XC8112/XC8113 Series

2ch Load switch IC with ideal diode function

■GENERAL DESCRIPTION

The XC8112/XC8113 series are 2ch load switch IC with ideal diode function.
These ICs perform regulation control to ensure that their V_{OUT} pin voltage is a value of V_{IN} - 20mV, so they can suppress heat generation to a greater extent than general diodes.

When a voltage is applied at the V_{OUT} pin and it becomes equal to or higher than V_{IN} - 20mV, the driver FET will turn OFF.
Furthermore, when the V_{OUT} pin voltage becomes equal to or higher than V_{IN} + 20mV, the IC's internal power supply will switch from V_{IN} to V_{OUT}, which can prevent backflow current flowing from the V_{OUT} pin through the parasitic diode to the V_{IN} pin, while also interrupting current flowing from V_{IN} to the IC.
This makes it possible to easily achieve an output voltage OR circuit, and to reduce battery consumption for backup purposes. Also, by connecting 2ch load switches in parallel, it can be used as ahigh current load switch load switch/low Ron load switch.

This IC has been certified by the international standard IEC 62368-1 that defines safety requirements,
and it is possible to simplify the single failure test of the subsequent circuits.
By adopting the foldback method for over current limiting, the short-circuit current can be suppressed to 50mA, and it can be used safely even in the event of a short-circuit.
In addition, the thermal shutdown function can prevent the IC from being destroyed by heat.

■APPLICATIONS

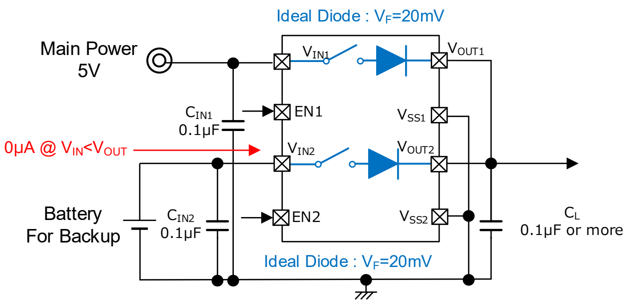
- Wearable devices
- Smart card devices
- IoT devices
- OR Application
- Backup power supply
- Replacement from diode

■FEATURES

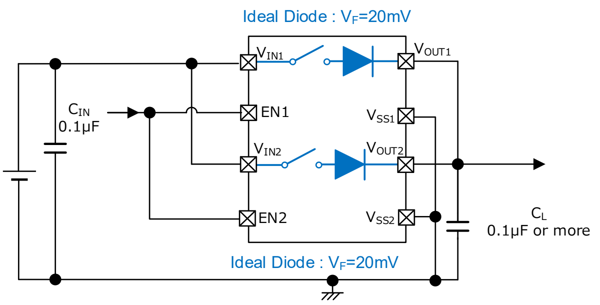
Input Voltage Range	1.5V ~ 6.0V
Output Current	XC8112 : 2ch x 500mA (V_{IN} > 1.7V)
	XC8113 : 2ch x1000mA (V_{IN} >2.0V)
Stand-by Current	0.65μA/ch
Quiescent Current	3.6μA/ch
Reverse Bias Current	0.8μA/ch
Forward Voltage	20mV
Over current limit	XC8112 : 850mA
	XC8113 : 1700mA
Short current	50mA
Function	Ideal diode function
	Reverse Protection
Protective function	Inrush current prevention
	Over current limit
	Thermal shutdown function
Standard	IEC 62368-1:2023 Certified
Operating Ambient Temperature	-40℃~ 105℃
Package	USP-8B06 (2.0x 2.0 x 0.33mm)

■TYPICAL APPLICATION CIRCUIT

●OR Circuit : Backup circuit etc(XC8112/XC8113)

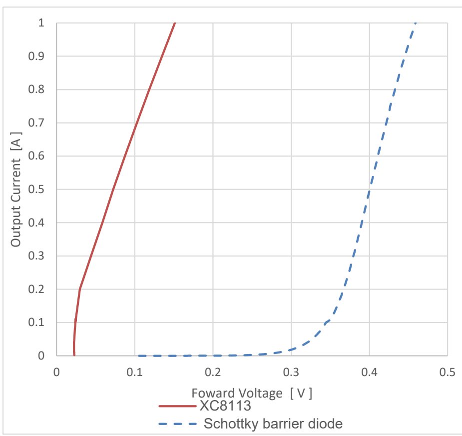


●Parallel connection(XC8112/XC8113)

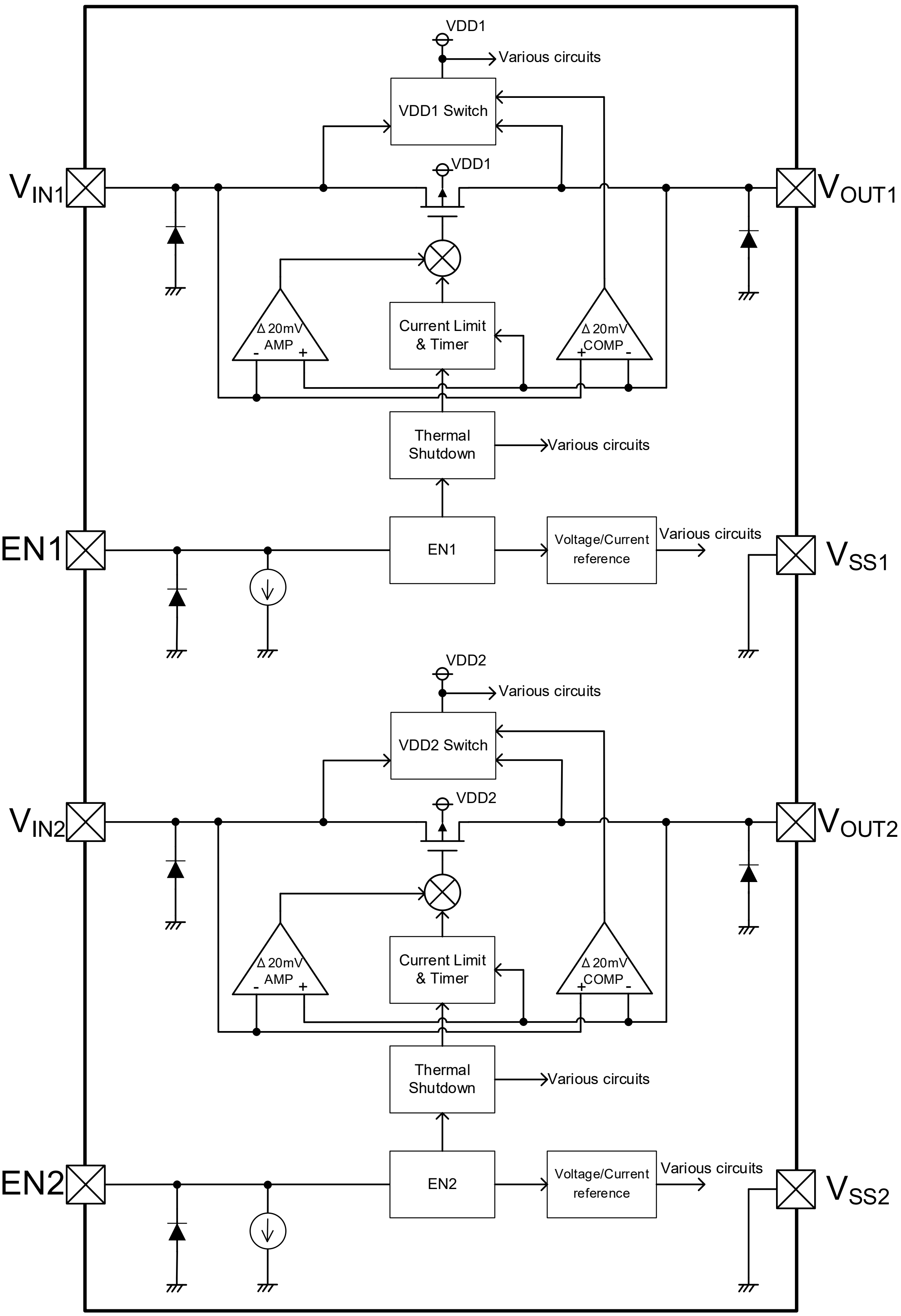


■TYPICAL PERFORMANCE CHARACTERISTICS

Forward characteristics



■BLOCK DIAGRAM



*Diodes inside the circuit are an ESD protection diodes and a parasitic diode.

■PRODUCT CLASSIFICATION

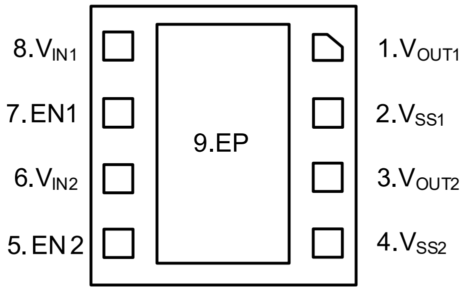
●Ordering Information

XC811①②③④⑤⑥⑦-⑧(*1)

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Product	2	2ch x 0.5A Output Current
		3	2ch x 1.0A Output Current
②	EN pin logic	A	EN High Active
③	Function	A	Ideal Diode function Equipped
④⑤	Internal Standard Number	01	-
⑥⑦-⑧	Packages Taping Type	ER-G(*1)	USP-8B06(5000pcs/Reel)

(*1) The "-G" suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

■PIN CONFIGURATION



USP-8B06
(BOTTOM VIEW)

■PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTION
1	V_{OUT1}	Load Switch 1ch : Output pin
2	V_{SS1}	Load Switch 1ch : Ground pin
3	V_{OUT2}	Load Switch 2ch : Output pin
4	V_{SS2}	Load Switch 2ch : Ground pin
5	EN2	Load Switch 2ch : Enable pin
6	V_{IN2}	Load Switch 2ch : Power Supply Input pin
7	EN1	Load Switch 1ch : Enable pin
8	V_{IN1}	Load Switch 1ch : Power Supply Input pin
9	EP	Exposed thermal pad. The Exposed pad want be connected to V_{SS}(Pin2,4).

■PIN FUNCTIONS ASSIGNMENT

Load Swtich : 1ch

PIN NAME	SIGNAL	STATUS	Applied voltage to V_{IN1}	Applied voltage to V_{OUT1}	Pch Driver FET	Reverse Protection
EN1	H	Active	1.5V ~ 6.0V	-	ON	-
			V_{IN1} - $V_{REV1} \leqq V_{OUT1}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		
	L	Stand-by	1.5V ~ 6.0V	-	OFF	-
			V_{IN1} - $V_{REV1} \leqq V_{OUT1}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		
	OPEN		1.5V ~ 6.0V	-	OFF	-
			V_{IN1} - $V_{REV1} \leqq V_{OUT1}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		

Load Swtich : 2ch

PIN NAME	SIGNAL	STATUS	Applied voltage to V_{IN2}	Applied voltage to V_{OUT2}	Pch Driver FET	Reverse Protection
EN2	H	Active	1.5V ~ 6.0V	-	ON	-
			V_{IN2} - $V_{REV2} \leqq V_{OUT2}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		
	L	Stand-by	1.5V ~ 6.0V	-	OFF	-
			V_{IN2} - $V_{REV2} \leqq V_{OUT2}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		
	OPEN		1.5V ~ 6.0V	-	OFF	-
			V_{IN2} - $V_{REV2} \leqq V_{OUT2}$	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		

■ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATINGS	UNITS
V_{IN1} Pin Voltage	V_{IN1}	-0.3 ~ 6.6	V
V_{IN2} Pin Voltage	V_{IN2}	-0.3 ~ 6.6	V
EN1 Pin Voltage	V_{EN1}	-0.3 ~ 6.6 (*1)	V
EN2 Pin Voltage	V_{EN2}	-0.3 ~ 6.6 (*1)	V
V_{OUT1} Pin Voltage	V_{OUT1}	-0.3 ~ 6.6	V
V_{OUT2} Pin Voltage	V_{OUT2}	-0.3 ~ 6.6	V
Power Dissipation (Ta=25℃)	Pd	1240 (JESD51-7 board) (*2)	mW
Junction Temperature	Tj	-40 ~ 125	℃
Storage Temperature	Tstg	-55 ~ 125	℃

All voltages are based on the V_{SS} of each channel(V_{SS1},V_{SS2}).

(*1) If a voltage of -0.2V or lower is applied to the EN1 and EN2 pins for more than 200μs during forward bias, the internal switch may turn on or the overcurrent limit value may become low. Once in this state, it will no longer function as an original load switch.

(*2) The power dissipation figure shown is PCB mounted and is for reference only.
Please refer to PACKAGING INFORMATION for the mounting condition.

■RECOMMENDED OPERATING CONDITIONS

Load Swtich : 1ch

PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNITS
Input Voltage	Applied voltage to V_{OUT1} : V_{OUT1} < 1.5V	V_{IN1}	1.5	-	6.0	V
	Applied voltage to V_{OUT1} : 1.5V ~ 6.0V		0.0	-	6.0	
Output Voltage	Applied voltage to V_{IN1} : V_{IN1} < 1.5V	V_{OUT1}	1.5	-	6.0	V
	Applied voltage to V_{IN1} : 1.5V ~ 6.0V		0.0	-	6.0	
Output Current (Ta=25℃) (*1)	XC8112 Series : 1.5V $\leqq$ V_{IN1} $\leqq$ 1.7V	I_{OUT1}	-	-	300	mA
	XC8112 Series : 1.7V < V_{IN1} $\leqq$ 6.0V		-	-	500	mA
	XC8113 Series : 1.5V $\leqq$ V_{IN1} $\leqq$ 2.0V		-	-	300	mA
	XC8113 Series : 2.0V < V_{IN1} $\leqq$ 6.0V		-	-	1000	mA
EN1 Pin Voltage		V_{EN1}	0.0	-	6.0	V
Operating Ambient Temperature		Topr	-40	-	105	℃
Input Capacitor (Effective Value)		C_{IN1}	0.033	0.1	-	μF
Output Capacitor (Effective Value)		C_{L1}	0.033	0.1	470 (*2)	μF

All voltages are based on the V_{SS1}

Load Swtich : 2ch

PARAMETER		SYMBOL	MIN.	TYP.	MAX.	UNITS
Input Voltage	Applied voltage to V_{OUT2} : V_{OUT2} < 1.5V	V_{IN2}	1.5	-	6.0	V
	Applied voltage to V_{OUT2} : 1.5V ~ 6.0V		0.0	-	6.0	
Output Voltage	Applied voltage to V_{IN2} : V_{IN2} < 1.5V	V_{OUT2}	1.5	-	6.0	V
	Applied voltage to V_{IN2} : 1.5V ~ 6.0V		0.0	-	6.0	
Output Current (Ta=25℃) (*1)	XC8112 Series : 1.5V $\leqq$ V_{IN2} $\leqq$ 1.7V	I_{OUT2}	-	-	300	mA
	XC8112 Series : 1.7V < V_{IN2} $\leqq$ 6.0V		-	-	500	mA
	XC8113 Series : 1.5V $\leqq$ V_{IN2} $\leqq$ 2.0V		-	-	300	mA
	XC8113 Series : 2.0V < V_{IN2} $\leqq$ 6.0V		-	-	1000	mA
EN2 Pin Voltage		V_{EN2}	0.0	-	6.0	V
Operating Ambient Temperature		Topr	-40	-	105	℃
Input Capacitor (Effective Value)		C_{IN2}	0.033	0.1	-	μF
Output Capacitor (Effective Value)		C_{L2}	0.033	0.1	470 (*2)	μF

All voltages are based on the V_{SS2}

(*1) Depending on the output current, the junction temperature may exceed the maximum junction temperature.
Please use within the range that does not exceed the maximum junction temperature.
(*2) If a large-capacity capacitor is used for the output capacity and the device is started under a heavy load, the output voltage may not rise.

■ELECTRICAL CHARACTERISTICS

Load Swtich : 1ch

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	CIRCUIT
Input Voltage Range	V_{IN1}	-		1.5	-	6.0	V	-
Quiescent Current	I_{Q1}	V_{IN1}=6.0V, V_{OUT1}=OPEN, V_{EN1}=6.0V		-	3.6	6.5	μA	1-1
Stand-by Current	I_{STB1}	V_{IN1}=3.6V, V_{OUT1}=0V, V_{EN1}=0V		-	0.65	1.30	μA	2-1
Reverse Bias Current (*1)	I_{RBC1}	V_{IN1}=3.6V, V_{OUT1}=3.7V V_{EN1}=3.7V		-	0.80	1.50	μA	3-1
Input Turn-Off Current (*2)	I_{TOFF1}	V_{IN1}=3.6V, V_{OUT1}=3.7V, V_{EN1}=3.7V		-0.1	0.0	0.1	μA	2-1
Reverse Current (*3)	I_{REV1}	V_{IN1}=0V, V_{OUT1}=6.0V, V_{EN1}=6.0V		-0.1	0.0	0.1	μA	2-1
Output Current	I_{OUT1}	XC8112 Series 1.5V < V_{IN1} ≦ 1.7V, V_{EN1}=V_{IN1}		300	-	-	mA	4-1
		XC8112 Series 1.7V ≦ V_{IN1} ≦ 6.0V, V_{EN1}=V_{IN1}		500	-	-	mA	
		XC8113 Series 1.5V < V_{IN1} ≦ 2.0V, V_{EN1}=V_{IN1}		300	-	-	mA	
		XC8113 Series 2.0V < V_{IN1} ≦ 6.0V, V_{EN1}=V_{IN1}		1000	-	-	mA	
Over Current Limit (*5)	I_{LIM1}	XC8112 Series V_{IN1}=6.0V, V_{OUT1}=5.0V		550	850	1200	mA	3-1
		XC8113 Series V_{IN1}=6.0V, V_{OUT1}=5.0V		1100	1700	2400		
Short Current	I_{SHORT1}	XC8112 Series V_{OUT1}=0V		30	50	100	mA	3-1
		XC8113 Series V_{OUT1}=0V		30	50	100		
Forward Voltage	$V_{FORWAR1}$	V_{IN1} - V_{OUT1}, I_{OUT1}=0.1mA		0 (*6)	20	35	mV	4-1
Reverse Detect Voltage (*4)	V_{REV1}	V_{OUT1} - V_{IN1}		0 (*6)	20	47	mV	2-1
Switch On Resistor	R_{ON1}	V_{IN1}=1.5V I_{OUT1}=100mA		-	0.41	0.88	Ω	4-1
		V_{IN1}=3.6V I_{OUT1}=200mA		-	0.18	0.32	Ω	
		V_{IN1}=6.0V I_{OUT1}=200mA		-	0.15	0.26	Ω	
Thermal Shutdown Temperature	T_{TSD1}	V_{IN1}=3.6V		-	150	-	℃	4-1
Thermal Hysteresis Width	T_{HYS1}	V_{IN1}=3.6V		-	25	-	℃	4-1
EN "H" Current	I_{ENH1}	V_{IN1}=6.0V, V_{EN1}=6.0V		0.04	0.48	1.50	μA	1-1
EN "L" Current	I_{ENL1}	V_{IN1}=6.0V, V_{EN1}=0V		-0.1	0.0	0.1	μA	1-1
EN "H" Voltage	V_{ENH1}	V_{EN1} = Step up	Ta=25℃ Ta=-40~105℃(*7)	1.2	-	6.0	V	1-1
EN "L" Voltage	V_{ENL1}	V_{EN1} = Step down	Ta=25℃ Ta=-40~105℃(*7)	V_{SS1}	-	0.3	V	1-1

■ELECTRICAL CHARACTERISTICS

Load Swtich : 2ch

Ta=25℃

PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT	CIRCUIT
Input Voltage Range	V_{IN2}	-		1.5	-	6.0	V	-
Quiescent Current	I_{Q2}	V_{IN2}=6.0V, V_{OUT2}=OPEN, V_{EN2}=6.0V		-	3.6	6.5	μA	1-2
Stand-by Current	I_{STB2}	V_{IN2}=3.6V, V_{OUT2}=0V, V_{EN2}=0V		-	0.65	1.30	μA	2-2
Reverse Bias Current (*1)	I_{RBC2}	V_{IN2}=3.6V, V_{OUT2}=3.7V V_{EN2}=3.7V		-	0.80	1.50	μA	3-2
Input Turn-Off Current (*2)	I_{TOFF2}	V_{IN2}=3.6V, V_{OUT2}=3.7V, V_{EN2}=3.7V		-0.1	0.0	0.1	μA	2-2
Reverse Current (*3)	I_{REV2}	V_{IN2}=0V, V_{OUT2}=6.0V, V_{EN2}=6.0V		-0.1	0.0	0.1	μA	2-2
Output Current	I_{OUT2}	XC8112 Series 1.5V < V_{IN2} ≦ 1.7V, V_{EN2}=V_{IN2}		300	-	-	mA	4-2
		XC8112 Series 1.7V ≦ V_{IN2} ≦ 6.0V, V_{EN2}=V_{IN2}		500	-	-	mA	
		XC8113 Series 1.5V < V_{IN2} ≦ 2.0V, V_{EN2}=V_{IN2}		300	-	-	mA	
		XC8113 Series 2.0V < V_{IN2} ≦ 6.0V, V_{EN2}=V_{IN2}		1000	-	-	mA	
Over Current Limit (*5)	I_{LIM2}	XC8112 Series V_{IN2}=6.0V, V_{OUT2}=5.0V		550	850	1200	mA	3-2
		XC8113 Series V_{IN2}=6.0V, V_{OUT2}=5.0V		1100	1700	2400		
Short Current	I_{SHORT2}	XC8112 Series V_{OUT2}=0V		30	50	100	mA	3-2
		XC8113 Series V_{OUT2}=0V		30	50	100		
Forward Voltage	$V_{FORWAR2}$	V_{IN2} - V_{OUT2}, I_{OUT2}=0.1mA		0 (*6)	20	35	mV	4-2
Reverse Detect Voltage (*4)	V_{REV2}	V_{OUT2} - V_{IN2}		0 (*6)	20	47	mV	2-2
Switch On Resistor	R_{ON2}	V_{IN2}=1.5V I_{OUT2}=100mA		-	0.41	0.88	Ω	4-2
		V_{IN2}=3.6V I_{OUT2}=200mA		-	0.18	0.32	Ω	
		V_{IN2}=6.0V I_{OUT2}=200mA		-	0.15	0.26	Ω	
Thermal Shutdown Temperature	T_{TSD2}	V_{IN2}=3.6V		-	150	-	℃	4-2
Thermal Hysteresis Width	T_{HYS2}	V_{IN2}=3.6V		-	25	-	℃	4-2
EN "H" Current	I_{ENH2}	V_{IN2}=6.0V, V_{EN2}=6.0V		0.04	0.48	1.50	μA	1-2
EN "L" Current	I_{ENL2}	V_{IN2}=6.0V, V_{EN2}=0V		-0.1	0.0	0.1	μA	1-2
EN "H" Voltage	V_{ENH2}	V_{EN2} = Step up	Ta=25℃ Ta=-40~105℃(*7)	1.2	-	6.0	V	1-2
EN "L" Voltage	V_{ENL2}	V_{EN2} = Step down	Ta=25℃ Ta=-40~105℃(*7)	V_{SS2}	-	0.3	V	1-2

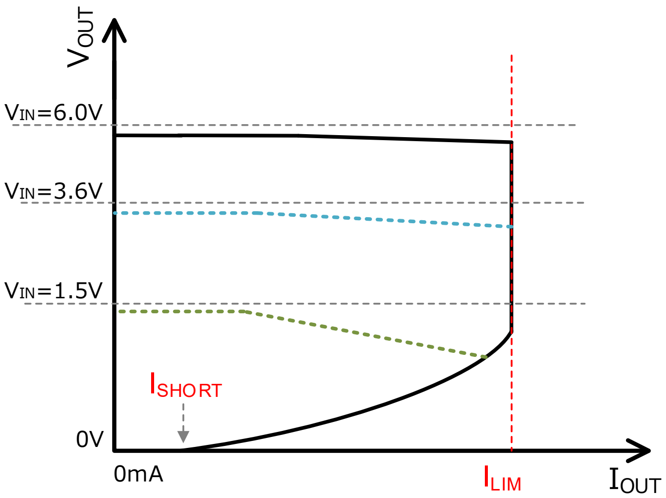
■ELECTRICAL CHARACTERISTICS

Unless otherwise specified

Load Swtich 1ch measurement : V_{SS1} is standard,V_{IN1}=3.6V, I_{OUT1}=0.1mA, V_{EN1}=V_{IN1}, V_{IN2}= V_{EN2}=V_{OUT2}=OPEN

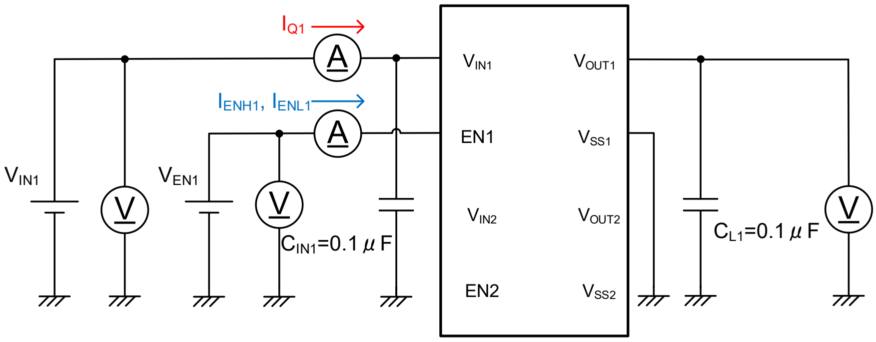
Load Swtich 2ch measurement : V_{SS2} s standard, V_{IN2}=3.6V, I_{OUT2}=0.1mA, V_{EN2}=V_{IN2}, V_{IN1}= V_{EN1}=V_{OUT1}=OPEN

(*1) When V_{OUT} voltage is higher than V_{IN} voltage, the current flowing from the output side to the V_{OUT} pin for each channel.
(*2) When V_{OUT} voltage is higher than V_{IN} voltage, the current flowing from the input side to the V_{IN} pin for each channel.
(*3) When V_{OUT} voltage is higher than V_{IN} voltage, the current flowing from the V_{IN} pin to the input side for each channel.
(*4) When V_{OUT} voltage becomes higher than V_{IN} voltage, the voltage at which the internal power supply switches from V_{IN} voltage to V_{OUT} voltage for each channel.
(*5) The RON which has an input voltage dependency, can impose a foldback current limit before reaching ILIM.
(*6) Design value
(*7) Design value at Ta=-40~105℃

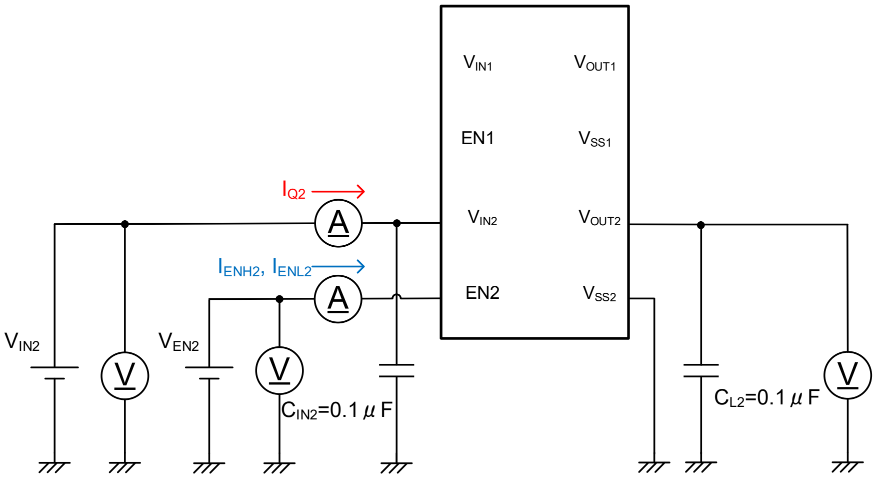


■TEST CIRCUITS

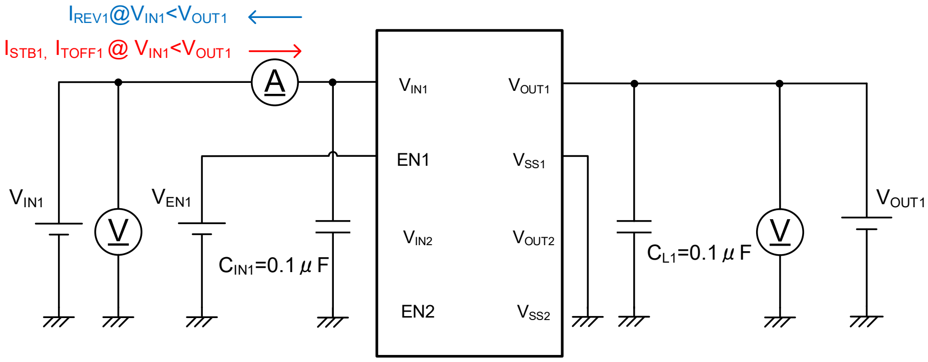
Test CIRCUITS1-1



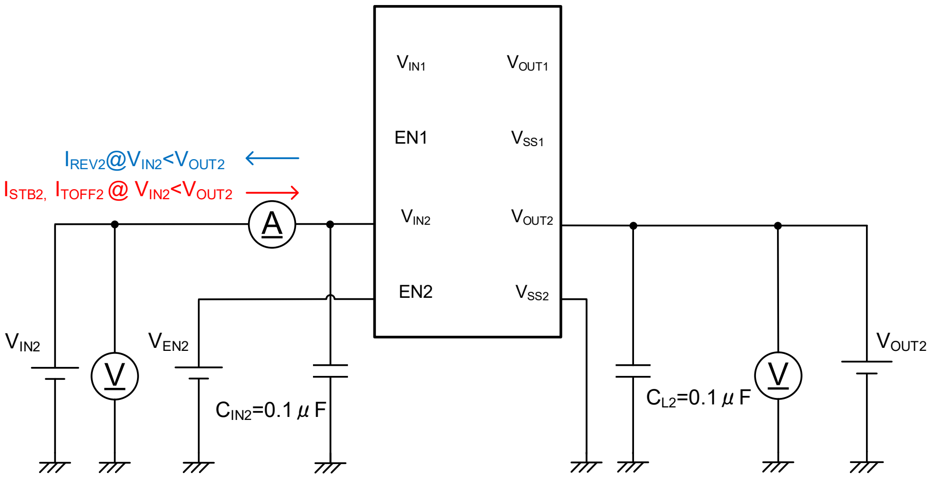
Test CIRCUITS1-2



Test CIRCUITS2-1

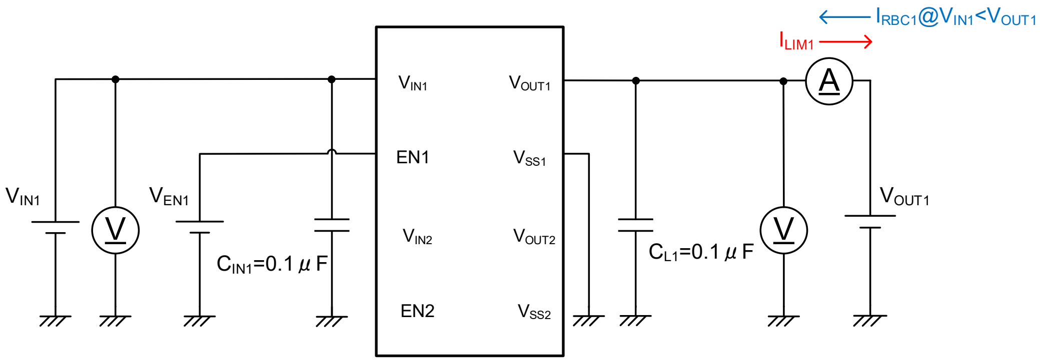


Test CIRCUITS2-2

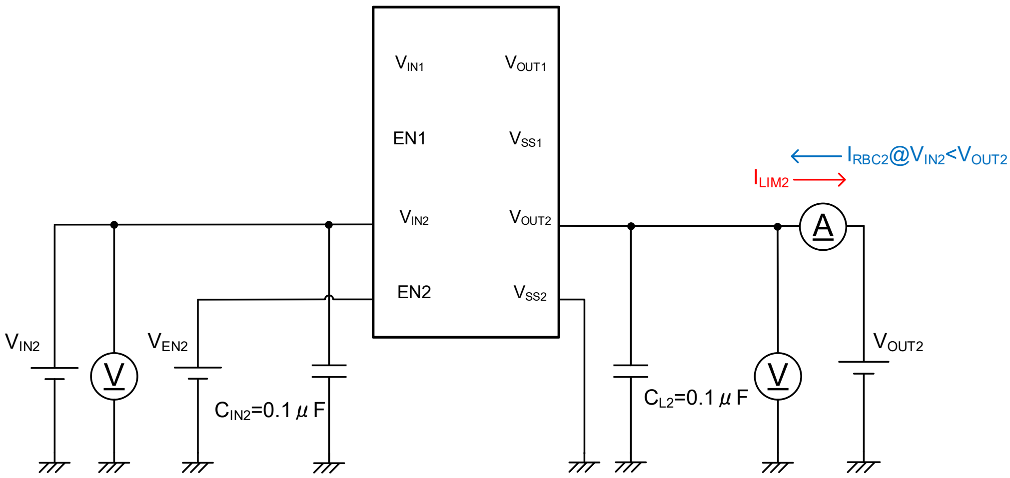


■TEST CIRCUITS

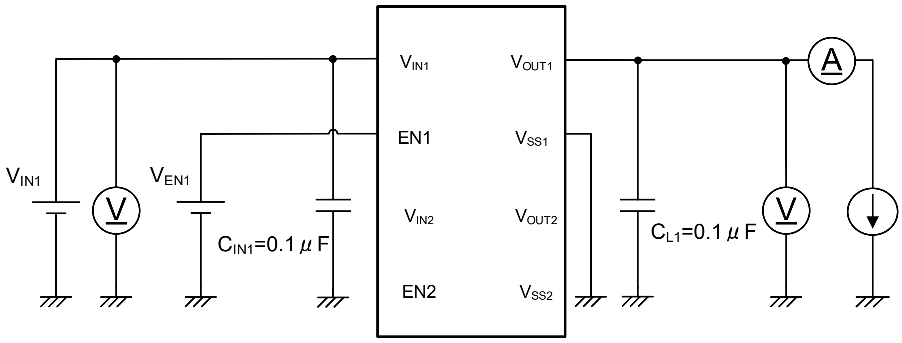
Test CIRCUITS3-1



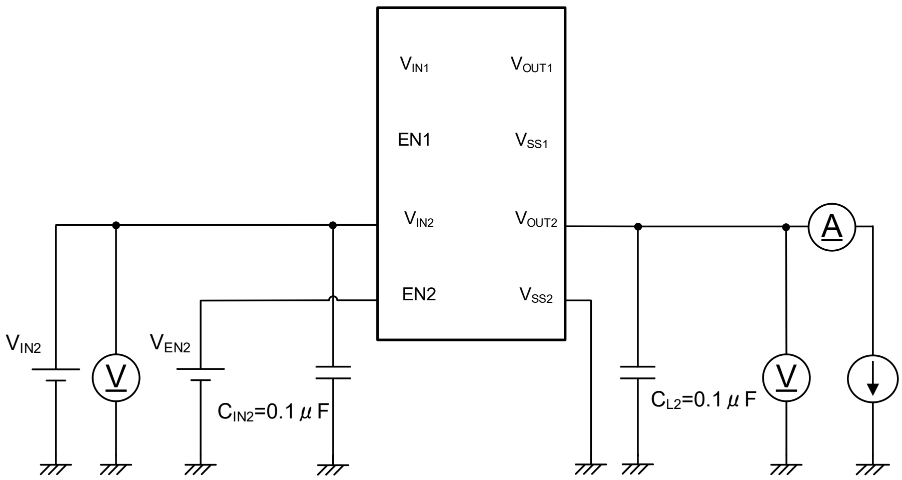
Test CIRCUITS3-2



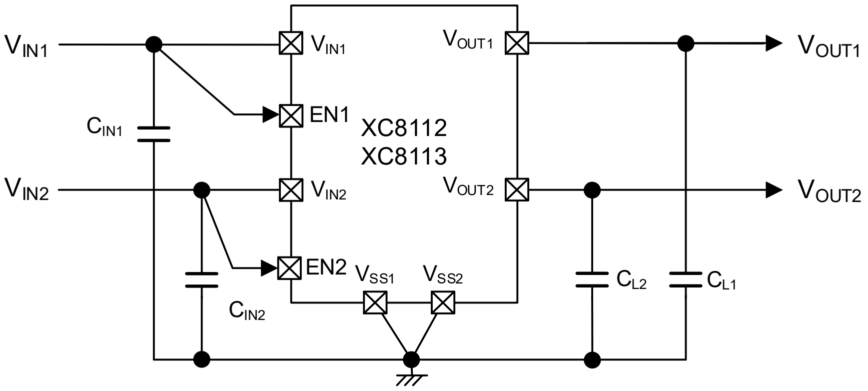
Test CIRCUITS4-1



Test CIRCUITS4-2



■TYPICAL APPLICATION CIRCUIT



【Typical Examples】(*1)

	MANUFACTURER	PRODUCT NUMBER	VALUE	SIZE (L×W×T)
C_{IN1}, C_{IN2}	-	-	0.1μF / 10V or more	-
C_{L1}, C_{L2}	-	-	0.1μF / 10V or more	-

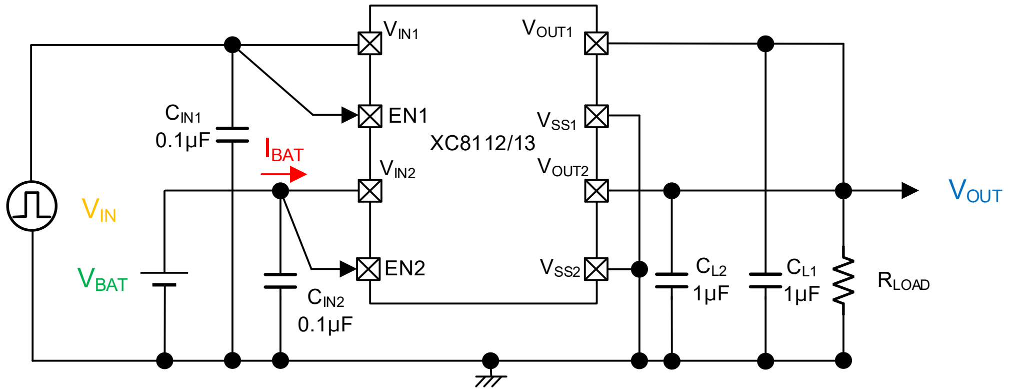
(*1) Select the appropriate parts according to the operating conditions (ambient temperature, input / output voltage).

■EXAMPLES OF APPLICATION CIRCUITS

(1-1) OR connection circuit①: Backup circuit, etc.

This is an example of OR connection circuit using the XC8112 / XC8113 series.

This is an example of circuit that realizes switching between two or more power supplies such as an internal power supply and an external power supply without voltage drop.

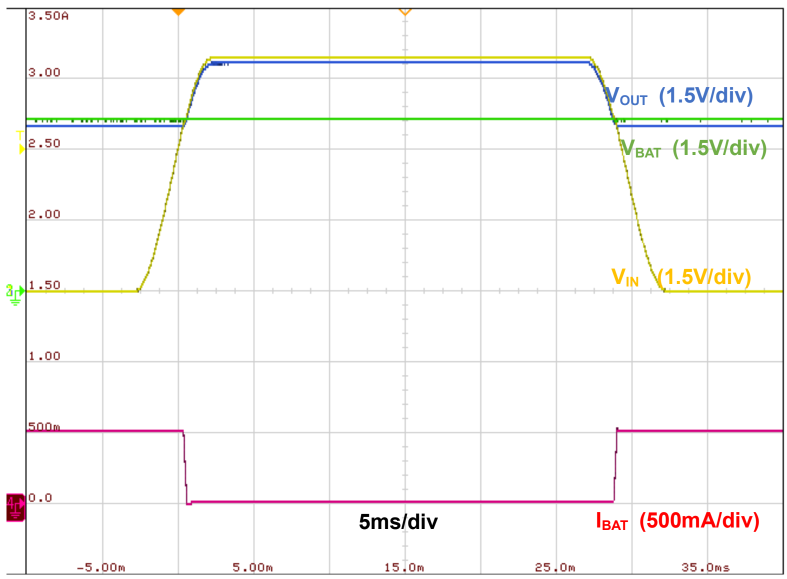


XC8113AA01ER-G

・V_{BAT}=3.6V, V_{IN1}=0V⇔5.0V (1.0V/ms), R_{LOAD}=7.2Ω,Ta=25℃

・$C_{IN1,2}$=0.1μF (GRM155R71A104MA01D)

・$C_{L1,2}$=1.0μF (GRM155C71A105ME11D)

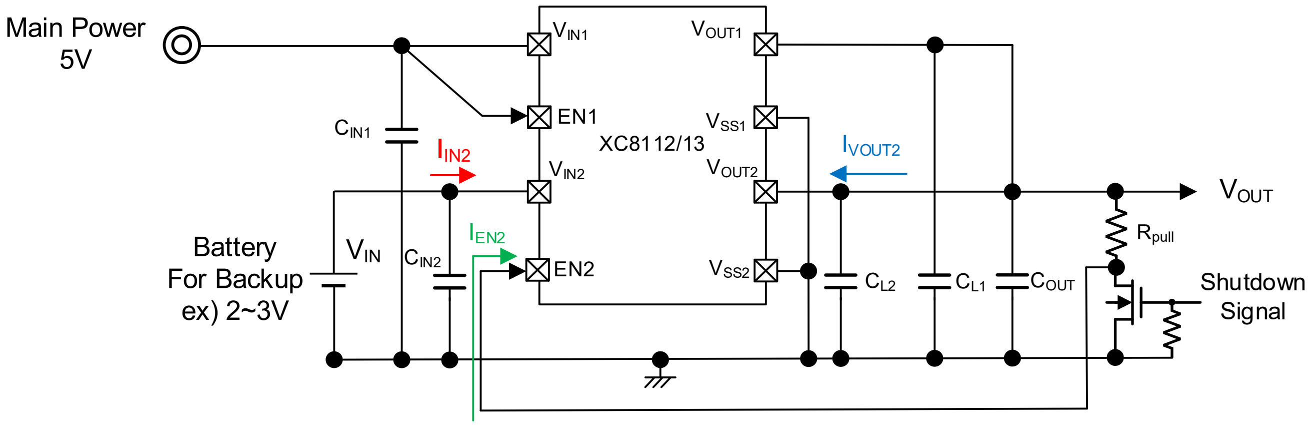


■EXAMPLES OF APPLICATION CIRCUITS

(1-2)OR connection circuit②: Example of shipment function (ship function)

This is an example of OR connection circuit equipped with a shipment function (ship function).

The XC8112 / XC8113 can be put into standby by inputting the “H” voltage to the “Shutdown Signal” when the product is stopped and shipped. As a result, the current consumption of the battery can be suppressed to I_{STB2} (TYP. 0.65μA), and the battery drive time can be extended.

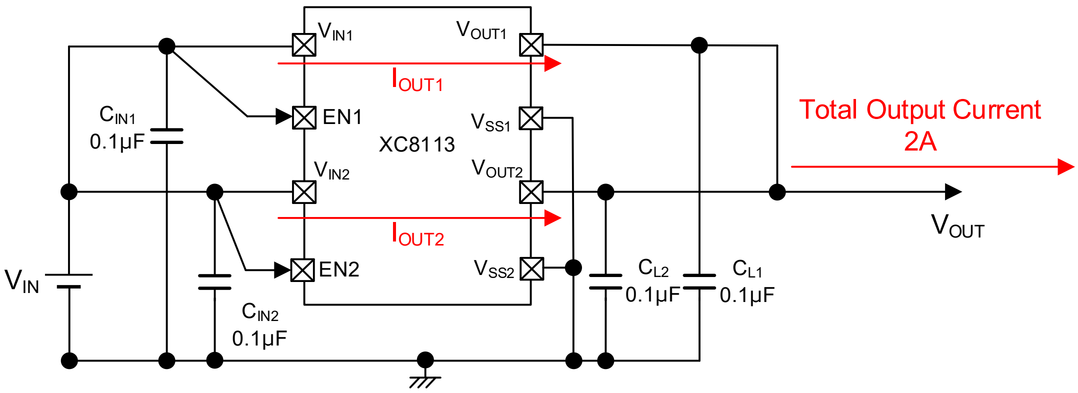


Current consumption at no load under each operating condition

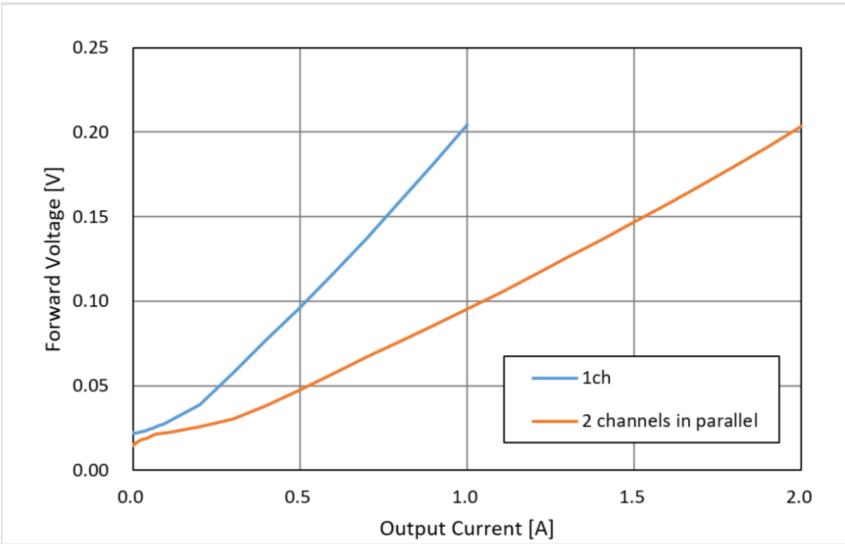
Battery For Back up Operating mode	Applied voltage to V_{IN1}	Applied voltage to V_{OUT1}	Shutdown Signal	EN2	I_{IN2}	I_{VOUT2}	I_{EN2}	2ch Pch Driver FET	Reverse Protection
External power supply applied	V_{IN1} + V_{REV1} ≦V_{OUT1}	V_{OUT1}	“L”	“H” (V_{OUT})	0μA	I_{RBC2} (0.8μA)	I_{ENH2} (0.5μA)	OFF	Yes
Backup Operation	1.5V ~ 6.0V	-	“L”	“H” (V_{OUT})	I_{Q2} (3.6μA)	0μA	I_{ENH2} (0.5μA)	ON	-
Backup Operation → Ship Mode	1.5V ~ 6.0V	-	“H” Pulse	“L” Pulse (GND)	I_{STB2} (0.65μA)	0μA	I_{ENL2} (0μA)	OFF	-
Ship Mode	1.5V ~ 6.0V	-	“L”	“L” (V_{OUT}=0V)	I_{STB2} (0.65μA)	0μA	I_{ENL2} (0μA)	OFF	-

■EXAMPLES OF APPLICATION CIRCUITS

(2) Supports large current output by parallel connection.
This is an example of circuit in which multiple XC8113 series are connected in parallel.
By connecting in parallel, the maximum output current can be increased to 2A or more.
* When connected in parallel, the amount of current flowing through each IC will differ due to IC variations and wiring impedance. For this reason, the output current and calorific value at which the current limit of each IC operates will differ. Make sure that there is no problem with the actual machine.



XC8113AA01ER-G
・V_{IN}=3.6V ,Ta=25℃
・$C_{IN1,2}$=$C_{L1,2}$=0.1μF (GRM155R71A104MA01D)

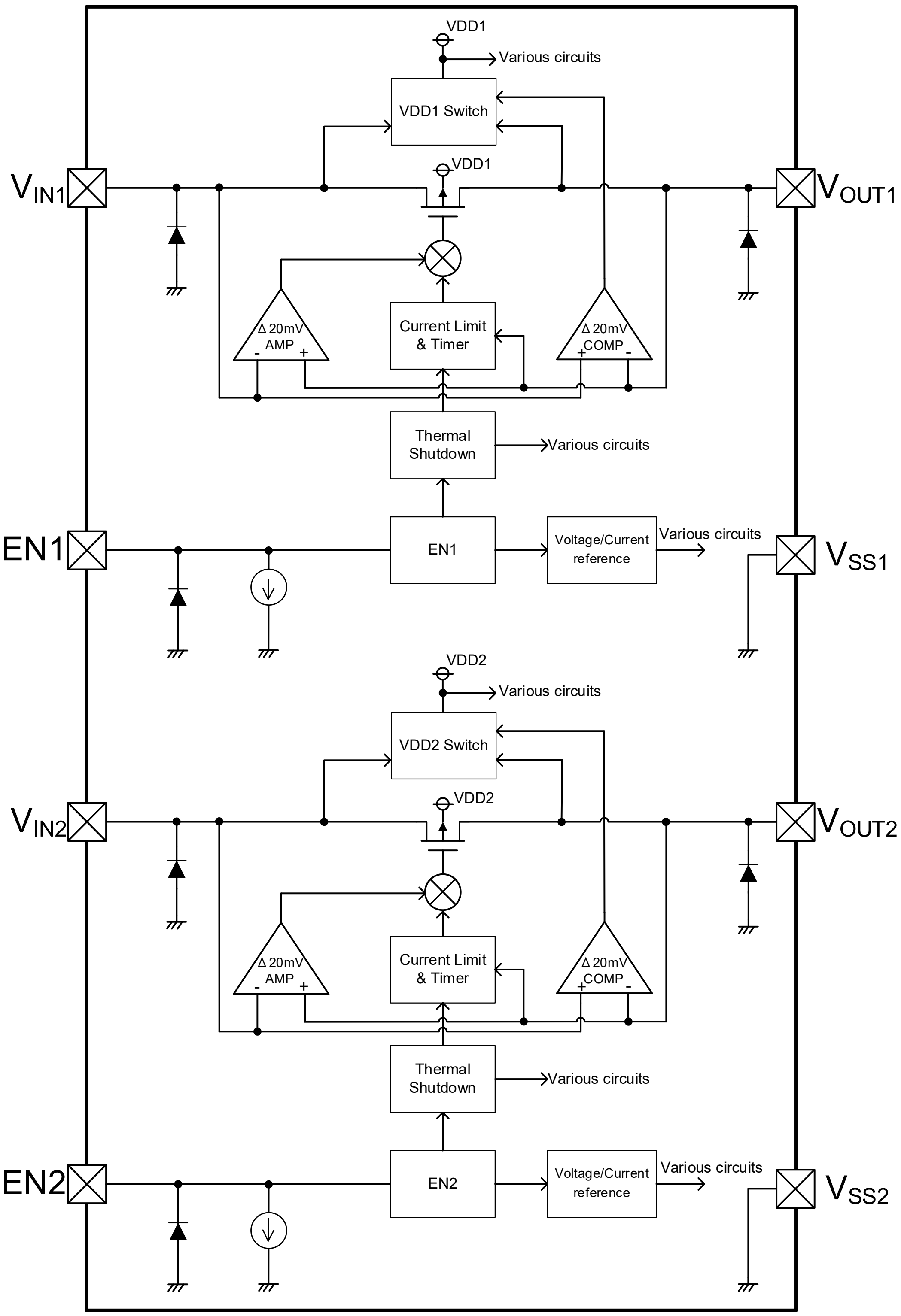


■OPERATIONAL EXPLANATION

The XC8112/XC8113 series are 2ch load switch ICs that replicate ideal diodes, and equipped with functions including enable, over current limit, inrush current limit, and thermal shutdown.

A 2ch load switch is realized by installing load switches with the same characteristics on 1ch and 2ch. Functionally, the 1ch and 2ch load switches operate independently.

In the instructions, we will use the load switch on the 1ch side as an example.



■OPERATIONAL EXPLANATION

<Normal operation: Ideal diode functions>

The XC8112/XC8113 series can achieve the functions of ideal diodes with ultra-low VF by the following functions (a) and (b).

(a) Forward bias operation

When the EN1voltage is “H”, the internal Pch driver FET (hereafter referred to as “internal switch”) will be controlled to output the value of “V_{IN} pin voltage - $V_{FORWARD1}$' (TYP. 20mV)” to the V_{OUT} pin.

As the output current increases, the V_{OUT1} pin voltage decreases due to the on resistance of the internal switch.

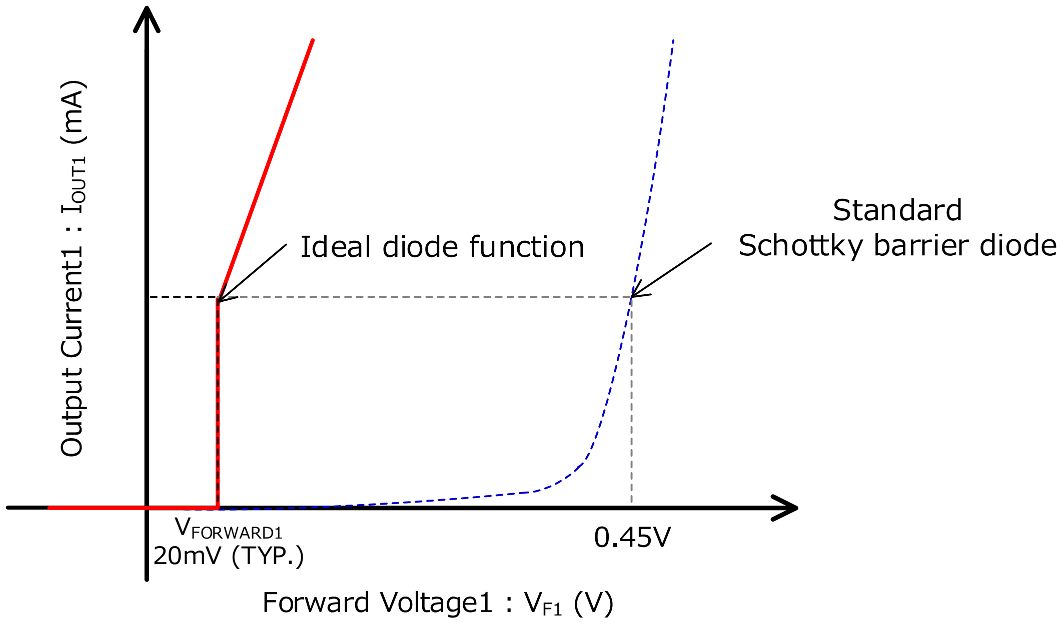
(b) Reverse bias operation (during reverse current protection) / Internal power supply switching function

When the V_{OUT1} pin voltage becomes equal to or higher than “V_{IN1} pin voltage - $V_{FORWARD1}$”, the internal switch will turn off.

Furthermore, When the V_{OUT1} pin voltage becomes higher than the V_{IN1} pin voltage by the amount of V_{REV1} (TYP. 20mV) or more, the internal power supply will switch from V_{IN1} to V_{OUT1}.

As a result, the cathode of the internal switch body diode becomes V_{OUT1}, to prevent backflow current from the V_{OUT1} pin to the V_{IN1} pin.

In the instructions, we will use the load switch on the 1ch side as an example.



Ideal diode and Schottky diode

■OPERATIONAL EXPLANATION

<EN function>

(a) During forward bias (V_{IN1} pin voltage - V_{REV1} > V_{OUT1} pin voltage)

When an “H” voltage (V_{ENH1}) is input to the EN1 pin, after the output voltage has been raised in association with Startup mode (inrush current prevention function), the operation will become normal.

When an “L” voltage (V_{ENL1}) is input to the EN1 pin, it goes into standby mode and the quiescent current will be suppressed.

(b) During reverse bias (V_{IN1} pin voltage - V_{REV1} ≤ V_{OUT1} pin voltage)

Regardless of the EN1 pin voltage, the internal switch will be in turned off.

When the EN1pin has an “H” voltage (V_{ENH1}) and the V_{IN} pin voltage has increased, operation will shift from “reverse bias operation” to “forward bias operation”.

When the EN1 pin has an “L” voltage (V_{ENL1}), even if the V_{IN} pin voltage increases, the internal switch will be turned off, so the output voltage will not increase.

In the instructions, we will use the load switch on the 1ch side as an example.

Load Swtich : 1ch

PIN NAME	SIGNAL	STATUS	Applied voltage to V_{IN1}	Applied voltage to V_{OUT1}	Pch Driver FET	Reverse Protection
EN1	H	Active	1.5V ~ 6.0V	-	ON	-
			V_{IN1} - V_{REV1}≦V_{OUT1}	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		
	L	Stand-by	1.5V ~ 6.0V	-	OFF	-
			V_{IN1} - V_{REV1}≦V_{OUT1}	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		
	OPEN		1.5V ~ 6.0V	-	OFF	-
			V_{IN1} - V_{REV1}≦V_{OUT1}	1.5V ~ 6.0V	OFF	Yes
			V_{IN1} < 1.5V	-	Undefined	Undefined
			-	V_{OUT1} < 1.5V		

Load Swtich : 2ch

PIN NAME	SIGNAL	STATUS	Applied voltage to V_{IN2}	Applied voltage to V_{OUT2}	Pch Driver FET	Reverse Protection
EN2	H	Active	1.5V ~ 6.0V	-	ON	-
			V_{IN2} - V_{REV2}≦V_{OUT2}	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		
	L	Stand-by	1.5V ~ 6.0V	-	OFF	-
			V_{IN2} - V_{REV2}≦V_{OUT2}	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		
	OPEN		1.5V ~ 6.0V	-	OFF	-
			V_{IN2} - V_{REV2}≦V_{OUT2}	1.5V ~ 6.0V	OFF	Yes
			V_{IN2} < 1.5V	-	Undefined	Undefined
			-	V_{OUT2} < 1.5V		

■OPERATIONAL EXPLANATION

<Startup mode / Inrush current prevention function>

During forward bias, changing the EN1 pin from an "L" voltage to an "H" voltage will operate the inrush current prevention function and raise the output voltage.

The operation of the inrush current prevention function and output voltage rise will be as described below.

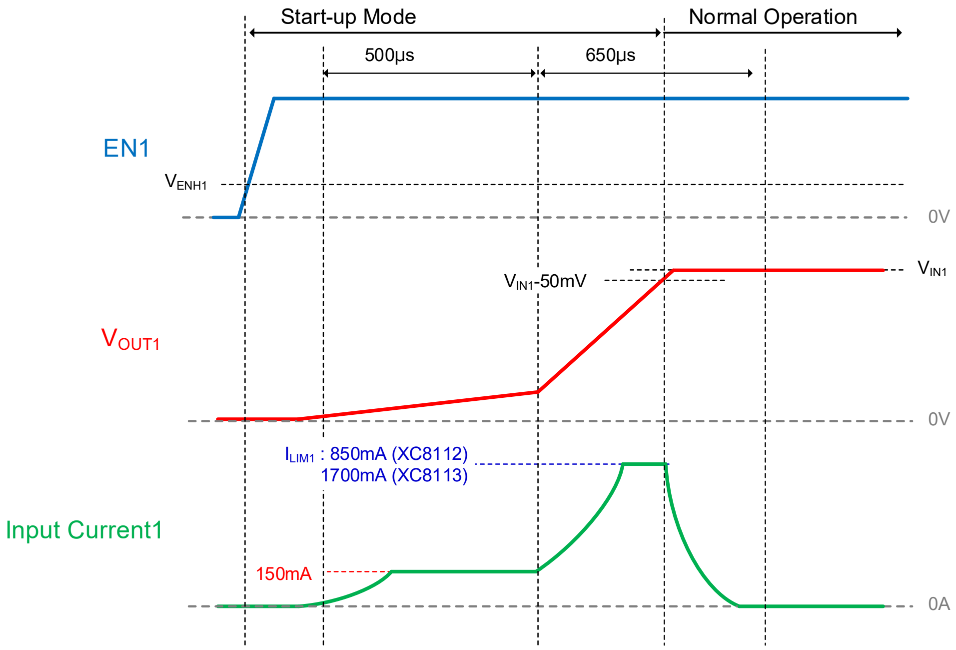
In the instructions, we will use the load switch on the 1ch side as an example.

(1) Over a duration of 500μs (TYP.), the current supplied from the input to the output via the internal switch will be limited to approximately 150mA.

(2) After (1), over an additional duration of 650μs (TYP.), the current supplied from the input to the output via the internal switch will be limited to I_{LIM1}.

*For the XC8112, I_{LIM1} is 850mA (TYP.), and for the XC8113 it is 1700mA (TYP.).

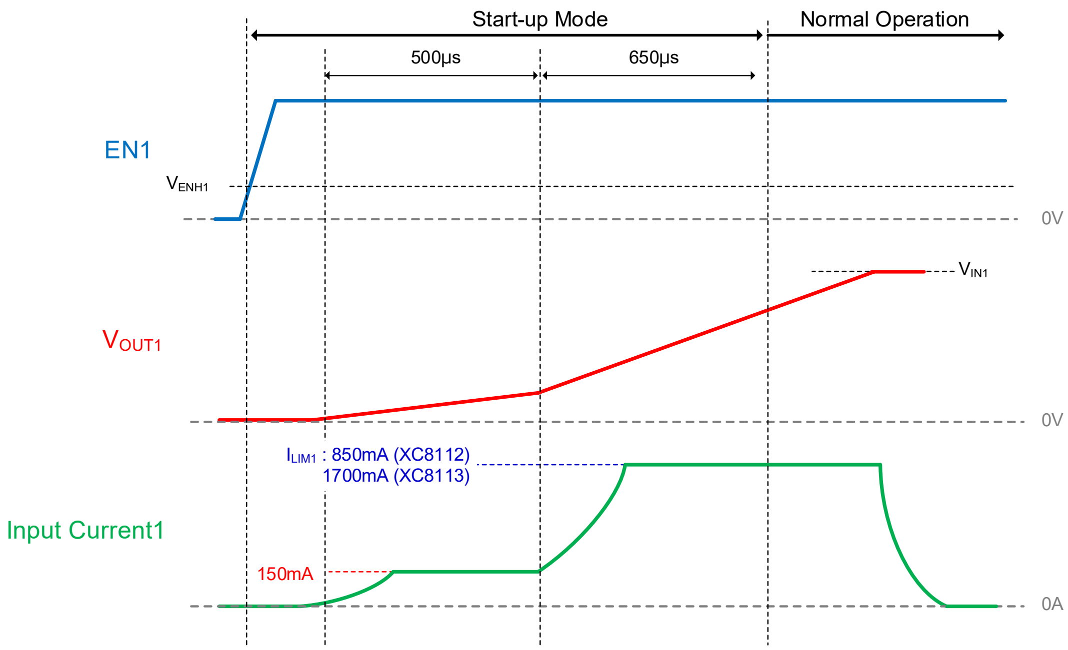
(3) After the durations of (1) and (2) have ended, or when the difference between the V_{OUT1} pin voltage and V_{IN1} pin voltage becomes equal to or lower than 50mV, the operation will shift from Startup mode to Normal mode.



As the output capacitor is large-capacity, or during heavy loads

When a large-capacity output capacitor is used, or a heavy load is applied during startup, the output voltage will not rise during Startup mode, and operation will shift from Startup mode to Normal mode.

After shifting to Normal mode, the over current limit function will be operated to raise the output voltage.



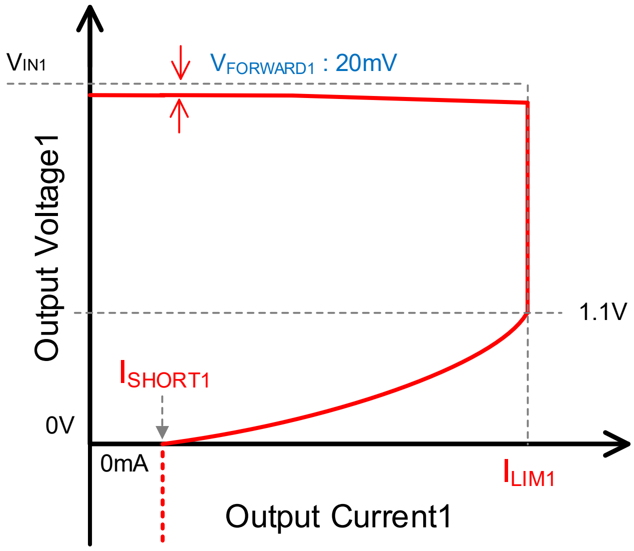
■OPERATIONAL EXPLANATION

<Over current limit function>

The over current limit function uses constant-current limit and foldback current limit.
When the load becomes equal to or higher than the over current limit I_{LIM1}, the constant-current limit circuit will limit the current and will decrease the V_{OUT1} pin voltage. When the V_{OUT1} pin voltage decreases to 1.1V (TYP.), the foldback current limit will operate, reducing both the V_{OUT1} pin voltage and the output current. If the V_{OUT1} pin voltage reaches a short-circuit state of 0V, the output current will be suppressed to I_{SHORT1} (TYP. 50mA), so it is possible to control heat generation from the IC even during a short-circuit condition.

Also, When the V_{OUT1} pin voltage becomes lower than 0V, the function will change to constant-current limit according to I_{SHORT1}. Therefore, it can be started without any problems even when a negative voltage is applied to the V_{OUT1} pin voltage due to the effect of the startup sequence.

In the instructions, we will use the load switch on the 1ch side as an example.



Over current limit function

■OPERATIONAL EXPLANATION

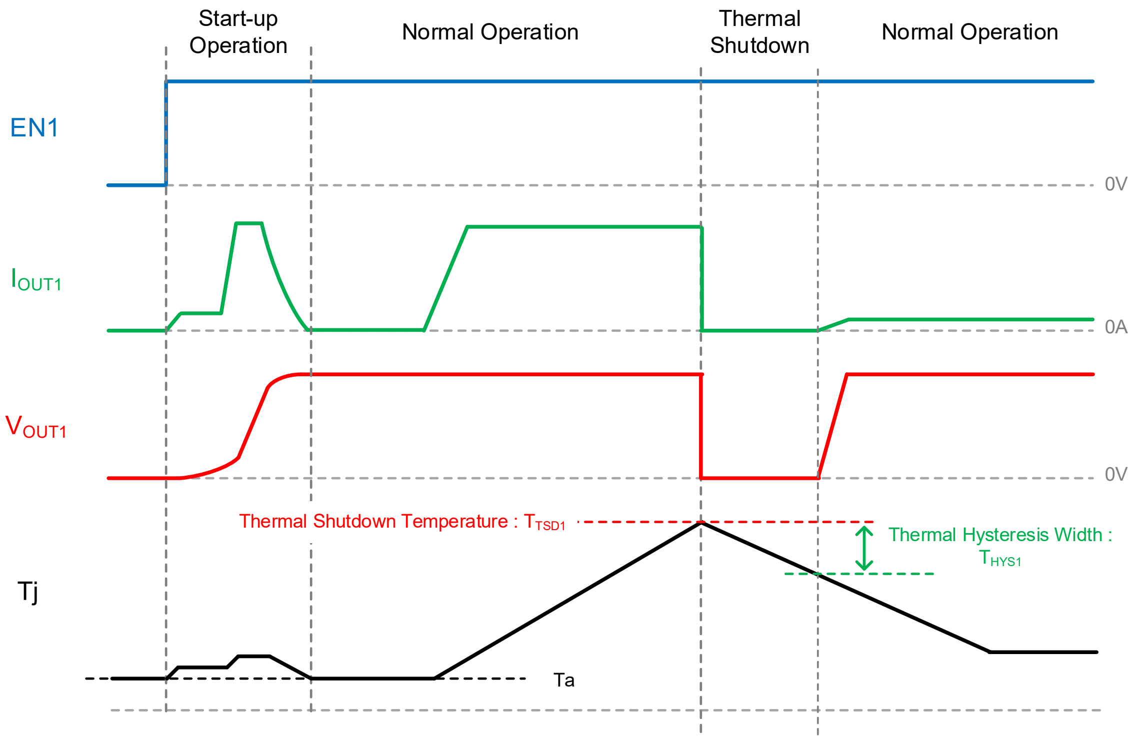
<Thermal shutdown function>

When the junction temperature becomes equal to or higher than T_{TSD1} (TYP. 150°C), the thermal shutdown function will detect an overheat state, and will turn the internal switch off.

When the junction temperature decreases from T_{TSD1} by the amount of T_{HYS1} (TYP. 25°C), the thermal shutdown function will be cancelled and normal operation will resume.

In the instructions, we will use the load switch on the 1ch side as an example.

Also, the thermal shutdown function of load switch 1ch and 2ch is independent for each channel, but the junction temperature may rise due to heat generated by the load switch of another channel and the thermal shutdown function may operate.



■NOTES ON USE

1) For the phenomenon of temporal and transitional voltage decrease or voltage increase, the IC may be damaged or deteriorated if IC is used beyond the absolute MAX. specifications. Also, if used under conditions outside the recommended operating range, the IC may not operate normally or may cause deterioration.

2) If a voltage of -0.2V or less is continuously applied to EN1and EN2 terminals for 200μs or more during forward bias, there is a possibility that the internal switch may be turned on or the overcurrent limit value may be low.
Once in this state, the IC will no longer function as the original load switch.

   Do not apply a voltage other than the recommended operating conditions to the EN1and EN2 pins.

3) If the external power supply is cut off or the voltage drops while the voltage is being applied from the output side in the active state (EN="H"), the output voltage drops momentarily due to the delay time when the driver FET transitions from OFF state to ON state.
Especially when the output voltage drop is 10mV/μs or more, the output voltage drop will be large.
Set an appropriate output capacitance value so that the drop in output voltage becomes small.

4) If a large-capacity capacitor is used for the output capacity and the device is started under a heavy load, the output voltage may not rise.
Since the foldback current limit is used for the overcurrent limit, if a heavy load is applied while the output voltage is 1.1V (TYP.) Or less, the output voltage will not rise during the start mode and the current limit state will be maintained.
Especially when the output capacitance value is 100μF or more and a heavy load is applied during the start mode, the output voltage does not rise is likely to occur.
Please use it after setting the output capacity value and designing the startup sequence.

5) Please place a low ESR capacitor such as a ceramic capacitor to the input capacitor (CIN) and the output capacitor (CL) as close to the IC as possible. For the input or output capacitor, a capacitance of 1.0μF or higher is recommended.
If a low-ESR capacitor is not connected in close to the IC, the IC internal circuit may malfunction due to external switching noise.

6) After the thermal shutdown function has been cancelled, startup will begin in Normal mode rather than Startup mode, so the inrush current prevention function will not operate.

7) Torex places an importance on improving our products and their reliability. We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.

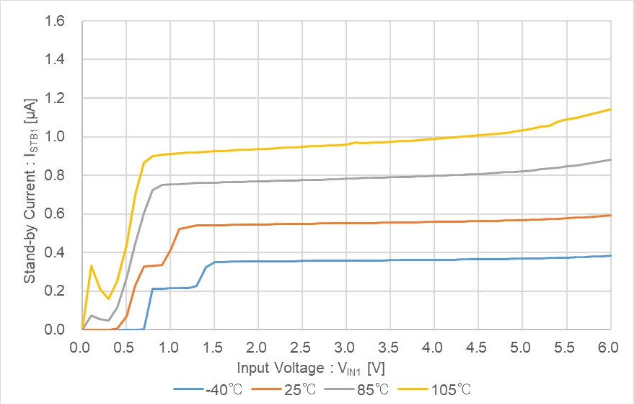
■CHARACTERISTICS

In the instructions, we will use the load switch on the 1ch side as an example.

(1-1) Stand-by Current vs Input Voltage

XC8112/XC8113Series

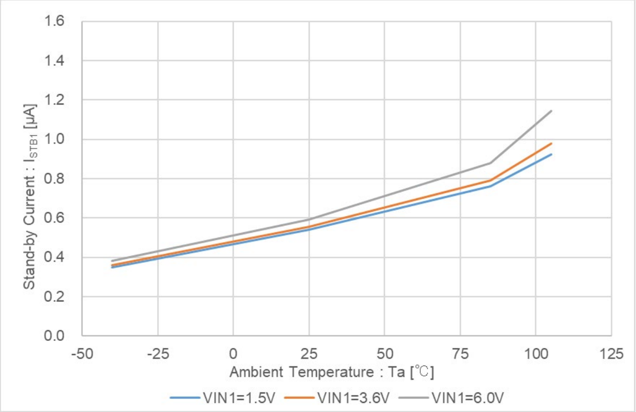
V_{OUT1}=EN1=0V, C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



(1-2) Stand-by Current vs Ambient Temperature

XC8112/XC8113Series

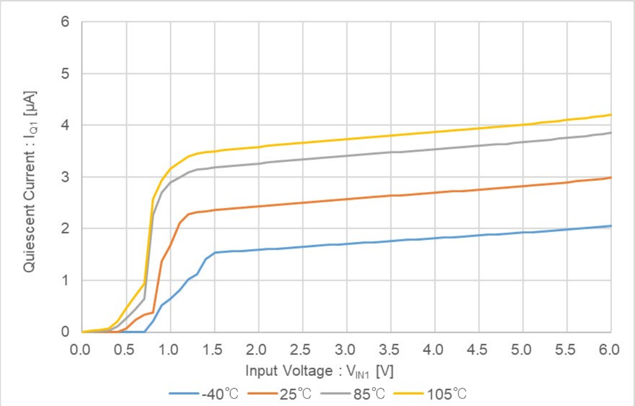
V_{OUT1}=EN1=0V, C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



(2-1) Quiescent Current vs Input Voltage

XC8112/XC8113 Series

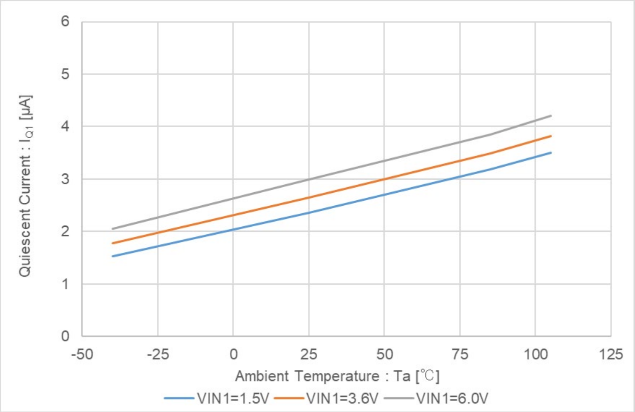
V_{OUT1}=OPEN, EN1="H", C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



(2-2) Quiescent Current vs Ambient Temperature

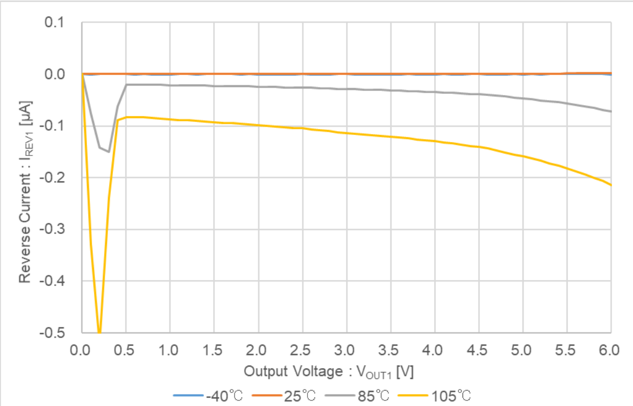
XC8112/XC8113 Series

V_{OUT1}=OPEN, EN1="H", C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)

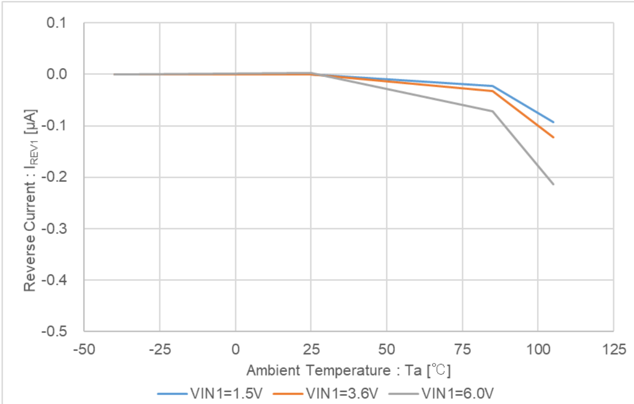


■特性例

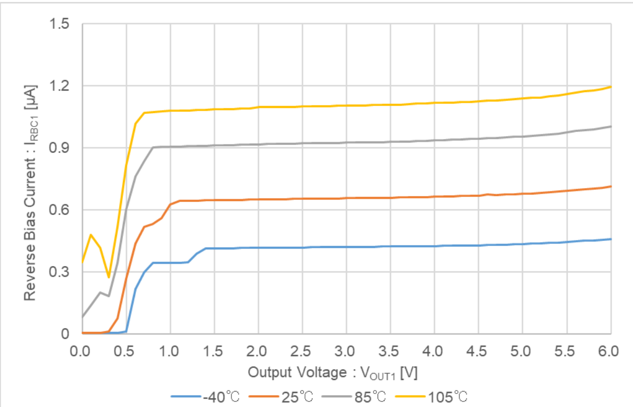
(3-1) Reverse Current vs Output Voltage
XC8112/XC8113 Series
V_{IN1}=0V, EN1="H", C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



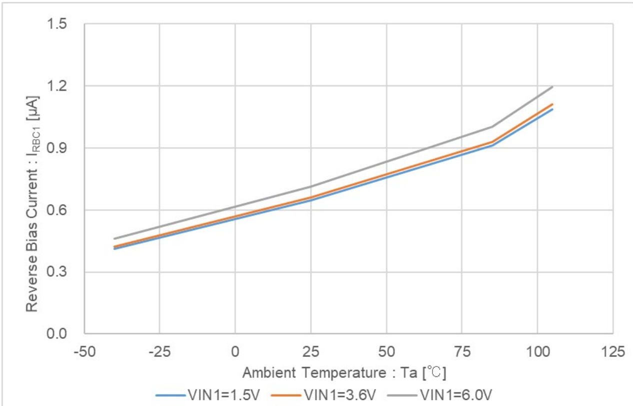
(3-2) Reverse Current vs Ambient Temperature
XC8112/XC8113 Series
V_{IN1}=0V, EN1="H", C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



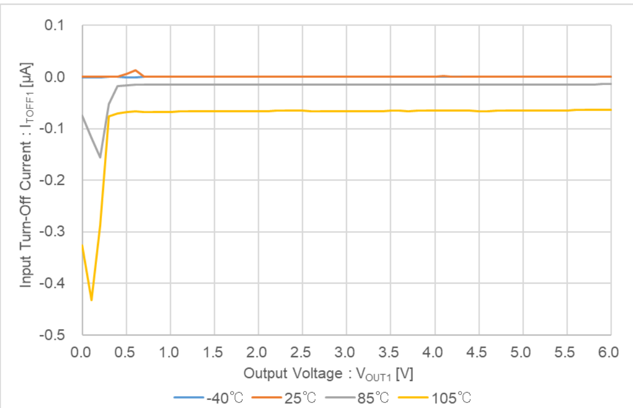
(4-1) Reverse Bias Current vs Output Voltage
XC8112/XC8113 Series
V_{IN1}=V_{OUT1}-0.1V, EN1="H",
C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



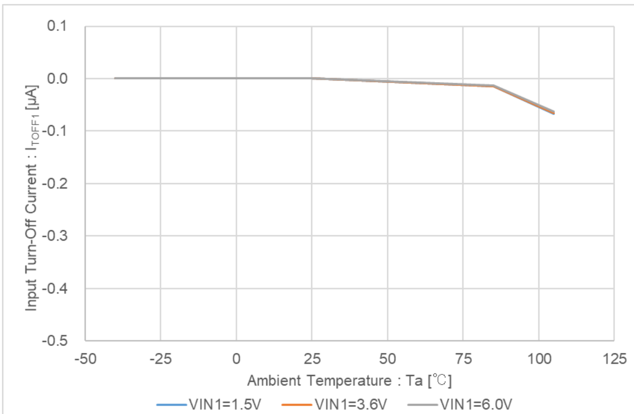
(4-2) Reverse Bias Current vs Ambient Temperature
XC8112/XC8113 Series
V_{IN1}=V_{OUT1}-0.1V, EN1="H",
C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)



(5-1) Input Turn-Off Current vs Output Voltage
XC8112/XC8113 Series
V_{IN1}=V_{OUT1}-0.1V, EN1="H",
C_{IN1}=C_{L1}=0.1μF (CGA2B3X7R1V104K050BB)

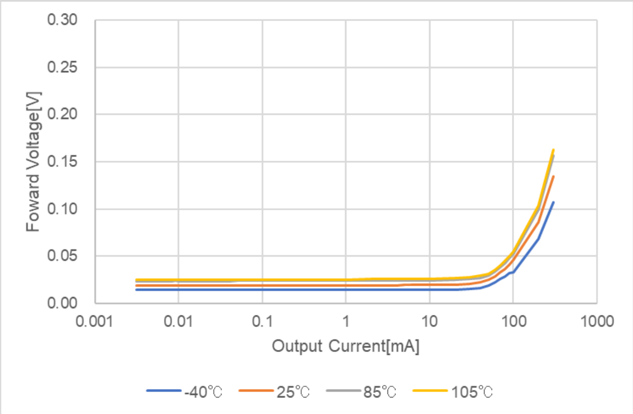


(5-2) Input Turn-Off Current vs Ambient Temperature
XC8112/XC8113 Series
V_{IN1}=V_{OUT1}-0.1V, EN1="H",
C_{IN1}=C_{L1}=0.1μF(CGA2B3X7R1V104K050BB)

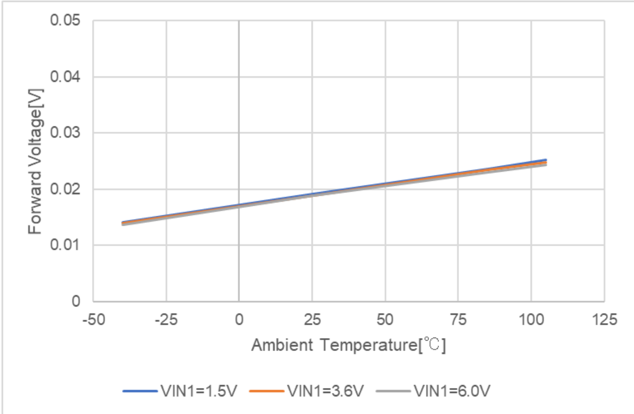


■CHARACTERISTICS

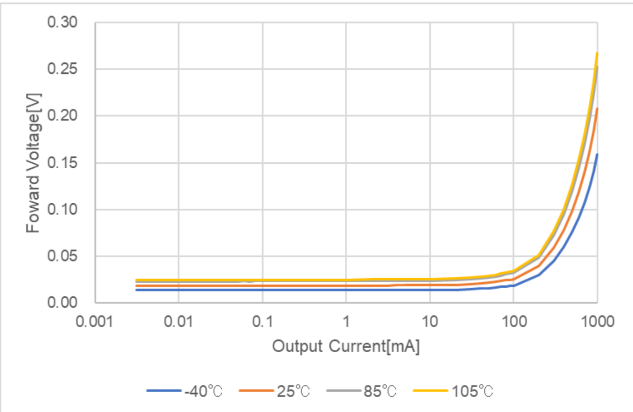
(6-1-1) Forward Voltage vs Output Current
XC8113AA01E
V_{IN1}=1.5V, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



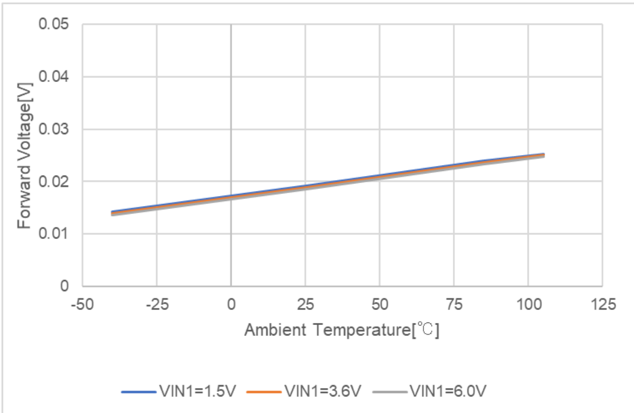
(6-2-1) Forward Voltage vs Ambient Temperature
XC8113AA01E
I_{OUT1}=1mA, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



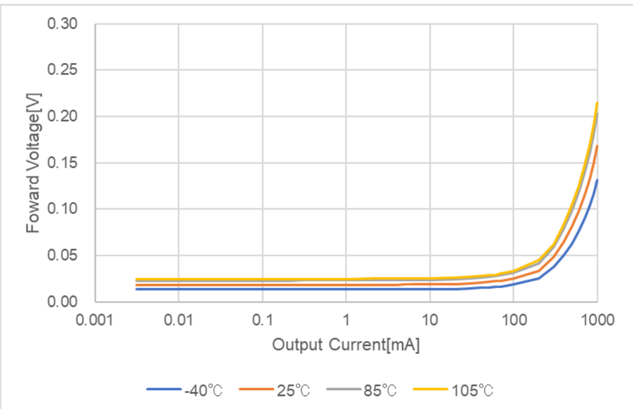
(6-1-2) Forward Voltage vs Output Current
XC8113AA01E
V_{IN1}=3.6V, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



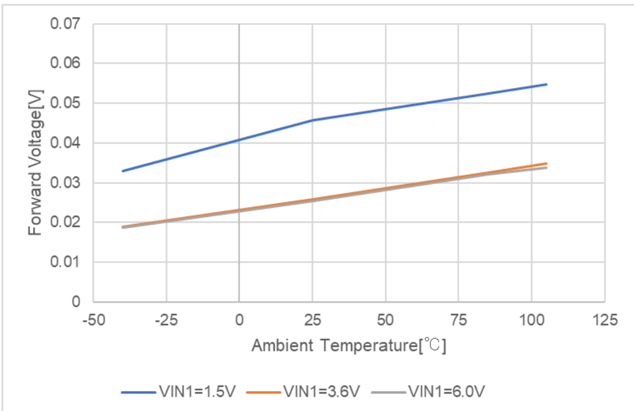
(6-2-2) Forward Voltage vs Ambient Temperature
XC8113AA01E
I_{OUT1}=1mA, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



(6-1-3) Forward Voltage vs Output Current
XC8113AA01E
V_{IN1}=6.0V, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



(6-2-3) Forward Voltage vs Ambient Temperature
XC8113AA01E
I_{OUT1}=100mA, C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)



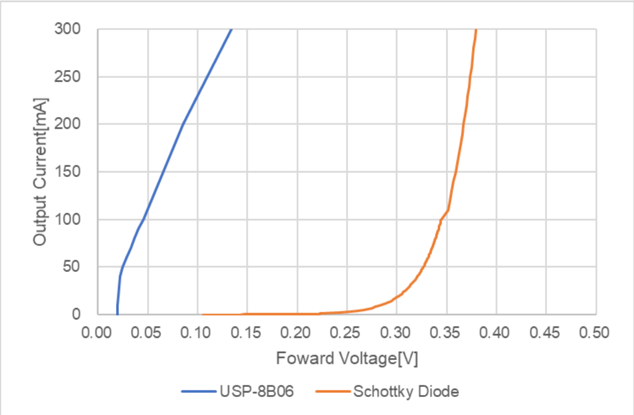
■CHARACTERISTICS

(7) Output Current vs Forward Voltage

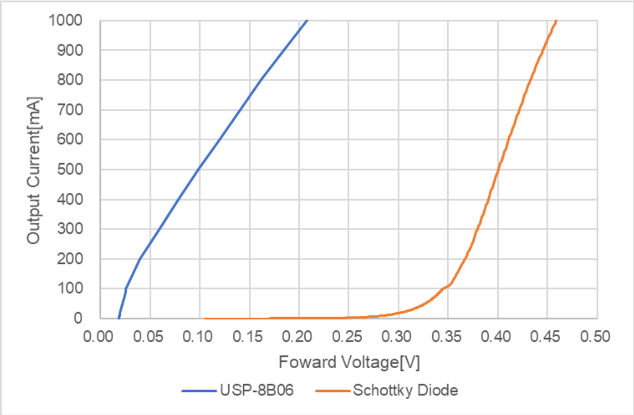
XC8113 Series, Ta=25℃

C_{IN1}=C_{L1}=1.0μF (GRM155C71A105ME11D)

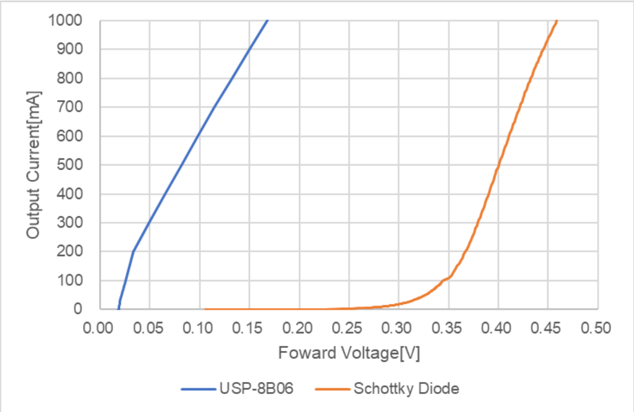
V_{IN1}=1.5V



V_{IN1}=3.6V

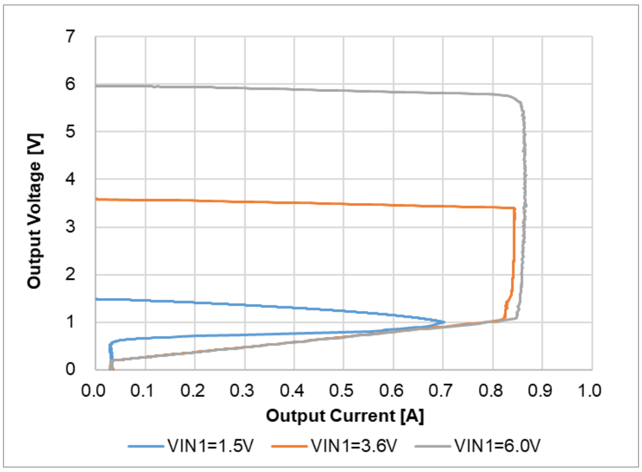


V_{IN1}=6.0V



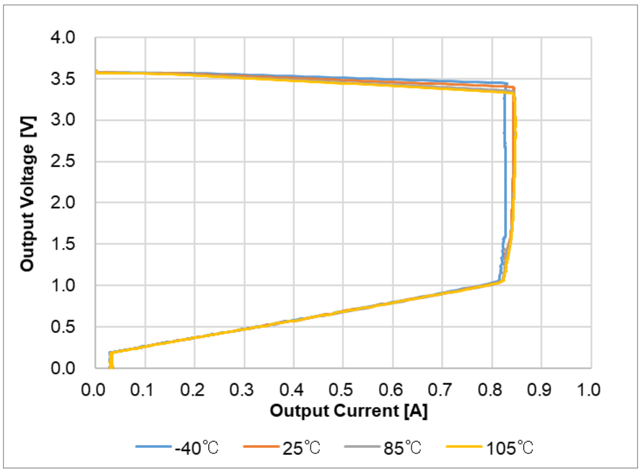
■CHARACTERISTICS

(8-1-1) Output Voltage vs Output Current
XC8112 Series, Ta=25℃
$C_{IN1}=C_{L1}=1.0\mu F$ (GRM155C71A105ME11D)

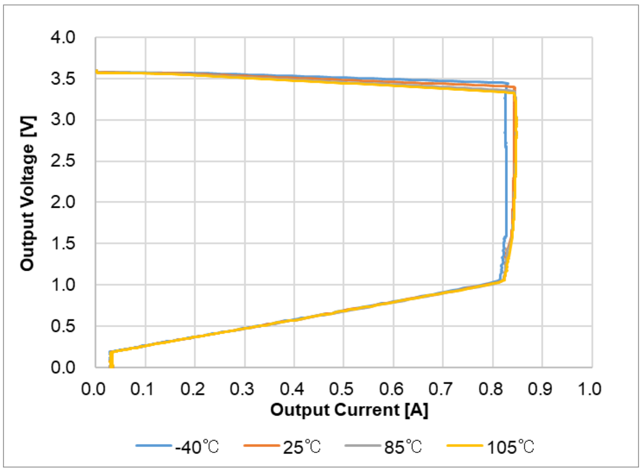


(8-1-2) Output Voltage vs Output Current
XC8112 Series
$C_{IN1}=C_{L1}=1.0\mu F$ (GRM155C71A105ME11D)

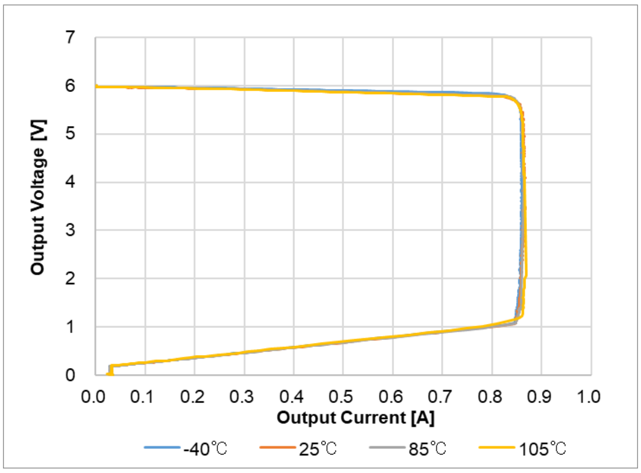
V_{IN1}=1.5V



V_{IN1}=3.6V,

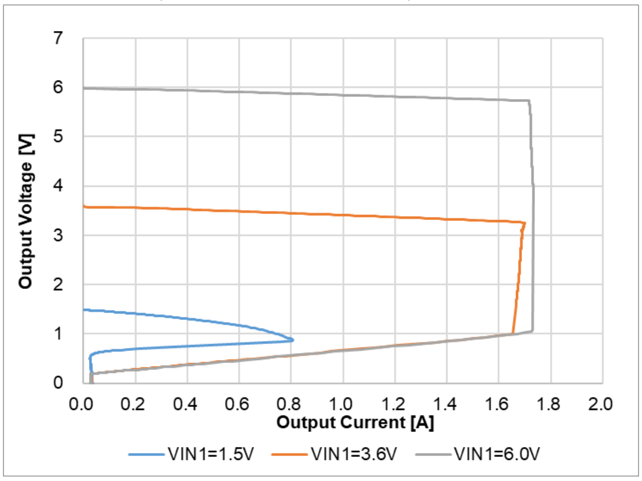


V_{IN1}=6.0V



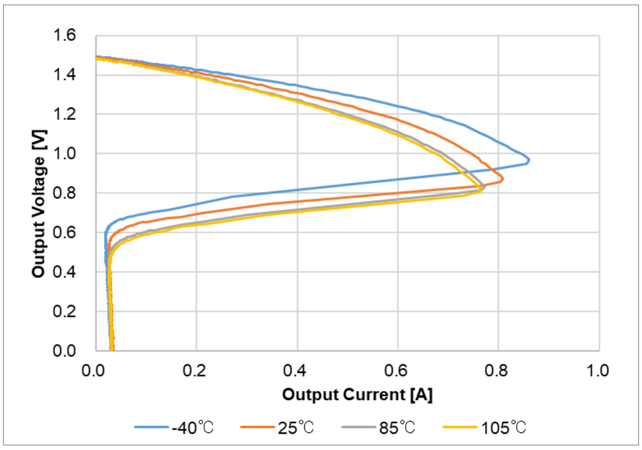
■CHARACTERISTICS

(8-2-1) Output Voltage vs Output Current
XC8113 Series, Ta=25℃
$C_{IN1}=C_{L1}=1.0\mu F$ (GRM155C71A105ME11D)

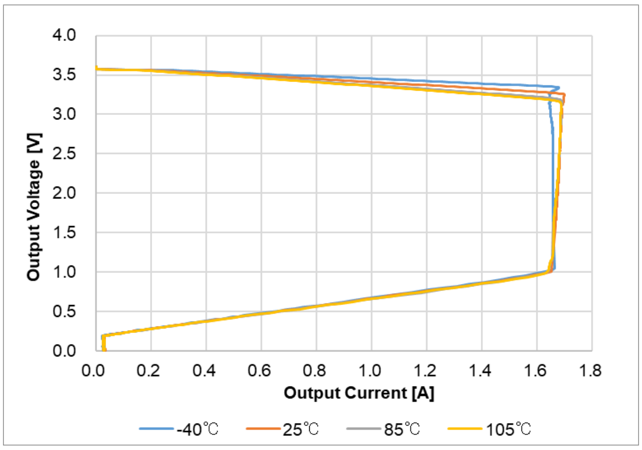


(8-2-2) Output Voltage vs Output Current
XC8113 Series
$C_{IN}=C_L=1.0\mu F$ (GRM155C71A105ME11D)

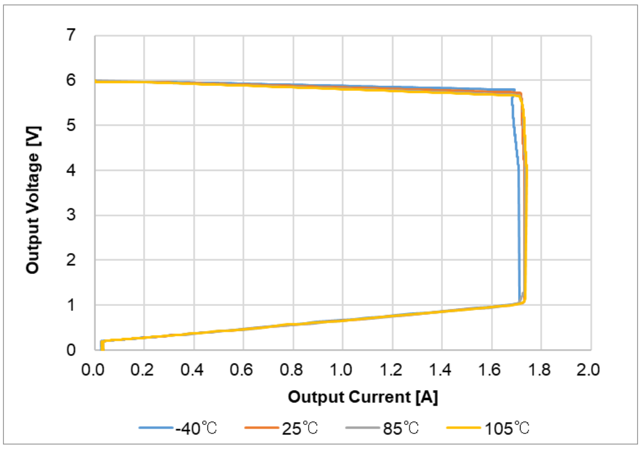
V_{IN1}=1.5V



V_{IN1}=3.6V



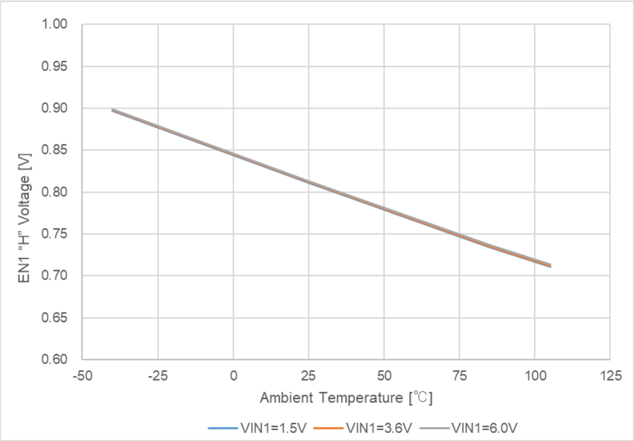
V_{IN1}=6.0V



■CHARACTERISTICS

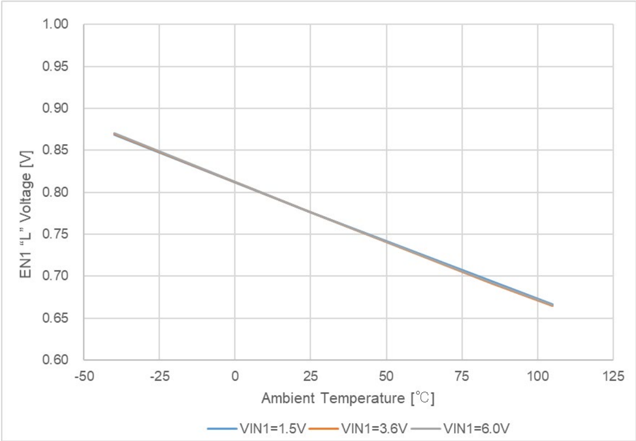
(9-1) EN1 “H” Voltage vs Ambient Temperature

XC8112/XC8113 Series



(9-2) EN1 “L” Voltage vs Ambient Temperature

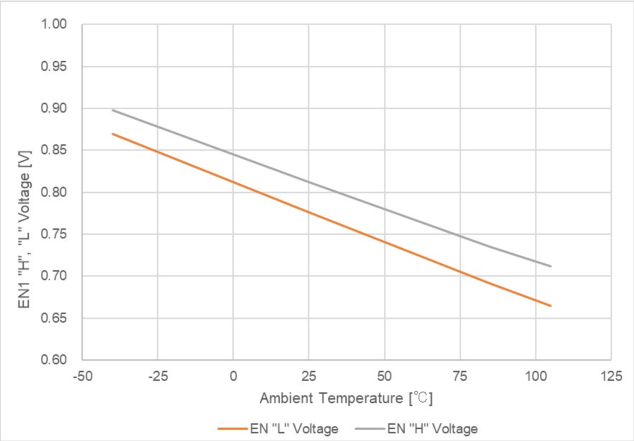
XC8112/XC8113 Series



(9-3) EN1 “H”, “L” Voltage vs Ambient Temperature

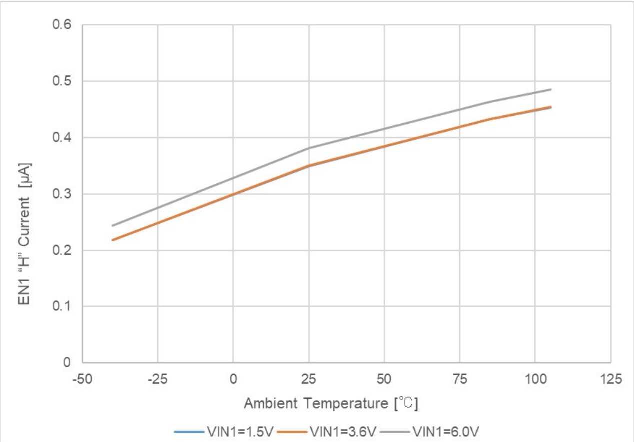
XC8112/XC8113 Series

V_{IN1}=3.6V



(10) EN1 “H” Current vs Ambient Temperature

XC8112/XC8113 Series

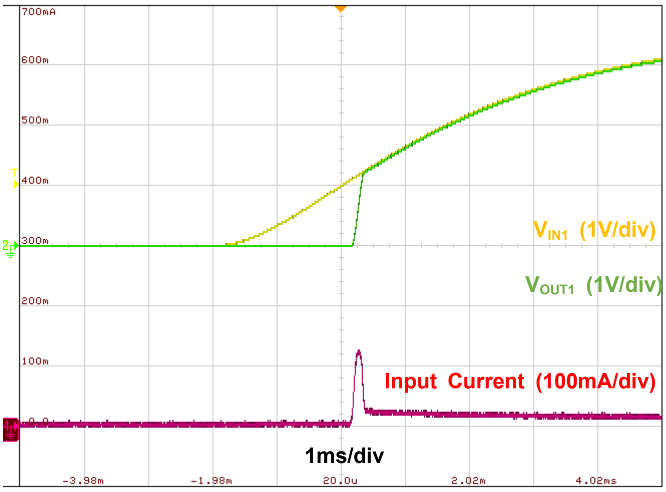


■CHARACTERISTICS

(11) V_{IN1} and EN1 are launched at the same time

XC8113 Series

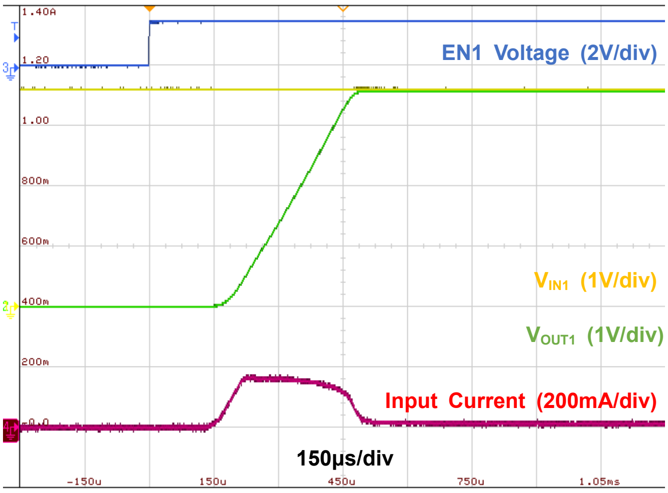
$V_{EN1}=V_{IN1}$, $I_{OUT1}=10mA$, $C_{L1}=10\mu F$ (C3225X7R1H106M250AC)



(12-1) Startup mode (at light load)

XC8113 Series

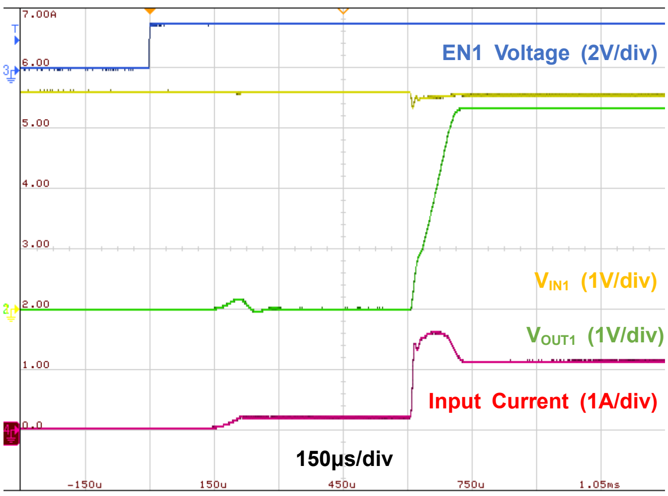
$V_{IN1}=3.6V$, $I_{OUT1}=1mA$, $C_{L1}=10\mu F$ (C3225X7R1H106M250AC)



(12-2) Startup mode (at heavy load)

XC8113 Series

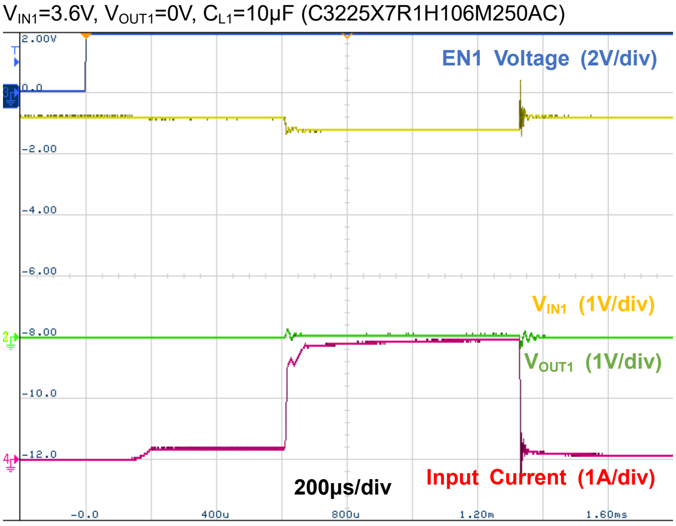
$V_{IN1}=3.6V$, $I_{OUT1}=1000mA$, $C_{L1}=10\mu F$ (C3225X7R1H106M250AC)



(12-3) Startup mode (at output short-circuit)

XC8113 Series

$V_{IN1}=3.6V$, $V_{OUT1}=0V$, $C_{L1}=10\mu F$ (C3225X7R1H106M250AC)

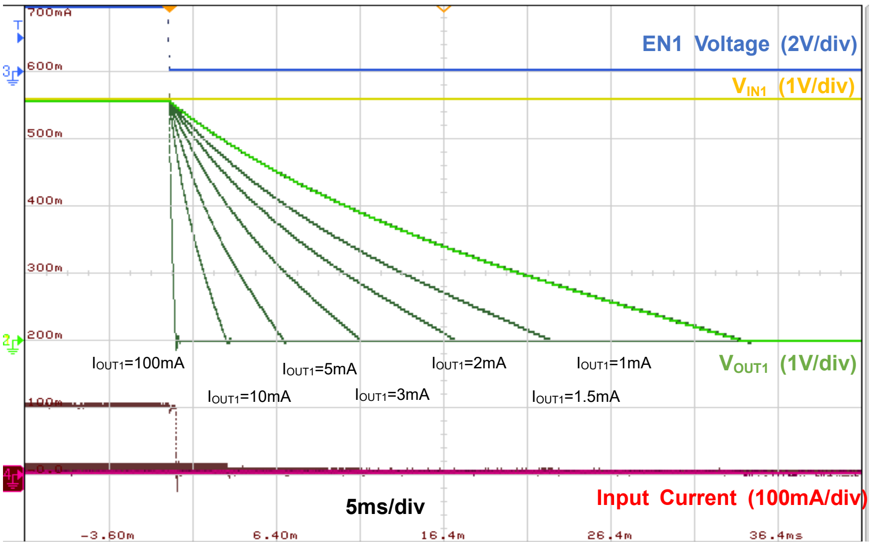


■CHARACTERISTICS

(13) Output drops due to EN1

XC8112/XC8113 Series

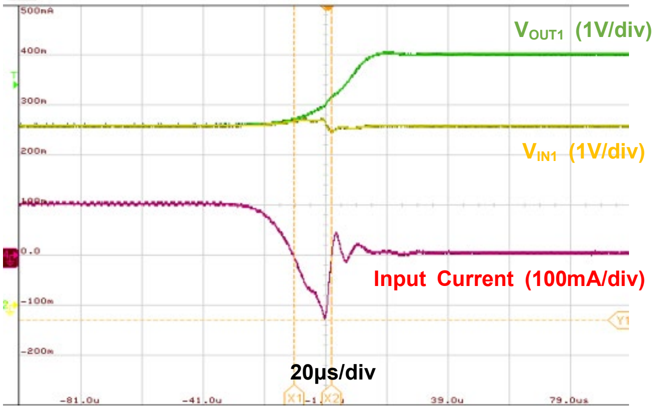
V_{IN1}=3.6V, I_{OUT1}=1mA~100mA, C_{L1}=10μF (C3225X7R1H106M250AC)



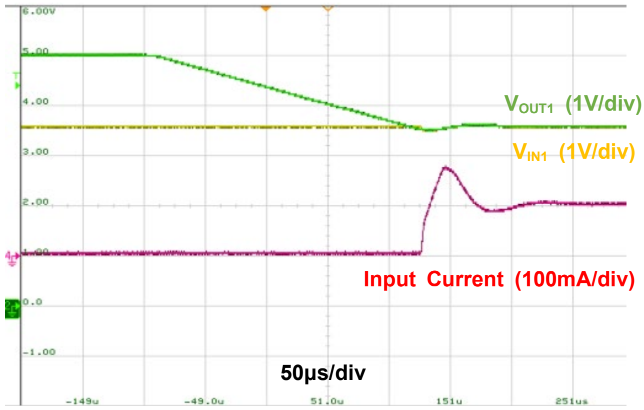
(14) Reverse Current Protection

XC8112/XC8113 Series, V_{IN1}=3.6V, V_{EN1}=V_{IN1}, I_{OUT1}=100mA, C_{IN1}=1.0μF (GRM155C71A105ME11D), C_{L1}=10μF (C3225X7R1H106M250AC)

V_{OUT1}=OPEN→5.0V



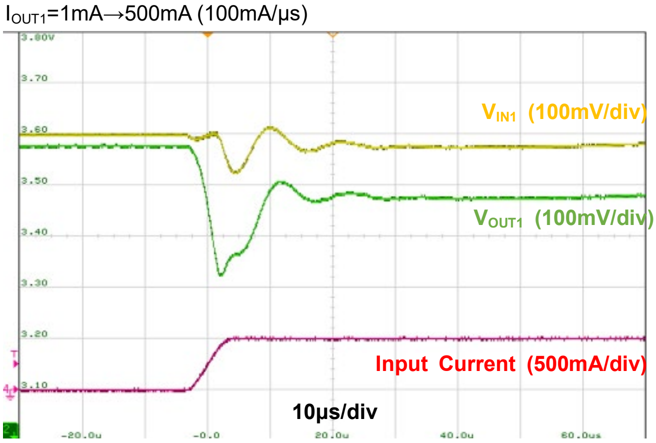
V_{OUT1}=5.0V→OPEN



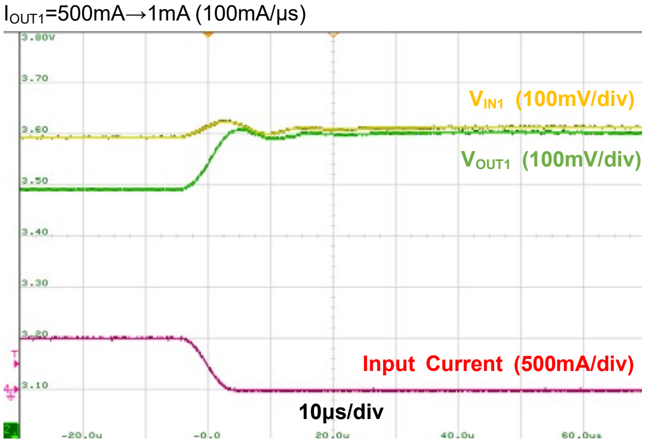
(15) Load Transient Response

XC8112/XC8113 Series, V_{IN1}=3.6V, C_{L1}=4.7μF (GRM188C71A475ME11D)

I_{OUT1}=1mA→500mA (100mA/μs)



I_{OUT1}=500mA→1mA (100mA/μs)

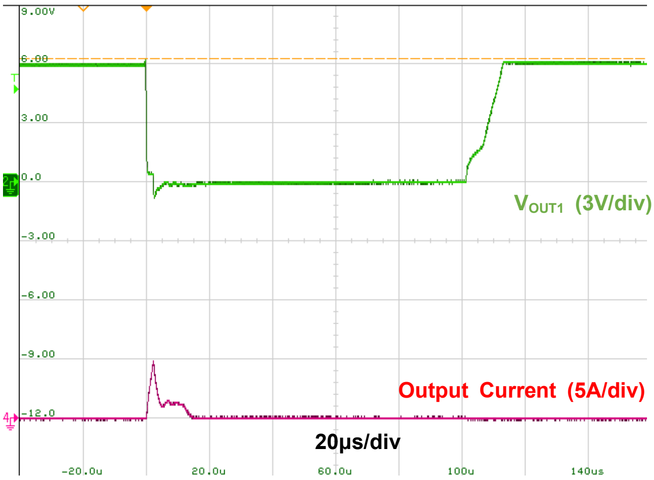


■CHARACTERISTICS

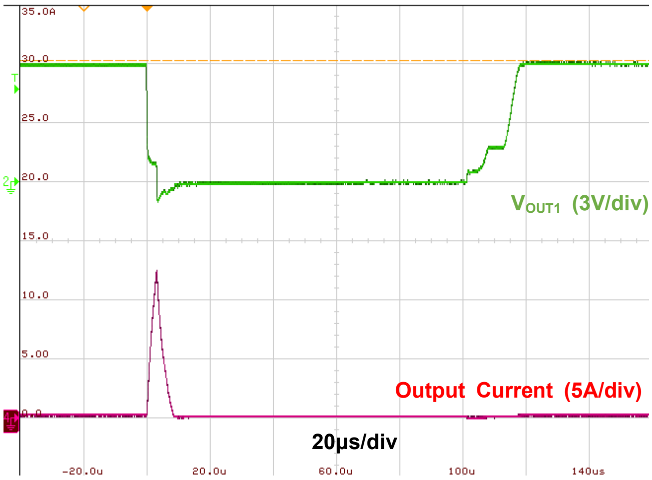
(16) Short-circuit operation waveform

XC8113 Series, V_{IN1}=6.0V, V_{EN1}=V_{IN1}, C_{IN1}=1000µF (RDEC71E476MWK1H03B parallel), C_{L1}=OPEN

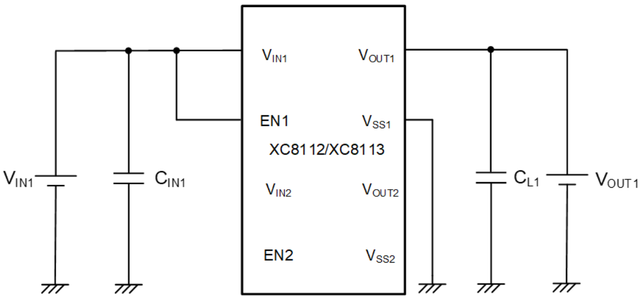
I_{OUT1}=0mA → Short

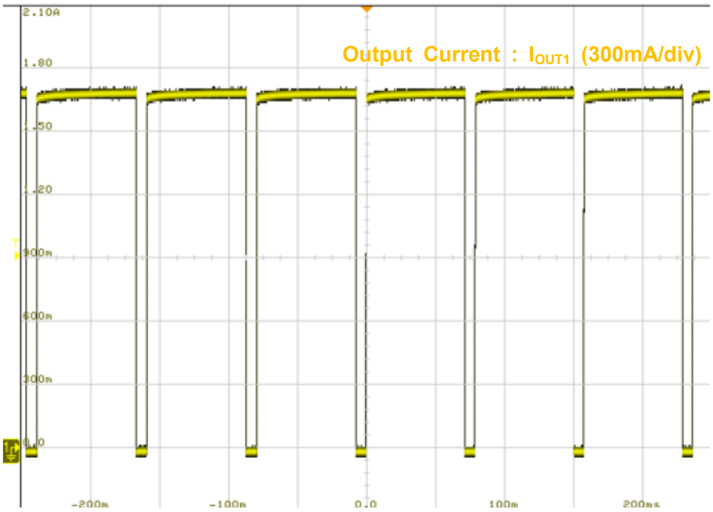


I_{OUT1}=200mA → Short



(17) Thermal Shutdown Operation





XC8113AA01ER-G

・V_{IN1}=3.6V, V_{OUT1}=2.9V

・C_{IN1}=C_{L1}=1.0µF (GRM155C71A105ME11D)

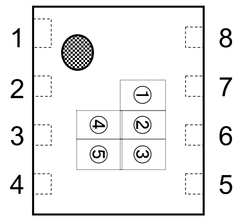
■PACKAGING INFORMATION

For the latest package information, please visit www.torexsemi.com/technical-support/packages

PACKAGE	OUTLINE / LAND PATTERN	THERMAL CHARACTERISTICS
USP-8B06	USP-8B06 PKG	USP-8B06 Power Dissipation

■MARKING RULE

USP-8B06



①②③represents products series.

①	②	③	PRODUCT SERIES
5	0	A	XC8112AA01E*-G
		B	XC8113AA01E*-G

④,⑤represents production lot number.
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to AZ, B1 to ZZ in order.
(G, I, J, O, Q, W excepted)
*No character inversion used.