HX4066

1A, Single Supercapacitor Linear Charger

GENERAL DESCRIPTION

The HX4066 is a complete constant current/ constant voltage linear charger for single cell supercapacitor. No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture.

The charge voltage is fixed at 2.45V, 2.65V or 2.7V, and the charge current can be programmed externally with a single resistor.

When the input supply (wall adapter or USB supply) is removed, the HX4066 automatically enter a low current state, drawing less than 0.1μA from the supercapacitors.

Other features include chip enable, undervoltage lockout, input OVP Protection, thermal regulation, protection for OUT reverse connection and the charge status indicator.

The HX4066 is available in ESOP8, DFN2x2-8L and DFN3x3-8L packages.

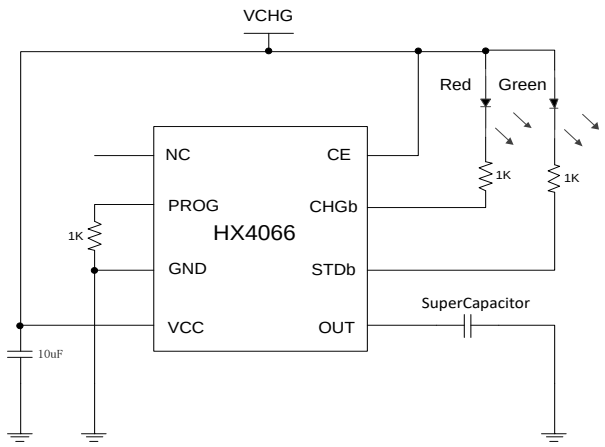
FEATURES

- Operating Voltage Range: 4V to 6V
- Programmable Charge Current Up to 1A
- Charge Current is Set by An External Resistor
- Under Voltage Lockout Protection
- Input OVP Protection
- Selectable 2.45V to 2.7V Regulation Final Voltage
- No external Blocking Diode or Current Sense Resistors Required
- Automatic Low-Power Sleep Mode When Input Supply Voltage is Removed
- Charge Status Output Pins
- Protection for OUT Reverse Connection

APPLICATIONS

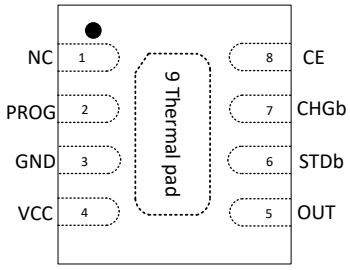
- Electric Meter
- SuperCap Backup Circuit
- PC Card, USB Modems
- Barcode scanner
- Dashboard camera
- Portable medical equipment
- Others portable electronic device

TYPICAL APPLICATION CIRCUIT



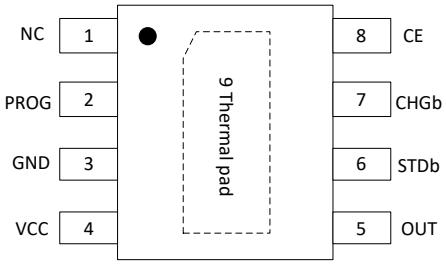
PIN CONFIGURATION

TOP VIEW



DFN2x2-8L/DFN3x3-8L

TOP VIEW



ESOP-8

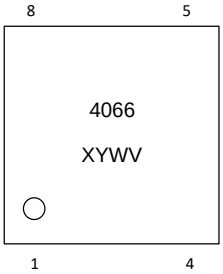
PIN DESCRIPTION

Pin Number	Pin Name	I/O	Function
1	NC	–	Not connected.
2	PROG	O	Charge current setting and monitor pin. The charging current is given by I_{BAT}= 1000/R_{PROG}(A). Please choose 1% precision resistor for R_{PROG}.
3	GND	G	Ground
4	VCC	P	Power Supply
5	OUT	O	Charge Current Output. Provides charge current to the supercapacitor and regulates the final voltage to 2.45V or 2.7V.
6	STDb	O	Open-Drain Charge termination indicated pin. When charge is terminated, it is pulled low, otherwise it is high impedance.
7	CHGb	O	Open-Drain Charge Status Output. When the supercapacitor is charging, the CHGb pin is pulled low. When the charge cycle is completed or VCC is removed, the CHGb is forced high impedance.
8	CE	I	Charge enable pin. High is enabled, low is disabled. Can not be floating.
9	Thermal pad	–	Thermal pad must be soldered to a large PCB and connected to GND for maximum thermal dissipation.

ORDERING INFORMATION

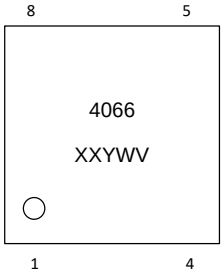
Part Number	V_{FINAL}	Package	Temperature	Tape & Reel
HX4066E8-245	2.45V	ESOP-8	-40 ~ +85°C	4000/Reel
HX4066E8-265	2.65V	ESOP-8	-40 ~ +85°C	4000/Reel
HX4066E8-27	2.7V	ESOP-8	-40 ~ +85°C	4000/Reel
HX4066D8-245	2.45V	TDFN2x2-8L	-40 ~ +85°C	4000/Reel
HX4066D8-265	2.65V	TDFN2x2-8L	-40 ~ +85°C	4000/Reel
HX4066D8-27	2.7V	TDFN2x2-8L	-40 ~ +85°C	4000/Reel
HX4066DC8-245	2.45V	TDFN3x3-8L	-40 ~ +85°C	5000/Reel
HX4066DC8-265	2.65V	TDFN3x3-8L	-40 ~ +85°C	5000/Reel
HX4066DC8-27	2.7V	TDFN3x3-8L	-40 ~ +85°C	5000/Reel

MARKING DESCRIPTION



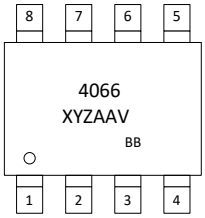
(DFN2x2-8L)

"XY": Internal Control Code
"W": The week of manufacturing.
"A" stands for week 1, "Z" stands for week 26,
"a" stands for week 27, "z" stands for week 52.
"V": Voltage code.



(DFN3x3-8L)

"XX": Internal Control Code
"W": The week of manufacturing.
"A" stands for week 1, "Z" stands for week 26,
"a" stands for week 27, "z" stands for week 52.
"V": Voltage code.



(ESOP-8)

"XYZ": Internal control code.
"BB": Internal control code.
"AA": Serial Number.
"V": Voltage Code.

Voltage Code Table

V_{FINAL}	Voltage Code
2.45V	M
2.65V	J
2.7V	K

ABSOLUTE MAXIMUM RATINGS (Note 1)

SYMBOL	ITEMS		VALUE	UNIT
V_{CC}	Input Voltage		-0.3~9	V
V_{OUT}	OUT Pin Voltage		-5~7	V
All other pins	Other Pins Voltage		-0.3 ~ V_{CC}+0.3	V
P_D	Power Dissipation	ESOP-8	2.0	W
		DFN2x2-8L	1.0	W
		DFN3x3-8L	1.5	W
$R_{\theta JA}$	Junction to Ambient Thermal Resistance	ESOP-8	60	°C /W
		DFN2x2-8L	100	°C /W
		DFN3x3-8L	67	°C /W
T_J	Junction Temperature		-40~125	°C
T_{STG}	Storage Temperature		-55 to 150	°C
T_{SOLDER}	Package Lead Soldering Temperature		260°C , 10s	
ESD	HBM		±5	KV

Note (1): Exceed these limits may damage the device. Exposure to absolute maximum rating conditions may affect device reliability.

RECOMMENDED OPERATING CONDITION

SYMBOL	DESCRIPTION	MIN	NOM	MAX	UNIT
V_{CC}	Input operating voltage range	4.0	5.0	6.0	V
I_{CC}	Constant charge current range	250	500	1000	mA
R_{PROG}	Constant charge current programming resistor	1	2	4	KΩ

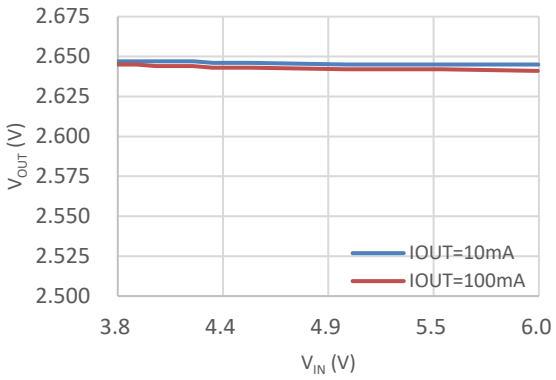
ELECTRICAL CHARACTERISTICS

The following specifications apply for V_{CC}=5V, T_A=25℃, unless specified otherwise.

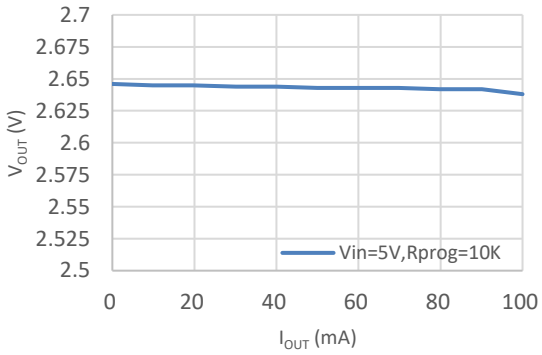
SYMBOL	ITEMS	CONDITIONS	MIN	TYP	MAX	UNIT
V_{CC}	Input voltage range		4	5	6	V
V_{UVLO}	UVLO Threshold	V_{CC} from low to high		3.75	4.0	V
$V_{UVLO, HYS}$	UVLO Hysteresis	V_{CC} from high to low		250		mV
V_{OVP}	OVP Threshold		5.80	6.30	6.80	V
V_{OVP_HYS}	OVP Threshold Hysteresis			650		mV
$I_{SPLYCHRG}$	Charge Mode GND Current	R_{PROG}=2kΩ, V_{CC}=5V, OUT floating		85		μA
$I_{SPLYSTBY}$	Standby Mode Supply Current	Charge Terminated		85		μA
I_{SPLYSD}	Shutdown Mode Supply Current	CE=High, 2V<V_{CC}<V_{OUT}		16		μA
		CE=Low, V_{CC}=5V		0.5		μA
$I_{OUTSTBY}$	Standby Mode OUT Pin Current	V_{OUT}=3V		1.4		μA
I_{OUTSD}	Shutdown Mode OUT Pin Current	2V<V_{CC}<V_{OUT}		0.45	1	μA
		CE=Low, V_{CC}=5V, V_{OUT}=3V		0.015		μA
$I_{OUTSLEEP}$	Sleep Mode OUT Pin Current	CE=Low, V_{CC}=0V or V_{CC} floating, V_{OUT}=3V		0.010	1	μA
I_{CC}	Constant Current Mode OUT Pin Current	R_{PROG}=1kΩ	0.9	1	1.1	A
		R_{PROG}=2kΩ	450	500	550	mA
		R_{PROG}=10kΩ	90	100	110	mA
V_{PROG}	PROG Pin Voltage in Current Mode			1.0		V
I_{PROG}	PROG Pin Pull-Up Current			0.01		μA
V_{OUT}	Output Charger Voltage	Charge Terminated	2.40	2.45	2.50	V
			2.60	2.65	2.70	V
			2.65	2.70	2.75	V
V_{CHGb}	CHGb Pin Output Low Voltage	I_{CHGb}=5mA, BAT=2.5V		0.15	0.3	V
V_{STDb}	STDb Pin Output Low Voltage	I_{STDb}=5mA, BAT=2.5V		0.15	0.3	V
V_{CEL}	CE Pin Input Low Voltage				0.4	V
V_{CEH}	CE Pin Input High Voltage		1.2			V
T_{LMT}	Thermal regulation			140		℃

TYPICAL PERFORMANCE CHARACTERISTICS

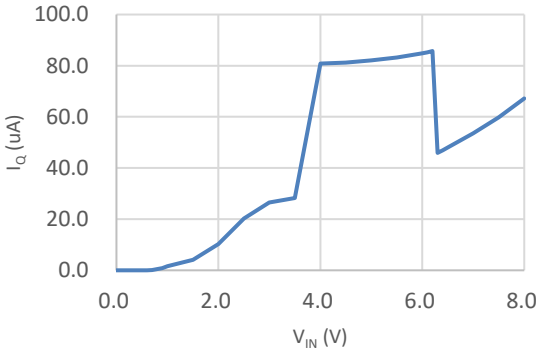
Line Regulation



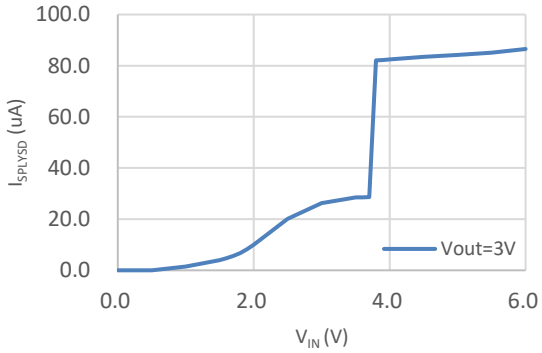
Load Regulation



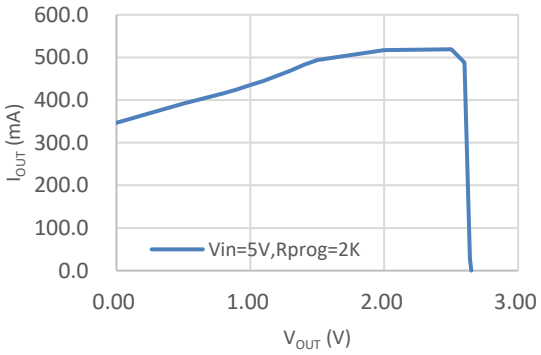
I_Q vs V_{IN}



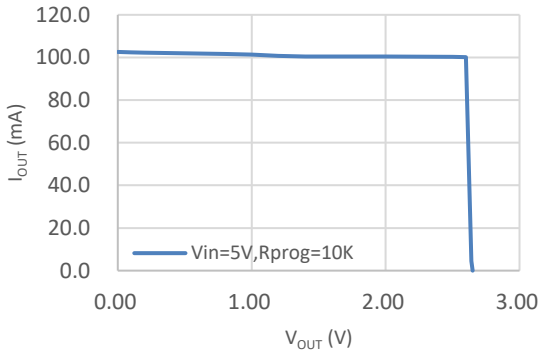
I_{SPLYSD} vs V_{IN}



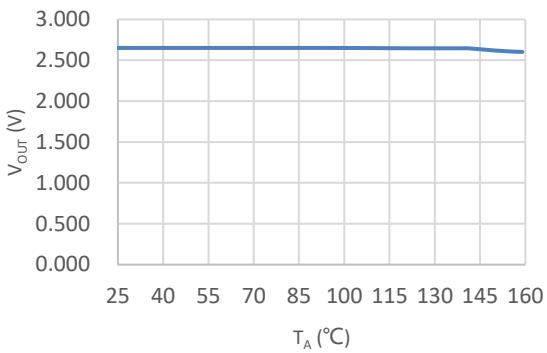
I_{OUT} vs V_{OUT}



I_{OUT} vs V_{OUT}

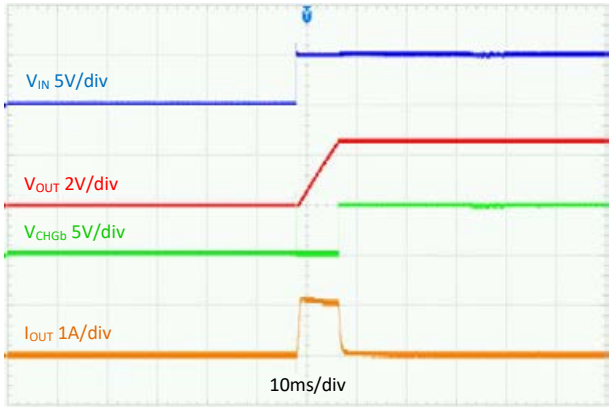


V_{OUT} vs T_A



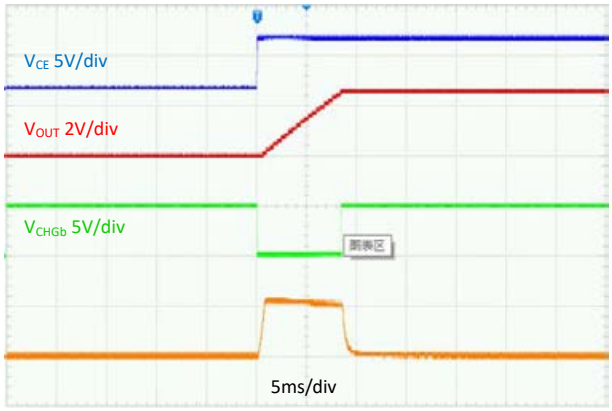
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

Startup from V_{IN} (4mF Capacitor)

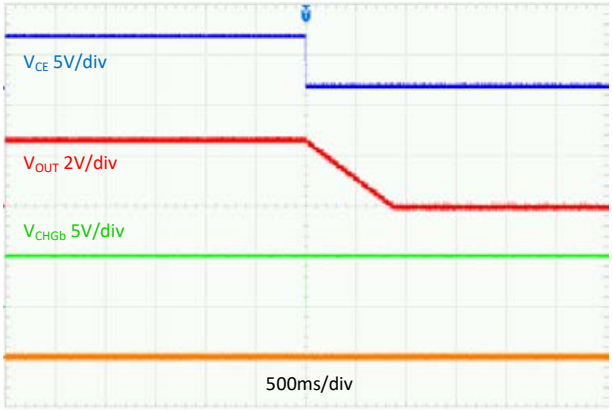


Shuntdown from V_{IN} (4mF Capacitor)

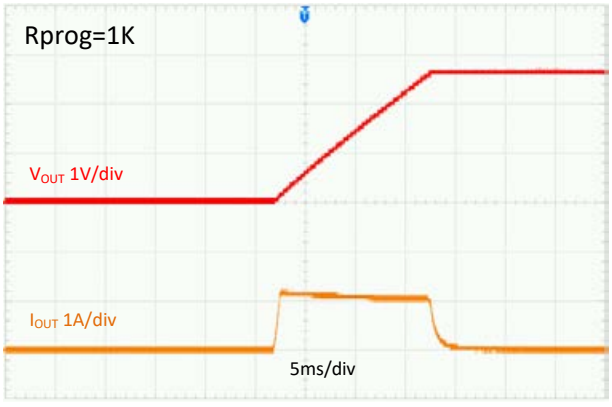
Startup from CE (4mF Capacitor)

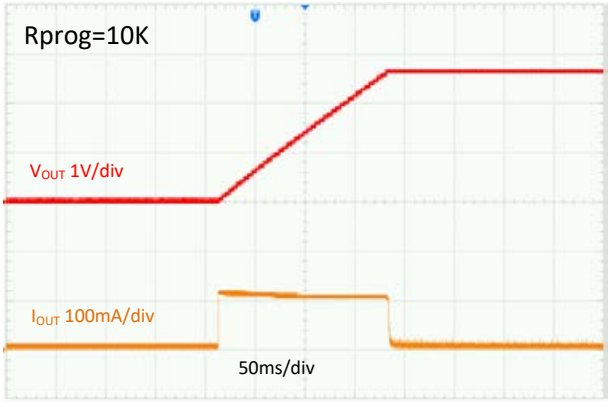


Shuntdown from CE (4mF Capacitor)

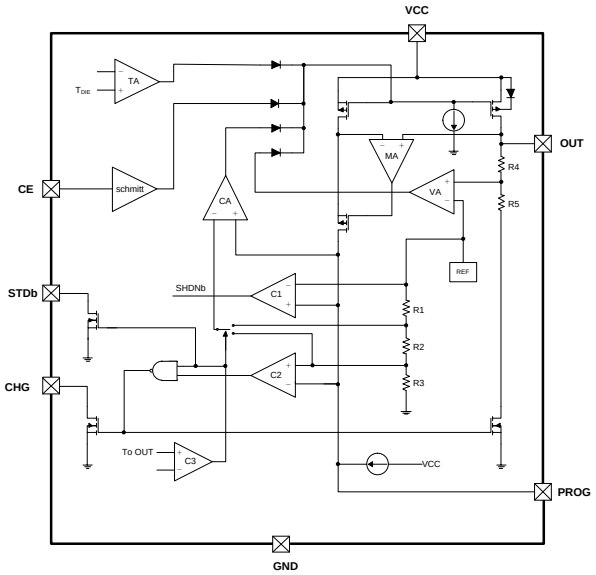


10mF Capacitor Charging Profiles





BLOCK DIAGRAM



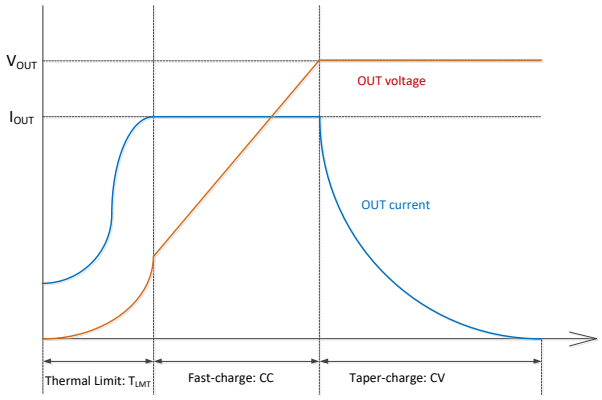
OPERATION INFORMATION

The HX4066is a single supercapacitor charger using a constant-current / constant-voltage algorithm. It can deliver up to 1A of charge current (using a good thermal PCB layout) with a final voltage accuracy of ±50mV. The HX4066includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required, thus the basic charger circuit requires only two external components. Furthermore, the HX4066 is capable of operating from a USB power source.

Normal charge cycle

A charge cycle begins when the voltage at the VCC pin rises above the UVLO threshold level and a 1% program resistor is connected from the PROG pin to ground or when a supercapacitor is connected to the charger output, the programmed charge current is supplied to the supercapacitor.

The device charges a supercapacitor in two phases: constant current and constant voltage. Power dissipation in the IC is greatest in fast charge with a lower supercapacitor voltage. If the IC temperature reaches T_{LMT}, the IC enters thermal regulation and reduces the charge current as needed to keep the temperature from rising any further. As the supercapacitor approaches the regulation voltage, the current tapers down to 0 mA. There is no current termination threshold as seen in Li-Ion chargers.



Supercapacitor Charging Profile with Thermal Limit

Programming charge current

The charge current is programmed using a single resistor from the PROG pin to ground. The supercapacitor charge current of constant current mode is 1000 times the current out of the PROG pin. The program resistor and the charge current of constant current are calculated using the following equations:

$$I_{OUT} = 1000 / R_{PROG} \text{ (A)}$$

Please choose 1% precision resistor for R_{PROG}, this will affect the accuracy of CC charge current.

Charge status indicator (CHGb and STDb)

The charge status output indicator is an open drain circuit. The pull-down state of CHGb and high impedance state of STDb indicates that the HX4066 is in a charge cycle. The high impedance state of CHGb and pull-down state of STDb indicates that the charge cycle is complete, the HX4066 is in standby mode status. The indicator also can be used to detect the charge states by a microprocessor with a pull-up resistor.

Shutdown mode (CE)

CE pin is active high enabled input. When CE is pulled to low level, the HX4066 enters shutdown mode. The input current and output current are very low at shutdown mode. This reduces the battery drain current to less than the I_{BATSD} and the supply current to less than the I_{SPLYSD}. A new charge cycle can be initiated by pull high CE pin at any time.

The HX4066 also be put into shutdown mode when VCC voltage down to UVLO threshold. In this state, the CHGb and STDb pin both are high impedance.

Thermal limit

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 140°C. This feature protects the HX4066from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the HX4066. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worse-case conditions.

Power dissipation

The conditions that cause the HX4066 to reduce charge current through thermal feedback can be approximated by considering the power dissipated in the IC. Nearly all of this power dissipation is generated by the internal MOSFET. This is calculated to be approximately:

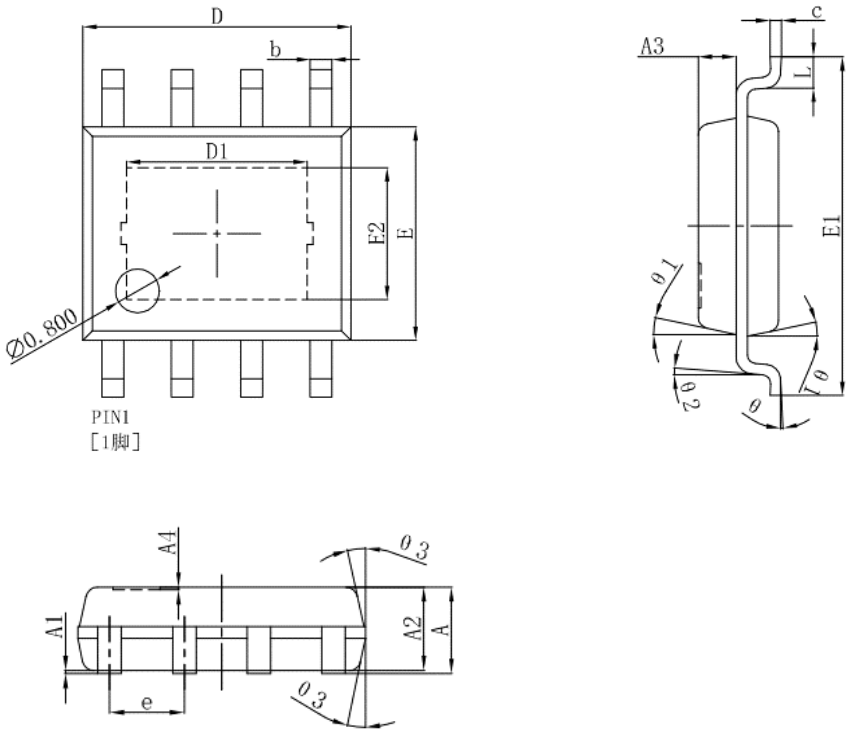
$$P_D = (V_{CC} - V_{OUT})*I_{CC}$$

It is important to remember that HX4066 applications do not be designed for worst-case thermal conditions since the IC will automatically reduce power dissipation when the junction temperature reaches approximately 140℃ (Constant temperature mode).

VCC bypass capacitor

Many types of capacitors can be used for input bypass, however, caution must be exercised when using multilayer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, a 10uF/16V ceramic capacitor is recommended for this bypass capacitor. Due to a high voltage transient will be generated under some start-up conditions, such as connecting the charger input to a live power source.

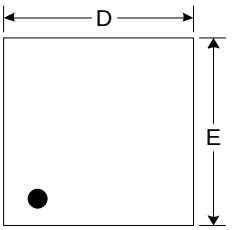
PACKAGE DIMENSION: ESOP-8



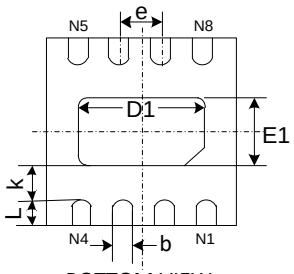
Unit: mm

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
A	1.300	1.500	1.700	E	3.800	3.900	4.000
A1	0.100	0.150	0.200	E1	5.800	6.000	6.200
A2	1.350	1.420	1.550	E2	2.313	2.413	2.513
A3	0.660	0.670	0.680	e	1.270BSC		
A4	0.020	--	0.050	L	0.450	0.600	0.750
b	0.330	0.400	0.510	θ	0°	3°	8°
c	0.170	0.203	0.250	θ1	12°REF.		
D	4.800	4.900	5.000	θ2	5°REF.		
D1	3.202	3.302	3.402	θ3	12°REF.		

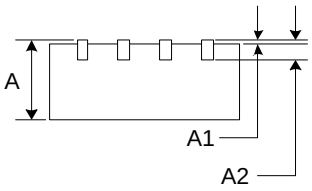
PACKAGE DIMENSION: TDFN2x2-8L



TOP VIEW



BOTTOM VIEW

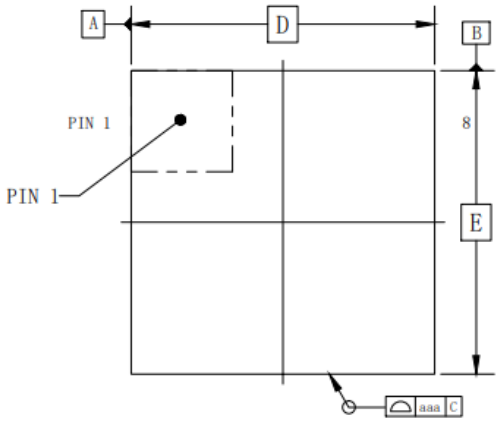


SIDE VIEW

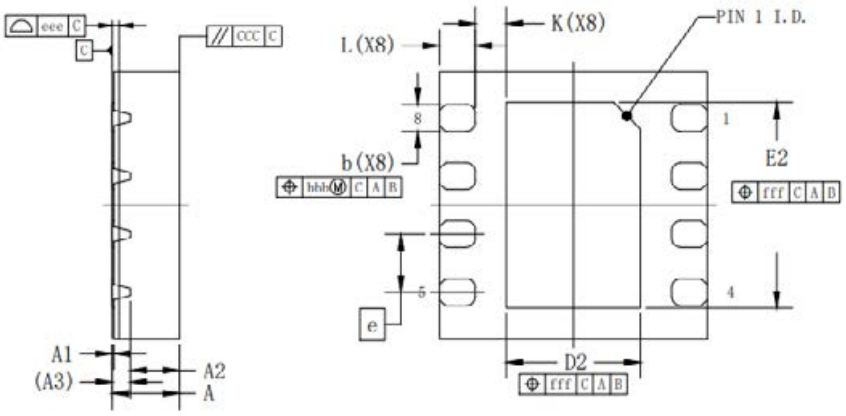
Unit: mm

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.50	0.55	0.6
A1	0.00	-	0.05
A3	0.152 REF.		
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D1	1.60	1.70	1.80
E1	0.80	0.90	1.00
k	0.20	-	-
b	0.15	0.20	0.25
e	0.50 TYP.		
L	0.25	0.30	0.35

PACKAGE DIMENSION: TDFN3x3-8L



TOP VIEW



SIDE VIEW　　BOTTOM VIEW

Unit: mm

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	3.0 BSC			b	0.25	0.30	0.35
E	3.0 BSC			L	0.30	0.40	0.50
D2	1.40	1.50	1.60	e	0.65 BSC		
E2	2.20	2.30	2.40	K	0.35 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			eee	0.08		
				fff	0.10		