400 mA Step-Down DC/DC Converter with Built-in Inductor

FEATURES

- **Built-in inductor and transistors**
- **Operating Input Voltage Range**: 2.0 V ~ 6.0 V (A/B types) or 1.8 V ~ 6.0 V (F type)
- **Output Voltage Range**: 0.8 V ~ 4.0 V
- **Output Voltage Error**: ±2%
- **Output Current**: 400 mA
- **High Efficiency**: 90% (V_{IN} = 4.2 V, V_{OUT} = 3.3V)
- **Oscillation Frequency**: 3 MHz
- **Maximum Duty Cycle**: 100%
- **Operating Modes**: PWM, PWM/PFM auto select
- **Functions:** Built-in Current Limit, High Speed Load Capacitor Discharge, Soft start
- **Operating Ambient temperature:** -40 ~ +85^{0}C
- **Package: USP-10B03**
- **EU RoHS Compliant, Pb Free**

APPLICATION

- Mobile Phones
- Bluetooth headsets
- Digital home appliances
- Office automation equipment
- Various portable equipment

DESCRIPTION

The IXD9208/09 series converters are synchronous step-down DC/DC converters with an inductor and a control IC in one tiny (2.5 x 2.15 x 1.0 mm) package. A stable power supply with an output current of 600 mA requires only two capacitors connected externally.

The operating voltage range is from 2.0 V to 6.0 V (1.8 V ~ 6.0 V for IXD920xG version).

The output voltage is internally set in a range from 0.8 V to 4.0 V in 0.05 V increments. The device operates at 3.0 MHz switching frequency, and includes a 0.42 Ω P-channel switching transistor and a 0.52 Ω N-channel transistor for synchronous rectification. The IXD9208 series operates in PWM mode, while the IXD9209 series automatically switches between PWM/PFM modes.

An automatic PWM/PFM switching allows fast response to the load changes, low ripple noise, and high efficiency over the full range of loads.

The CE pin allows setting of the device into stand-by mode with a current consumption below 1.0 µA.

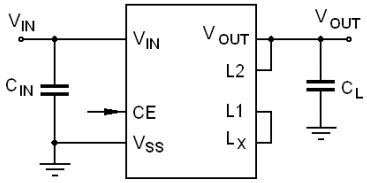
The built-in Under Voltage Lockout (UVLO) function forces the internal switching transistor OFF when input voltage becomes less than 1.4V

The B and G versions of the IXD9208/09 series have a fast soft start function internally set at 0.25 ms (typ).

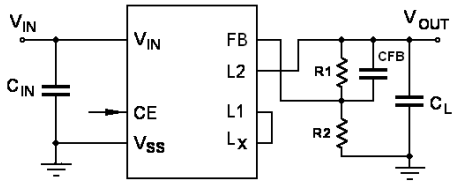
The B, C, and G versions of the IXD9208/09 series also have fast load capacitor C_L auto discharge function, which allows fast C_L discharge through a switch located between the L_X and V_{SS} pins. When the devices enter stand-by mode, output voltage quickly returns to the V_{SS} level because of this function.

TYPICAL APPLICATION CIRCUITS

Type A/B



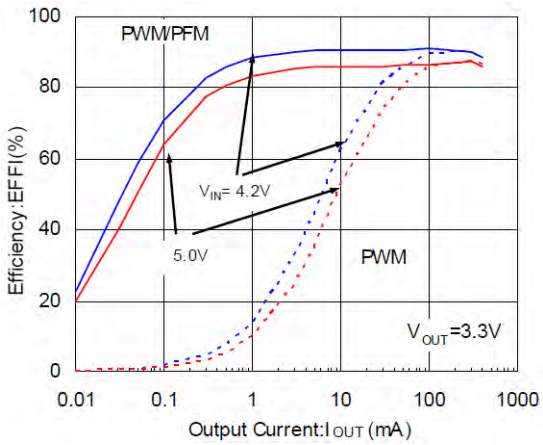
Type F



Pins L1 – L_X and L2 – V_{OUT} should be connected externally

TYPICAL PERFORMANCE CHARACTERISTIC

Efficiency vs. Output Current (f_{OSC} = 3.0 MHz, V_{OUT} = 3.3 V)



ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNITS
V_{IN} Pin Voltage	V_{IN}	– 0.3 ~ 6.5	V
L_X Pin Voltage	V_{LX}	– 0.3 ~ V_{IN} + 0.3[1]	V
V_{OUT} Pin Voltage	V_{OUT}	– 0.3 ~ 6.5	V
FB Pin Voltage	V_{FB}	– 0.3 ~ 6.5	V
CE Pin Voltage	V_{CE}	– 0.3 ~ 6.5	V
Lx Pin Current	I_{LX}	±1500	mA
Inductor Current at ΔT = 40^{0}C	I_{LMAX}	700	mA
Power Dissipation	P_D	500[2)]	mW
Operating Temperature Range	T_{OPR}	– 40 ~ + 85	^{0}C
Storage Temperature Range	T_{STG}	– 50 ~ +125	^{0}C

NOTE:

1. L_X pin voltage should not exceed V_{IN} +0.3 V or 6.5 V, which is less.
2. Power dissipation shown for a PCB mounted part.

ELECTRICAL OPERATING CHARACTERISTICS

IXD9208/09 series, Ta = 25^{0}C

PARAMETER		SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Operating Voltage Range		V_{IN}		2.0	-	6.0	V	①
Output Voltage		V_{OUT}	V_{IN} = V_{CE} = 5.0 V, I_{OUT} = 30 mA (A, B versions only)	E-1	E-2	E-3	V	①
FB Voltage[15)]		V_{FB}	V_{IN} = V_{CE} = 5.0 V	0.784	0.800	0.816	V	③
Maximum Output Current		I_{OUT_MAX}	V_{IN} = $V_{OUT(E)}$ + 2.0 V, V_{CE} = 1.0 V[8)]	400			mA	①
UVLO Voltage		V_{UVLO}	V_{CE} = V_{IN}, V_{OUT} = 0[1), 10)]	1.00	1.40	1.78	V	③
Supply Current	IXD9208	I_Q	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = $V_{OUT(E)}$ x 1.1 V		46	65	μA	②
	IXD9209				21	35		
Standby Current		I_{STB}	V_{IN} = 5.0 V, V_{CE} = 0 V, V_{OUT} = $V_{OUT(E)}$ x 1.1 V		0	1.0	μA	②
Oscillation Frequency		f_{OSC}	V_{IN} = $V_{OUT(E)}$ + 2 V, V_{CE} = 1.0 V, I_{OUT} = 100 mA	2550	3000	3450	kHz	①
PFM Switching Current		I_{PFM}[11)]	V_{IN} = V_{CE} = $V_{OUT(E)}$ + 2 V, , I_{OUT} = 1 mA	E-4	E-5	E-6	mA	⑨
P-channel ON time maximum		t_{PON_MAX}[11)]	V_{IN} = V_{CE} = $V_{OUT(T)}$ + 1 V, I_{OUT} = 1 mA		$2D_{max}$	$3D_{MAX}$		①
Maximum Duty Cycle Ratio		D_{MAX}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = $V_{OUT(E)}$ x 0.9 V	100			%	③
Minimum Duty Cycle Ratio		D_{MIN}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = $V_{OUT(E)}$ x 1.1 V			0	%	③
Efficiency [2)]		EFFI	V_{IN} = V_{CE} = $V_{OUT(E)}$ + 1.2 V, I_{OUT} = 100 mA		E-7		%	①
L_X "H" ON Resistance 1[3)]		R_{LXH1}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = 0 V, I_{LX} = 100 mA		0.35	0.55	Ω	④
L_X "H" ON Resistance 2[3)]		R_{LXH2}	V_{IN} = V_{CE} = 3.6 V, V_{OUT} = 0 V, I_{LX} = 100 mA		0.42	0.67	Ω	④
L_X "L" ON Resistance 1[4)]		R_{LXL1}	V_{IN} = V_{CE} = 5.0 V		0.45	0.65	Ω	
L_X "L" ON Resistance 2[4)]		R_{LXL2}	V_{IN} = V_{CE} = 3.6 V		0.52	0.77	Ω	
L_X "H" Leakage Current[5)]		I_{LXH}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = 0 V, V_{LX} = 5.0 V		0.01	1.0	μA	⑤
L_X "L" Leakage Current[5), 15)]		I_{LXH}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = 0 V, V_{LX} = 5.0 V		0.01	1.0	μA	⑤
Current Limit[10)]		I_{LIM}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = $V_{OUT(E)}$ x 0.9 V[7)]	600	800	1000	mA	⑥
Output Voltage Temperature Characteristics		$\frac{\Delta V_{OUT}}{V_{OUT} * \Delta T_{OPR}}$	-40^{0}C ≤ T_{OPR} ≤ 85^{0}C, I_{OUT} = 30 mA		±100		ppm/^{0}C	①
CE "H" Voltage[13)]		V_{CEH}	V_{OUT} = 0 V	0.65		6.0	V	③
CE "L" Voltage[14)]		V_{CEL}	V_{OUT} = 0 V	0		0.25	V	③
CE "H" Current		I_{ENH}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = 0 V	-0.1		0.1	μA	⑤
CE "L" Current		I_{ENL}	V_{IN} = 5.0 V, V_{CE} = 0 V, V_{OUT} = 0 V	-0.1		0.1	μA	⑤
Soft-Start Time	A version	t_{SS}	I_{OUT} = 1 mA	0.5	0.9	2.5	ms	①
	B version				E-11	E-12		
	F version				0.25	0.4		

ELECTRICAL OPERATING CHARACTERISTICS (CONTINUED)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Latch Time[6)]	t_{LAT}	V_{IN} = V_{CE} = 5.0 V, V_{OUT} = 0.8 x $V_{OUT(E)}$, L_X short with 1 Ω resistor to ground	1.0		20.0	ms	⑦
Short Protection Threshold Voltage	V_{SHORT}	V_{IN} = V_{CE} = 5.0 V, L_X short with 1 Ω resistor to ground[12)]	E-8	E-9	E-10	V	⑦
C_L Discharge Resistance[13)]	R_{CLD}	V_{IN} = L_X = 5 V, V_{CE} = 0, V_{OUT} = open	200	300	450	Ω	⑧
Inductance Value	L	Test frequency 1 MHz		1.5		μH	
Inductor Current Maximum	I_{LMAX}	ΔT = 40°C		700		mA	

NOTE:
Test conditions: Unless otherwise stated, V_{IN} = 5.0 V, $V_{OUT\,(E)}$ = Nominal Voltage

1) Including hysteresis operating voltage range
2) EFFI = {(output voltage × output current) / (input voltage × input current)} × 100%
3) ON resistance (Ω) = (V_{IN} - Lx pin measurement voltage) / 100mA
4) Design target value
5) A 10μA (maximum) current may leak at high temperature
6) Time from moment when V_{OUT} is shorted to GND via 1 Ω resistor to the moment, when Current Limit generates pulse stopping L_X oscillations
7) When V_{IN} is less than 2.4 V, current limit may not be reached because of voltage drop across ON resistance
8) When the difference between input and output voltage is small, some cycles may be skipped completely before current maximizes. If load current increases in this state, output voltage will decrease because of the voltage drop across P-channel transistor
9) Current limit denotes the level of an inductor peak current
10) Voltage, when L_X pin voltage is "L"=+0.1 V ~ -0.1 V
11) IXD9209 series only
12) V_{OUT} voltage at which L_X pin state changes from "H" to "L" within 1 ms
13) B and F versions only
14) Version A only
15) Version F only

E-TABLES

NOMINAL OUTPUT VOLTAGE	V_{OUT}, (V)			IPFM, (mA)			EFF, %	V_{SHORT}, (V)			t_{SS}, (ms)	
	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12
$V_{OUT(T)}$, V	MIN	TYP	MAX	MIN	TYP	MAX	TYP	MIN	TYP	MAX	TYP	MAX
1.00	2.0V	0.980	1.000	1.020	190	260	350	79	0.375	0.500	0.625	0.25
1.20	2.20	1.176	1.200	1.224	190	260	350	82	0.450	0.600	0.750	0.25
1.50	2.50	1.470	1.500	1.530	180	240	300	84	0.563	0.750	0.938	0.25
1.80	2.80	1.764	1.800	1.836	170	220	270	85	0.675	0.900	1.125	0.32
2.50	3.50	2.450	2.500	2.550	170	220	270	86	0.938	1.250	1.563	0.32
2.80	3.80	2.744	2.800	2.856	170	220	270	86	1.050	1.400	1.750	0.32
2.85	3.85	2.793	2.850	2.907	170	220	270	86	1.069	1.425	1.781	0.32
3.00	4.00	2.940	3.000	3.060	170	220	270	86	1.125	1.500	1.875	0.32
3.30	4.30	3.234	3.300	3.366	170	220	270	86	1.238	1.650	2.063	0.32

IXD9208/09F TYPE OUTPUT VOLTAGE SETTING

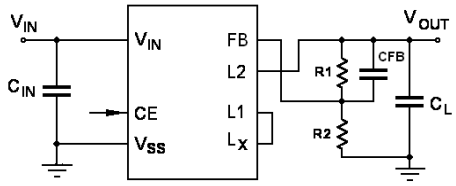
The IXD9208/09F type IC allows setting the output voltage by external resistive divider. The output voltage is determined by R1 and R2 as $V_{OUT} = 0.8 \times (R1+R2)/R2$
The sum of R1 and R2 should be 1MΩ or less. The output voltage can be set from 0.9 V to 5.0 V based on the 0.8 V ±2.0% internal reference voltage.
Note that output voltage (V_{OUT}) higher than the input voltage (V_{IN}) cannot be generated.
Adjust the value of the phase compensation capacitor C_{FB} so that f_{zfb} = 1/(2 × π × C_{FB}×R1) is 10 kHz or less. The optimum value is from 1 kHz to 20 kHz, based on the components used and the board layout.

Calculation example

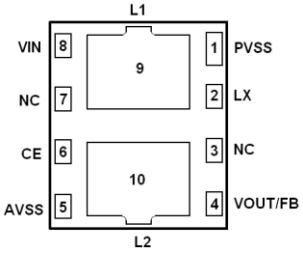
When R1 = 470 kΩ, R2 = 150 kΩ, V_{OUT} = 0.8 × (470 k+150 k)/150 k = 3.3 V

Recommended resistive divider values

V_{OUT}, (V)	R1, (kΩ)	R2, (kΩ)	C_{FB}, (pF)
0.9	100	820	150
1.2	150	300	100
1.5	130	150	220
1.8	300	240	150
2.5	510	240	100
3.0	330	120	150
3.3	470	150	100
4.0	120	30	470



PIN CONFIGURATION



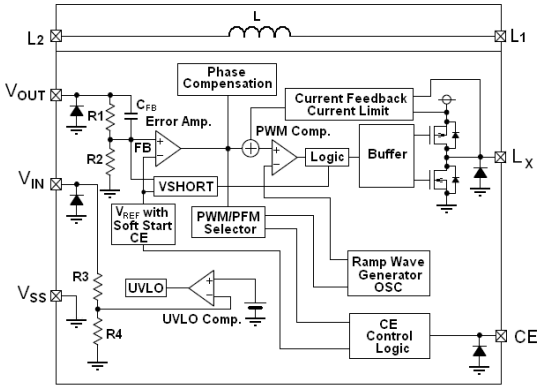
Bottom View

PIN ASSIGNMENT

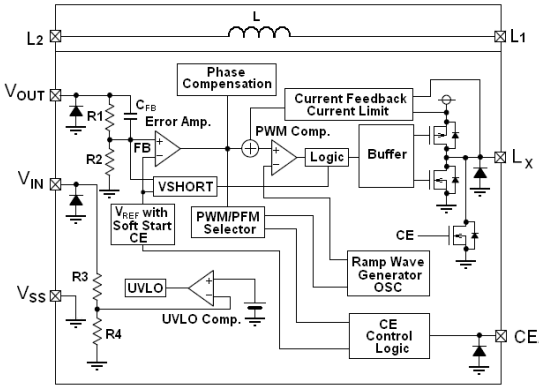
PIN NUMBER	PIN NAME	FUNCTIONS
1	PVSS	Power Ground
2	L_X	Switching Node
3, 7	NC	No Connect
4	VOUT/FB	Fixed Output Voltage (A, B Versions)/Feedback (F version) Sense Pin
5	AVSS	Analog Ground
6	CE	Enable (Active HIGH), Do not left this pin open
8	V_{IN}	Power Input
9	L1	Inductor Connection
10	L2	Inductor Connection

BLOCK DIAGRAMS

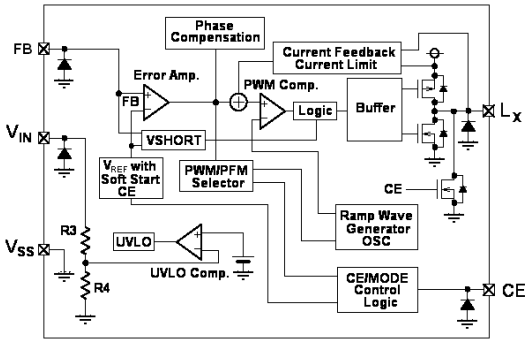
IXD9208/09 A Series



IXD9208/09 B Series



IXD9208/09 F Series



Internal diodes include an ESD protection and a parasitic diodes

BASIC OPERATION

The IXD9208/09 series consists of a Reference Voltage source, Ramp Wave Generator, Error Amplifier, PWM Comparator, Phase Compensation circuit, output voltage resistive divider, P-channel switching transistor, N-channel transistor for the synchronous switch, Current Limiter circuit, UVLO circuit, and other features. (See the block diagrams above.)

The Error Amplifier compares output voltage divided by internal resistors R_1/R_2 with the internal reference voltage. Amplified difference between these two signals applies to the one input of the PWM Comparator, while ramp voltage from the Ramp Wave Generator applies to the second input. Resulting PWM pulse determines switching transistor ON time. It goes through the Buffer and it appears at the gate of the internal P-channel switching transistor. This continuous process stabilizes output voltage.

The Current Feedback circuit monitors current of the P-channel transistor at each switching cycle, and modulates output signal from the Error Amplifier to provide additional feedback. This guarantees a stable converter operation even with low ESR ceramic load capacitor.

Reference Voltage Source

The Reference Voltage Source provides the reference voltage to ensure stable output voltage of the DC/DC converter.

Ramp Wave Generator

The Ramp Wave Generator produces ramp waveform signal needed for PWM operation, and signals to synchronize all the internal circuits. It operates at internally fixed 1.2 MHz or 3.0 MHz frequency.

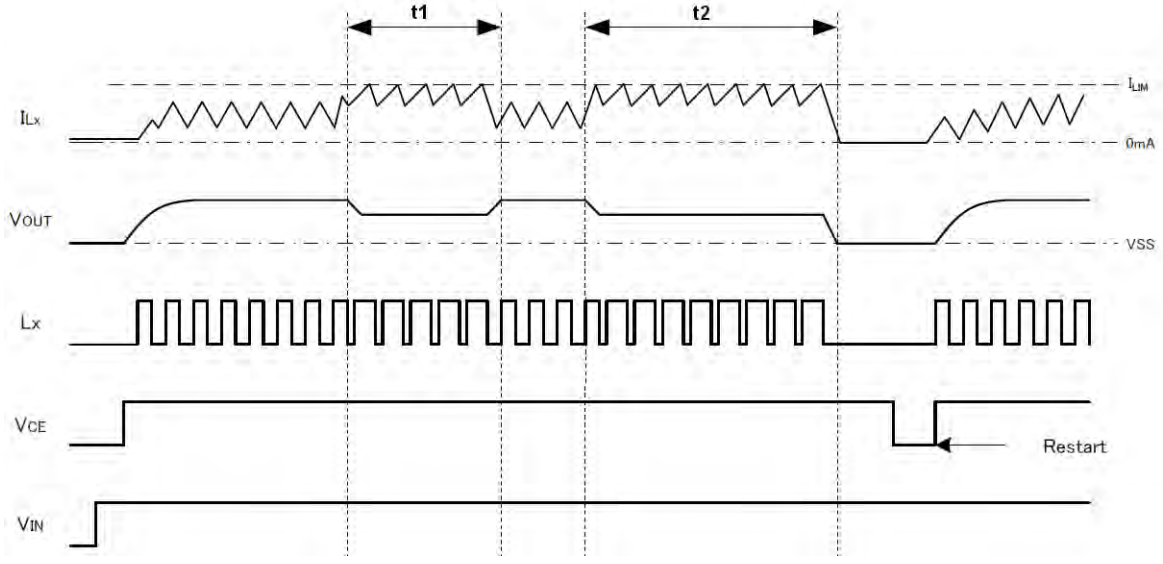
Error Amplifier

The Error Amplifier monitors output voltage through a resistive divider connected to the V_{OUT} (FB) pin. If output voltage falls below preset value and Error Amplifier's input signal becomes less than internal reference voltage, the Error Amplifier/s output signal increases. This results in wider PWM pulse and respectively longer ON time for the switching transistor to increase output voltage. The gain and frequency characteristics of the error amplifier output are fixed internally to optimize IC performance.

Current Limiter

The Current Limiter circuit monitors current flowing through the P-channel transistor connected to the Lx pin, and combines the function of the current limit and operation suspension.

When the transistor's current is greater than a specified level, the Current Limiter turns off the P-channel transistor immediately. After that, the Current Limiter turns off too, returning to monitoring mode.



The driver transistor turns on at the next cycle, but the Current Limiter turns it off immediately if an over- current exists. When the over current state is eliminated, the IC resumes its normal operation.

The IC waits for end of the over current state repeating the steps above (t1 in the figure above). If an over-current state continues for a few ms with the IC repeatedly performing above steps, the Current Limiter latches the P-channel transistor in OFF state, and the IC suspends operations (t2 in the figure above). To restart IC operation after this condition, either the CE pin should be toggled H – L – H, or the V_{IN} pin voltage should be set below UVLO to resume operations from soft start.

The suspension mode is not a standby mode. In the suspension mode, pulse output is suspended; however, internal circuitries remain in operation mode consuming power.

Short-Circuit Protection

Short-circuit protection monitors the R_{FB1}/R_{FB2} divider voltage (FB point in the block diagram). If output is accidentally shorted to the ground, FB voltage starts falling. When this voltage becomes less than half of the reference voltage (V_{REF}) and the P-channel switching transistor's current is more than the I_{LIM} threshold, Short-Circuit Protection turns off and quickly latches the P-channel transistor.

In the D/E/F/G series, Short Circuit Protection starts after the FB voltage becomes less than 0.25 of the reference voltage (V_{REF}), irrespective of the transistor's current.

To restart IC operation after this condition, either the EN pin should be toggled H – L – H, or the V_{IN} pin voltage should be set below UVLO to resume operations from soft start.

The sharp load transients creating a voltage drop at the V_{OUT} propagate to the FB point through $C_{FB;}$ that may result in Short Circuit protection operating at voltages higher than 1/2 V_{REF} voltage.

UVLO Circuit

When the V_{IN} pin voltage becomes 1.4V or lower, the P-channel transistor is forced OFF to prevent false pulse output caused by unstable operation of the internal circuitry. When the V_{IN} pin voltage becomes 1.8 V or higher, switching operations resume with the soft start. The soft start function operates even when the V_{IN} voltage falls below the UVLO threshold for a very short time. The UVLO circuit does not cause a complete shutdown of the IC, but causes pulse output to be suspended; therefore, the internal circuitry remains in operation.

PFM Switch Current

In PFM mode, the IC keeps the P-channel transistor on until inductor current reaches a specified level (I_{PFM}).

P-channel transistor's ON time is equal

$$t_{ON} = L \times I_{PFM} / (V_{IN} - V_{OUT}), \mu s,$$

where L is an inductance in µH, and I_{PFM} is a current limit in A.

PFM Duty Limit

In PFM mode, P-channel ON time maximum (t_{PON_MAX}) is set to $2D_{MAX}$, i.e. two periods of the switching frequency. Therefore, under conditions, when the ON time increases (i.e. step-down ratio is small), it is possible that P-channel transistor to be turned off, even when inductor current does not reach to I_{PFM}. (See Figures 1 and 2 below)

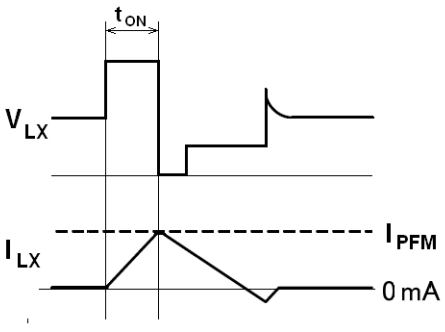


Figure 1

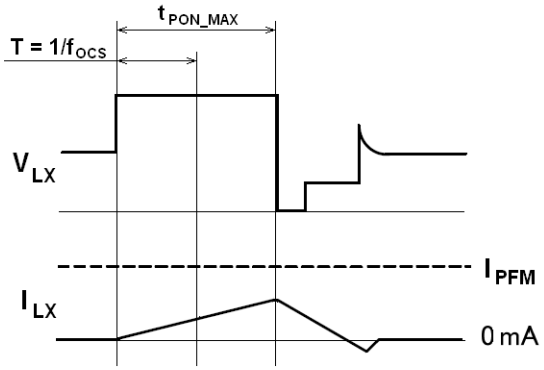


Figure 2

C_L High Speed Discharge

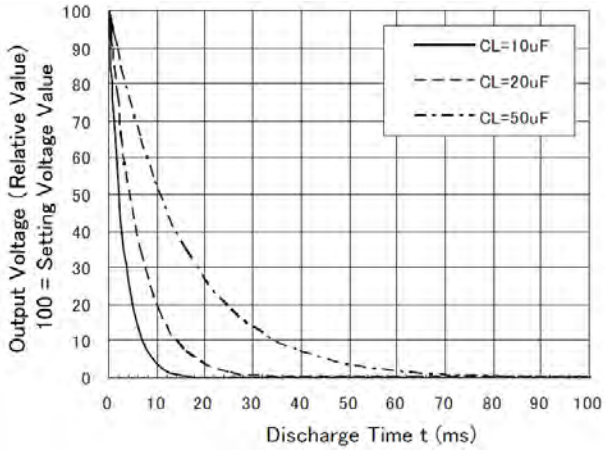
The IXD9208/09 B, C, and G series can quickly discharge the output capacitor (C_L) to avoid application malfunction, when the CE pin set logic LOW to disable IC.

C_L Discharge Time is proportional to the resistance (R) of the N-channel transistor located between the L_X pin and ground and the output C_L capacitance as shown below.

$$t_{DSH} = RC_L \times Ln (V_{OUT(E)} / V), \text{ where}$$

V - Output voltage after discharge
$V_{OUT(E)}$ - Output voltage
R = 300 Ω (Typical value)

Output Voltage Discharge Characteristics



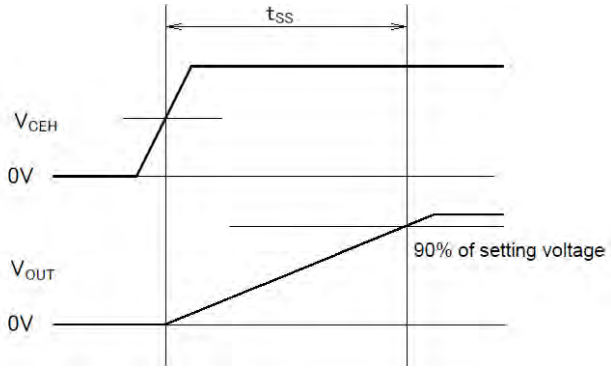
CE Pin Function

The IXD9208/09 series enters the shut down mode when a LOW logic-level signal applies to the CE pin. In the shutdown mode, IC current consumption is ~0 µA (Typical value), with the Lx and V_{OUT} pins at high impedance state. The IC starts its operation when a HIGH logic-level signal applies to the CE.

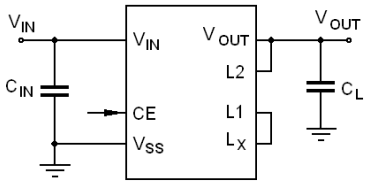
Soft Start

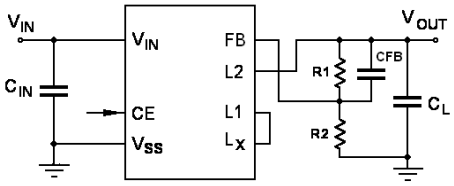
Soft start time is available in two options via product selection.

The soft-start time of the IXD9208/09 series is optimized by using internal circuits The definition of the soft-start time is the time when the output voltage goes up to the 90% of nominal output voltage after the IC is enabled by the CE ”H” signal.



TYPICAL APPLICATION CIRCUITS



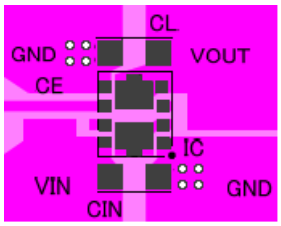


EXTERNAL COMPONENTS

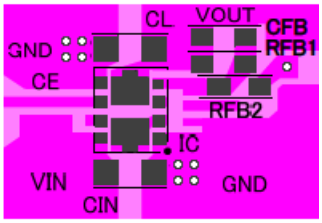
f_{OSC}	3.0 MHz
C_{IN}, µF	4.7
C_L, µF	10

Capacitors should be X7R or X5R series to minimize power losses.

LAYOUT AND USE CONSIDERATIONS



A/B Version Layout



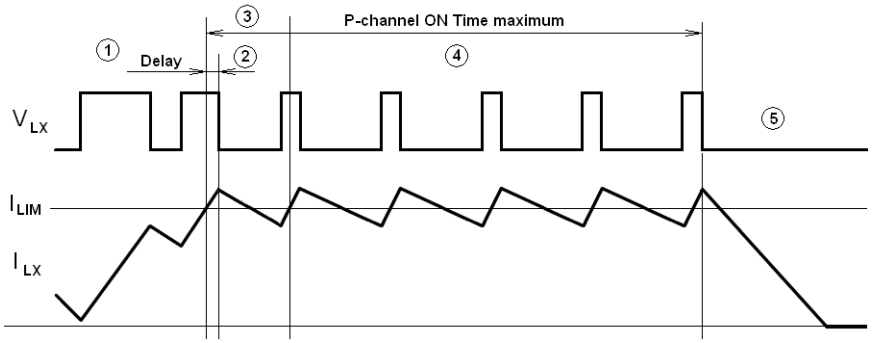
F Version Layout

1. Wire external components as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance. Pay special attention to the V_{IN} and GND wiring. Switching noise, which occurs from the GND, may cause the instability of the IC, so, position V_{IN} and V_{CL} capacitors as close to IC as possible (See recommended layout on the right).
2. Transitional voltage drops or voltage rising phenomenon could make the IC unstable if ratings are exceeded.
3. The IXD9208/09 series is designed to work with ceramic output capacitors. However, if the difference between input and output voltages is too high, a ceramic capacitor may fail to absorb the resulting high switching energy and oscillation could occur. In this case, connect an electrolytic capacitor in parallel to ceramic one to compensate for insufficient capacitance.
4. In PWM mode, IC generates very narrow pulses, and there is a possibility that some cycles will be skipped completely, if the difference between V_{IN} and V_{OUT} is high.
5. If the difference between V_{IN} and V_{OUT} is small, IC generates very wide pulses, and there is a possibility that some cycles will be skipped completely at the heavy load current.
6. When dropout voltage or load current is high, Current Limit may activate prematurely that will lead to IC instability. To avoid this condition, choose inductor's value to set peak current below Current Limit threshold. Calculate the peak current according to the following formula:

$$I_{PK} = (V_{IN} - V_{OUT}) \times D / (2 \times L \times f_{OSC}) + I_{OUT,} \text{ where}$$

L - Inductance
f_{OSC} -- Oscillation Frequency
D – Duty cycle

7. The inductor's rated current exceeds Current Limit threshold to avoid damage, which may occur until P-channel transistor turns off after Current Limiter activates, but pulse current may exceed this value(see figure below).

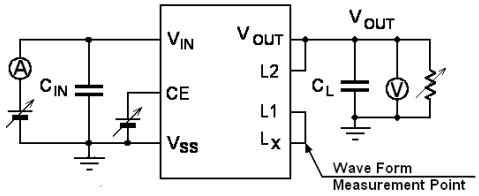


① Current flows into P-channel transistor reaches the current limit (I_{LIM}).
② Current is more than I_{LIM} due the circuit's delay time from the current limit detection to the P-channel transistor OFF.
③ The inductor's current time rate becomes quite small.
⑨ IC generates very narrow pulses for several milliseconds.
⑤ The circuit latches, stopping operation.

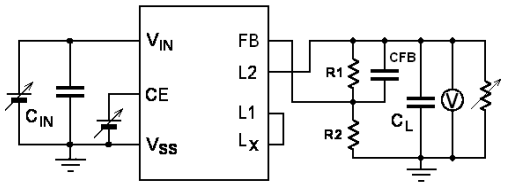
8. If V_{IN} voltage is less than 2.4 V, current limit threshold may not be reached due to a voltage drop caused by the switching transistor's ON resistance.
9. Latch time may become longer or latch may not work due electrical noise. To avoid this effect, the board should be laid out so that input capacitors are placed as close to the IC as possible.
10. Use of the IC at voltages below recommended voltage range may lead to instability.
11. At high temperature, output voltage may increase up to input voltage level at no load, because of the leakage current of the driver transistor.
12. High step-down ratio and very light load may be cause of intermittent oscillations in PWM mode.
13. In PWM/PFM automatic switching mode, IC may become unstable during transition to continuous mode. Please verify with actual components.
14. Pins L1 – L_X (#9 - #2) and L2 – V_{OUT} (#10 - #4) should be connected externally on the PC board for A/B type of IC. Type F requires only pins L1 – L_X (#9 - #2) to be connected together. Pins PGND (#1) and AGND (#5) should be both connected to the ground plane.

TEST CIRCUITS

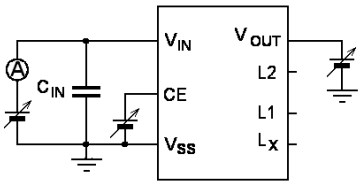
Circuit ① A/B type



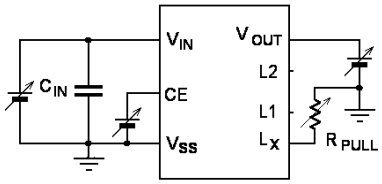
F type



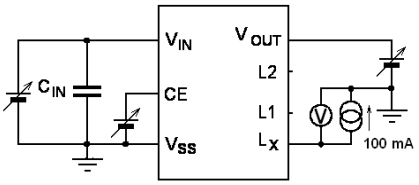
Circuit ②



Circuit ③

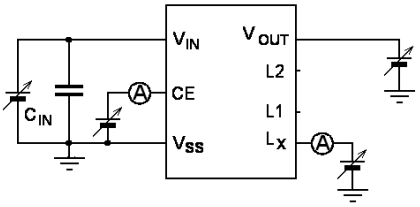


Circuit ④

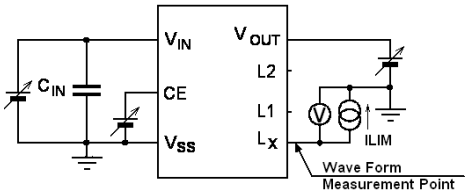


ON Resistance = (V_{IN} – V_{OUT}/100 mA

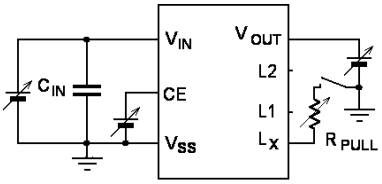
Circuit ⑤



Circuit ⑥

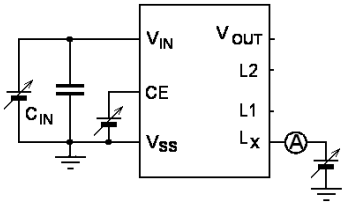


Circuit ⑦

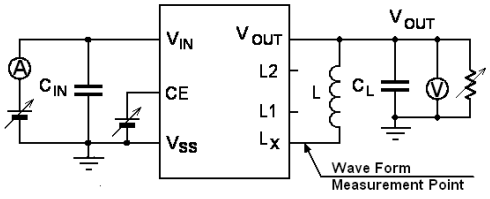


R_{PULL} = 1 Ω

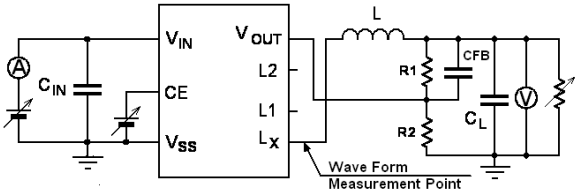
Circuit ⑧



Circuit ⑨ A/B type



Circuit ⑨ F type

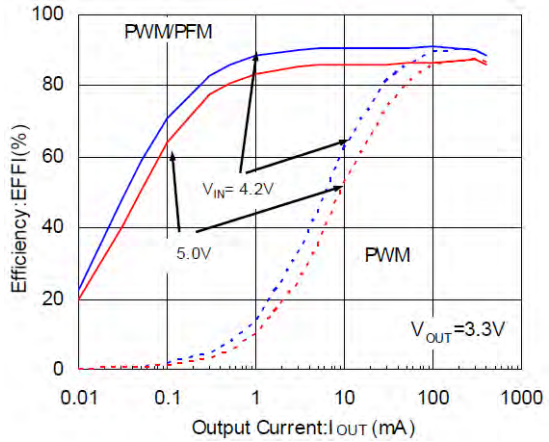


External Components
C_{IN} = 4.7 µF (ceramic), C_L = 10 µF (ceramic)
L = 1.5 µH
R1 = 150 kΩ, R2 = 300 kΩ, C_{FB}= 120 pF
R_{PULL} = 200 Ω

TYPICAL PERFORMANCE CHARACTERISTICS

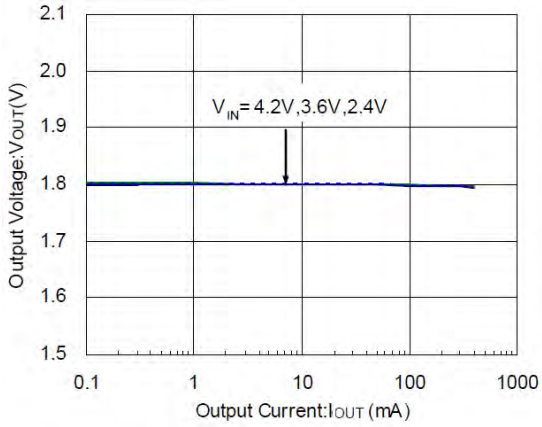
(1) Efficiency vs. Output Current

IXD920xB183DR
C_{IN} = 4.7 µF, C_L= 10 µF



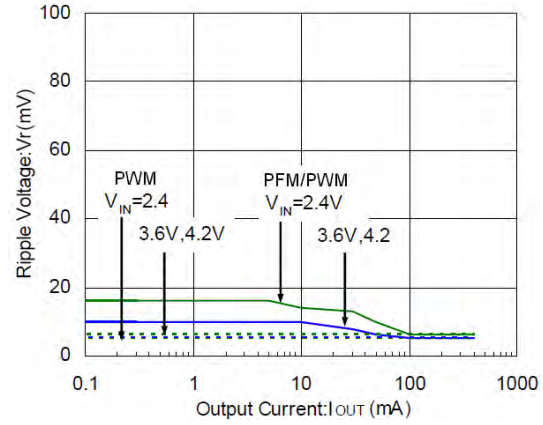
(2) Output Voltage vs. Output Current

IXD920xB183DR



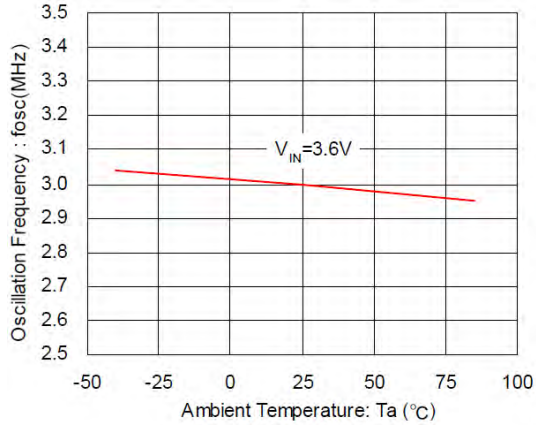
(3) Ripple Voltage vs. Output Current

IXD920xB183DR



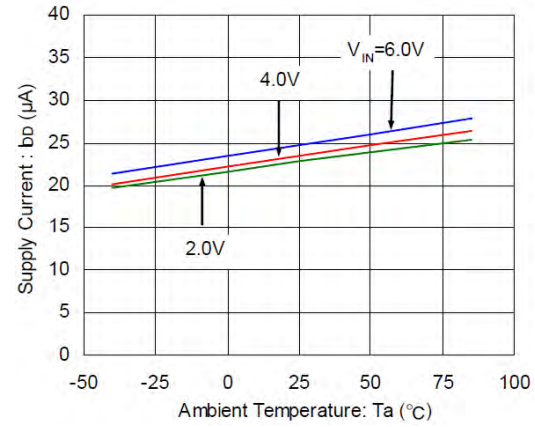
(4) Oscillation Frequency vs. Ambient Temperature

IXD920xB183DR



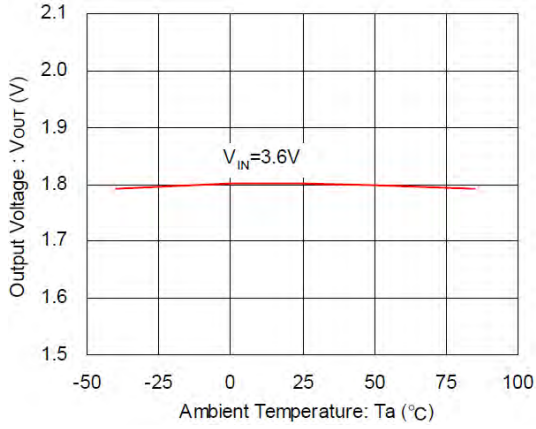
(5) Supply Current vs. Ambient Temperature

IXD920xB183DR



(6) Output Voltage vs. Ambient Temperature

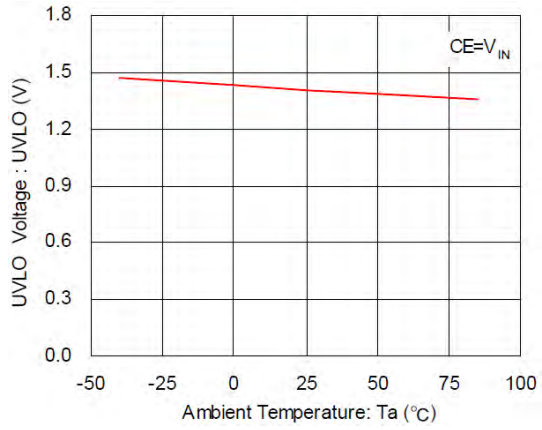
IXD920xB183DR



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

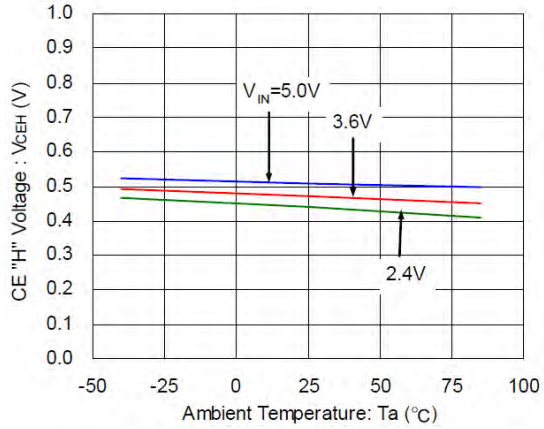
(7) UVLO Voltage vs. Ambient Temperature

IXD920xB183DR



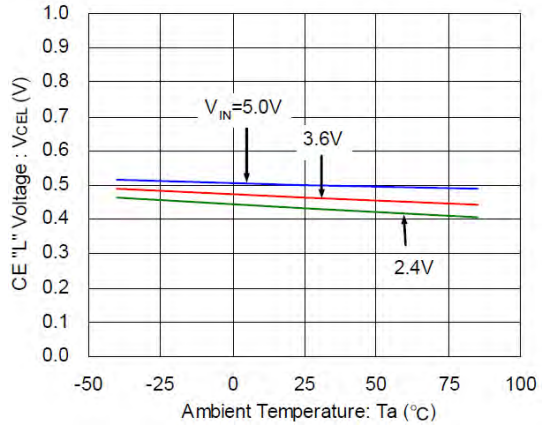
(8) CE "H" Voltage vs. Ambient Temparature

IXD920xB183DR



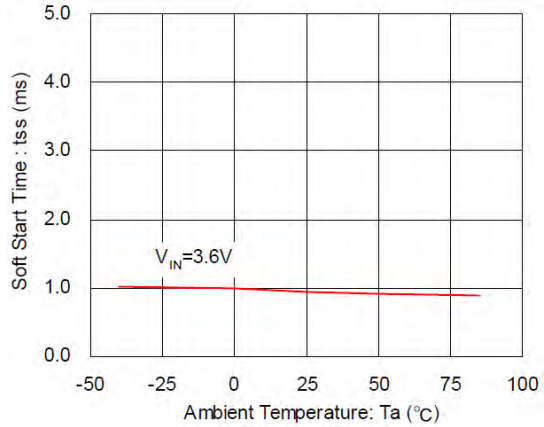
(9) CE "L" Voltage vs. Ambient Temperature

IXD920xB183DR



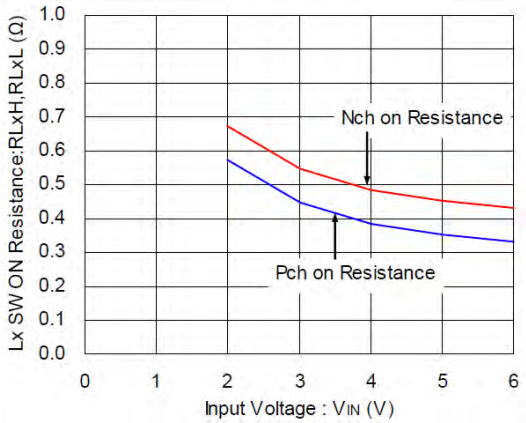
(10) Soft Start Time vs. Ambient Temperature

IXD920xB183DR



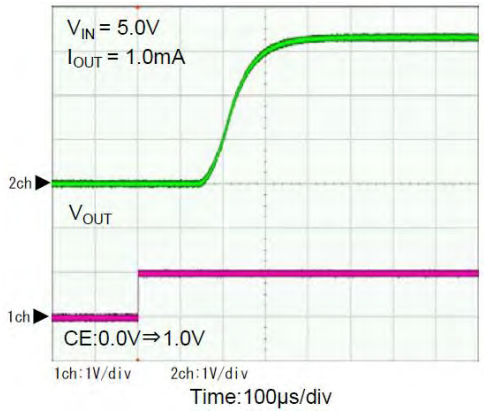
(11) ON Resistance vs. Ambient Temperature

IXD920xB183DR



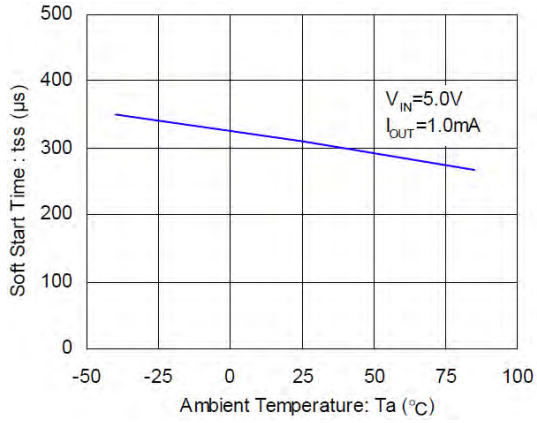
(12) Start Wave Form

IXD920xB333DR



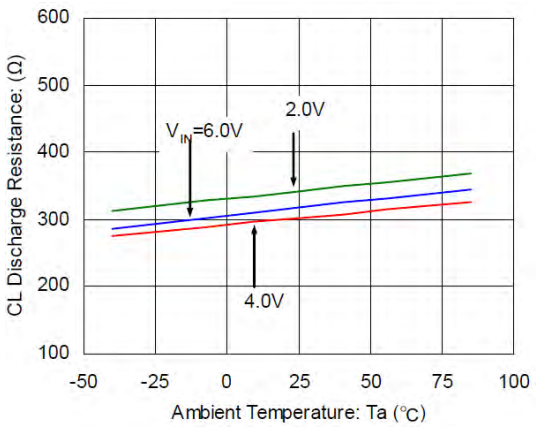
(13) Soft Start Time vs. Ambient Temperature

IXD920xB333DR



(14) C_L Discharge Time vs. Ambient Temperature

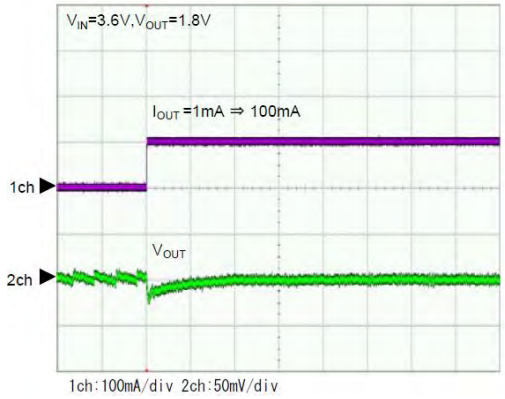
IXD920xB333DR



(15) Load Transient Response

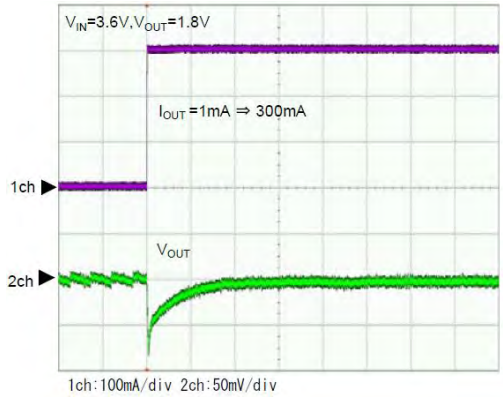
MODE: PWM/PFM Auto Switching

IXD9209B183DR



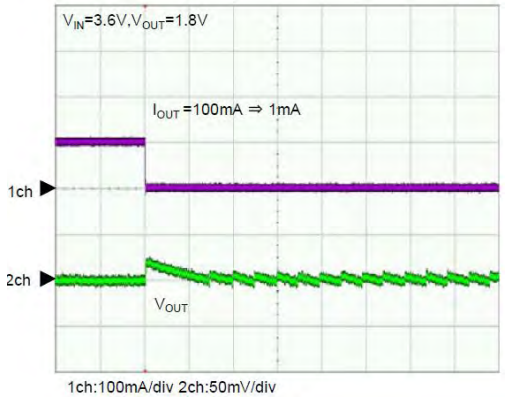
Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9209B183DR



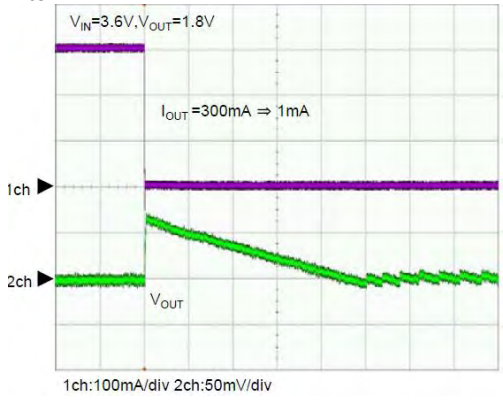
Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9209B183DR



Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9209B183DR



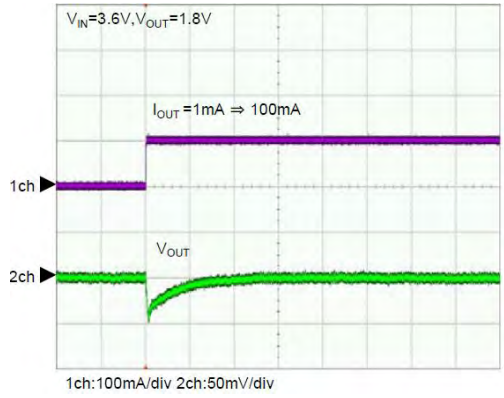
Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(15) Load Transient Response (Continued)

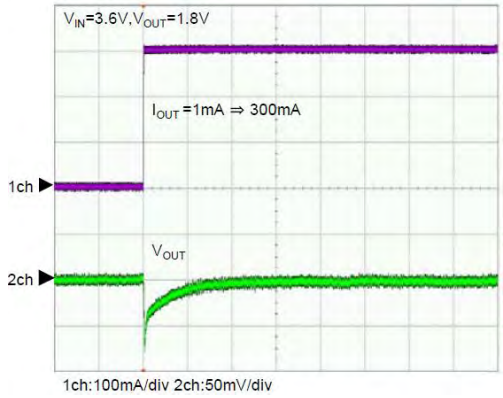
MODE: PWM

IXD9208B183DR



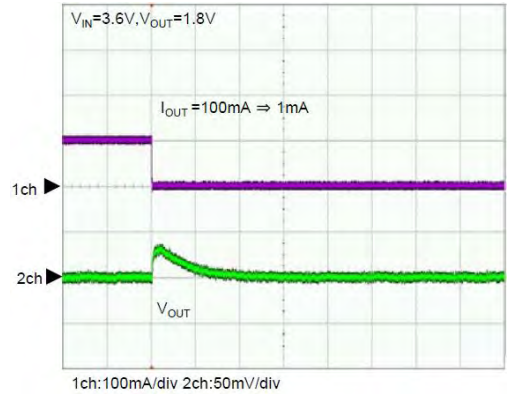
Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9208B183DR



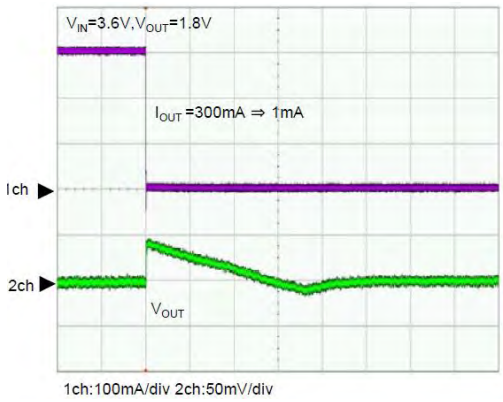
Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9208B183DR



Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

IXD9208B183DR



Ch1 – I_{OUT}, Ch2 – V_{OUT} 50 mV/div, Time – 100 µs/div

ORDERING INFORMATION

IXD9208①②③④⑤⑥-⑦ PWM Mode only
IXD9209①②③④⑤⑥-⑦ PFM/PWM Mode auto switching

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of DC/DC Controller	A	V_{IN} ≥ 2 V, No C_L auto discharge, standard soft start, fixed output voltage
		B	V_{IN} ≥ 2 V, C_L auto discharge, fast soft start, fixed output voltage
		F	V_{IN} ≥ 1.8 V, C_L auto discharge, fast soft start, adjustable output voltage
②③	Fixed Output Voltage, V[2]	08 - 40	② - integer part, ③ - decimal part, i.e. V_{OUT} = 2.8 V - ② = 2, ③ = 8 0.05 V increments: 0.05 = A, 0.15 = B, 0.25 = C. 0.35 = D, 0.45 = E, 0.55 = F, 0.65 = H, 0.75 = K, 0.85 = L, 0.95 = M V_{OUT} = 2.85 V - ② = 2, ③ = L
④	Oscillation Frequency	3	3.0 MHz
⑤⑥-⑦[1]	Packages (Order Limit)	DR	USP-10B03 (3000/reel)

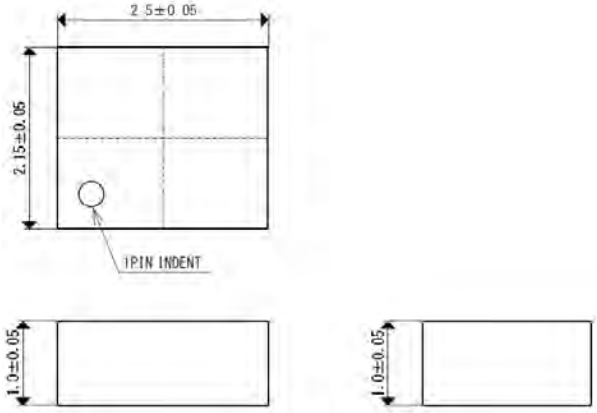
NOTE:

1) The "-G" suffix denotes halogen and antimony free, as well as being fully RoHS compliant.
2) Standard output voltages are: 1.0, 1.2, 1.5, 1.8, 2.5, 2.8, 2.85, 3.0, and 3.3 V. 0.8 V is available with external setting for F series. Contact local representative for more information if other voltages in the range from 0.8 to 4.0 V require.

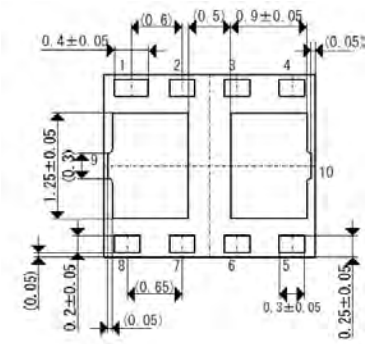
PACKAGE DRAWING AND DIMENSIONS

(Units: mm)

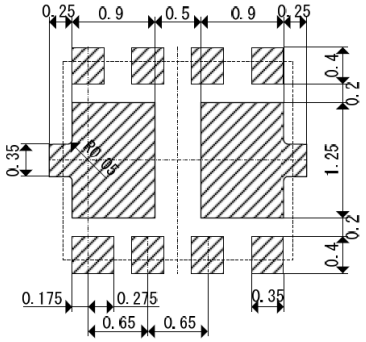
USP-10B03



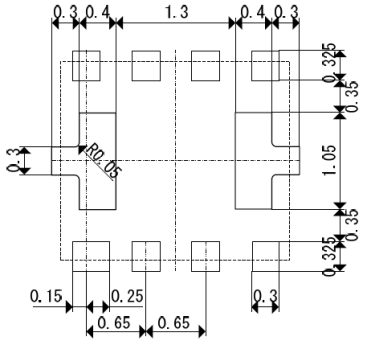
Bottom View



Reference Pattern Layout

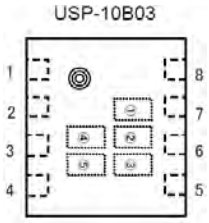


Reference Metal Mask Design



MARKING

USP-10B03



① Represents product series

MARK	PRODUCT SERIES
8	IXD9208xx3xx
9	IXD9209xx3xx

② Represents integral part of the voltage value

OUTPUT VOLTAGE, V	MARK	
	IXD920xA/Bxx3xx	IXD920xFxx3xx
0.x	0	F
1.x	1	
2.x	2	
3.x	3	
4.x	4	

③ Represents decimal part of the Voltage value

V_{OUT}, V	MARK
x.00	0
x.05	A
x.10	1
x.15	B
x.20	2
x.25	C
x.30	3
x.35	D
x.40	4
x.45	E
x.50	5
x.55	F
x.60	6
x.65	H
x.70	7
x.75	K
x.80	8
x.85	L
x.90	9
x.95	M

④⑤ Represents production lot number
01～09、0A～0Z、11～9Z、A1～A9、AA～AZ、B1～ZZ in order
(G, I, J, O, Q, and W excluded)

Example for marks②,③
V_{OUT} = 2.80 V – mark ② = 2, mark ③ = 8
V_{OUT} = 2.85 V – mark ② = 2, mark ③ = L

Customer Support

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