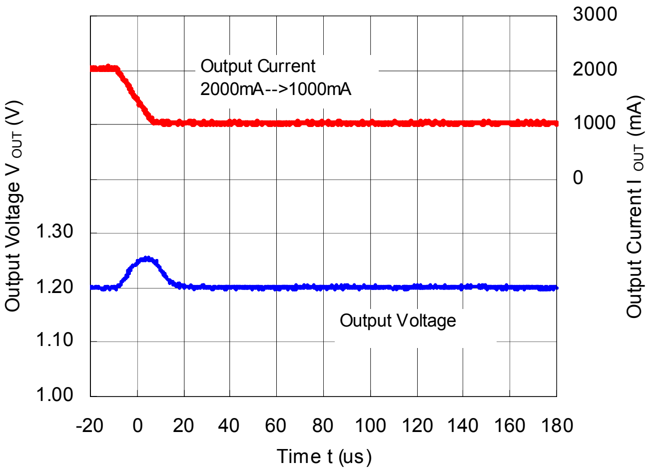
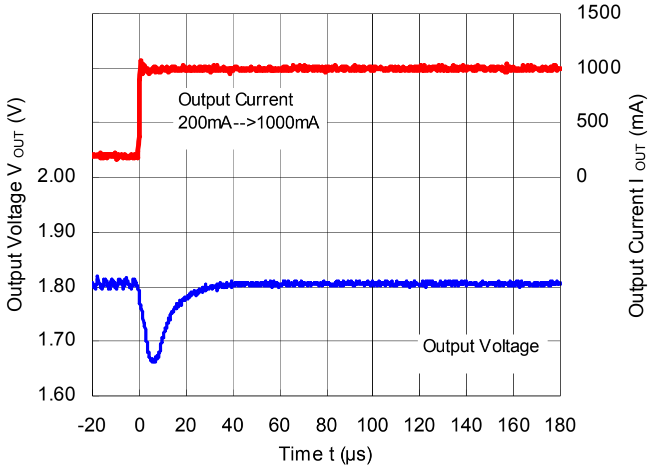


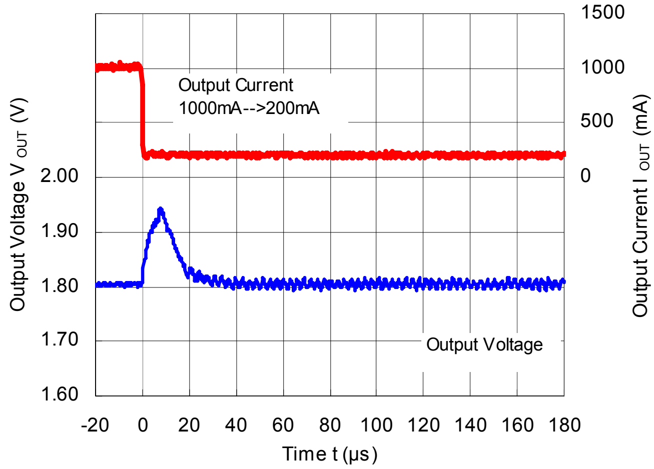
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V)



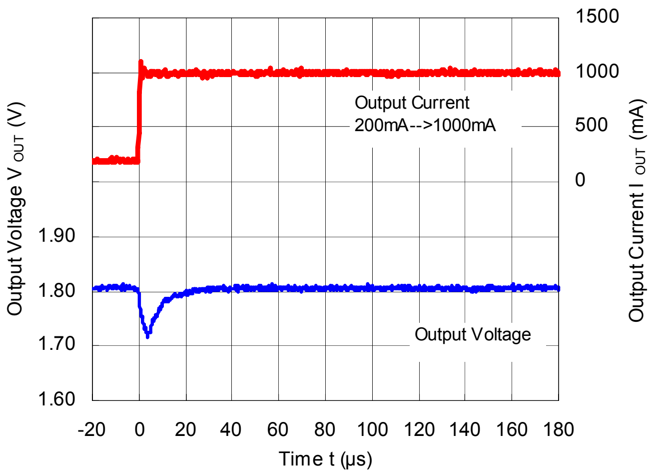
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V) MODE="L"PWM/VFM Auto Switching Control



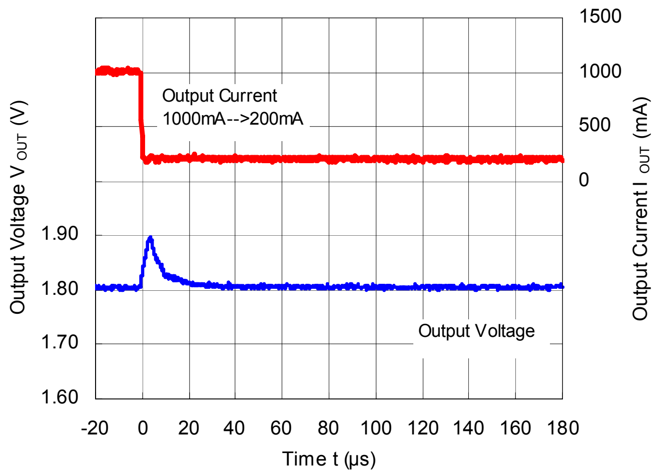
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V) MODE="L"PWM/VFM Auto Switching Control



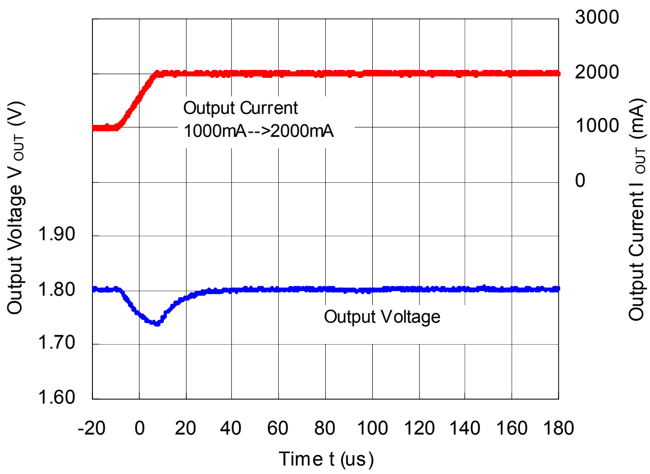
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V) MODE="H" Forced PWM Control



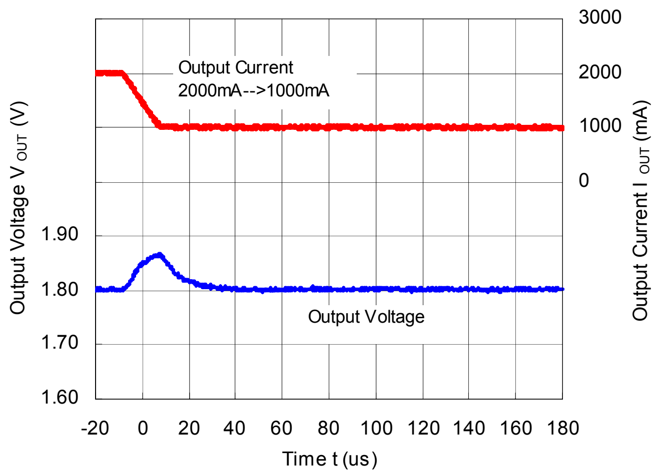
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V) MODE="H" Forced PWM Control



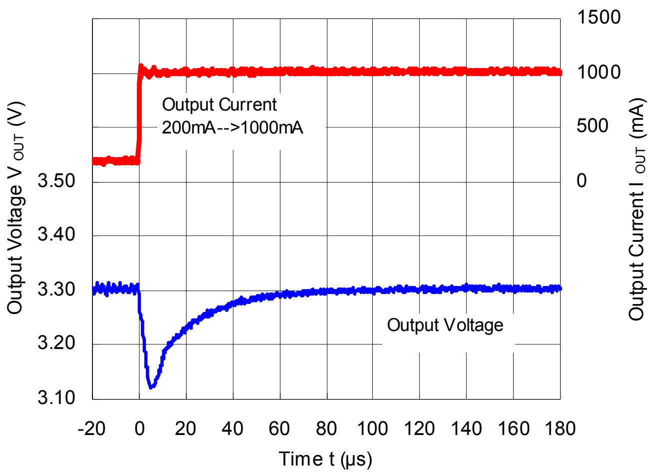
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V)



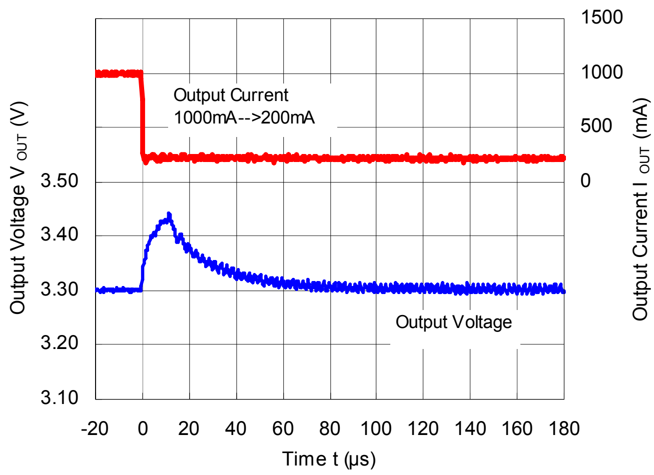
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V)



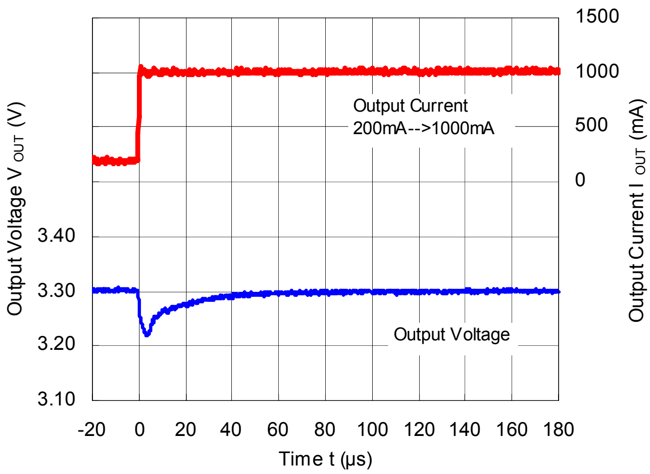
RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="L"PWM/VFM Auto Switching Control



RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="L"PWM/VFM Auto Switching Control



RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)
MODE="H" Forced PWM Control



RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)
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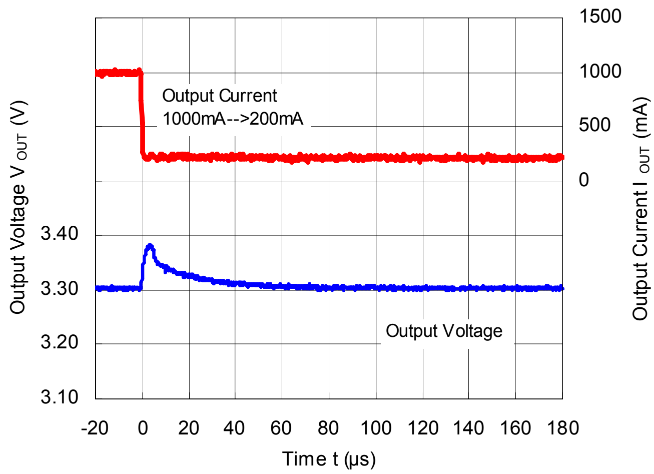
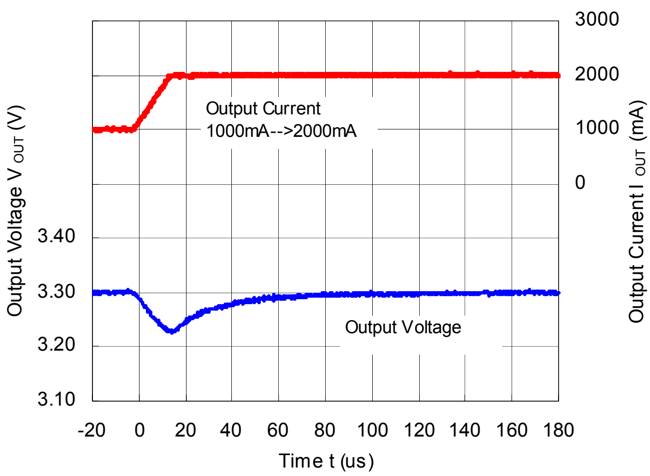
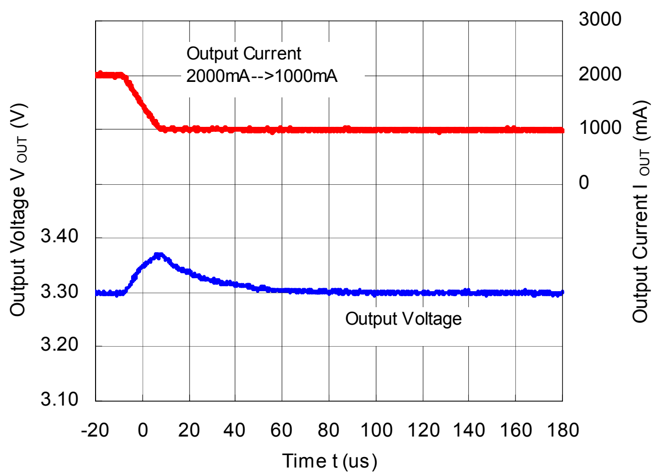


RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)

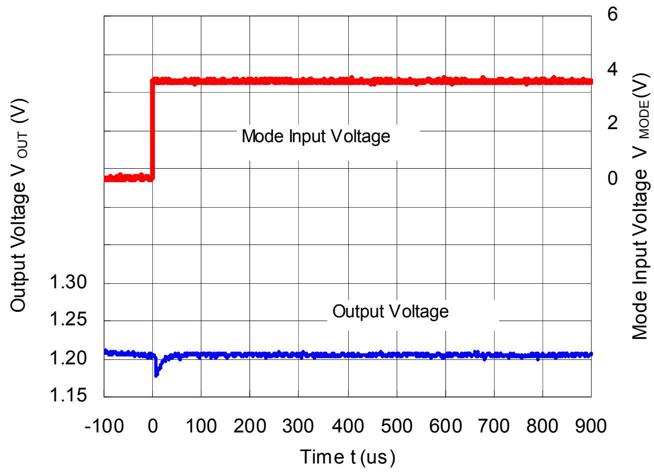


RP506Kxx1D/E/F (V_{IN}=5.0V, V_{OUT}=3.3V)



20) Auto Switching Control Waveform

RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V, I_{OUT}=1mA)
MODE="L" --> MODE="H"



RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.2V, I_{OUT}=1mA)
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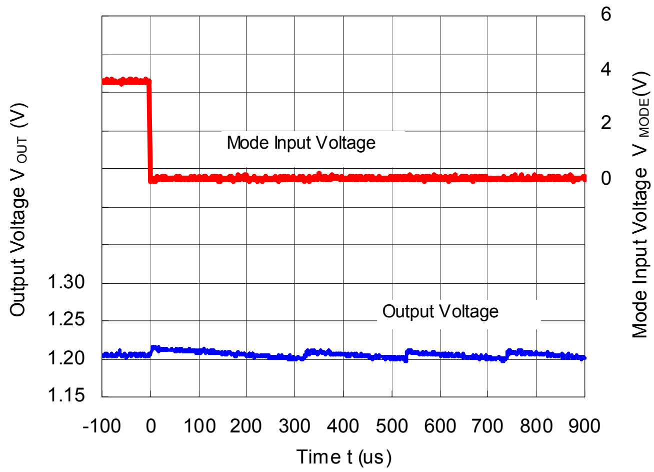
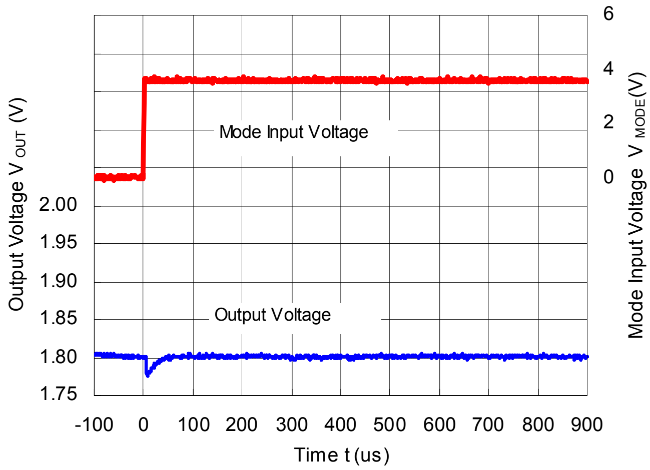
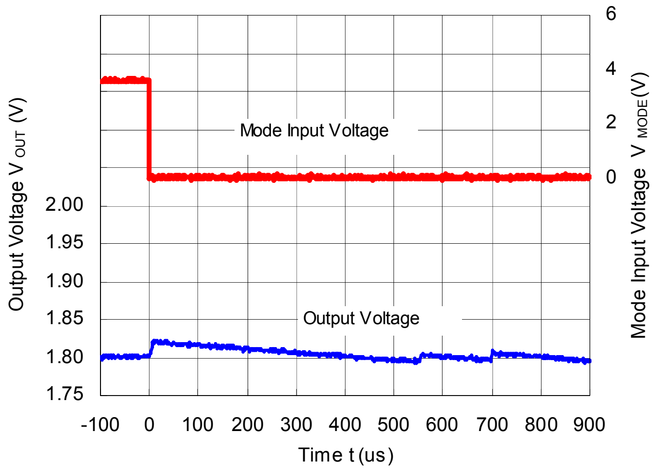


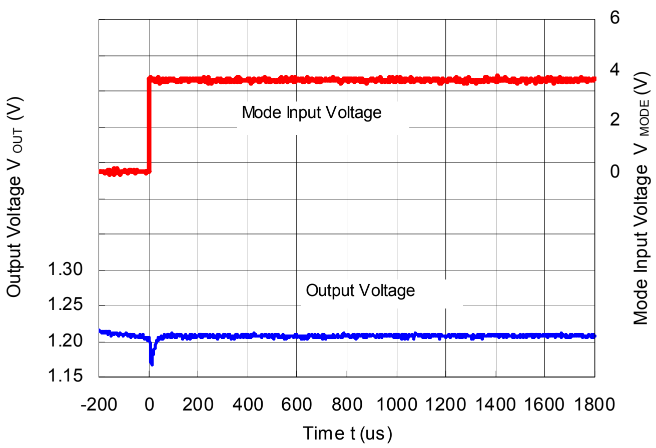
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=1mA)
MODE="L" --> MODE="H"



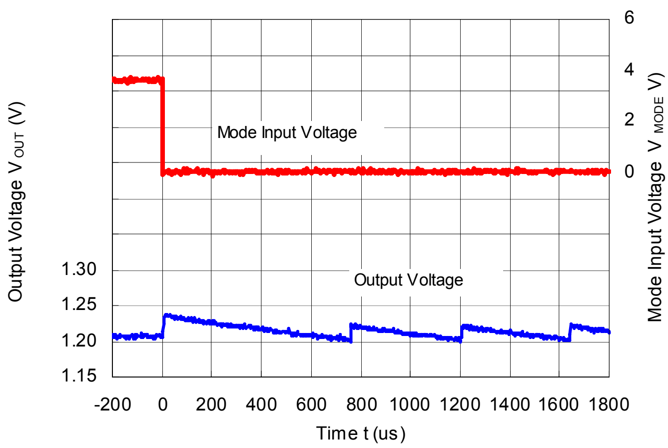
RP506Kxx1A/B/C (V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=1mA)
MODE="H" --> MODE="L"



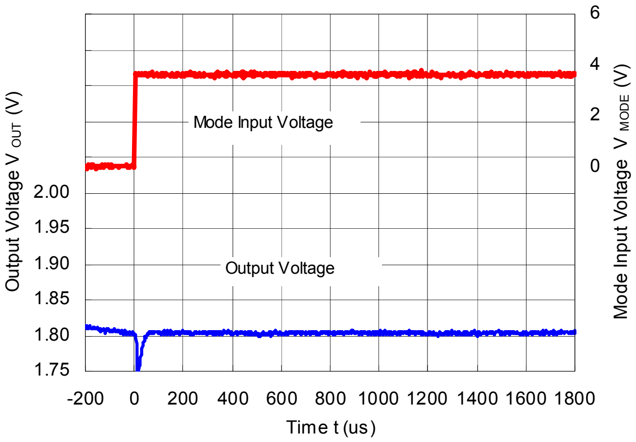
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V, I_{OUT}=1mA)
MODE="L" --> MODE="H"



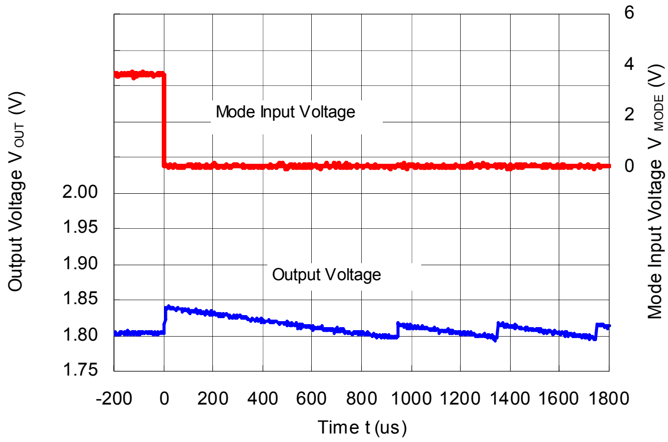
RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.2V, I_{OUT}=1mA)
MODE="H" --> MODE="L"



RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=1mA)
MODE="L" --> MODE="H"



RP506Kxx1D/E/F (V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=1mA)
MODE="H" --> MODE="L"



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