IS31FL3198

3-LED DRIVER WITH CHARGE PUMP

March 2025

GENERAL DESCRIPTION

The IS31FL3198 is a compact and efficient 3-channel charge pump LED driver. It is capable of driving 1 to 3 LEDs with a low drop-out and current matching so all 3 LEDs maintain consistent brightness. Each channel can support up to 80mA of current. The current of each channel can be adjusted by the setting of current resistor and the control.

The built−in charge pump (CP) structure will automatically toggle 2x operations. This DC/DC converter operates at a high switching frequency which enables the use of small external capacitors. The IS31FL3198 is shutdown consuming less than 1μA.

The IS31FL3198 is available in a small QFN-16 (3mm×3mm) package. It operates at 3.3V over the temperature range of -40°C to +125°C.

FEATURES

- 3.3V±5% supply voltage
- Maximum output current of OUT_X: 80mA, adjustment external resister: 22mA ~ 80mA
  - 3 channel independent ON/OFF control
  - Current setting in eight steps
  - Total of 3 channel current should less than 120mA
- Charge pump
  - 2x operating mode
  - ≥ 6.27V CPOUT voltage to support LED (LED V_F≤ 4.8V)
- ISET pin short protection
- Current mismatch (channel to channel): ±3%
- Current accuracy (device to device): ±6%
- LED Current rise/fall time 10μs (Typ.) (10%~90%)
- QFN-16 (3mm×3mm) package
- Operating temperature range is -40°C ~ +125°C
- RoHS & Halogen-Free Compliance
- TSCA Compliance

APPLICATIONS

- CIS module

TYPICAL APPLICATION CIRCUIT

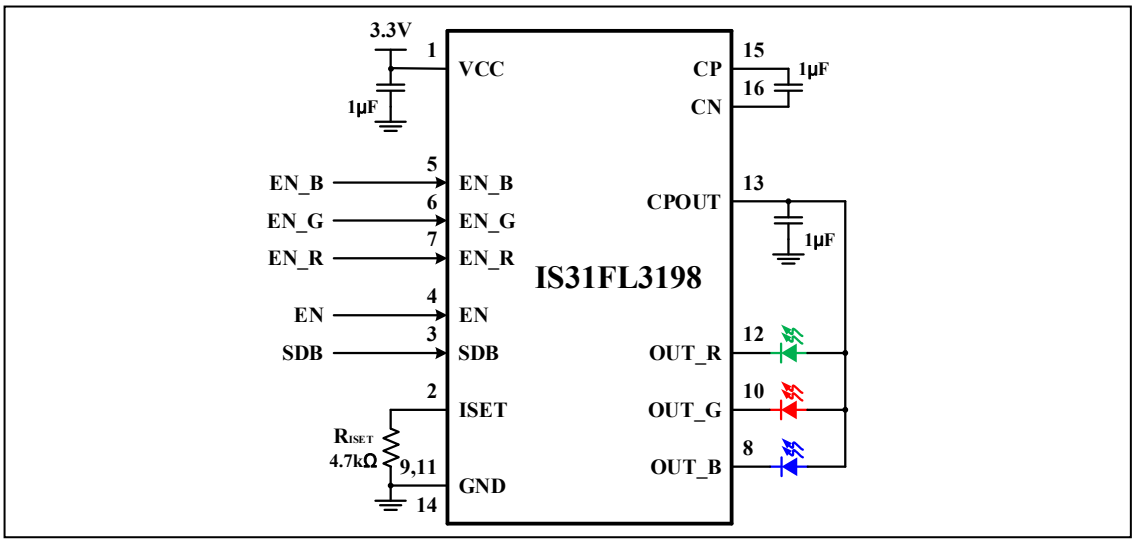
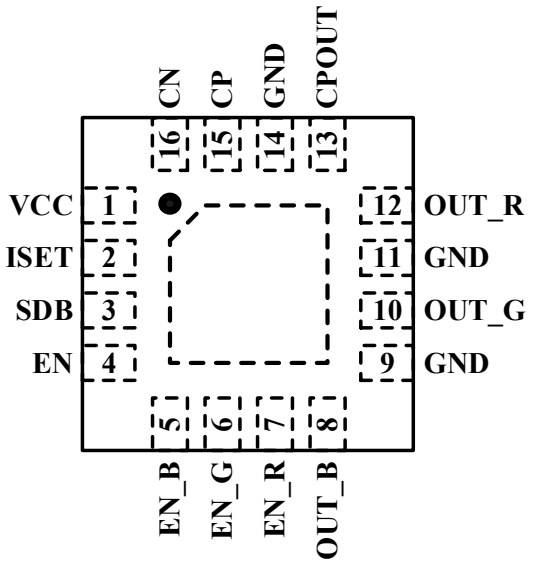


Figure 1 Typical Application Circuit

PIN CONFIGURATION

Package	Pin Configuration (Top View)
QFN-16	

PIN DESCRIPTION

No.	Pin	Description
1	VCC	Power supply
2	ISET	LED current setting pin
3	SDB	Pull below 0.4V to activate low power shutdown mode. H: normal operation mode, L: shut down mode
4	EN	Outputs current enable pin. H: outputs enable, L: outputs disable
5	EN_B	OUT_B enable pin, H: OUT_B enable, L: OUT_B disable
6	EN_G	OUT_G enable pin, H: OUT_G enable, L: OUT_G disable
7	EN_R	OUT_R enable pin, H: OUT_R enable, L: OUT_R disable
8	OUT_B	Output pin, blue channel
9, 11, 14	GND	GND
10	OUT_G	Output pin, green channel
12	OUT_R	Output pin, red channel
13	CPOUT	Charge pump power supply output pin to drive load circuits, requires 1μF capacitor connected between this pin and ground pin.
15	CP	Charge pump flying capacitor positive terminal. (Note 1)
16	CN	Charge pump flying capacitor negative terminal. (Note 1)
	Thermal Pad	Connect to GND.

Note 1: The flying capacitors should be placed as close as possible to the IC and the signal trace between the capacitor and CP terminals keep as short as possible.

ORDERING INFORMATION

Industrial Range: -40°C to +125°C

Order Part No.	Package	QTY/Reel
IS31FL3198-QFLS4-TR	QFN-16, Lead-free	2500

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a.) the risk of injury or damage has been minimized;

b.) the user assume all such risks; and

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ABSOLUTE MAXIMUM RATINGS (NOTE 2)

Supply voltage, V_{CC}	-0.3V ~ +6.0V
Voltage at CPOUT	-0.3V ~ +7.5V (Note 3)
Voltage at any input pin	-0.3V ~ V_{CC}+0.3V
Maximum junction temperature, T_{JMAX}	+150°C
Operating temperature range, T_A=T_J	-40°C ~ +125°C
Storage temperature range, T_{STG}	-65°C ~ +150°C
Package thermal resistance, junction to ambient (4-layer standard test PCB based on JESD 51-2A standard), θ_{JA}	56.5°C/W
ESD (HBM) ESD (CDM)	±7kV ±750V

Note 2: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 3: If CPOUT is higher than 7.5V (Typ.), IC will disable the charge pump function. If CPOUT is lower than 7.0V (Typ.), IC will enable the charge pump function again.

ELECTRICAL CHARACTERISTICS

T_A= -40°C ~ +125°C, V_{CC}= 3.3V, unless otherwise noted. Typical value are T_A= 25°C.

Symbol	Parameter	Condition		Min.	Typ.	Max.	Unit
V_{CC}	Supply voltage			3.135	3.3	3.465	V
I_{CC}	Quiescent operating current	2x mode, all outputs disable			2.5	3.5	mA
I_{SD}	Shutdown current	V_{SDB}= 0V			0.5	1	μA
V_{CPOUT}	Voltage of CPOUT	LED current= 0mA		6.27	6.6	6.93	V
I_{OUT}	Output current of R/G/B	R_{ISET}= 4.7kΩ±1%, V_{OUT_X}= 3.5V (Note 4)		62	66	70	mA
		R_{ISET}= 3.9kΩ±1%, V_{OUT_X}= 3.5V (Note 4)			79.5		mA
I_{PT}	LED protect current	R_{ISET}< 1.45kΩ Quit the protection when R_{ISET}> 3kΩ		105	150	217.5	mA
I_{MAT}	Current matching	R_{ISET}= 4.7kΩ±1%, V_{OUT_X}= 3.5V		-3		3	%
I_{ACC}	Current accuracy	R_{ISET}= 4.7kΩ±1%, V_{OUT_X}= 3.5V		-6		6	%
V_{HR}	Current sink headroom	I_{OUT}= 66mA			250	350	mV
V_F	LED forward voltage	(Note 5)		1.1		4.8	V
I_{LED}	LED current	V_{OUT_x}= 3.5V	EN_R, G, B= "000"		100		%
			EN_R, G, B= "001"		87.5		
			EN_R, G, B= "010"		75		
			EN_R, G, B= "011"		62.5		
			EN_R, G, B= "100"		50		
			EN_R, G, B= "101"		37.5		
			EN_R, G, B= "110"		25		
			EN_R, G, B= "111"		12.5		
T_{SD}	Thermal shutdown	(Note 6)			166		°C
T_{SD_HY}	Thermal shutdown hysteresis	(Note 6)			24		°C
Charge Pump Characteristics							
t_{R_CPOUT}	CPOUT rise time	C_{CPOUT}= 1μF, C_{CPCN}= 1μF				1	ms
t_{F_CPOUT}	CPOUT fall time	C_{CPOUT}= 1μF, C_{CPCN}= 1μF (Note 6) Time V_{CPOUT}= 6.6V to V_{CPOUT}= 3.3V				20	ms

ELECTRICAL CHARACTERISTICS (CONTINUED)

T_A= -40°C ~ +125°C, V_{CC}= 3.3V, unless otherwise noted. Typical value are T_A= 25°C.

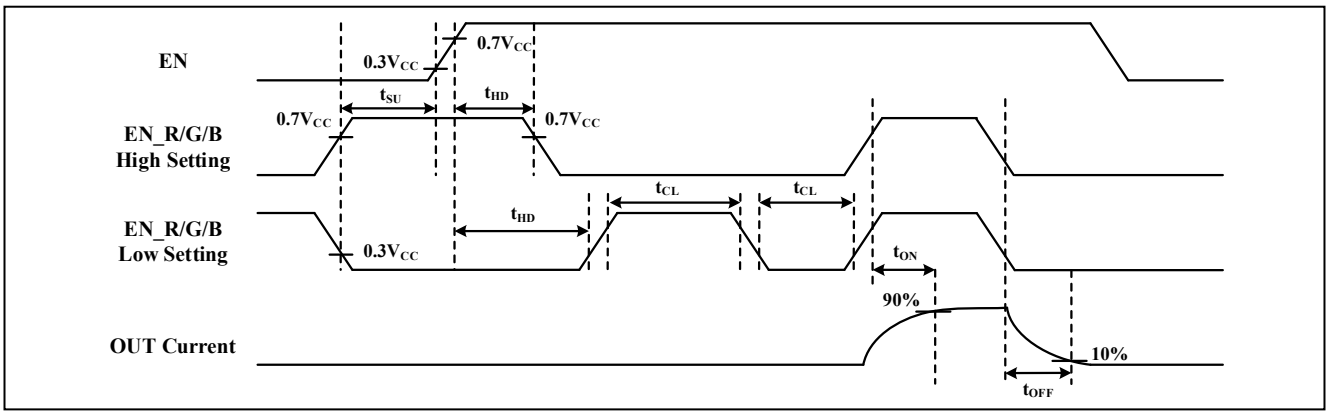
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
f_{CLK}	Charge pump operating frequency			1000		kHz
Logic Electrical Characteristics (SDB, EN, EN_R, G, B)						
V_{IL}	Logic “0” input voltage	V_{CC} = 3.135V~3.465V	0		0.3V_{CC}	V
V_{IH}	Logic “1” input voltage	V_{CC} = 3.135V~3.465V	0.7V_{CC}		V_{CC}	V
I_{IL}	Logic “0” input current	V_{INPUT} = 0V (Note 6)		5		nA
I_{IH}	Logic “1” input current	V_{INPUT} = V_{IO} (Note 6)		5		nA
SDB Switch Characteristics						
t_{ON}	LED current on time	(Note 7)		3.3	10	μs
t_{OFF}	LED current off time	(Note 7)		0.5	10	μs
t_{SU}	Reset valid setup time	EN_R/G/B to EN (Note 7)	1			μs
t_{HD}	Count up setup time	EN to EN_R/G/B (Note 7)	1			μs
t_{CL}	Current set clean time	(Note 7)	1			μs
t_{SDB1}	Shutdown period 1	(Note 8)	150			ns
t_{SDB2}	Shutdown period 2	(Note 8)	150			ns
t_{STUP}	Startup time	(Note 8)			1	ms

Note 4: I_{OUT}= 66×4.7kΩ/R_{ISET}, recommend minimum R_{ISET} value is 3.9kΩ (I_{OUT}= 79.5mA).

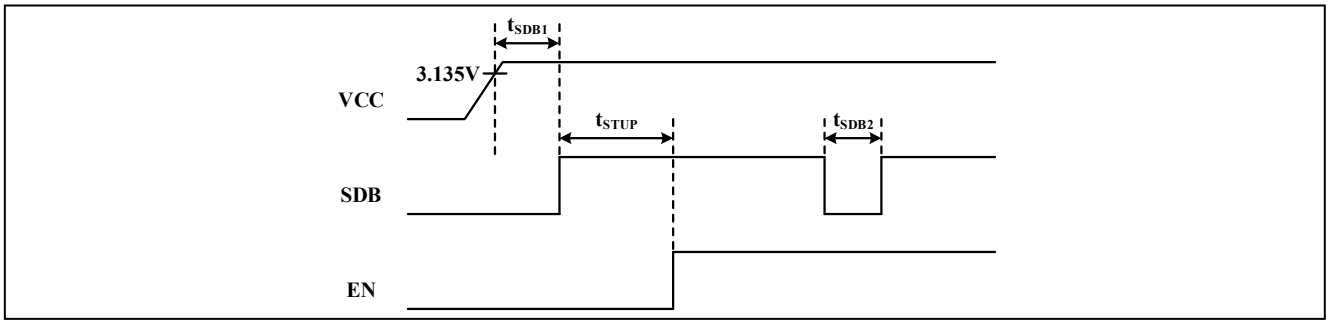
Note 5: Set a lower limit value 1.1V only 1 of 3 channels and the other 2 channels low limit is 2V.

Note 6: Guaranteed by design.

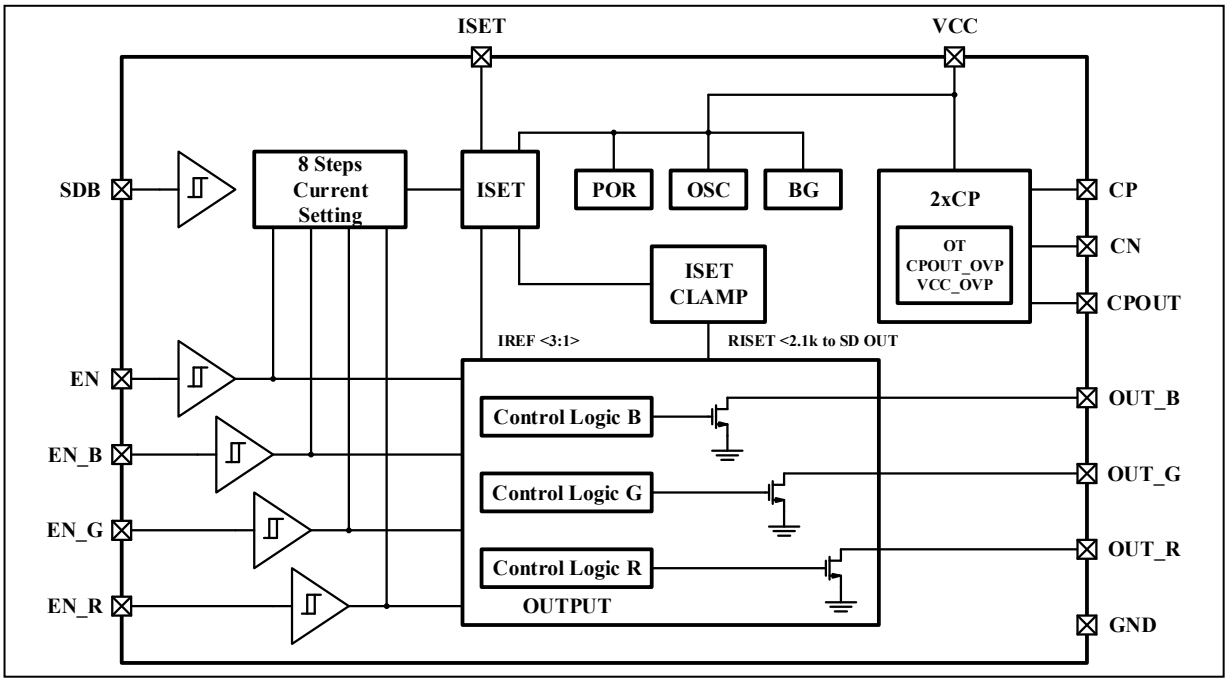
Note 7:



Note 8: SDB and EN pin should keep low when turning on the VCC.



FUNCTIONAL BLOCK DIAGRAM



TYPICAL APPLICATION INFORMATION

GENERAL DESCRIPTION

The IS31FL3198 include the charge pump power supply and 3 channels LED driver who drives the LED of the anode common in the constant current. The current to pass for each channel can be adjusted by the external resistance and the control signals' setting. Also, it has the control pins which turn on or off the current.

The IS31FL3198 LED driver integrates a switched capacitor charge pump to power three LEDs with a programmable regulated current, up to 80mA (Max.) per channel. It only requires four external components: supply decoupling capacitor, an output bypass capacitor, a flying capacitors and a R_{ISET} resistor.

Upon power up, the built-in charge pump converter will initialize in the 2x mode. The IS31FL3198 will remain in this mode always.

The current delivered through the LED load is controlled by an internal configurable low dropout current source.

CHARGE PUMP

The converter is based on a 2-stage charge pump technique to efficiently generate a DC voltage to supply the RGB LED current.

The integrated capacitive charge pump is designed for CPOUT = V_{CC} × 2. The charge pump converter only needs three external components: supply decoupling capacitor, output bypass capacitor and flying capacitors.

To maintain the lowest output resistance, use capacitors with low ESR. The charge-pump output resistance is a function of CP and COUT's ESR and the internal switch resistance. Minimizing the charge-pump capacitor's ESR minimizes the total resistance.

Using a larger flying capacitor (CP) reduces the output impedance and improves efficiency however, above a certain point, increasing CP's capacitance has a negligible effect because the output resistance becomes dominated by the internal switch resistance and capacitor ESR. But when space is a constraint, it may be necessary to sacrifice low output resistance for the sake of small capacitor size.

Increasing the output capacitance (C_{OUT}) reduces the output ripple voltage. Decreasing its ESR reduces both output resistance and ripple. Smaller capacitance values can be used with light loads. Use the following equation to calculate the peak-to-peak ripple:

$$V_{RIPPLE} = I_{OUT}/(f_{OSC} \times C_{OUT}) + 2 \times I_{OUT} \times ESRCOUT \quad (1)$$

A bypass capacitor on the incoming supply will reduce its AC impedance and the impact of the charge pump switching noise. A 1μF bypass capacitor is sufficient.

ISET MAXIMUM OUTPUT CURRENT

The maximum output current of OUT1~OUT3 can be adjusted by the external resistor, R_{ISET}, as described in Formula (1).

$$I_{OUT} = \frac{66}{R_{ISET}} \times 4.7k\Omega \quad (1)$$

The recommended value of R_{ISET} is 4.7kΩ (I_{OUT}= 66mA).

The recommended minimum value of R_{ISET} is 3.9kΩ (I_{OUT}= 79.54mA).

The recommended maximum value of R_{ISET} is 14kΩ (I_{OUT}= 22.16mA).

The current setting can be set to 8 levels with EN_R/G/B and EN combination.

The current level is set by the levels by latch the pattern of EN_R, EN_G, EN_B at the time of following EN rise to decide the current value. After the EN_R, EN_G, EN_B signal fall once, the current interlocks with EN_R, EN_G, EN_B's on or off.

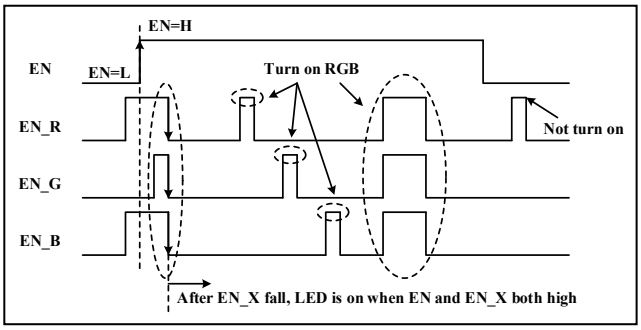


Figure 2 EN Control

The relation between the pattern and the current setting value of EN_R, EN_G, EN_B at the time of the EN rise as follows.

EN_R	EN_G	EN_B	Current Setting
0	0	0	100%
0	0	1	87.5%
0	1	0	75%
0	1	1	62.5%
1	0	0	50%
1	0	1	37.5%
1	1	0	25%
1	1	1	12.5%

SHUTDOWN MODE

Shutdown mode can either be used as a means of reducing power consumption or generating a flashing display (repeatedly entering and leaving shutdown mode).

The chip enters hardware shutdown when the SDB pin is pulled low, wherein it consumes only 0.5μA (Typ.) current.

CLASSIFICATION REFLOW PROFILES

Profile Feature	Pb-Free Assembly
Preheat & Soak Temperature min (Tsmin) Temperature max (Tsmax) Time (Tsmin to Tsmax) (ts)	150°C 200°C 60-120 seconds
Average ramp-up rate (Tsmax to Tp)	3°C/second max.
Liquidous temperature (TL) Time at liquidous (tL)	217°C 60-150 seconds
Peak package body temperature (Tp)*	Max 260°C
Time (tp)** within 5°C of the specified classification temperature (Tc)	Max 30 seconds
Average ramp-down rate (Tp to Tsmax)	6°C/second max.
Time 25°C to peak temperature	8 minutes max.

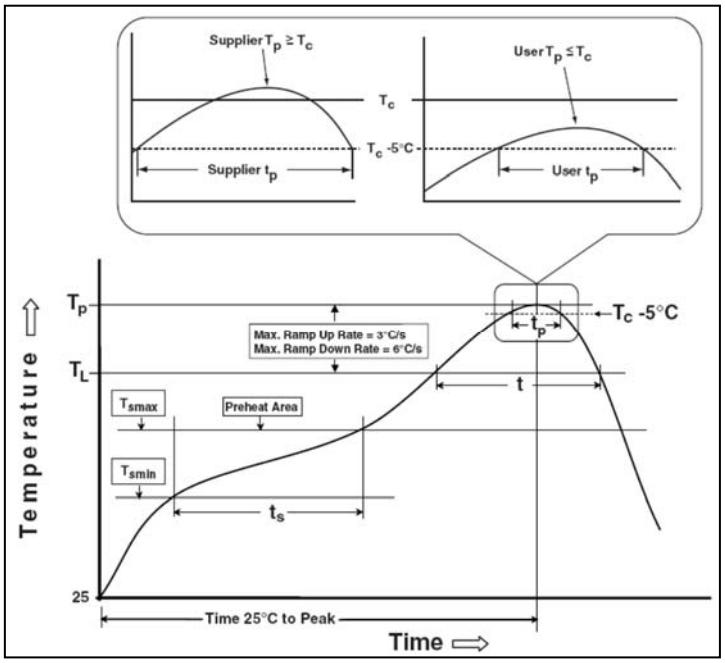
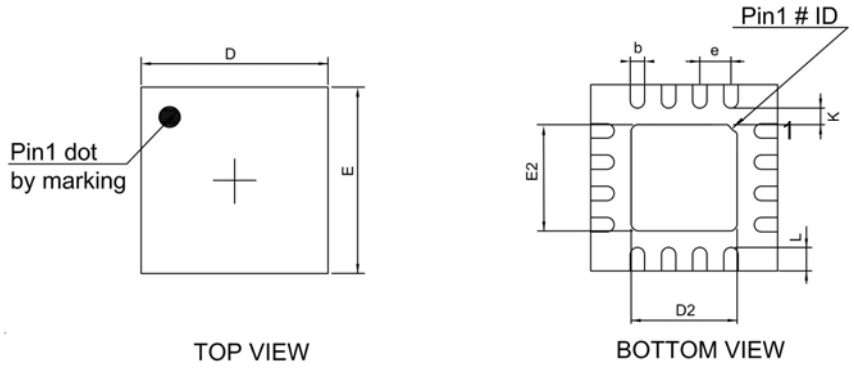
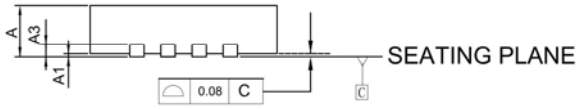


Figure 3 Classification Profile

PACKAGE INFORMATION

QFN-16





SIDE VIEW

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
A3	0.15	0.20	0.25
K	0.20	-	-
b	0.18	-	0.30
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.60	1.70	1.80
E2	1.60	1.70	1.80
e	0.50BSC		

L/F SIZE (mil) \ SIZE (mm)	L		
	MIN	NOM	MAX
75x75	0.30	0.40	0.50

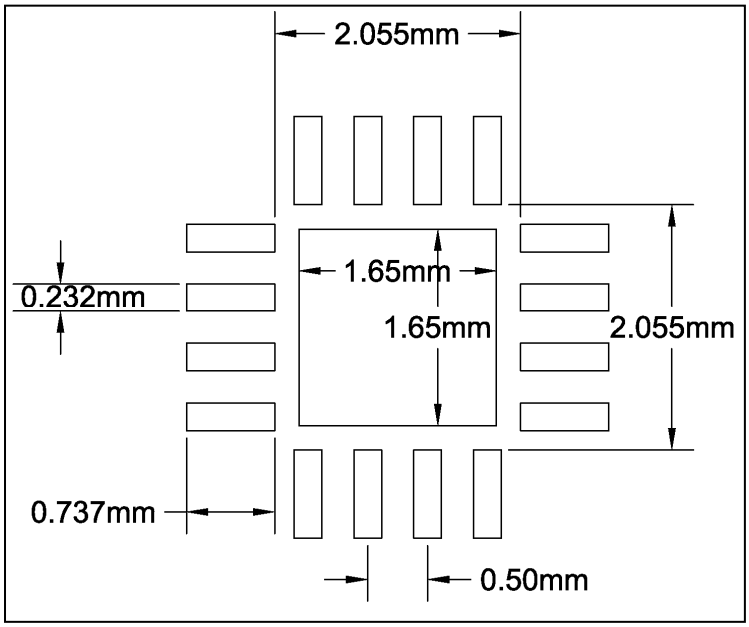
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NOTE:

1. CONTROLLING DIMENSION : MM
2. REFERENCE DOCUMENT: JEDEC MO-220
3. THE PIN'S SHARP AND THERMAL PAD SHOWS DIFFERENT SHAPE AMONG DIFFERENT FACTORIES.

RECOMMENDED LAND PATTERN

QFN-16



Note:

1. Land pattern complies to IPC-7351.
2. All dimensions in MM.
3. This document (including dimensions, notes & specs) is a recommendation based on typical circuit board manufacturing parameters. Since land pattern design depends on many factors unknown (eg. User's board manufacturing specs), user must determine suitability for use.

REVISION HISTORY

Revision	Detail Information	Date
0A	Initial relesae	2021.04.28
A	1. Update ELECTRICAL CHARACTERISTICS table 2. Update the part number from QFLS2 (-40-85) to QFLS4(-40-125)	2021.07.19
B	Add 5V application case.	2022.02.15
C	1. Delect 5V application case If compare with version A, the update items is: update PACKAGE INFORMATION (add POD information) 2. Add function block 3. Update figure 1	2023.04.12
D	Update to new Lumissil logo	2024.03.29
E	Update PACKAGE INFORMATION's D2 and E2 value	2025.03.14