

**Low Noise, High Efficiency****WhiteLED Charge Pump****FEATURES**

- **4 Current Source Outputs**
- **20mA Full Scale Current for each LED**
- **Power efficiency up to 93%**
- **32 levels for brightness**
- **2 wires interface**
- **Low Noise Constant Frequency Operation**
- **High Accuracy Brightness Matching**
- **White LED Backlighting**
- **0.5% LED current matching**
- **Automatic Soft-Start**
- **No External Inductors, Schottky, or Zener Diode and Resistor Required**
- **500KHz Switching Frequency (1MHz optional)**
- **2.7V to 5.5V supply voltage**
- **Shutdown current is less 1uA**
- **Temperature Range -40 to 85°C**
- **16-Pin QFN**

**Applications**

- Cellular Phones
- Portable Communication Devices
- Handheld devices
- Digital Cameras
- PDAs
- LED/Display Back Light Driver
- LEDs for Camera Flash

**PART NUMBER EXAMPLES**

<b>PART NO.</b>	<b>PACKAGE</b>	<b>Marking</b>
T6313A-AF	QFN 4mm X 4mm	6313
T6313A-BF	QFN 3mm X 3mm	6313

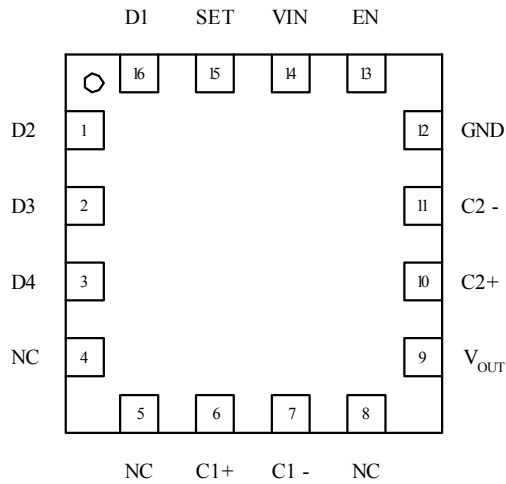
**GRNERAL DESCRIPTION**

The T6313A is a charge pump DC/DC converter driving a constant current up to 20mA for each LED of total four LEDs. It is a high efficiency device that is up to 93%, and it would be a suitable driving device for LED back light application. The T6313A operates in a 1.5x charge pump mode based on input voltage from 2.7v to 5.5v. Operation frequency is at fixed high frequencies either 500KHz or 1MHz typically. It can drive 4 white LEDs connected in parallel and provides tightly matched regulated current to achieve uniformity of brightness in LCD backlighting applications.

The T6313A uses two input pins to enable, disable, and set the LED drive current for one of 32 levels of brightness. Also has a built-in soft-start circuitry to prevent excessive inrush current during start-up. A very low shutdown current feature and a low quiescent current will consume very little power and allow the device to operate in a very high efficiency. The T6313A is available in 16-pin QFN packages.

**PIN ARRANGEMENT(Top view)**

**QFN- 4mm x 4mm AND 3mm x 3mm –16**



**PIN DESCRIPTION**

SYMBOL	Pin no.	DESCRIPTION
	QFN-16	
D2	1	Current source output 2
D3	2	Current source output 3
D4	3	Current source output 4
N.C.	4	No Connect
N.C.	5	No Connect
C1+	6	Flying capacitor 1 + terminal
C1-	7	Flying capacitor 1 – terminal
N.C.	8	No Connect
V <sub>OUT</sub>	9	Charge pump output. Requires 1uF bypass capacitor to ground.
C2+	10	Flying capacitor 2 + terminal
C2-	11	Flying capacitor 2 – terminal
GND	12	Ground
EN	13	Enable T6313A signal, H:active, L:power down
VIN	14	Input power supply. Requires 1uF bypass capacitor to ground.
SET	15	Set brightness level
D1	16	Current source output 1.Required reference current source.

**BLOCK DIAGRAM**

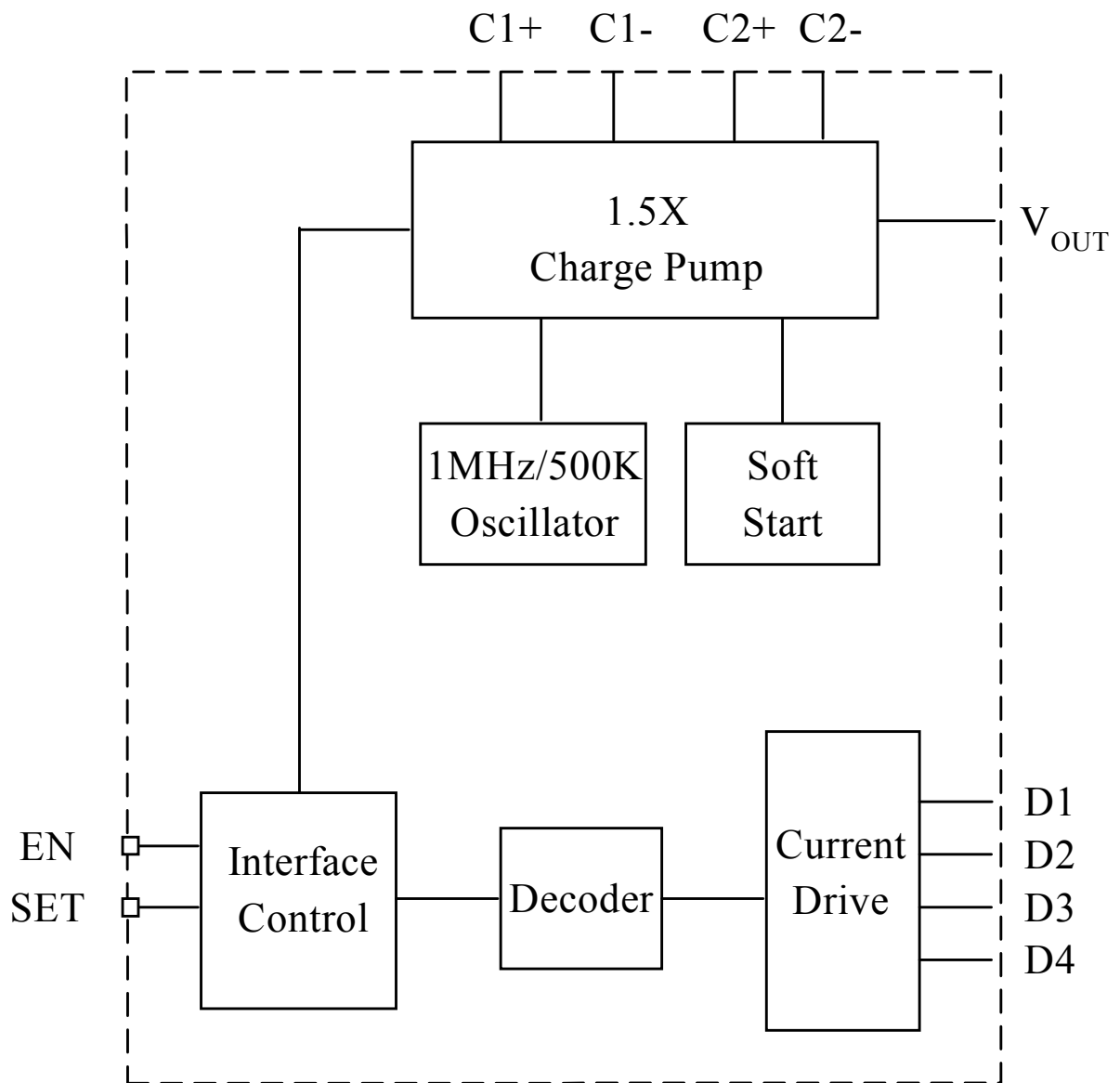


Fig-1

**ABSOLUTE MAXIMUM RATINGS (TA = 25°C unless otherwise noted)**

IN, OUT, EN to GND .....-0.3V to 6V  
 LED1 ~4 to GND .....-0.3V to (VIN+0.3V)  
 Operating Temperature .....-40 to 85°C  
 Storage Temperature .....-40 to 150°C

**Electrical Characteristics**

(TA = -40 to 85°C unless otherwise noted. Typical values are at TA =25°C, VIN =3.5V)

Symbol	Description	Conditions	Min.	Typ.	Max	Unit
VIN	Input Voltage		2.7		5.5	V
V <sub>EN (low)</sub>	Enable threshold Low	VIN=2.7 to 5.5V			0.4	V
V <sub>EN (high)</sub>	Enable threshold High	VIN=2.7 to 5.5V	1.4			V
V <sub>SET (low)</sub>	Enable threshold Low	VIN=2.7 to 5.5V			0.4	V
V <sub>SET (high)</sub>	Enable threshold High	VIN=2.7 to 5.5V	1.4			V
ICC	Operating Current	Active, No Load Current		1.3	2	mA
ISHDN	Shutdown Supply Current	EN=0			1	uA
I <sub>out</sub>	Output Current	3.2V ≤ VIN ≤ 5.5V, TA=25°C, All Outputs Max. Current	18	20	22	mA
I <sub>out_m</sub>	Current Matching between D1 and any other outputs	VD1 : VDn=3.6V, VIN=3.3V		0.5		%
I <sub>ILEN</sub>	EN input leakage	VIN= 5.5V	-1		1	uA
I <sub>ILset</sub>	SET input leakage	VIN= 5.5V	-1		1	uA
t <sub>SS</sub>	Soft start time			500		us
t <sub>LO</sub>	SET low time		0.5			us
t <sub>OFF</sub>	SET off time			350	500	us
t <sub>HI</sub>	Minimum SET high time			50		ns
η	Efficiency	VIN=3.5V, I <sub>OUT (total)</sub> =40mA		93		%
f <sub>OSC</sub>	Frequency	Oscillator Free Running		1000/ 500		KHz

**Typical Operating Characteristics**

( $V_{IN}=+3.5V$ ,  $C_{IN}=C_{OUT}=C1=C2=1\mu F$ ,  $T_A=+25\text{ }^\circ\text{C}$ , unless otherwise noted.)

TBD

**Functional Description**

The T6313A uses a fractional (x1.5) conversion charge pump to generate a voltage for the regulated current sinks. These current sinks are used to ensure a constant current for each LED.

The charge pump can generate total 80 mA of output current, so each of the 4 LED outputs can be powered with up to 20 mA of current.

The T6313A uses two wires to enable and set the LED currents. The EN pin is used to either enabling or disabling the T6313A.

When EN is high, then the numbers of pulse shift from SET pin are valid and an internal counter counts up from 1 from the

first rising edge of SET and increases by one when another rising edge of SET is shifted in. The outputs of the counter will map to 32 levels of LED current. Each level (code) is mapped to a different current, which is a different brightness (Fig-2 & Tabell). Once the final clock cycle is input for the desired brightness level, the SET pin is held high to maintain the device output current at the programmed level. The device is disabled 350us after the SET pin transitions to a logic low state. A level will stay until EN goes low. T6313A is power down when EN goes low. After EN goes low then any pulse shifting from SET pin is invalid (Fig-3).

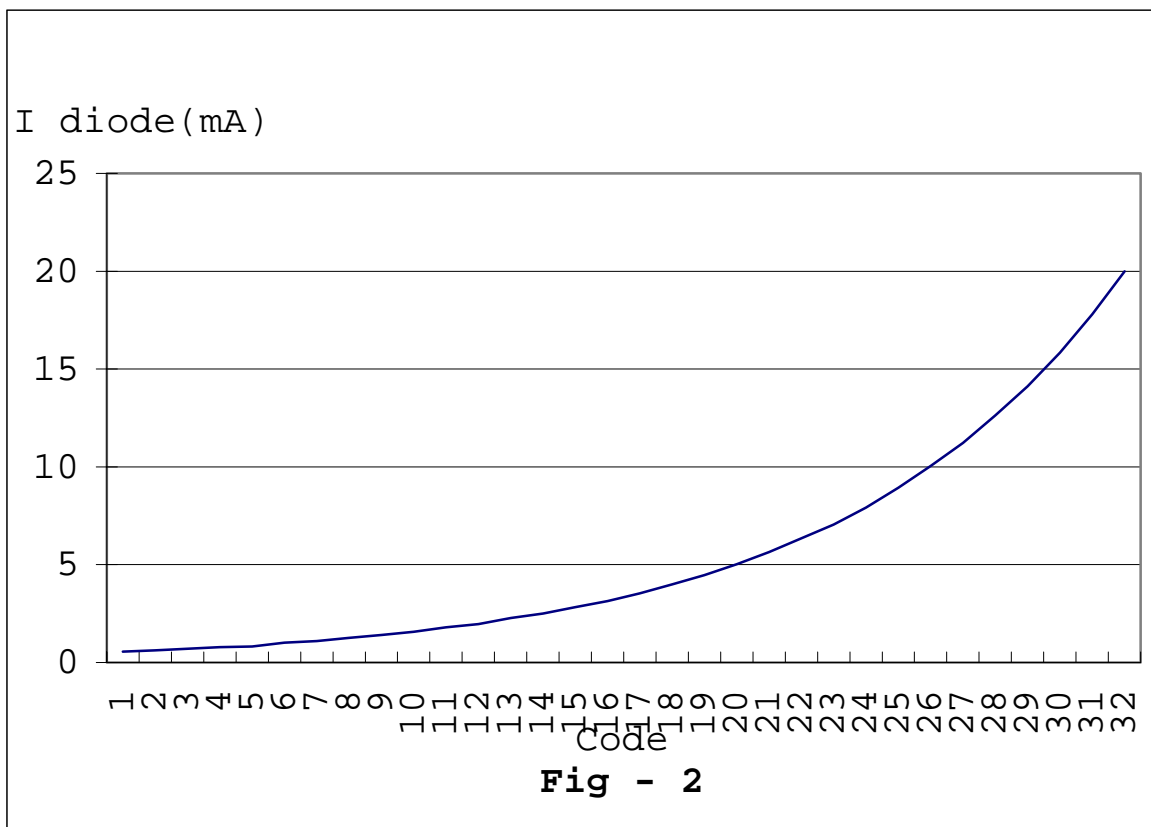


Table1 : current level (mA)

code	20mA max.
1	0.549
2	0.627
3	0.706
4	0.784
5	0.863
6	1.020
7	1.098
8	1.255
9	1.412
10	1.569
11	1.804
12	1.961
13	2.275
14	2.510
15	2.824
16	3.137

code	20mA max.
17	3.529
18	4.000
19	4.471
20	5.020
21	5.647
22	6.353
23	7.059
24	7.922
25	8.941
26	10.039
27	11.216
28	12.627
29	14.118
30	15.843
31	17.804
32	20.000

**SET vs ILED**

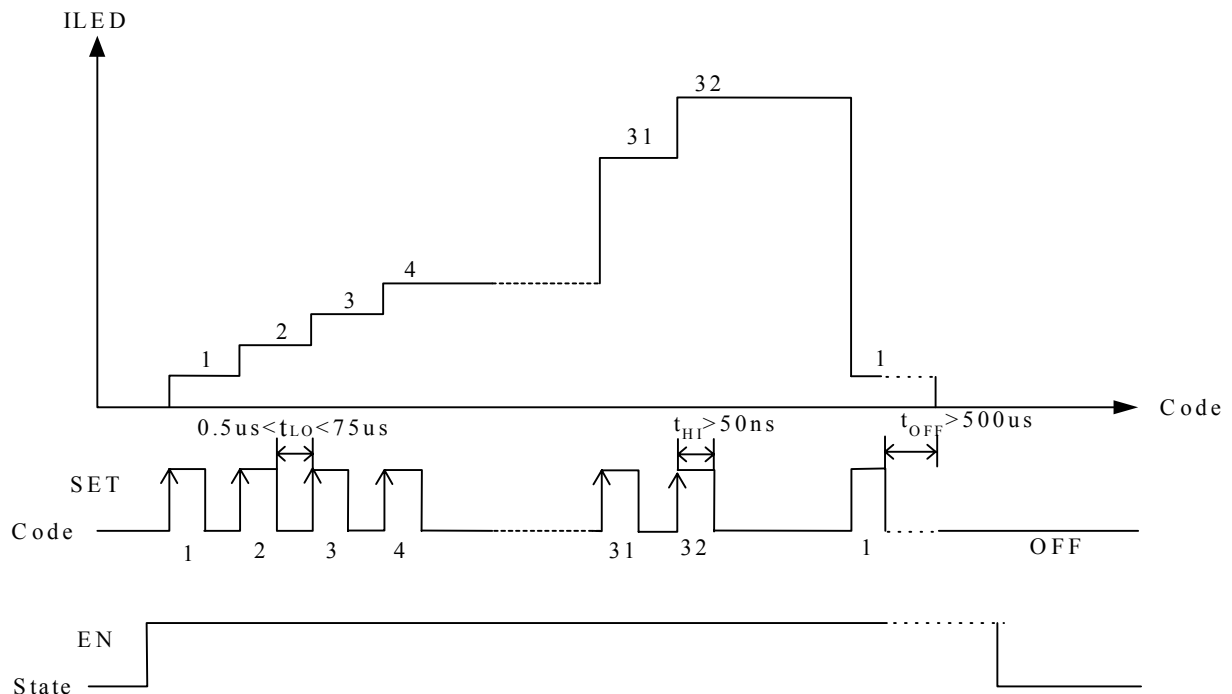
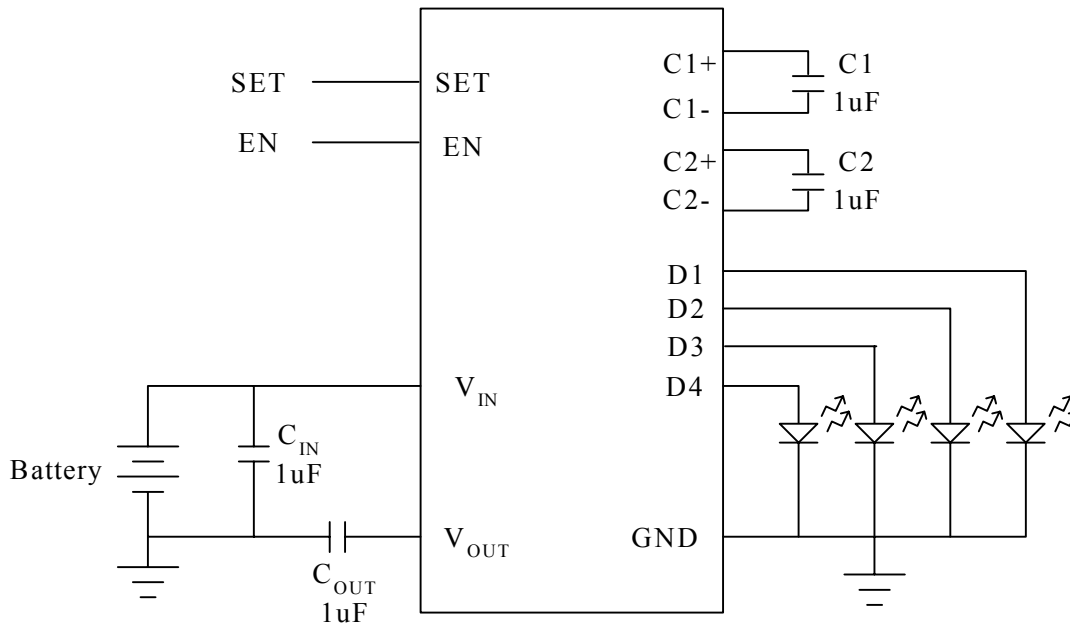


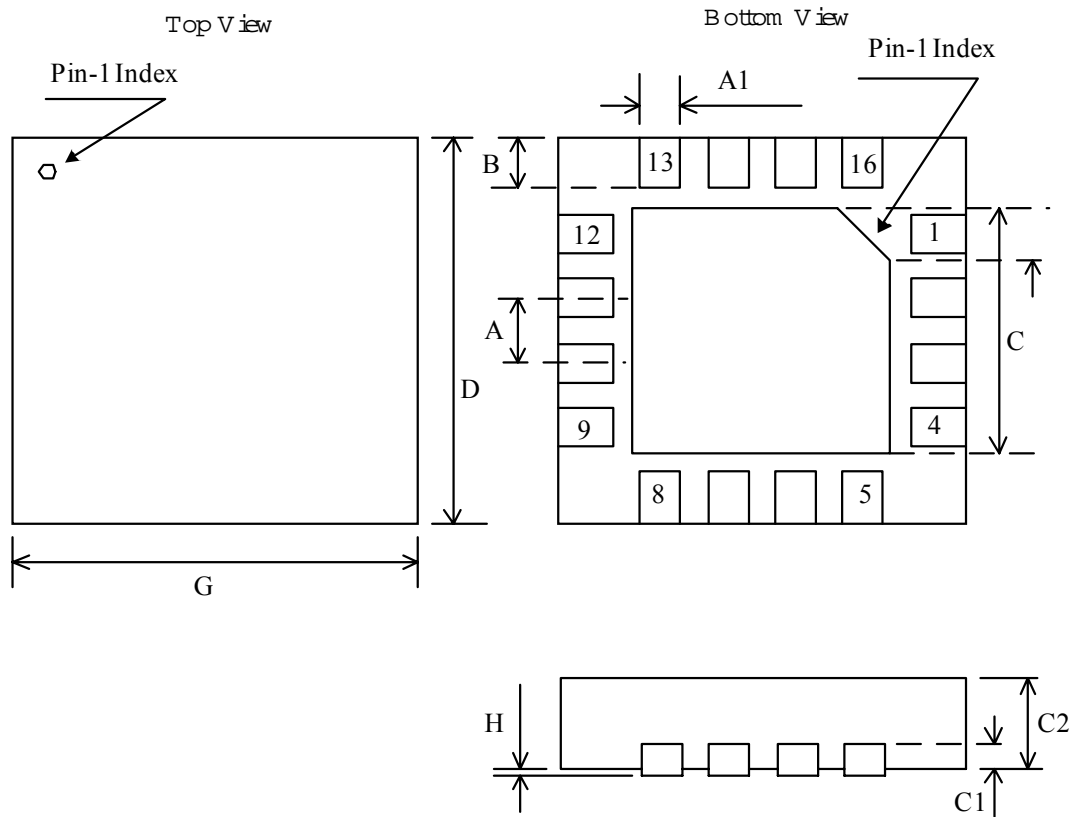
Fig.-3 Enable / Disable / LED Brightness Level Set Data Input

**TYPICAL APPLICATION CIRCUITS**



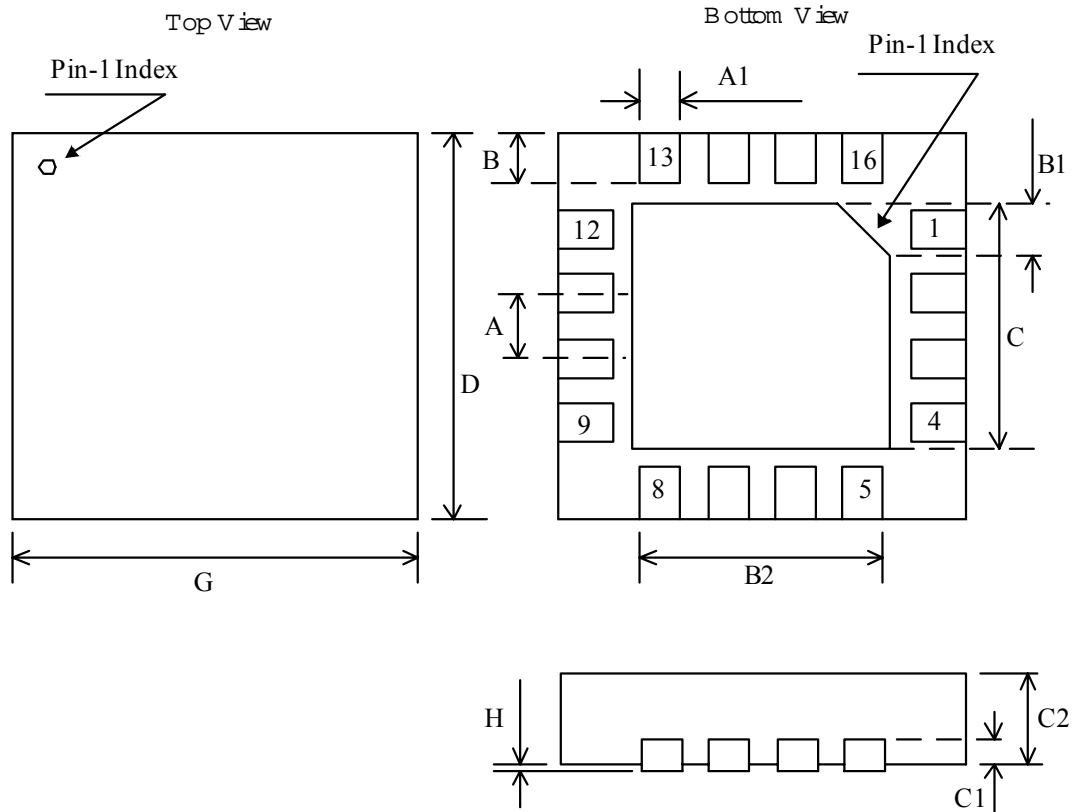


**PACKAGE DIMENSIONS**  
**QFN3mm x 3mm-16**



Symbol	Dimension in mm			Dimension in mil		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		0.50(BSC)			19.69	
A1	0.18	0.23	0.30	7.09	9.06	11.81
B	0.30	0.40	0.50	11.81	15.75	19.69
C	1.40	1.50	1.60	55.12	59.06	62.99
C1		0.20			8.00	
C2	0.70	0.75	0.80	27.6	29.5	31.5
D	2.90	3.00	3.10	114.17	118.11	122.05
G	2.90	3.00	3.10	114.17	118.11	122.05
H	0	0.02	0.05	0	0.79	1.97

**PACKAGE DIMENSIONS**  
**QFN4mm x 4mm-16**



Symbol	Dimension in mm			Dimension in inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		0.65(BSC)			0.025(BSC)	
A1	0.28	0.33	0.38	0.011	0.013	0.015
B	0.55	0.60	0.65	0.022	0.024	0.026
B1	0.40	0.45	0.50	0.016	0.018	0.020
B2		2.28(REF)			0.090(REF)	
C	2.35	2.40	2.45	0.092	0.094	0.096
C1	0.17	0.20	0.23	0.006	0.008	0.009
C2	0.85	0.90	0.95	0.033	0.035	0.037
D	3.95	4.00	4.05	0.155	0.157	0.159
G	3.95	4.00	4.05	0.155	0.157	0.159
H	0.00	0.12	0.25	0.000	0.005	0.009