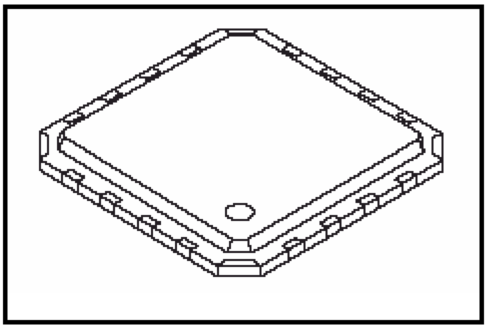
TOSHIBA CMOS INTEGRATED CIRCIUTS SILICON MONOLITHIC

TCA62735AFLG

Charge Pump type DC/DC Converter for White LED Driver

The TCA62735AFLG is a charge pump type DC/DC Converter specially designed for constant current driving of White LED.
This IC can outputs LED current 120mA or more to 2.8-4.2V input.
This IC observes the power-supply voltage and the output voltage, and does an automatic change to the best of step up mode 1, 1.5 or 2 times. It is possible to prolong the battery longevity to its maximum.
This IC is especially for driving back light white LEDs in LCD of PDA, Cellular Phone, or Handy Terminal Equipment.

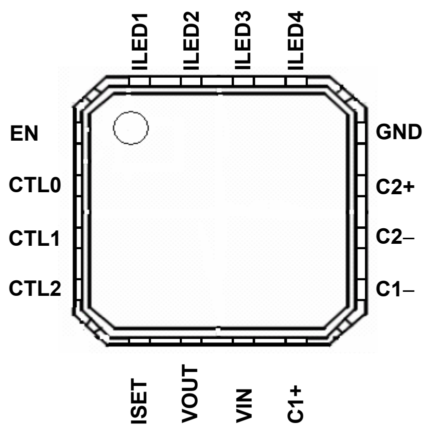


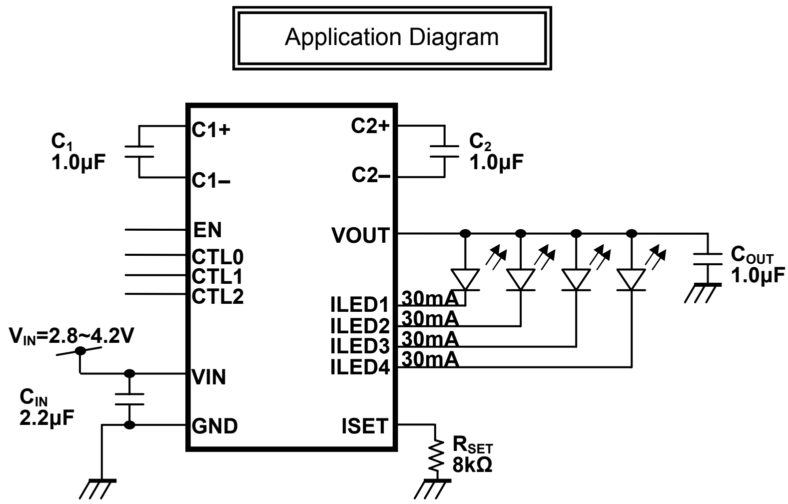
Weight: 0.016 g (Typ.)

Characteristics

- Fabricating with CMOS Process
- Package : QFN16 (4mm × 4mm × 0.8mm)
- Input Voltage : 2.8V (Min)
- Output Voltage : 4.2V (Min)
- Switching Frequency : 1MHz(Typ.)
- Output Drive Current Capability : Greater than 120mA
- 4 Channels Built in Constant Sink Current Drivers
- Sink Current Adjustment by External Resistance
- Soft Start Function
- Output Open Detection Function
- Integrated protection circuit TSD (Thermal Shut Down)

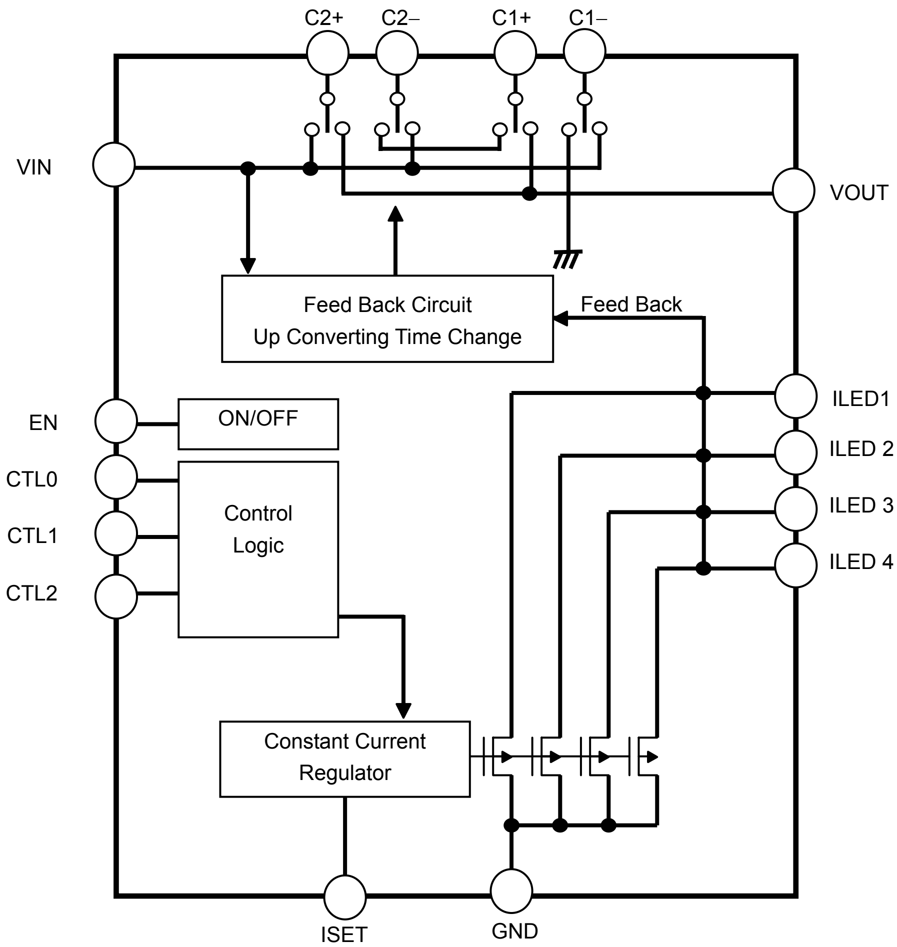
Pin Assignment (top view)





TENTATIVE

Block Diagram



Explanation of Terminals

No	Symbol	Function
1	EN	Logic input terminal. (input a chip enable signal) EN = ”H” → Operation mode, EN = ”L” → Shutdown mode
2	CTL0	Logic input terminal. (Selection of an output number) Please refer to the truth table on page 10.
3	CTL1	
4	CTL2	
5	ISET	Resistance connection terminal for setting up output current.
6	VOUT	Output terminal.
7	VIN	Power supply terminal.
8	C1+	Capacitance connection terminal for charge pump.
9	C1–	
10	C2–	
11	C2+	
12	GND	GND terminal.
13	ILED4	Constant Sink Current Driver terminal. ILED(mA) = 0.61V × 400 / R_{SET}(kΩ)
14	ILED3	
15	ILED2	
16	ILED1	

TENTATIVE

Absolute Maximum Ratings (T_{opr} = 25°C if without notice)

Characteristics	Symbol	Ratings	Unit
Power Supply Voltage	V_{IN}	−0.3~+6.0	V
Input Voltage	V_{in}	−0.3~V_{IN}+0.3(*1)	mA
Output Current	I_{OUT}	200	mA/ch
Operating Temperature	T_{opr}	−40~+85	°C
Storage Temperature	T_{stg}	−55~+150	°C
Junction Temperature	T_j	150	°C

*1 : please do not exceed 6V.

Recommended Operating Condition (T_{opr}=-40°C to 85°C if without notice)

Characteristics	Symbol	Test Condition	Min	Typ	Max	Unit
Power Supply	V_{IN}	-	2.8	-	4.2	V
Logic Input Voltage	V_{in}	EN,CTL0,CTL1,CTL2	0	-	V_{IN}	V
Input Ripple Voltage	$V_{IN(ripple)}$	-	-	-	40	mVpp
Capacitance for Charge Pump	C_1,C_2	-	0.8	1.0	2.2	µF
Capacitance for output	C_{OUT}	-	0.8	2.2	4.7	µF
Capacitance for input	C_{IN}	-	0.8	2.2	10.0	µF
R_{SET} resistance	R_{SET}	-	2	8	80	kΩ

Electrical Characteristics

DC-DC Regulator part (V_{IN}=3.6V, T_{opr}=-40 to 85°C, if it is not specified.)

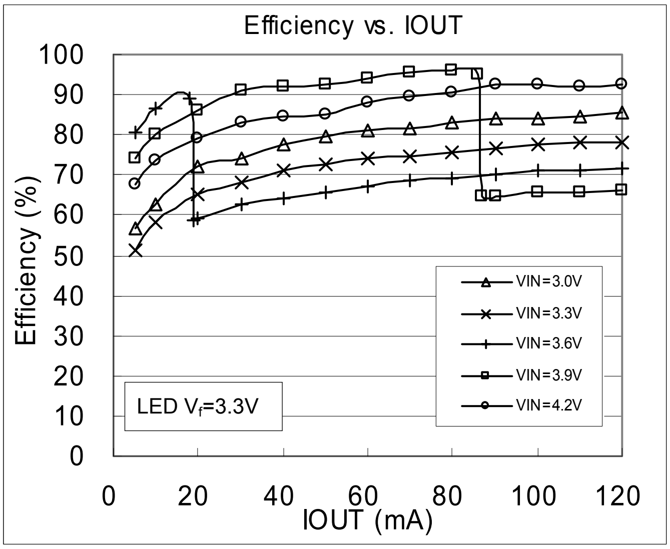
Characteristics		Symbol	Test Condition	Min	Typ	Max	Unit
Output Current Ability		$I_{OUT(MAX)}$	2 time up converting	120	-	-	mA
			1.5 time up converting	120	-	-	
			1 time up converting	120	-	-	
Consumption Current		$I_{IN(ON)}$	I_{OUT}=5mA	-	1	2	mA
Stand By Consumption Current		$I_{IN(OFF)}$	I_{OUT}=0mA EN="L"	-	0	1	µA
Logic Input Voltage	High	V_{IH}	EN, CTL0,CTL1,CTL2 V_{IN}=2.8V to 4.2V	0.7V_{IN}	-	-	V
	Low	V_{IL}	EN,CTL0,CTL1,CTL2 V_{IN}=2.8V to 4.2V	-	-	0.3V_{IN}	
Logic Input Current		I_{leak}	EN,CTL0,CTL1,CTL2	-	-	0.1	µA
Clock Frequency		f_{OSC}	-	-	1000	-	kHz
TOTAL R_{ON}		R_{ON}	1.5 time up converting	-	5	10	Ω
1X mode to 1.5X mode transition voltage		$V_{TRANS1X}$	LED V_f=3.6V,I_{OUT}=80mA V_{IN} falling	-	4.0	-	V

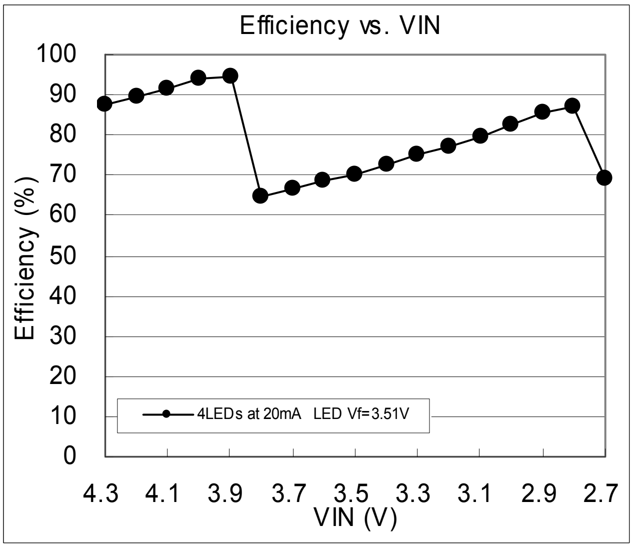
Constant Current Driver part

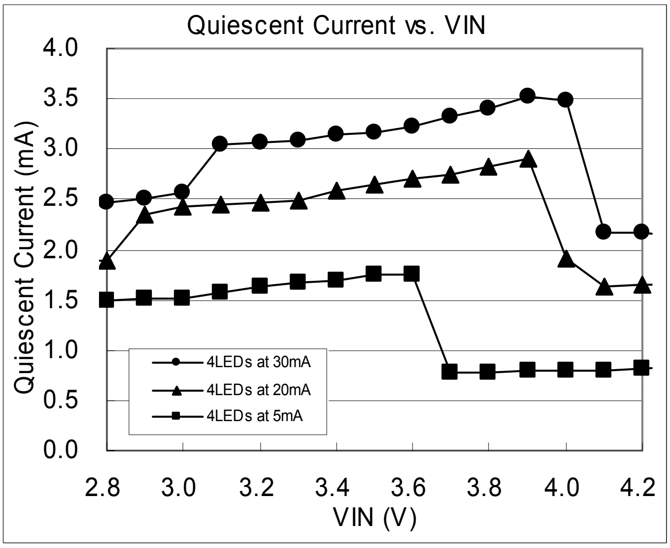
(V_{IN}=2.8V to 4.2V, T_{opr}=-40 to 85°C, if it is not specified.)

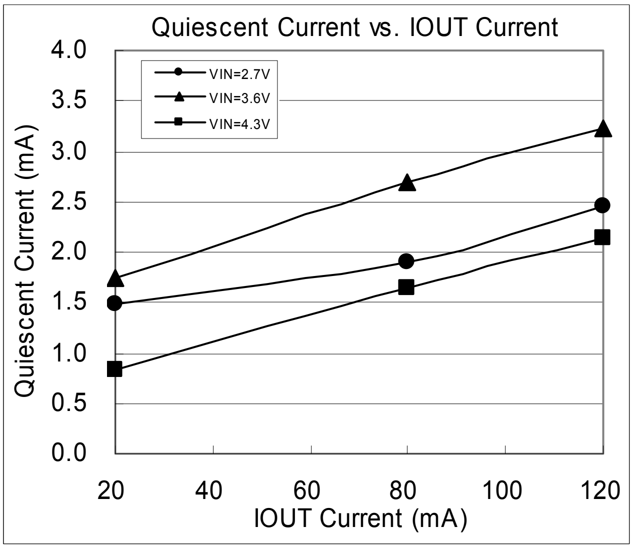
Characteristics		Symbol	Test Condition	Min	Typ	Max	Unit
Constant Current Drive Setting		$I_{LED1\sim4}$	R_{SET}=47kΩ	-	5.1	-	mA
			R_{SET}=12kΩ	-	19.6	-	
			R_{SET}=8.2kΩ	-	28	-	
ISET Terminal Output Voltage		V_{SET}	R_{SET}=8.2kΩ	-	0.61	-	V
Constant Current Accuracy	Between Chs	$\lvert I_{LED\text{-}LED\text{-}ERR}\rvert$	-	–	2.5	–	%
	Between ICs	$\lvert I_{LED\text{-}ERR}\rvert$	-	–	5	–	%
Constant Sink Current Supply Voltage Regulation		$\lvert\Delta I_{LED}\rvert$	V_{IN}=3.6V center V_{IN}=2.8 to 4.2V I_{OUT}=80mA C_{IN}=2.2μF	–	1	–	%
Output leakage current		$I_{LEAK1\sim4}$	EN="H" ILED1 to4="OFF"	–	–	1	μA

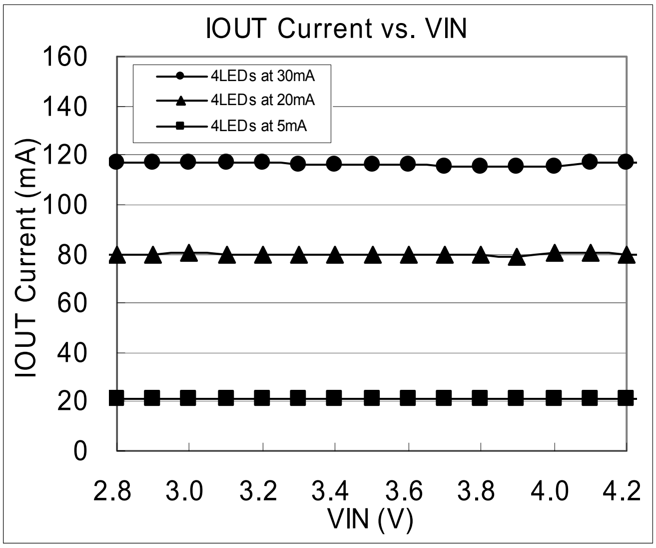
Reference data

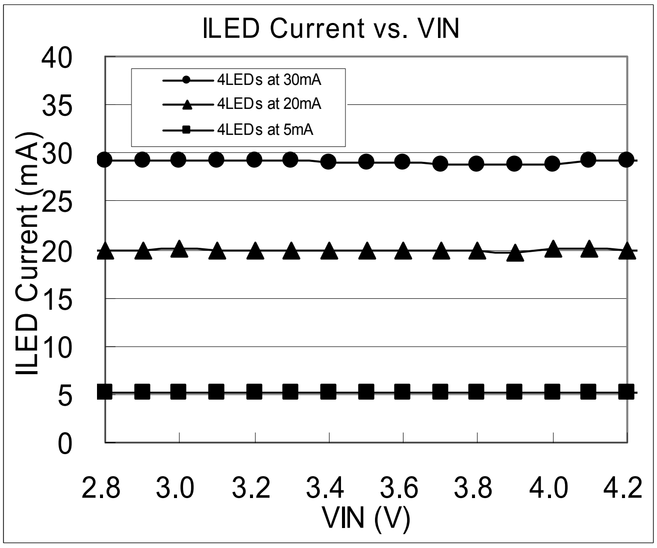


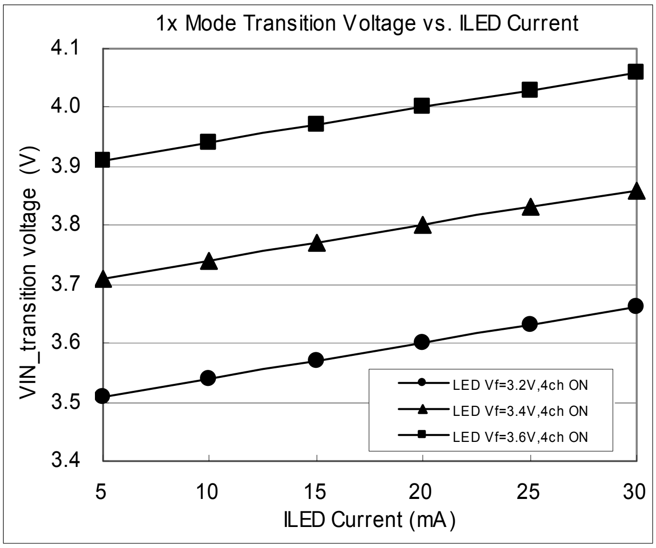




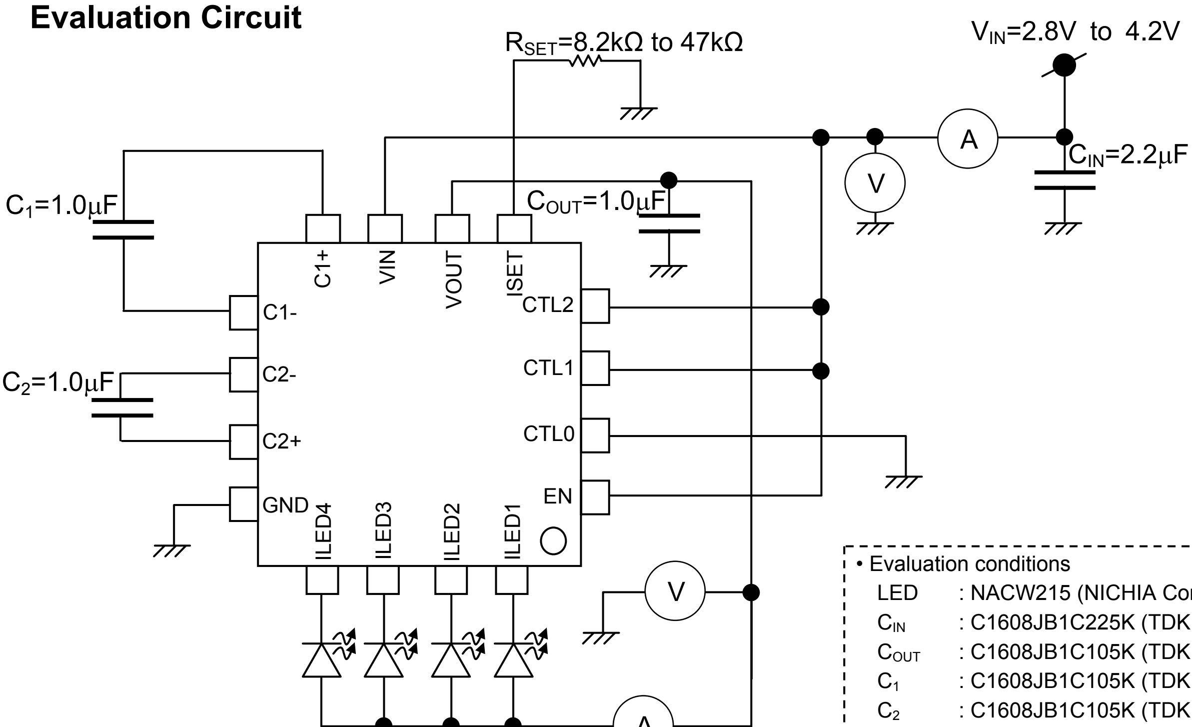








Evaluation Circuit



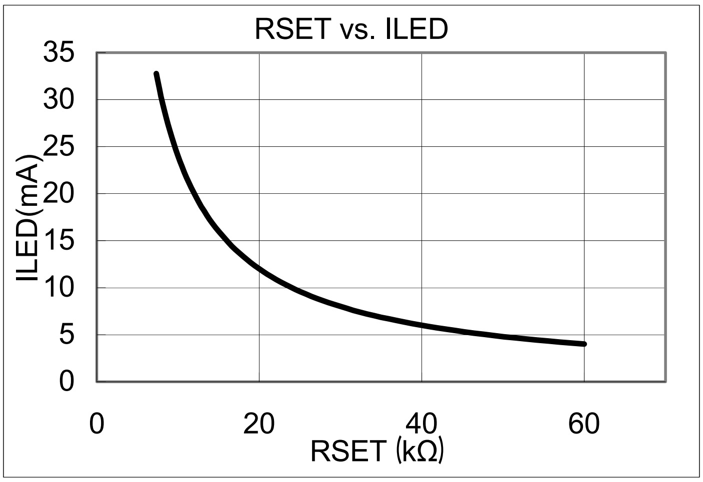
- Evaluation conditions

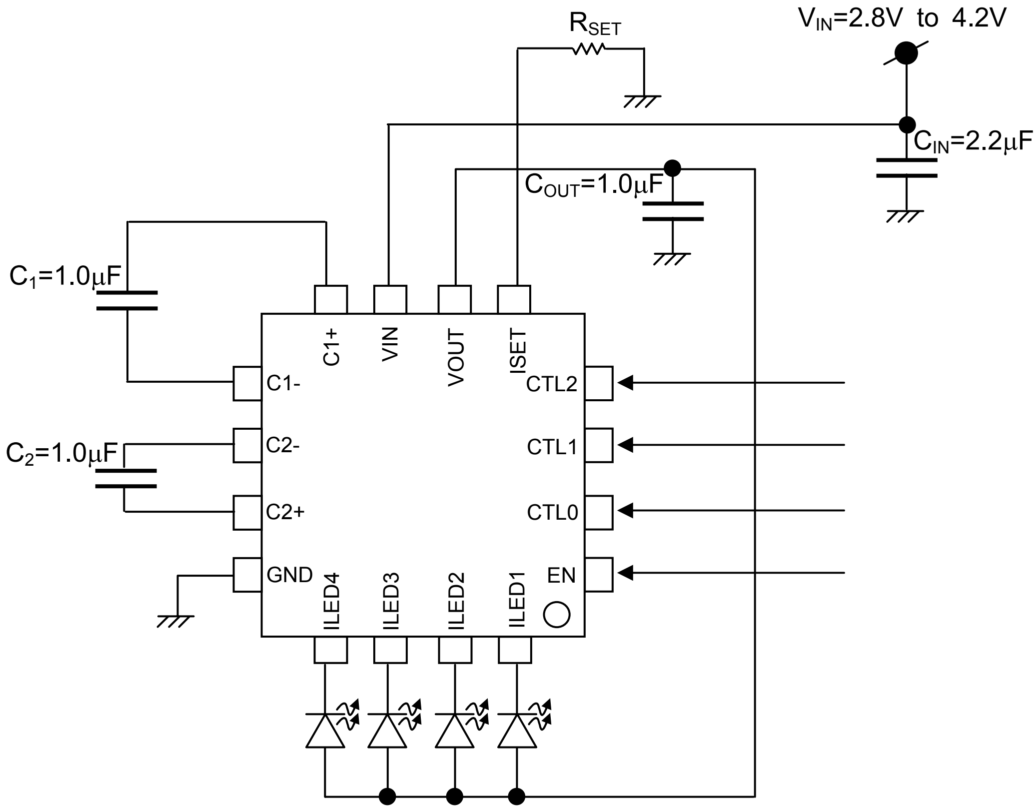
LED	: NACW215 (NICHIA Corp.)
C_{IN}	: C1608JB1C225K (TDK Corp.)
C_{OUT}	: C1608JB1C105K (TDK Corp.)
C_1	: C1608JB1C105K (TDK Corp.)
C_2	: C1608JB1C105K (TDK Corp.)

Method of setting ILED

The current of the terminal ILED1 to 4 is set by resistance RSET connected with the terminal ISET.
ILED can be set according to the next expression.

$$ILED[mA] = \frac{400 \times 0.61[V]}{R_{SET}[k\Omega]}$$





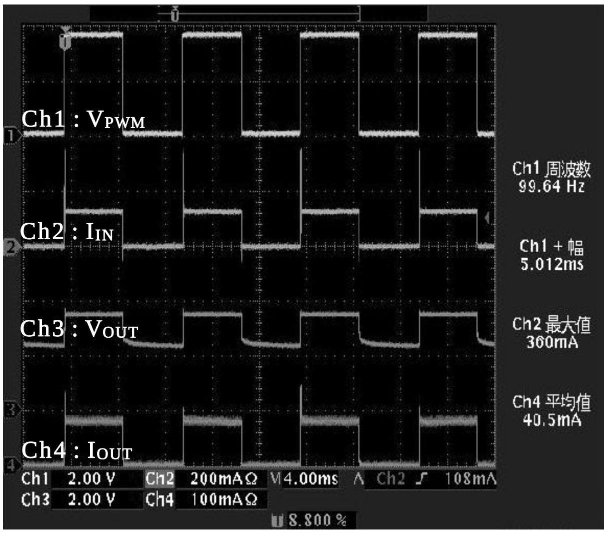
Method of Current Dimming control

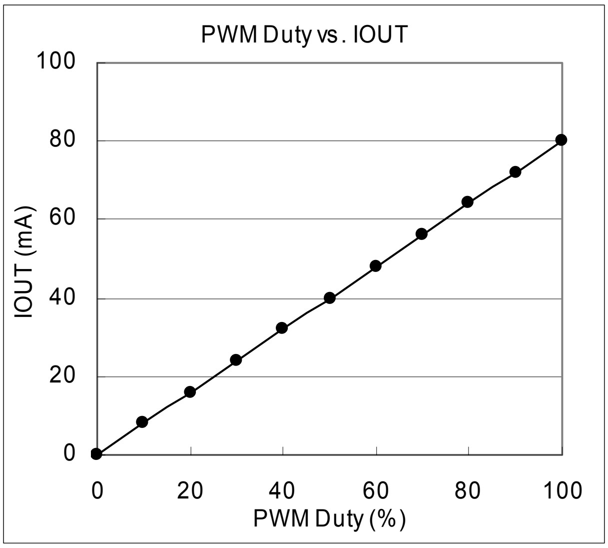
1) Input PWM signal to SHDN terminal

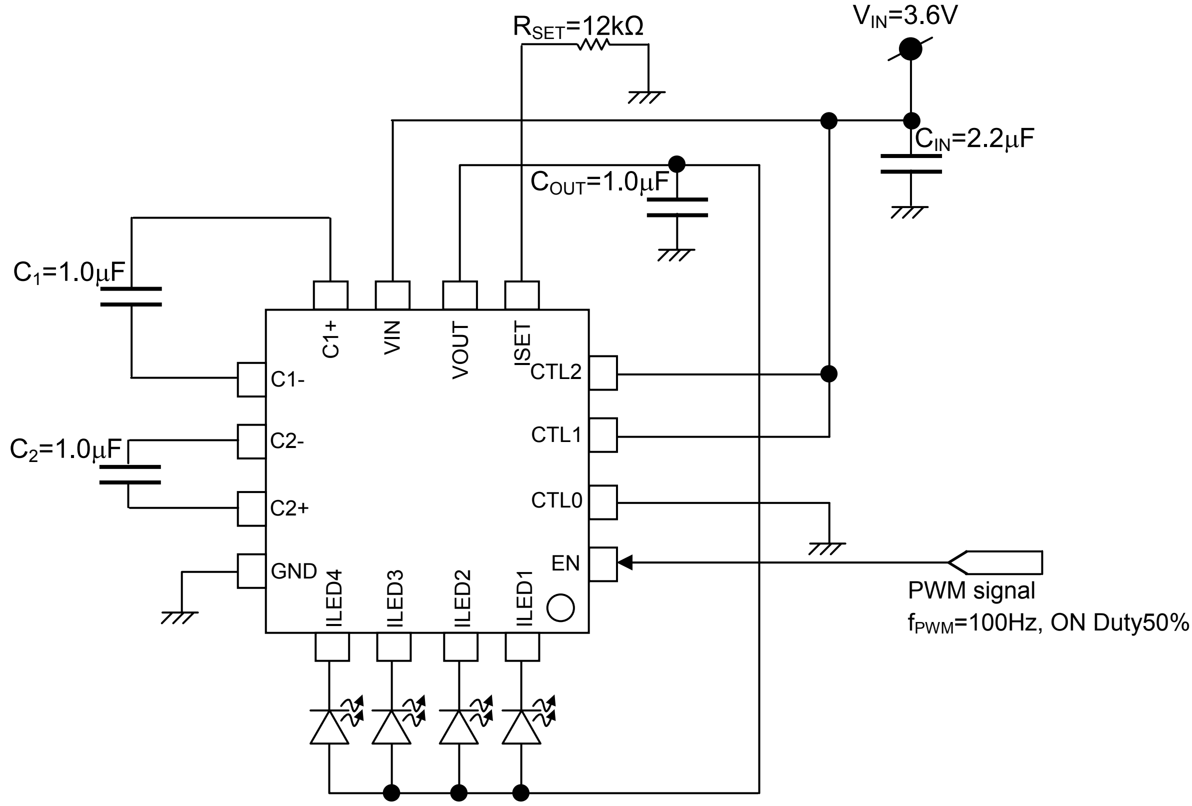
ILED can be set according to the next expression.

$$ILED[mA] = \frac{0.61[V] \times 400 \times ON\ Duty[\%]}{R_{SET}[k\Omega]}$$

f_{PWM} will recommend 100Hz.







*In this PWM control operation, This IC repeats ON/OFF. In this result, rush current is occur when ON timing with supplying charge to C_{2OUT}. Please note it.

TENTATIVE

2) Input analog voltage to ISET terminal

1. Precondition
   - Please set the range of the analog voltage input by 0 to 0.61V.
2. The maximum current is defined as αmA.

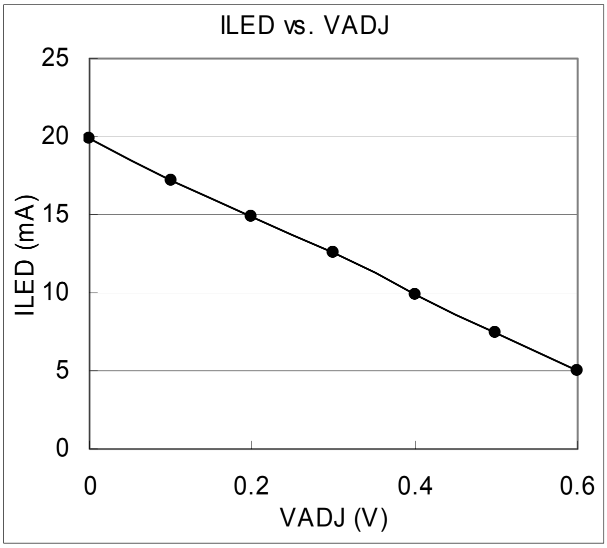
$$\alpha[\mathrm{mA}] = 0.61[\mathrm{V}] \times \frac{R_1[\mathrm{k\Omega}] + R_2[\mathrm{k\Omega}]}{R_1[\mathrm{k\Omega}] \times R_2[\mathrm{k\Omega}]} \times 400$$

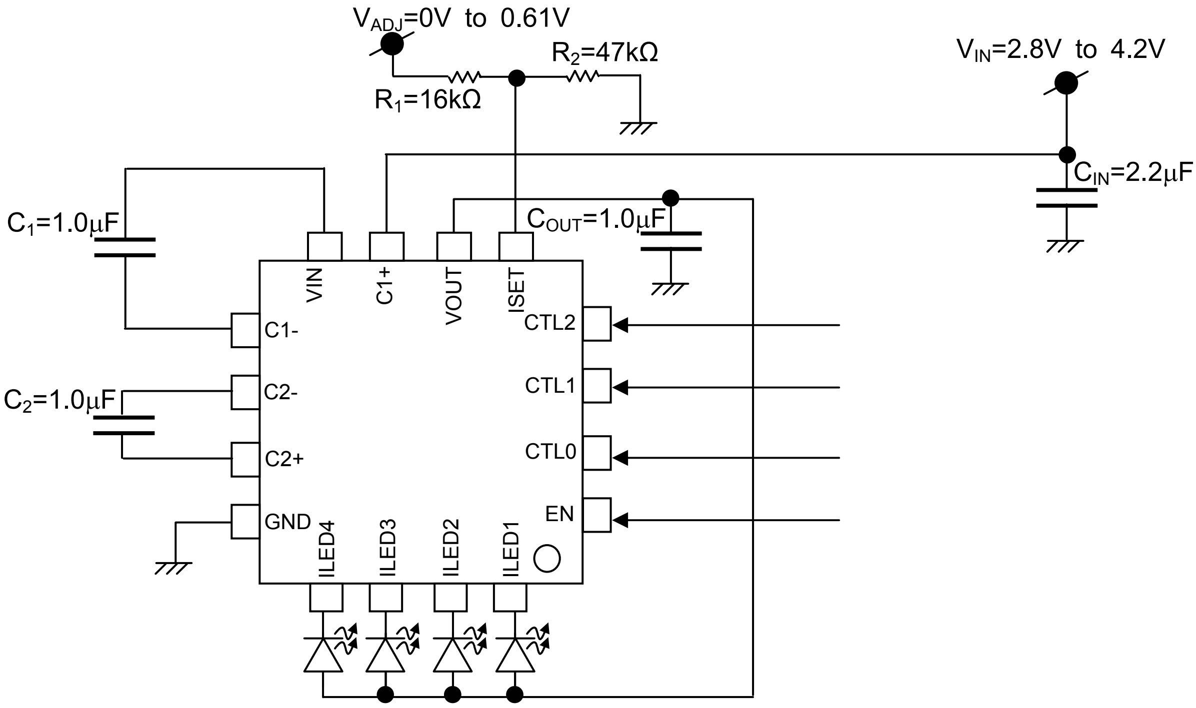
3. A minimum current is defined as βmA.

$$\beta[\mathrm{mA}] = 0.61[\mathrm{V}] \times \frac{1}{R_2[\mathrm{k\Omega}]} \times 400$$

4. ILED can be set according to the next expression.

$$\mathrm{ILED}[\mathrm{mA}] = V_{ADJ}[\mathrm{V}] \times \frac{\beta[\mathrm{mA}] - \alpha[\mathrm{mA}]}{0.61[\mathrm{V}]} + \alpha[\mathrm{mA}]$$





*This method is without repeating IC ON/OFF, and no need to consider holding rash current.

3) Input Logic signal

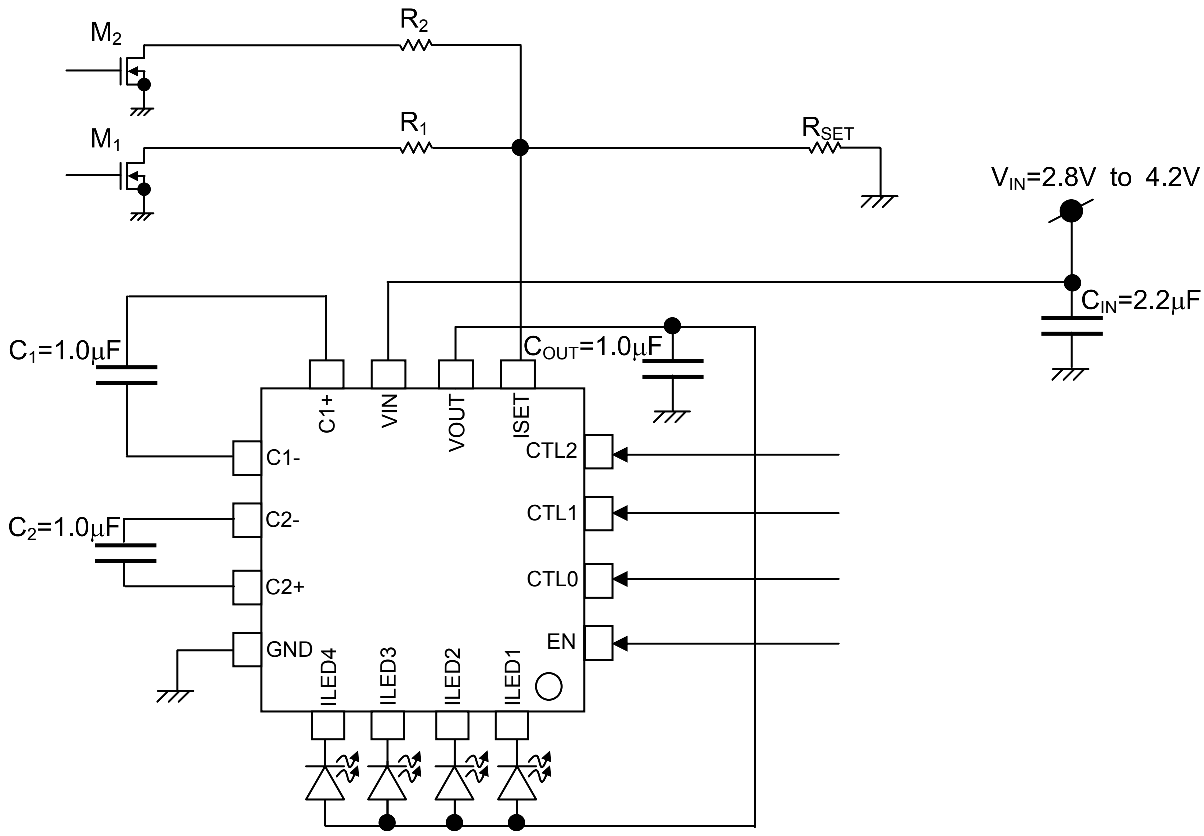
User can adjust ILED with Logic signal input as indicated in recommended circuit.
The Resistor connected the ON-State Nch MOS Drain and R_{SET} determines ILED.

ILED can be set according to the next expression.

$$\text{ILED[mA]} = \frac{400 \times 0.61[\text{V}]}{\text{R}[\text{k}\Omega]}$$

About combined resistance R[kΩ]

M1	M2	R[kΩ]
ON	ON	$\dfrac{R_{SET}[k\Omega] \times R_1[k\Omega] \times R_2[k\Omega]}{R_1[k\Omega]\times R_{SET}[k\Omega] + R_2[k\Omega]\times R_{SET}[k\Omega] + R_1[k\Omega]\times R_2[k\Omega]}$
ON	OFF	$\dfrac{R_{SET}[k\Omega] \times R_1[k\Omega]}{R_{SET}[k\Omega] + R_1[k\Omega]}$
OFF	ON	$\dfrac{R_{SET}[k\Omega] \times R_2[k\Omega]}{R_{SET}[k\Omega] + R_2[k\Omega]}$
OFF	OFF	$R_{SET}[k\Omega]$



*This method is without repeating IC ON/OFF, and no need to consider holding rash current.

Selection of an output number by CTL0, CTL1, and CTL2 Terminal

Truth Table

Input				Output			
CTL2	CTL1	CTL0	EN	ILED4	ILED3	ILED2	ILED1
L	L	L	H	OFF	OFF	OFF	ON
L	L	H	H	OFF	OFF	ON	OFF
L	H	L	H	OFF	ON	OFF	OFF
L	H	H	H	ON	OFF	OFF	OFF
H	L	L	H	OFF	OFF	ON	ON
H	L	H	H	OFF	ON	ON	ON
H	H	L	H	ON	ON	ON	ON
H	H	H	H	OFF	OFF	OFF	OFF
L	L	L	L	OFF	OFF	OFF	OFF
L	L	H	L	OFF	OFF	OFF	OFF
L	H	L	L	OFF	OFF	OFF	OFF
L	H	H	L	OFF	OFF	OFF	OFF
H	L	L	L	OFF	OFF	OFF	OFF
H	L	H	L	OFF	OFF	OFF	OFF
H	H	L	L	OFF	OFF	OFF	OFF
H	H	H	L	OFF	OFF	OFF	OFF

*Soft Start Function

This device is integrated Soft start function. When the power supply is ON or output is started to operate, the transition time is controlled in order to decrease the rush current. (Reference data: The output voltage is time 200μs of made from 0 to 4.0V at the V_{IN}=2.8V time.)

*Inrush Current of Input Current

The inrush current flows when start-up and mode switching. (Reference data: Inrush current at CE1/CE2="L" to “H” is 500mA.)

*Thermal Shut Down Function

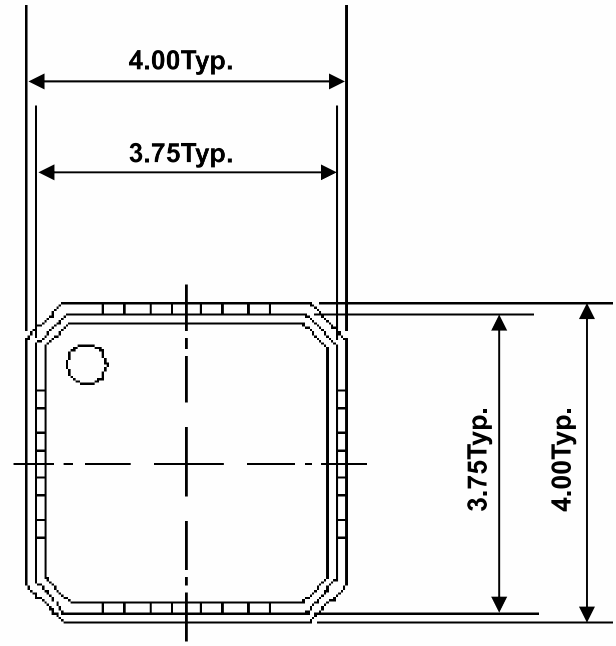
This device has Thermal Shutdown Function to protect from thermal damage when the output is shorted.
The temperature to operate this function is set around from 140 to 160°C. (This is not guaranteed Value.)

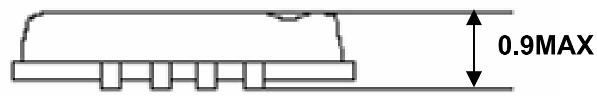
*The Selection of Capacitor for Charge Pump, Input and Output

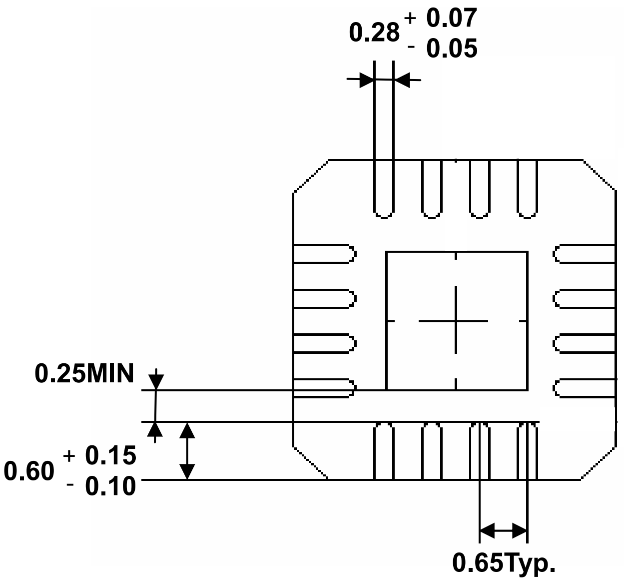
The input capacitor is effective to decrease the impedance of power supply and also input current is averaged.
The input capacitor should be selected by impedance of power supply, it is better to choose with lower ESR (Equivalent Series Resistor). (i.e. ceramic capacitor etc.) Regarding to the capacitance values, it is recommended to choose in the range from 0.8 μF to 10 μF, however larger than 2.2 μF should be better.
The output capacitor is effective to decrease the ripple noise of the output line. Also, it is better to choose the capacitor.) Regarding to the capacitance values, it is recommended to
choose in the range from 0.8 μF to 4.7 μF, however larger than 2.2 μF should be better.
The capacitor for charge pump operation is also selected the capacitor with low ESR. .) Regarding to the capacitance values, it is recommended to choose in the range from 0.8 μF to 2.2 μF, however larger than 1.0 μF should be better.

Package Dimensions

QFN16 Unit : mm







Weight: 0.016 g (Typ.)

Regarding solder ability

Regarding solder ability, the following conditions have been confirmed.

- Solder ability
  (1) Use of Sn-63Pb solder bath
  - solder bath temperature = 230°C, dipping time = 5 seconds, number of times = once, use of R-type flux

  (2) Use of Sn-3.0Ag-0.5Cu solder bath
  - solder bath temperature = 245°C, dipping time = 5 seconds, number of times = once, use of R-type flux

NOTES

- Utmost care is necessary in the design of the output line, VCC, COMMON and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.
- Do not insert devices in the wrong orientation. Make sure that the positive and negative terminals of power supplies are connected correctly. Otherwise, the rated maximum current of power dissipation may be exceeded and the device may break down or undergo performance degradation, causing it to catch fire or explode and resulting in injury.
- Please take care that IC might be destroyed in case external components were destroyed or not connected exactly.