Step-Up DC/DC Controller

FEATURES

- **Operating Voltage Range**: 1.8 V ~ 6.0 V
- **Output Voltage Range**: 1.5 V~30 V
- **Reference Voltage:** 0.9 V ± 2%
- **Oscillation Frequency**: 100 kHz ± 15%
- **Output Current:** ≥ 80 mA
- **Operation Modes:** PWM (IXD2120), PWM/PFM auto switching (IXD2121), and PWM/PFM external selection (IXD2122)
- **Maximum Duty Cycle:** 93% typical
- **Low Standby Current**: < 1 µA
- **High Efficiency:** > 85% typical
- Load Capacitors: Low ESR Ceramic
- **Packages**: SOT-25, USP-6C

APPLICATION

- Mobile phones
- Cameras, VCRs
- Various portable equipment
- Power Supplies for LCD and OLEDs

DESCRIPTION

The IXD2120/21/22 series is a series of step-up DC/DC controllers operating either in PWM or PWM/PFM auto/external selection switching modes.

The 93% maximum duty cycle ratio makes this series suitable for applications that require high step-up ratios, such as LCD and OLED panels. The IXD2120/21/22 series provides stable output voltage and high efficiency under such conditions. The internal 0.9 V (± 2.0%) reference voltage allows setting of output voltage in the range of 1.5 V to 30 V using an external resistive divider.

The current sense resistor R_{SENSE} allows the use of ceramic capacitors with low ESR as load capacitors that reduces output ripple and PCB area requirements.

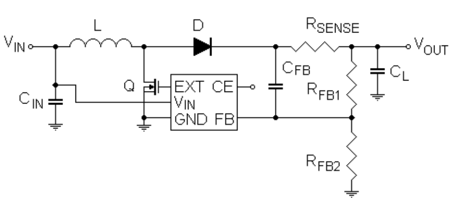
The IXD2121 automatically changes the operation mode from PWM to PFM at light load, while IXD2122 enables changing of the operation mode from PWM to PFM using an external signal.

In standby mode (when the CE pin is logic low), all circuits are in shutdown, which reduces current consumption to less than 1.0 µA.

The over-current limit circuit monitors the ripple voltage of the FB pin and turns the IC off, when the ripple voltage is above 250mV. The IC resumes its operation with a toggle of the CE pin or by turning the power supply off/on.

The IXD2120/21/22 series is available in SOT-25 and UCP-6C packages.

TYPICAL APPLICATION CIRCUIT

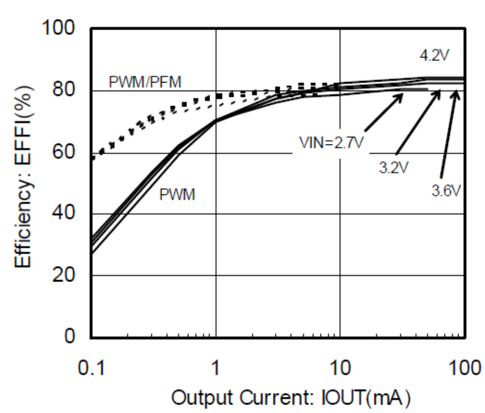


External components:

L = 47 µH (CDRH5D28), D: XBS104S14R, C_L = 40 µF (Ceramic), Q: XP161A1355
R_{FB1} = 470 kΩ, R_{FB2} = 30 kΩ, R_{SENSE} = 30 mΩ
V_{IN} = 2.7 – 4.2 V, V_{OUT} = 15 V

TYPICAL PERFORMANCE CHARACTERISTIC

Efficiency vs. output Current
IXD2122D091
f_{OSC} = 100 kHz, V_{OUT} = 15.0 V
L = 47 µH (CDRH5D28), D: XB01SB04A2, C_L = 40 µF (Ceramic), Q: 161A11A1



ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
V_{IN} Voltage		V_{IN}	– 0.3 ~ 12.0	V
FB Pin Voltage		V_{Lx}	– 0.3 ~ 12.0	V
CE Input Voltage		V_{CE}	– 0.3 ~ 12.0	V
EXT Pin Voltage		V_{EXT}	V_{SS} – 0.3 ~ V_{IN} + 0.3	V
EXT Pin Current		I_{EXT}	± 100	mA
Power Dissipation	SOT-25	P_D	250	mW
	USP-6C		120	
Operating Temperature Range		T_{OPR}	– 40 ~ + 85	^{0}C
Storage Temperature Range		T_{STG}	– 55 ~ +125	^{0}C

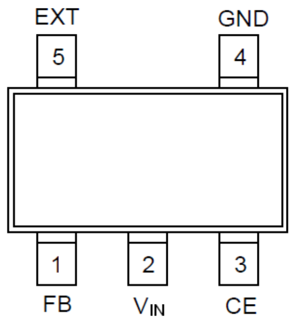
ELECTRICAL OPERATING CHARACTERISTICS

Ta = 25 ^{0}C

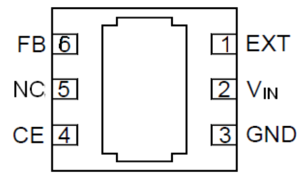
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
FB Voltage	V_{FB}		0.882	0.900	0.918	V	④
Input Voltage Range[1)]	V_{IN}		1.8		6.0	V	①
Output Voltage Setting Range	$V_{OUT(E)}$	V_{IN} = $V_{OUT(E)}$ x 0.6, V_{DD} = 3.0 V, I_{OUT} = 1.0 mA	1.5		30	V	②
Operating Start Voltage	V_{ST1}	V_{OUT} = 3.3 V, I_{OUT} = 1 mA	-		0.9	V	③
Oscillation Start Voltage[1)]	V_{ST2}	V_{CE} =V_{DD}, V_{FB} = 0	-	-	0.8	V	③
Operating Hold Voltage	V_{HLD}	V_{OUT} = 3.3 V, I_{OUT} = 1 mA,		-	0.7	V	③
Supply Current 1	I_{DD1}	V_{CE} = V_{DD} = 3.3 V, V_{FB} = 0	-	25	50	µA	④
Supply Current 2	I_{DD2}	V_{OUT} = 3.3 V, I_{OUT} = 1 mA, V_{FB} = 1.2 V	-	13	30	µA	④
Standby Current	I_{STB}	V_{CE} = 0 V, V_{DD} = 3.3 V, V_{FB} = 0			1.0	µA	⑤
Oscillation Frequency	f_{OSC}	V_{CE} = V_{DD} = 3.3 V, V_{FB} = 0	85	100	115	kHz	④
Maximum Duty Ratio	D_{MAX}	V_{CE} = V_{DD} = 3.3 V, V_{FB} = 0	89	93	96	%	④
PFM Duty Ratio	D_{PFM}	No load, IXD3221/22 type	24	32	40	%	④
Over-current Sense Voltage[2)]	V_{LIM}	V_{EXT} = 0 V, IXD3220/21/22 B type	150	250	400	mV	④
Efficiency[3)]	EFFI	I_{OUT} = 100 mA		85		%	①
Soft Start Time	t_{SFT}		5.0	10.0	20.0	ms	①
CE "High" Voltage	V_{CEH}	V_{DD} = 3.3 V, V_{FB} = 0	0.65			V	⑤
CE "Low" Voltage	V_{CEL}	V_{DD} = 3.3 V, V_{FB} = 0			0.20	V	⑤
EXT "H" ON Resistance	R_{EXTH}	V_{CE} = V_{DD} = 3.3 V, V_{FB} = 0, V_{EXT} = V_{OUT} – 0.4 V	-	24	36	Ω	④
EXT "L" ON Resistance	R_{EXTL}	V_{CE} = V_{DD} = 3.3 V, V_{FB} = 0, V_{EXT} = 0.4 V	-	16	24	Ω	④
PWM "H" Voltage[4)]	V_{PWMH}	I_{OUT} = 1 mA, IXD2122	V_{DD}-0.2			V	①
PWM "L" Voltage[4)]	V_{PWML}	I_{OUT} = 1 mA, IXD2122			V_{DD}-1	V	①
CE "High" Current	I_{CEH}	V_{DD} = V_{CE} = 3.3 V, V_{FB} = 1.2 V			0.1	µA	⑤
CE "Low" Current	I_{CEL}	V_{DD} = 3.3 V, V_{FB} = 1.2 V, V_{CE} = 0 V			-0.1	µA	⑤
FB "High" Current	I_{FBH}	V_{FB} = V_{DD} = V_{CE} = 3.3 V,			0.1	µA	⑤
FB "Low" Current	I_{FBL}	V_{CE} =V_{DD} = 3.3 V, V_{FB} = 0 V			-0.1	µA	⑤

Test Conditions: Unless otherwise stated, C_L ceramic, recommended MOSFET should be connected. When V_{OUT} = 15V, V_{IN} = V_{DD} = 3.6 V.
NOTE:
1) Although the IC starts step-up operations from a V_{DD} = 0.8 V, the output voltage and oscillation frequency are stabilized at V_{DD} > 1.8 V. Therefore, a V_{DD} of more than 1.8 V is recommended when V_{DD} is supplied from V_{IN} or other power sources.
2) Pulse ≥ 2 µs applied to FB pin. The over-current limit circuit monitors the ripple voltage, so external components should be selected to prevent V_{LMT} being reached under expected operating conditions.
3) EFFI = *{(output voltage) x (output current)} / {(input voltage) x (input current)} x 100*
4) The CE pin of the IXD2122 series combines functions of chip enable and PWM/PFM external switch pin. PWM control becomes effective when the V_{CE} > V_{DD}-0.2V. PWM/PFM automatic switching control becomes effective with 32% duty cycle, when the V_{CEH} < V_{CE} < V_{DD}-1.0 V,

PIN CONFIGURATION



SOT-25 (TOP VIEW)



USP-6C (BOTTOM VIEW)

The dissipation pad for the USP-6C package should be solder-plated in recommended mount pattern and metal masking to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the pin No.2.

PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTIONS
SOT-25	USP-6C		
1	6	FB	Feedback Input
2	2	V_{IN}	Supply Voltage
3	4	CE	Chip Enable (PWM/PFM Switch)
4	3	GND	Ground
5	1	EXT	External Switching transistor drive, Connect to the gate of N-channel transistor
-	5	NC	No Connection

CE PIN FUNCTION

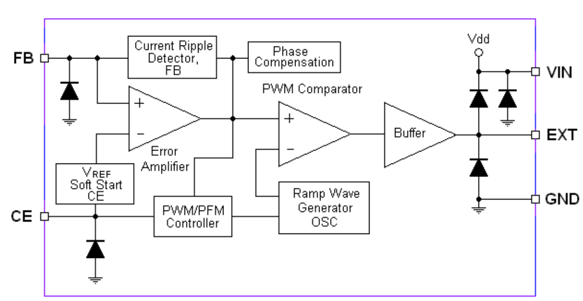
IXD2120/21 Series

CE PIN STATE	IC OPERATION STATE
H	Operation
L	Standby

IXD2122 Series

CE PIN STATE	CE PIN VOLTAGE	IC OPERATION STATE
H	$V_{CE} > V_{IN} - 0.2$ V	Operation in PWM Mode
M	$0.65\text{ V} < V_{CE} < V_{IN} - 1.0$ V	Operation in PWM/PFM Auto Switching Mode
L	$0\text{ V} < V_{CE} < 0.2$ V	Standby

BLOCK DIAGRAM



CE and FB pins are CMOS inputs, EXT pin is a CMOS otput.

BASIC OPERATION

The IXD2120/21/22 series consists of a Reference Voltage source, Ramp Wave Generator, Error Amplifier, PWM Comparator, Phase Compensation circuit, and Current Limiter circuit. IC's Error Amplifier compares the internal reference voltage with the feedback voltage from the V_{FB} pin. Phase compensated signal from the Error Amplifier's output applies to the inverting PWM Comparator's input, which non-inverting input is connected to the output of the Ramp Wave Generator. Resulting PWM modulated signal from Comparator determines turn-on time. It applies to the buffer, which drives gate/base of the external transistor. This process performs continuously to ensure stable output voltage by changing duty cycle of PWM pulses in respect to error signal.

Reference Voltage Source

The reference voltage source provides the reference voltage to ensure stable output voltage of the DC/DC

Ramp Wave Generator

The Ramp Wave Generator produces saw tooth pulses needed for PWM operation. 100 kHz Clock pulses generated in this circuit synchronize also all internal circuits.

Error Amplifier

The error amplifier compares reference voltage with the voltage from the V_{FB} pin. When a V_{FB} is lower than the reference voltage, output voltage increases, resulting in longer ON time of the switching transistor.

The gain and frequency characteristics of the error amplifier are set internally to deliver an optimized signal to the PWM comparator.

PWM Comparator

The PWM Comparator compares outputs from the Error Amplifier and saw-tooth waveform generated by Ramp Wave Generator. When the voltage from the Error Amplifier is above tooth wave, the PWM Comparator turns external switch transistor on. When the voltage from the Error Amplifier becomes less than tooth wave, the PWM Comparator turns external switch transistor off, creating PWM pulses to regulate output voltage.

PWM/PFM Controller

The IXD2120 operates in PWM mode only, the IXD2121 automatically switches between PWM and PFM modes depend on load, while the IXD2122 switches between PWM and PWM/PFM operating modes by an external signal, providing most flexibility in accommodating different loads.

The IXD2122 PWM/PFM automatic switching control becomes effective when the voltage of the CE pin is less than VDD-1.0V, but above LOW level. The IXD2122 operates in PWM mode if $V_{IN} \geq V_{CE} > V_{IN} - 0.2$ V.

Reference Voltage Source (V_{REF}) with Soft Start

The reference voltage V_{REF} = 0.9 V is adjusted by laser trimming. The Soft-start circuit protects power source from inrush current, when the input power is turned on. It protects also against voltage overshoot, however, this circuit does not protect the load capacitor (C_L) form spikes in a load current.

Enable Function

The CE pin controls operations of the IC. When the voltage of the CE pin is 0.2V or less, IC is disabled, all operations stop, and the EXT pin goes low to keep external transistor in off state. The IC current consumption in disabled state is less than 1.0 µA. When the CE pin's voltage is 0.65 V or above, the IC starts normal operations.

Current Limiter Circuit

The Current Limiter circuit monitors an output ripple voltage. If the ripple voltage exceeds Current Limiter's threshold, it stops IC operations and locks it in this state with EXT pin LOW. To resume normal IC operation, CE pin or input power should be toggled off/on to let IC restart from Soft Start.

Output Voltage Setting

The Output voltage set by external resistive divider R_{FB1}/R_{FB2} is equal

$$V_{OUT} = 0.9 \times (R_{FB1} + R_{FB2}) / R_{FB2}$$

The sum of R_{FB1} and R_{FB2} should be 2 MΩ or less.

The value of C_{FB}, a speed-up capacitor for phase compensation, should create $fzfb = 1/(2 \times \pi \times C_{FB} \times R_{FB1})$ equal to 15 kHz. Adjustments are allowed between 5 kHz to 30 kHz depend on the application, value of the inductor (L), and load capacitor (C_L).

Example: Output Voltage Setting

V_{OUT}, V	R_{FB1}, kΩ	R_{FB2}, kΩ	C_{FB}, pF	V_{OUT}, V	R_{FB1}, kΩ	R_{FB2}, kΩ	C_{FB}, pF
30.0	390	12	27	15.0	470	30	22
25.0	270	10	39	10.0	150	15	68
20.0	470	22	22	7.0	150	22	69
18.0	510	27	18	3.3	150	56	68

The Use of Ceramic Load Capacitor C_L

The IXD2120/21/22 series has a specialized circuit, which creates negative feedback from output voltage and load current. An inexpensive current sense resistor of approximately 50 mΩ set in series with load, allows achieve stable IC operation using low ESR ceramic capacitors.

Recommended External Components

Transistors Q:

XP161A1355PR (N-Channel Power MOSFET, TOREX,), breakdown voltage 20V, V_{ST} = 1.2 V (max)
XP161A11A1PR (N-Channel Power MOSFET, TOREX,), breakdown voltage 30V, V_{ST} = 2.5 V (max)
2SD1628 (N-P-N Bi-polar Transistor, SANYO)

If Bi-polar transistor is used, additional components require:
R_B = 500 Ω (Adjust with transistors h_{SE} and load)
C_B = 2200 pF (Ceramic)
$C_B < 1 / (2\pi \times R_B \times f_{OSC} \times 0.7)$, ($f_{OSC}$ = 100 kHz)

Diode D:

XBS104S14R-G (Schottky Barrier Diode, TOREX)

Inductors L:

47 µH (CDRH5D28, SUMIDA)
22 µH (CDRH5D28, SUMIDA)

Capacitors C_L:

10 µF, 25 V (Ceramic, TMK316BJ106KL, TAIYO YUDEN)
10 µF, 10 V (Ceramic, LMK325BJ106ML, TAIYO YUDEN)
47 µF, 25 V (Tantalum type, TAJ series, KYOCERA)
47 µF, 16 V (Tantalum type, TAJ series, KYOCERA)

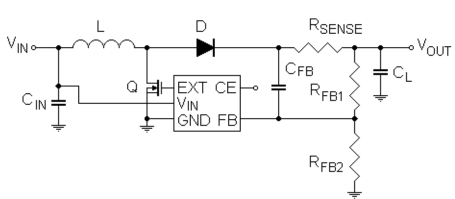
If step-up ratio and output current are large, use formula below to determine C_L value.

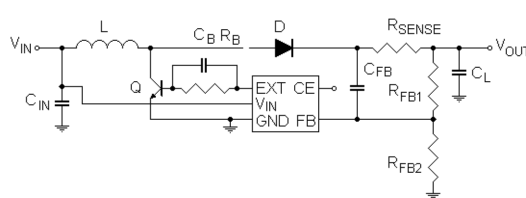
$$C_L = (C_L \text{ recommended value} \times (I_{OUT}\,(mA) / 100\,mA \times V_{OUT} / V_{IN})$$

R_{SENSE}

If ceramic capacitor C_L is used, R_{SENSE} = 50 mΩ
If tantalum capacitor C_L is used, R_{SENSE} = 0 Ω.

TYPICAL APPLICATION CIRCUITS





External components:

L = 47 µH (CDRH5D28), D: XBS104S14R, C_L = 10 µF x 4 (Ceramic), Q: XP161A1355 R_{FB1} = 470 kΩ, R_{FB2} = 30 kΩ, C_{FB} = 22 pF, R_{SENSE} = 50 mΩ
V_{IN} = 2.7 – 4.2 V, V_{OUT} = 15 V

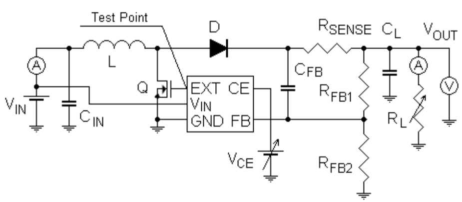
R_{SENSE} is used with low ESR capacitors only. Tantallum or electrolitic capacitors do not require this resistor. In such case R_{SENSE} = 0.

LAYOUT AND USE CONSIDERATIONS

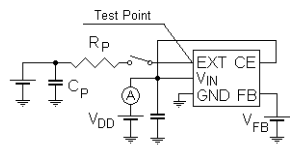
1. Do not exceed the value of stated absolute maximum ratings.
2. The IC performance is greatly influenced by not only the ICs' characteristics, but also by those of the external components. Care must be taken when selecting external components.
3. Ensure that the PCB ground traces are as thick as possible, as variations in ground potential caused by high ground currents at the time of switching may result in instability of the IC.
4. Mount each external component as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance.
5. If the IC is powered from a source other than V_{IN} (V_{OUT}), a bypass capacitor C_{DD} should be installed between the V_{IN} and GND pins to provide stable operation.
6. R_{SENSE} should not be used with C_L capacitors other than low ESR ceramic type.

TEST CIRCUITS

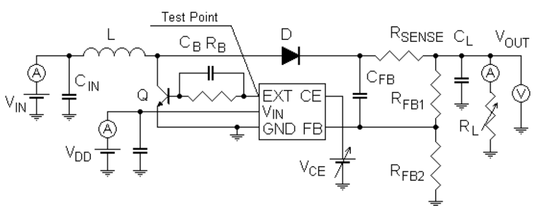
Circuit ①



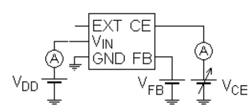
Circuit ④



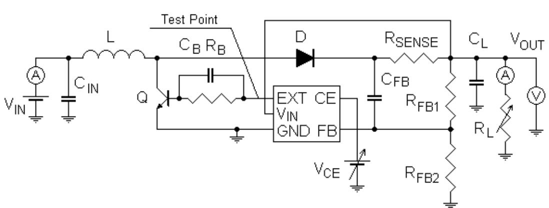
Circuit ②



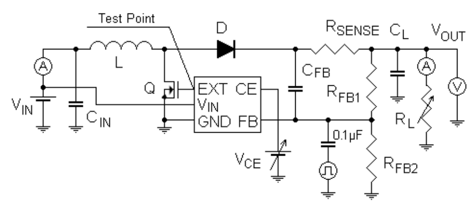
Circuit ⑤



Circuit ③



Circuit ⑥



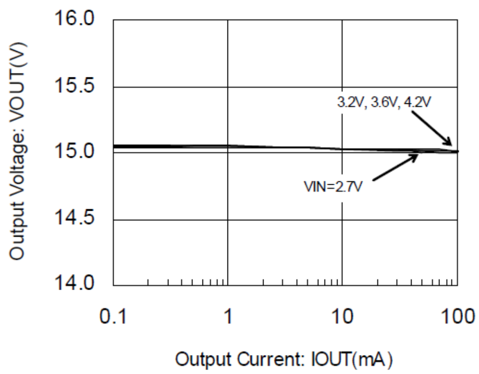
TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

Topr = 25 ^{0}C

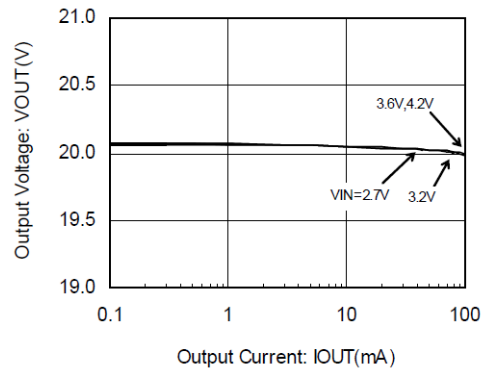
IXD2122D091 V_{OUT} = 15.0V

L = 47 µH (CDRH5D28), C_L = 40 µF (Ceramic), D - XBS104S14R, Q - 161A11A1



IXD2122D091 V_{OUT} = 20.0V

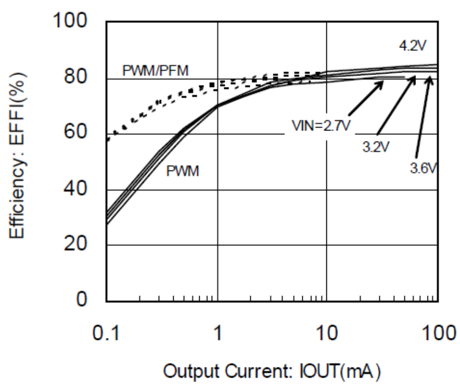
L = 47 µH (CDRH5D28), C_L = 40 µF (Ceramic), D - XBS104S14R, Q - 161A11A1



(2) Efficiency vs. Output Current

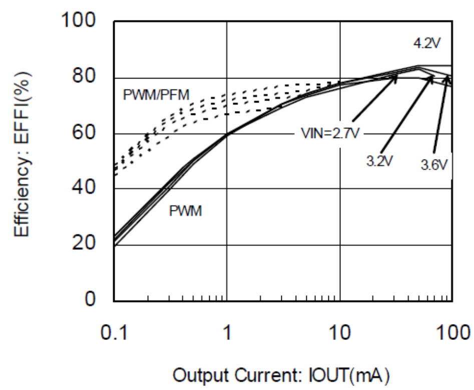
IXD2122D091 V_{OUT} = 15.0V

L = 47 µH (CDRH5D28), C_L = 40 µF (Ceramic), D - XBS104S14R, Q - 161A11A1



IXD2122D091 V_{OUT} = 20.0V

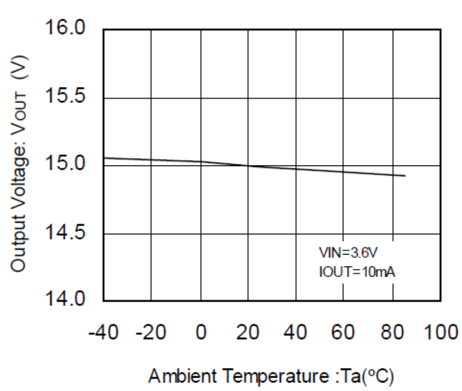
L = 47 µH (CDRH5D28), C_L = 40 µF (Ceramic), D - XBS104S14R, Q - 161A11A1



(3) Output Voltage vs. Ambient Temperature

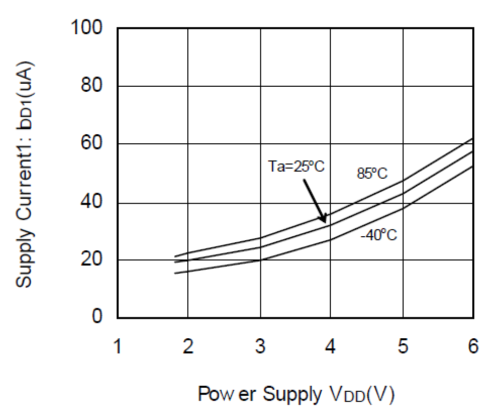
IXD2122D091 V_{OUT} = 15.0V

L = 22 µH (CDRH5D28), C_L = 20 µF(Ceramic), D - XBS104S14R, Q - XP161A1355PR



(4) Supply Current 1 vs. Supply Voltage

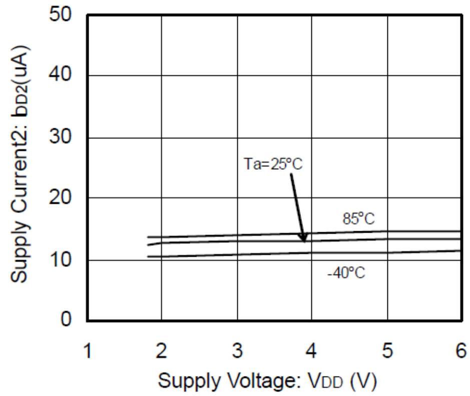
IXD2122D091



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

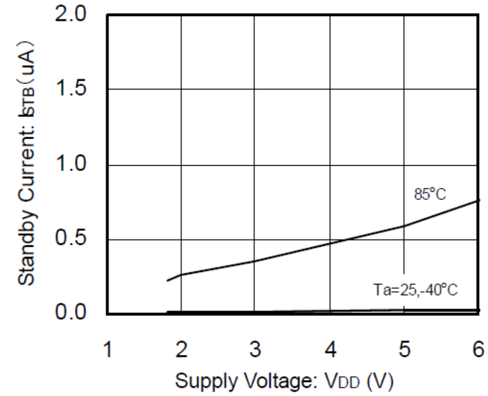
(5) Supply Current 2 vs. Supply Voltage

IXD2122D091



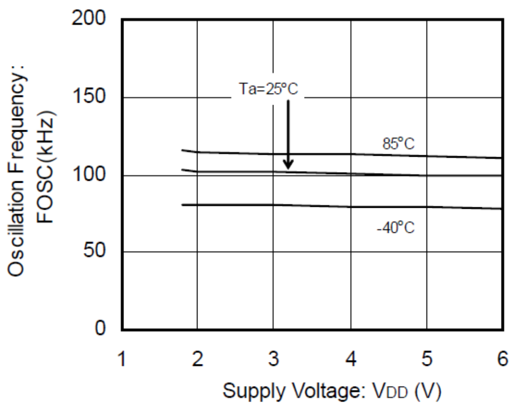
(6) Standby Current vs. Supply Voltage

IXD2122D091



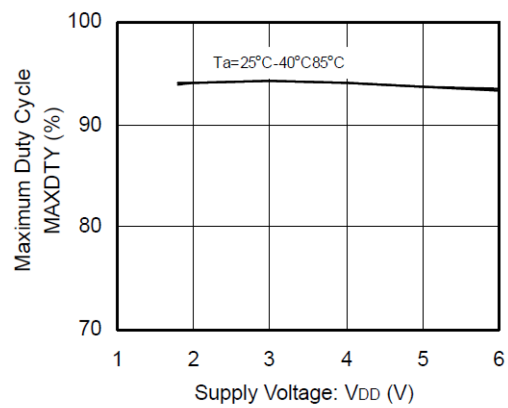
(7) Oscillation Frequency vs. Supply Voltage

IXD2122D091



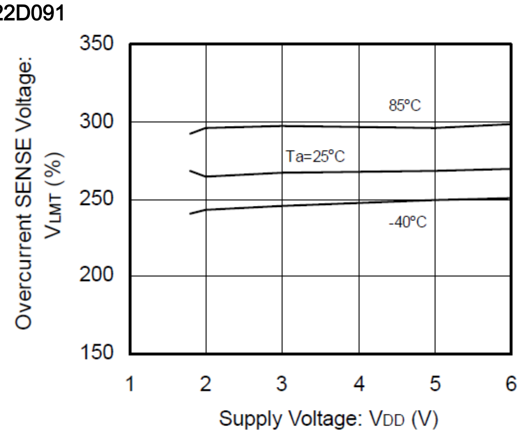
(8) Maximum Duty cycle Ratio vs. Supply Voltage

IXD2122D091



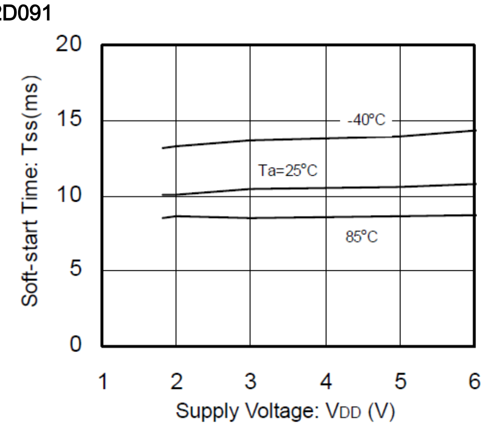
(9) Over-current sense Voltage vs. Supply Voltage

IXD2122D091



(10) Soft Start Time vs. Supply Voltage

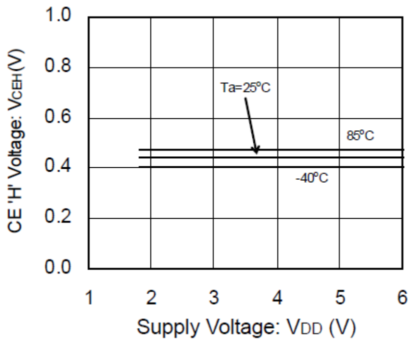
IXD2122D091



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

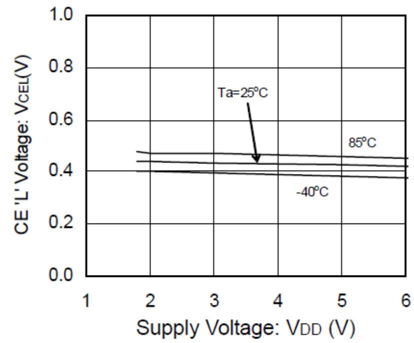
(11) CE “H” Voltage vs. Supply Voltage

IXD2122D091



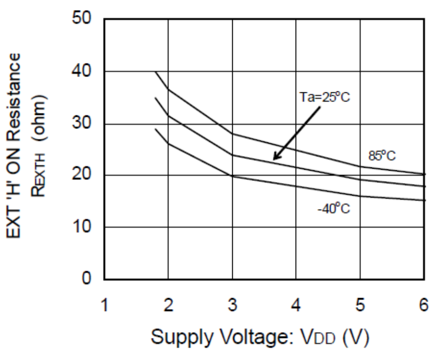
(12) CE “L” Voltage vs. Supply Voltage

IXD2122D091



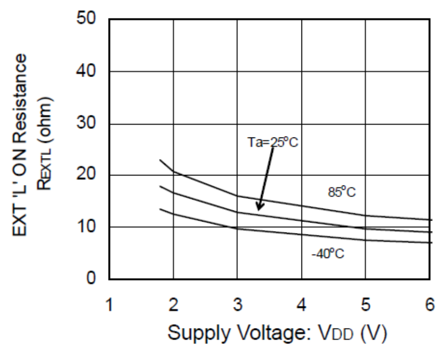
(13) EXT Pin “H” On Resistance vs. Supply Voltage

IXD2122D091



(14) EXT Pin “L” On Resistance vs. Supply Voltage

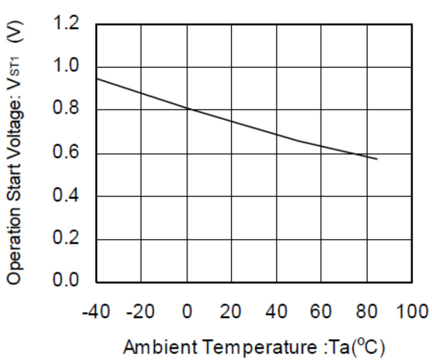
IXD2122D091



(15) Operation Start Voltage vs. Ambient Temperature

IXD2122D091

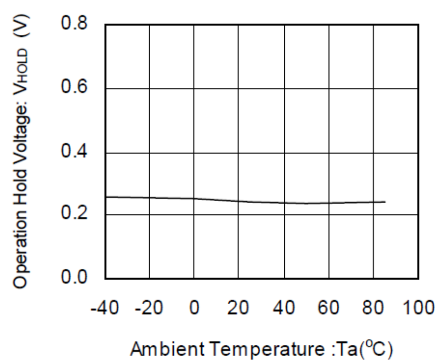
L = 22 µH (CDRH5D28), C_L = 20 µF (Ceramic), D - XBS104S14R, Q - 2SD1628



(16) Operation Hold Voltage vs. Ambient Temperature

IXD2122D091

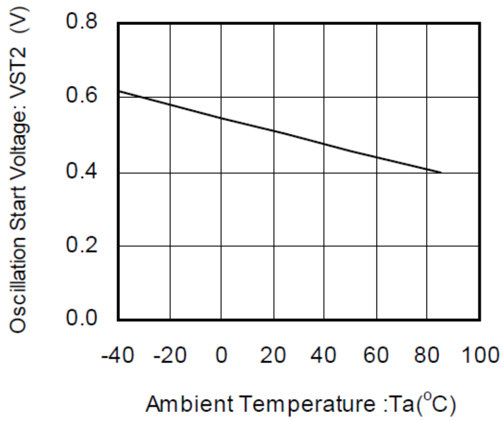
L = 22 µH (CDRH5D28), C_L = 20 µF (Ceramic), D - XBS104S14R, Q - 2SD1628



TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

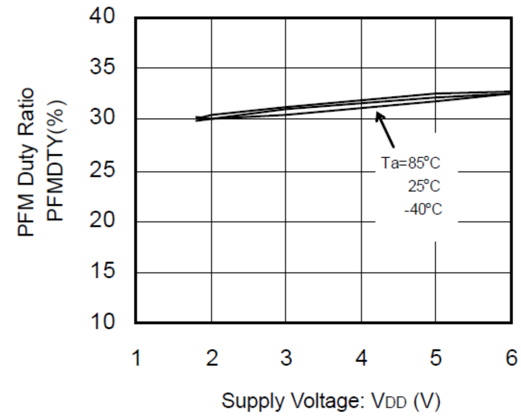
(17) Oscillation Start Voltage vs. Ambient Temperature

IXD2122D091



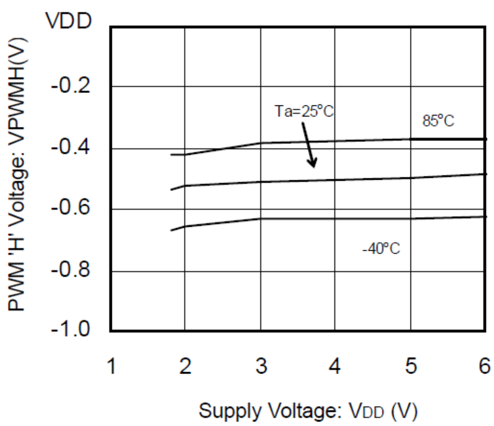
(18) PFM Duty Cycle Ration vs. Supply Voltage

IXD2122D091



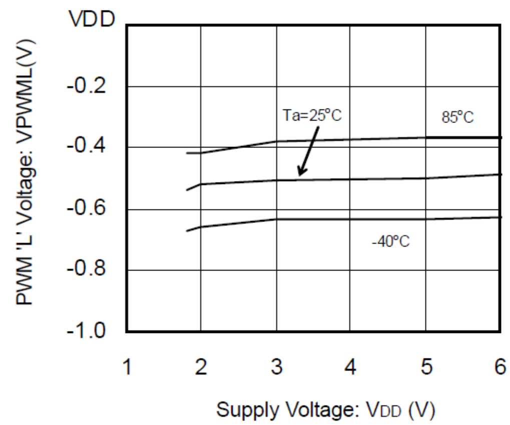
(19) PWM "H" Voltage vs. Supply Voltage

IXD2122D091



(20) PWM "H" Voltage vs. Supply Voltage

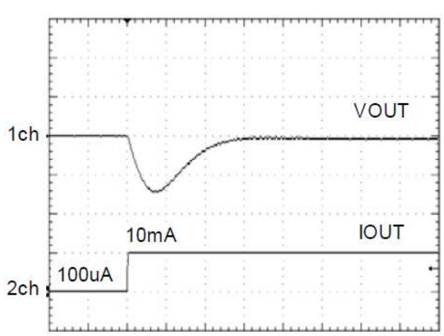
IXD2122D091



(21) Load Transient Response

IXD2122D091

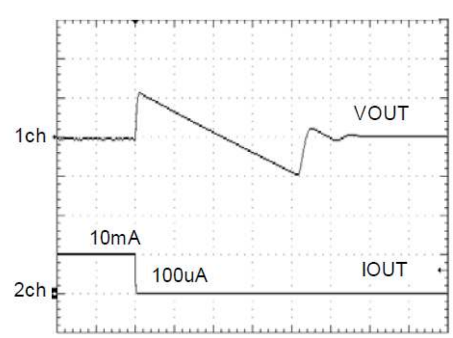
V_{IN} = 3.6 V, V_{OUT} = 15 V,, I_{OUT} = 100 µA → 10 mA



1ch - V_{OUT} – 100 mV/div. 2ch - I_{OUT} – 10 mA/div, Time – 400 µs/div

IXD2122D091

V_{IN} = 3.6 V, V_{OUT} = 15 V,, I_{OUT} = 10 mA → 100 µA



1ch - V_{OUT} – 100 mV/div. 2ch - I_{OUT} – 10 mA/div, Time – 4 ms/div

ORDERING INFORMATION

IXD2120①②③④⑤⑥-⑦ - PFM mode
IXD2121①②③④⑤⑥-⑦- PWM/PFM auto switching mode selection

IXD2122①②③④⑤⑥-⑦ - PWM/PFM externaly switching mode selection

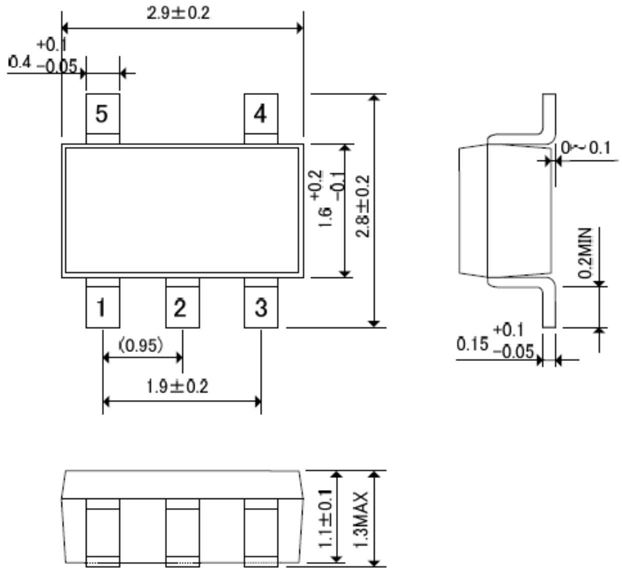
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type of DC/DC Controller	B	With Current Limiter
		D	Without Current Limiter
②③	Reference Voltage	09	FB Voltage = 0.9 V
④	Oscillation Frequency	1	100kHz
⑤⑥−⑦*	Packages (Typing Type)[2)]	MR	SOT-25 (3,000/Reel)
		MR-G[1)]	SOT-25 (3,000/Reel) (Halogen and Antimony free)
		ER	USP-6C (3,000/Reel)
		ER-G	USP-6C (3,000/Reel) (Halogen and Antimony free)

1) The “-G” suffix denotes halogen and antimony free, as well as being fully ROHS compliant.
2) The device orientation is fixed in its embossed tape pocket. For reverse orientation, please contact your local IXYS sales office or representative. (Standard orientation: ⑤R-⑦, Reverse orientation: ⑤L-⑦)

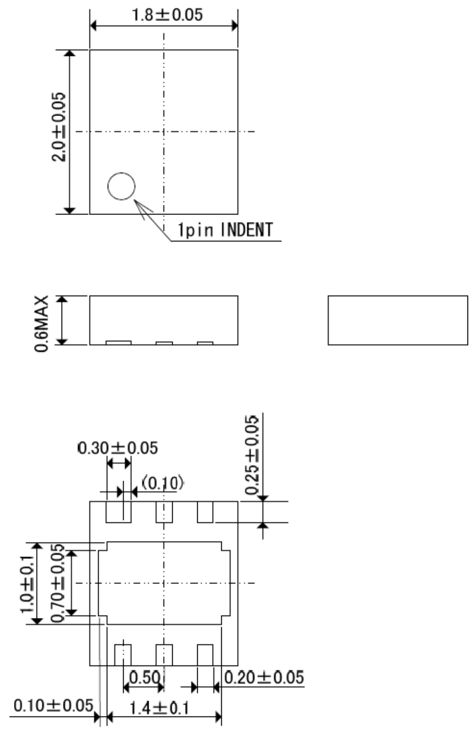
PACKAGE DRAWING AND DIMENSIONS

Units: mm

SOT-25

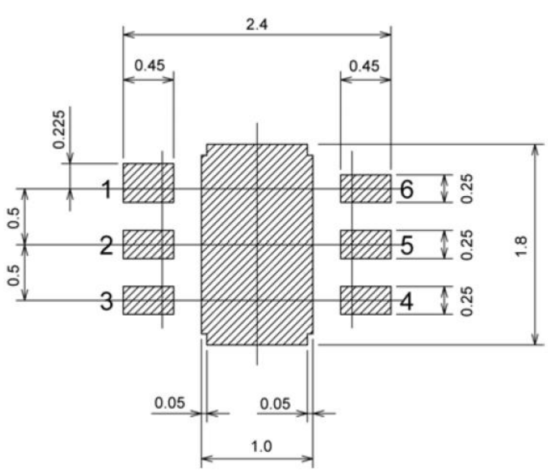


USP-6C

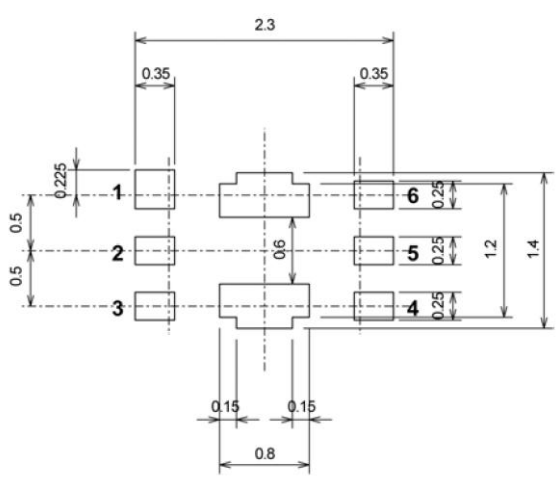


Note: The pins side is not gilded, but nickel plaited.

USP-6C Reference Pattern Layout

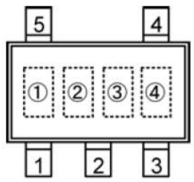


USP-6C Reference Metal Mask Design



MARKING

SOT-25



SOT-25 (TOP VIEW)

① - represents product series

MARK	PRODUCT SERIES
M	IXD2120x091Mx
N	IXD2121x091Mx
P	IXD2122x091Mx

② - represents current limit function

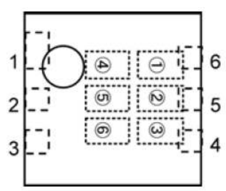
MARK	FUNCTION	PRODUCT SERIES
B	With Current Limit	IXD212xB091Mx
D	Without Current Limit	IXD212xD091Mx

③ - represents oscillation frequency

MARK	OSCILLATION FREQUENCY, kHz	PRODUCT SERIES
1	100	IXD212xx091Mx

④ represents production lot number 0 to 9, A to Z repeated (G, I, J, O, Q, W excluded)

USP-6C



USP-6C (TOP VIEW)

① - represents product series

MARK	PRODUCT SERIES
E	IXD2120x091Ex
F	IXD2121x091Ex
H	IXD2122x091Ex

② - represents current limit function

MARK	FUNCTION	PRODUCT SERIES
B	With Current Limit	IXD212xB091Ex
D	Without Current Limit	IXD212xD091Ex

③④ - represents FB Voltage

MARK		FB VOLTAGE, V	PRODUCT SERIES
③	④		
0	9	09	IXD212xx091Ex

⑤ -represents oscillation frequency

MARK	OSCILLATION FREQUENCY, kHz	PRODUCT SERIES
1	100	IXD212xx091Ex

⑥ – represents production lot number 0 to 9, A to Z repeated (G, I, J, O, Q, W excluded)

Customer Support

To share comments, get your technical questions answered, or report issues you may be experiencing with our products, please visit Zilog's Technical Support page at http://support.zilog.com. To learn more about this product, find additional documentation, or to discover other fac-ets about Zilog product offerings, please visit the Zilog Knowledge Base at http:// zilog.com/kb or consider participating in the Zilog Forum at http://zilog.com/forum. This publication is subject to replacement by a later edition. To determine whether a later edition exists, please visit the Zilog website at http://www.zilog.com.

Warning: DO NOT USE THIS PRODUCT IN LIFE SUPPORT SYSTEMS.

LIFE SUPPORT POLICY ZILOG'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF ZILOG CORPORATION.

As used herein Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.