Low Noise, High Efficiency
WhiteLED Charge Pump

FEATURES

- 4 Current Source Outputs
- 20mA Full Scale Current for each LED
- Power effcency 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

| PART NO.	PACKAGE	Marking
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.

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PIN ARRANGEMENT(Top view)

QFN- 4mm x 4mm AND 3mm x 3mm –16
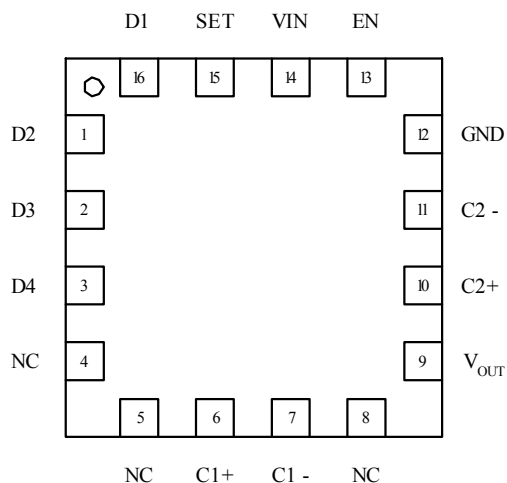
PIN DESCRIPTION

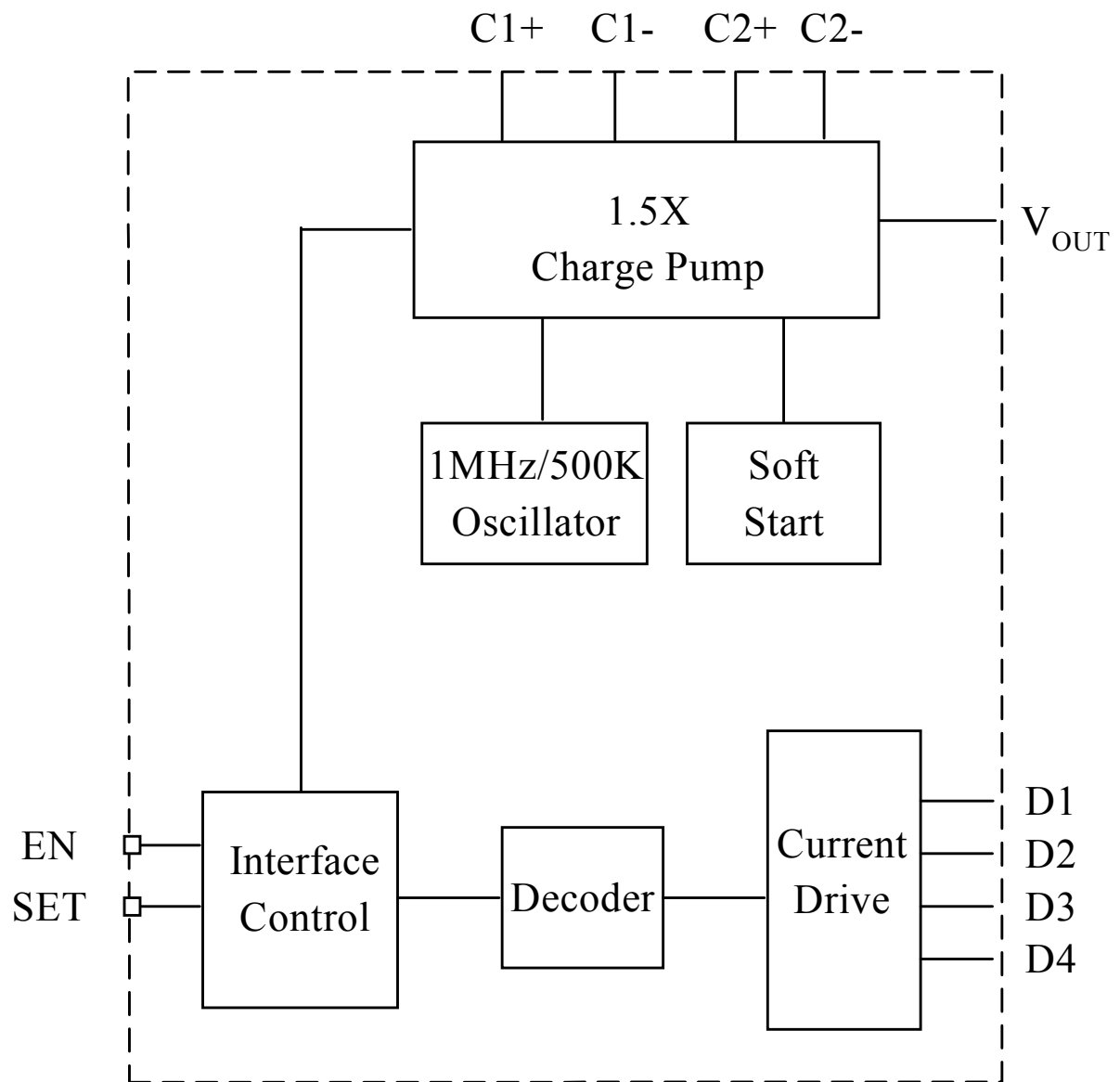| SYMBOL	Pin no. QFN-16	DESCRIPTION
D2	1	Current source output 2
D3	2	Current source output 3
D4	3	Current source output 4
N.C.	4	No Connect
N.C.	5	No Connect
C1+	6	Flying capacitor 1 + terminal
C1-	7	Flying capacitor 1 – terminal
N.C.	8	No Connect
V_{OUT}	9	Charge pump output. Requires 1uF bypass capacitor 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.

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BLOCK DIAGRAM

C1+   C1-   C2+   C2-

1.5X
Charge Pump

V_{OUT}

1MHz/500K
Oscillator

Soft
Start

EN

SET

Interface
Control

Decoder

Current
Drive

D1
D2
D3
D4

Fig-1

ABSOLUTE MAXIMUM RATINGS (T_A = 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

(T_A = -40 to 85°C unless otherwise noted. Typical values are at T_A =25°C, V_{IN} =3.5V)

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

Typical Operating Characteristics

(V_{IN}=+3.5V, C_{IN}= C_{OUT}=C1=C2=1uF, T_A=+25 ºC, 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 defferent brightness (Fig-2 & Tabel1). 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).
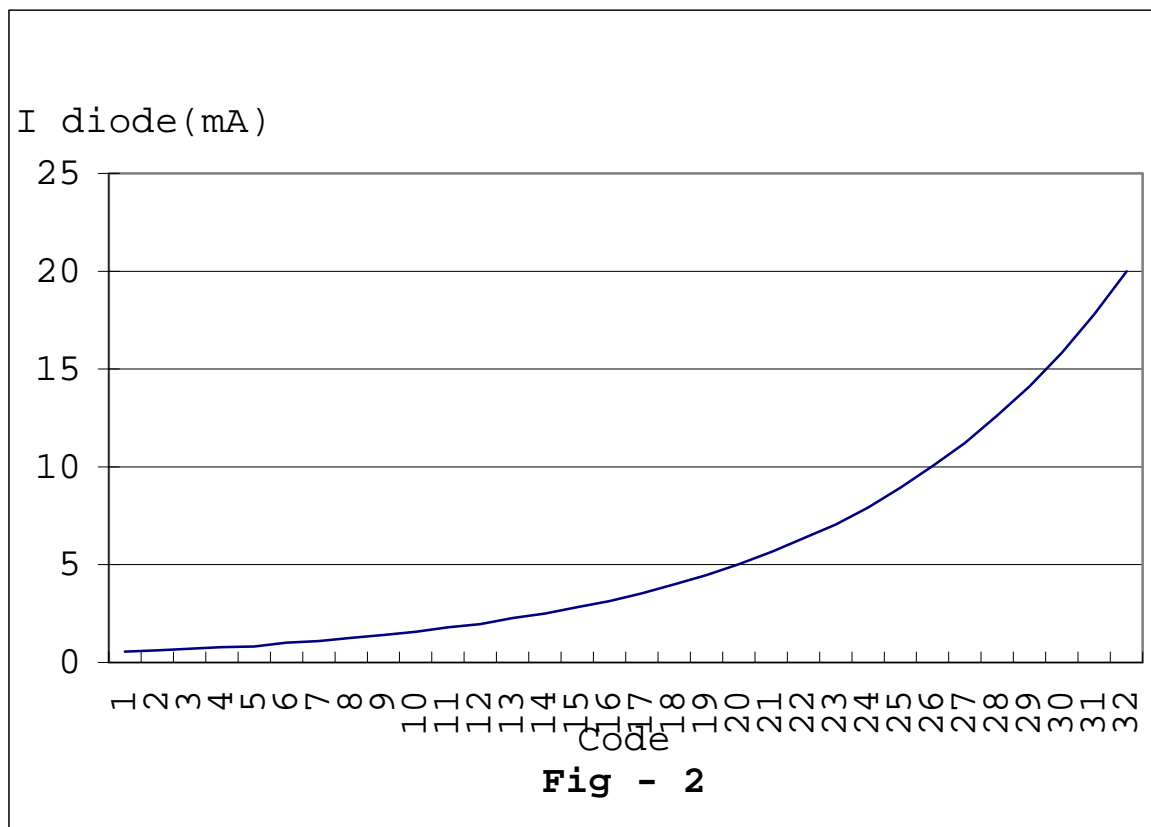

Fig - 2

Table1 : current level (mA)

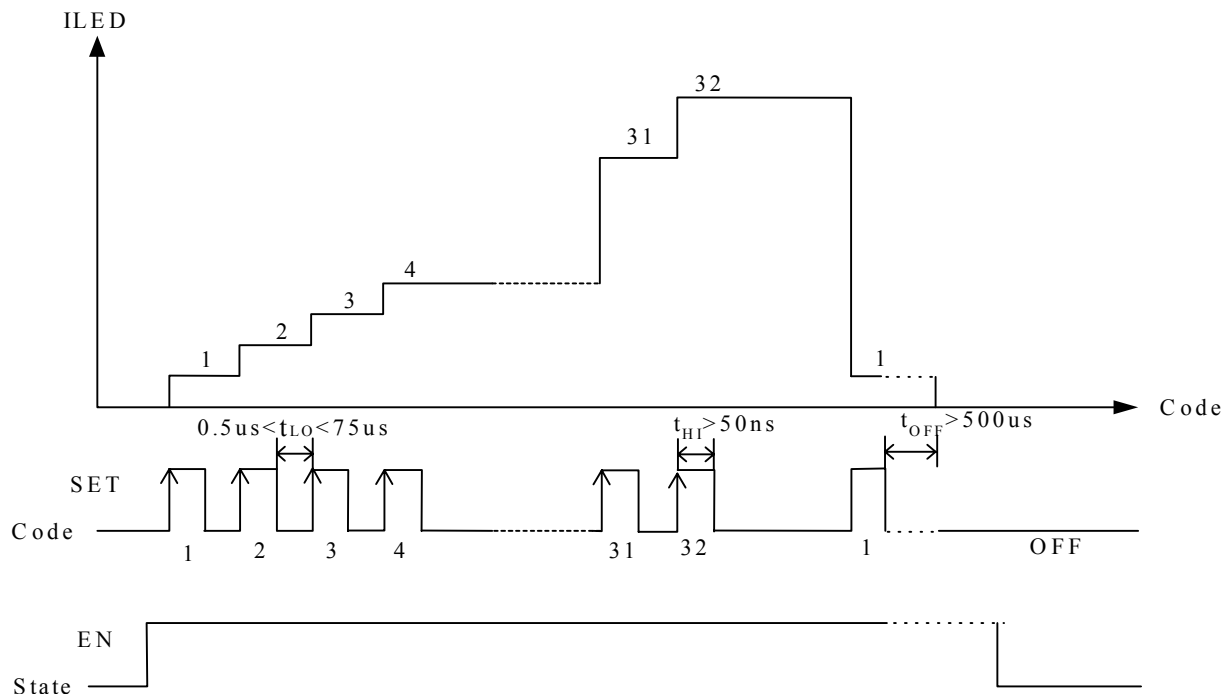| code	20mA max.	code	20mA max.
1	0.549	17	3.529
2	0.627	18	4.000
3	0.706	19	4.471
4	0.784	20	5.020
5	0.863	21	5.647
6	1.020	22	6.353
7	1.098	23	7.059
8	1.255	24	7.922
9	1.412	25	8.941
10	1.569	26	10.039
11	1.804	27	11.216
12	1.961	28	12.627
13	2.275	29	14.118
14	2.510	30	15.843
15	2.824	31	17.804
16	3.137	32	20.000

SET vs ILED

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

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TYPICAL APPLICATION CIRCUITS

SET — SET
EN — EN

C1+ — C1
C1- — 1uF
C2+ — C2
C2- — 1uF

D1
D2
D3
D4

V_{IN}

Battery
C_{IN}
1uF

V_{OUT}
C_{OUT}
1uF

GND

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P. 8
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Revision:C

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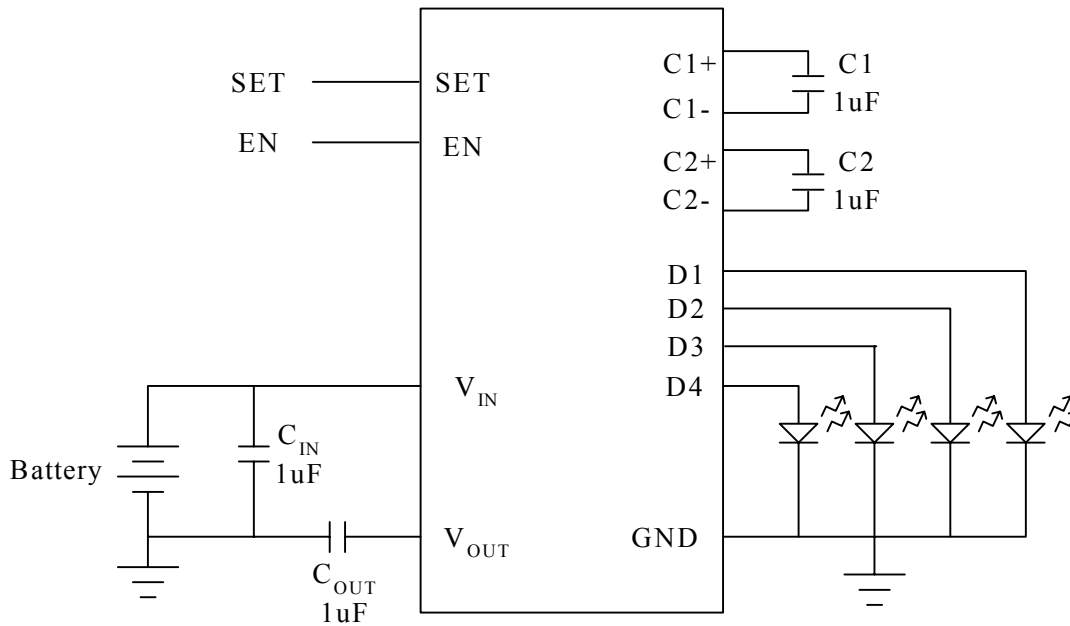
PACKAGE DIMENSIONS
QFN3mm x 3mm-16
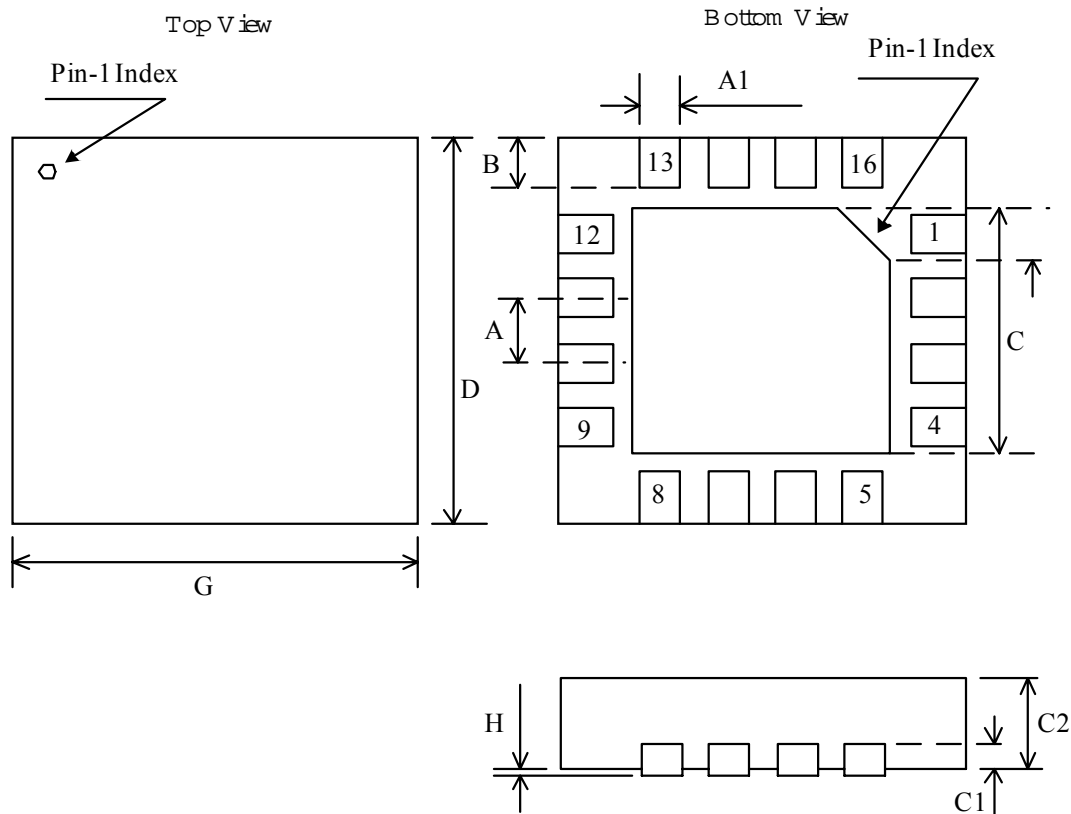
Symbol	Dimension in mm			Dimension in mil		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		0.50(BSC)			19.69	
A1	0.18	0.23	0.30	7.09	9.06	11.81
B	0.30	0.40	0.50	11.81	15.75	19.69
C	1.40	1.50	1.60	55.12	59.06	62.99
C1		0.20			8.00	
C2	0.70	0.75	0.80	27.6	29.5	31.5
D	2.90	3.00	3.10	114.17	118.11	122.05
G	2.90	3.00	3.10	114.17	118.11	122.05
H	0	0.02	0.05	0	0.79	1.97

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PACKAGE DIMENSIONS
QFN4mm x 4mm-16
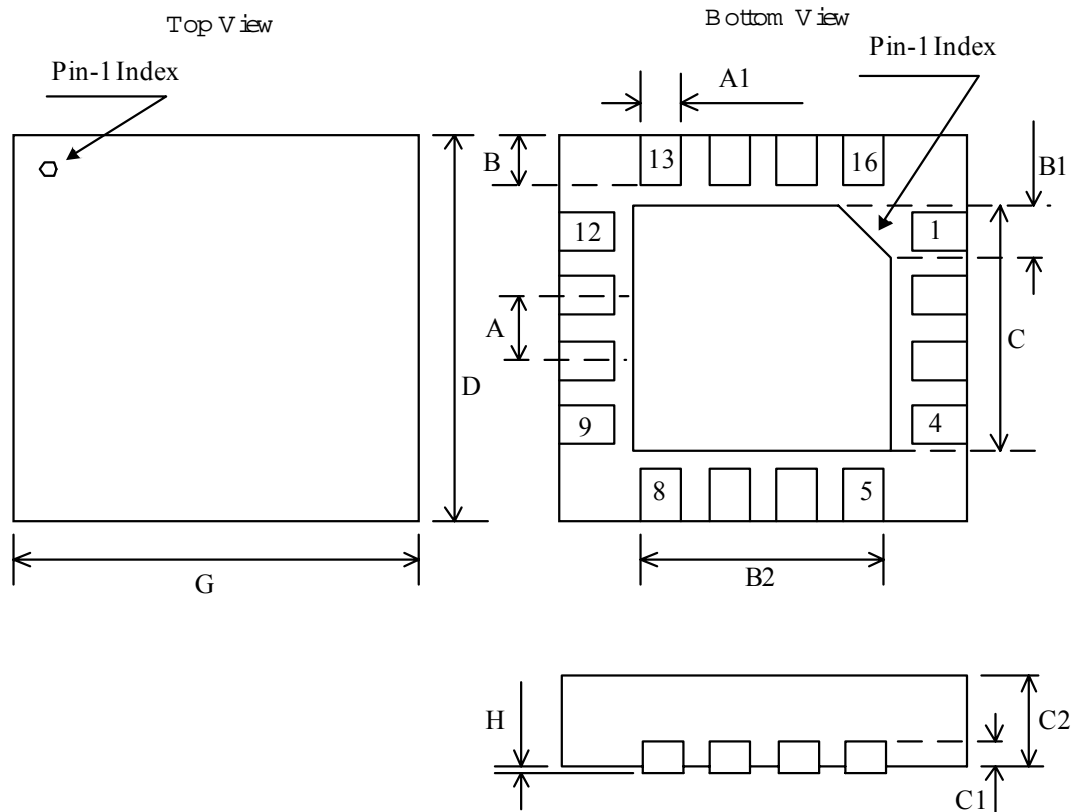
Symbol	Dimension in mm			Dimension in inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		0.65(BSC)			0.025(BSC)	
A1	0.28	0.33	0.38	0.011	0.013	0.015
B	0.55	0.60	0.65	0.022	0.024	0.026
B1	0.40	0.45	0.50	0.016	0.018	0.020
B2		2.28(REF)			0.090(REF)	
C	2.35	2.40	2.45	0.092	0.094	0.096
C1	0.17	0.20	0.23	0.006	0.008	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