KTD3122

High Efficiency Step-Up LED Driver with Integrated Power Diode

Features

- Wide input range: 2.7V to 5.5V
- Highly integrated solution with high efficiency
  - Integrated 30V power diode
  - Integrated 30V power MOSFET
- Integrated 2-channel current sinks, up to 8-LEDs per string
  - High accuracy up to 30mA/ch
  - 0.6% current matching at 20mA
  - 1.5% current accuracy at 20mA
- Dual dimming control scheme
  - I²C interface control with 256 steps
  - Wide range PWM Dimming for CABC
    - 100Hz to 100kHz Frequency
    - 0.1%~100% Duty Cycle at 10kHz
- Input PWM glitch filter
- I²C interface for various controls
- Programmable current sink ramp up/down time and shape (Exponential/Linear)
- Selectable 1MHz and 500kHz switching frequency with frequency shift option
- Programmable OVP (30V/24V), current limit (1A/0.7A) and LX pin slew rate
- LED open/short protection
- Pb-free Packages: TQFN33-16, WLCSP-12
- -40°C to +85°C Temperature Range

Applications

- Smartphone/Tablet Backlight
- PDA/GPS Backlight

Brief Description

KTD3122 is the ideal power solution for white LED backlighting used with small to medium size LCD panels. It is a highly integrated step-up converter accommodating single cell lithium ion batteries or 5V regulated supply. KTD3122 integrates a 30V power diode and a 30V power MOSFET as well as compensation and soft start circuitry, which results in a simpler and smaller solution with much fewer external components. Adjustable switching frequency (1MHz/500kHz) and OVP threshold (30V/24V) allow the use of a smaller inductor and capacitor to further reduce the solution size.

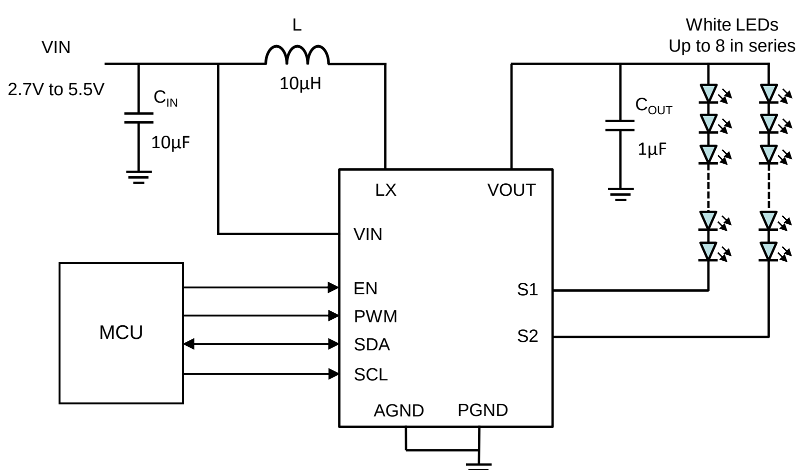
KTD3122 has two regulated current sinks up to 30mA per string. With a maximum of 30V at the output of the step-up converter, each string can connect up to 8 LEDs in series, or up to 16 LEDs total.

KTD3122 is equipped with I²C interface for various controls. For additional flexibility, wide frequency (100Hz to 100kHz) and duty cycle range (0.1% to 100% at 10kHz) PWM dimming control is included and can support Content Adaptive Brightness Control (CABC).

Various protection features are built into KTD3122, including cycle-by-cycle input current limit protection, output over-voltage protection, LED fault (open or short) protection and thermal shutdown protection.

KTD3122 is available in a RoHS compliant and Green 16-lead 3mm x 3mm x 0.75mm Thin-QFN or 12-ball 1.21mm x 1.65mm x 0.62mm WLCSP package.

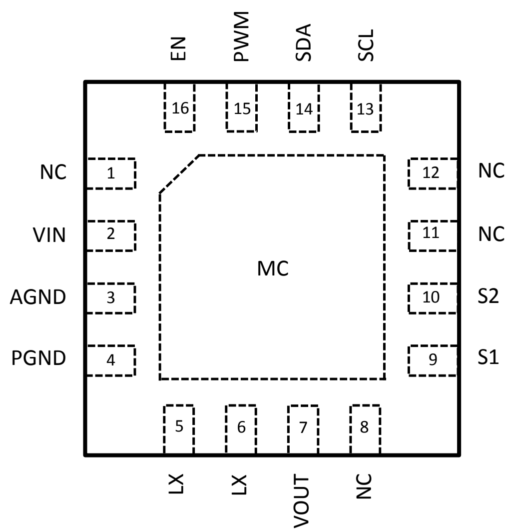
Typical Application



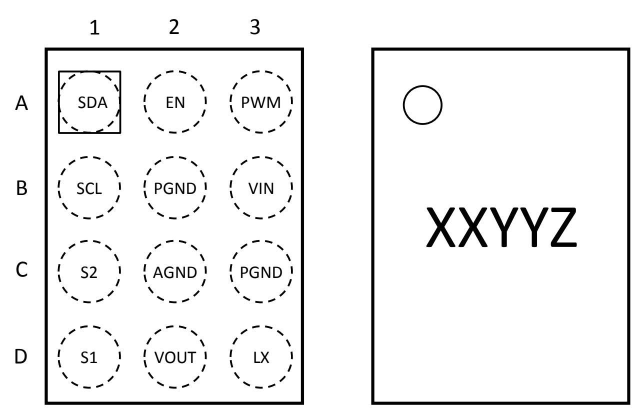
Pin Descriptions

Pin # (TQFN33-16)	Pin # (WLCSP-12)	Name	Function
14	A1	SDA	Bi-direction data pin of the I²C interface. If I²C interface is not used, SDA should be connected to VIN.
16	A2	EN	IC enable pin. An active logic high enables the device. There is an internal 400kΩ pull-down resistor at this pin.
15	A3	PWM	PWM dimming input pin. There is an internal 400kΩ pull-down resistor at this pin.
13	B1	SCL	Clock input pin of the I²C interface. If I²C interface is not used, SCL should be connected to VIN.
4	B2, C3	PGND	Power Ground pin
2	B3	VIN	Input supply pin for the device
10	C1	S2	Regulated output current sink #2
3	C2	AGND	Analog Ground pin
9	D1	S1	Regulated output current sink #1
7	D2	VOUT	Output pin of the step-up converter
5, 6	D3	LX	Switching pin of the step-up converter
1, 8, 11,12	-	NC	Not internally connected
MC	-		Metal chassis. Connect to ground for electrical and thermal usage. MC is internally connected to Analog Ground pin.

TQFN33-16
(Top View)



WLCSP-12
(Top View)



12-Bump 1.21mm x 1.65mm x 0.62mm WLCSP Package
YYZ (Date Code and Assembly Code)
XX = Device Code (Top Mask)

Absolute Maximum Ratings[1]

(T_A = 25°C unless otherwise noted)

Symbol	Description	Value	Units
VIN	Input voltage pins	-0.3 to 6	V
LX, VOUT	High voltage pins	-0.3 to 34	V
S1, S2	High voltage pins	-0.3 to 22	V
SCL, SDA, PWM, EN	Control pins	-0.3 to VIN+0.3	V
T_J	Operating Temperature Range	-40 to 150	°C
T_S	Storage Temperature Range	-65 to 150	°C
T_{LEAD}	Maximum Soldering Temperature (at leads, 10 sec)	300	°C
ESD	HBM electrical static discharge	2.0	kV

1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. Functional operation at conditions other than the operating conditions specified is not implied. Only one Absolute Maximum rating should be applied at any one time.

Thermal Capabilities

Symbol	Description	Value	Units
TQFN33-16			
θ_{JA}	Thermal Resistance – Junction to Ambient[2]	43	°C/W
P_D	Maximum Power Dissipation at $T_A \leq 25°C$	2.0	W
$\Delta P_D/\Delta T$	Derating Factor Above T_A = 25°C	-20	mW/°C
WLCSP-12			
θ_{JA}	Thermal Resistance – Junction to Ambient[2]	90	°C/W
P_D	Maximum Power Dissipation at $T_A \leq 25°C$	1.1	W
$\Delta P_D/\Delta T$	Derating Factor Above T_A = 25°C	-11	mW/°C

2. Junction to Ambient thermal resistance is highly dependent on PCB layout. Values are based on thermal properties of the device when soldered to an EV board.

Ordering Information

Part Number	Marking[3]	Operating Temperature	Package
KTD3122EFJ-TR	GWYYZ	-40°C to +85°C	TQFN33-16
KTD3122EAZ-TR	GWYYZ	-40°C to +85°C	WLCSP-12, 1.21mm x 1.65mm x 0.62mm

3. "YYZ" is the date code and assembly code.

Electrical Characteristics[4]

Unless otherwise noted, the *Min* and *Max* specs are applied over the full operation temperature range of -40°C to +85°C, while *Typ* values are specified at room temperature (25°C). VIN = 3.6V.

Symbol	Description	Conditions	Min	Typ	Max	Units
IC Supply						
V_{IN}	Input operating range		2.7		5.5	V
UVLO	Input under voltage lockout	Rising edge		2.5	2.65	V
$UVLO_{HYST}$	UVLO hysteresis			0.15		V
I_Q	IC standby current	Not switching		1.36	2	mA
	IC operating current	Switching		1.9	2.6	mA
I_{SHDN}	Shutdown current	V_{IN} = 5.5V		3	5	µA
Step-Up Converter						
$R_{DS(ON)}$	NMOS on-resistance			0.4		Ω
I_{LIM}	Peak NMOS current limit	Default		1		A
f_{SW}	Oscillator frequency	Default	0.9	1.0	1.1	MHz
D_{max}	Maximum duty cycle	1MHz setting		92	94	%
V_{OV}	OVP threshold	Default	27.5	30	32.5	V
Current Sink						
I_{SINK}	Output current accuracy	Current setting = 20mA, T_A = 25°C	-1.5		1.5	%
		Current setting = 1mA, T_A = 25°C	-4.5		4.5	%
		Current setting = 50µA, T_A = 25°C	-8		8	%
	Output current matching[5]	Current setting = 20mA, T_A = 25°C	-0.6		0.6	%
V_sov	Current sink over voltage threshold			6.0		V
T_{FAULT}	Current sink fault delay			59		ms
Logic Control						
V_{TH-L}	EN/PWM pin logic low threshold				0.4	V
V_{TH-H}	EN/PWM pin logic high threshold		1.4			V
f_{PWM}	PWM dimming frequency		0.1		100	kHz
D_{PWM}	PWM dimming duty cycle	F_{PWM} = 10kHz	0.1		100	%
T_{PWM_OFF}	PWM minimum turn off pulse width		20			ms
R_{EN}	EN pull-down resistor			400		kΩ
R_{PWM}	PWM pull-down resistor			400		kΩ
I²C-Compatible Voltage Specifications (SCL, SDA)						
V_{IL}	Input Logic Low Threshold				0.4	V
V_{IH}	Input Logic High Threshold		1.4			V

4. KTD3122 is guaranteed to meet performance specifications over the –40°C to +85°C operating temperature range by design, characterization and correlation with statistical process controls.

5. The current matching between channels is defined as $(I_{S2}-I_{S1})/(I_{S2}+I_{S1})$.

Electrical Characteristics[6] (continued)

Unless otherwise noted, the *Min* and *Max* specs are applied over the full operation temperature range of -40°C to +85°C, while *Typ* values are specified at room temperature (25°C). VIN = 3.6V.

Symbol	Description	Conditions	Min	Typ	Max	Units
I²C-Compatible Timing Specifications (SCL, SDA), see Figure 1						
t_1	SCL (Clock Period)		2.5			µs
t_2	Data In Setup Time to SCL High		100			ns
t_3	Data Out Stable After SCL Low		0			ns
t_4	SDA Low Setup Time to SCL Low (Start)		100			ns
t_5	SDA High Hold Time After SCL High (Stop)		100			ns
Thermal Shutdown						
T_{J-TH}	IC junction thermal shutdown threshold			150		°C
	IC junction thermal shutdown hysteresis			15		°C

6. KTD3122 is guaranteed to meet performance specifications over the –40°C to +85°C operating temperature range by design, characterization and correlation with statistical process controls.

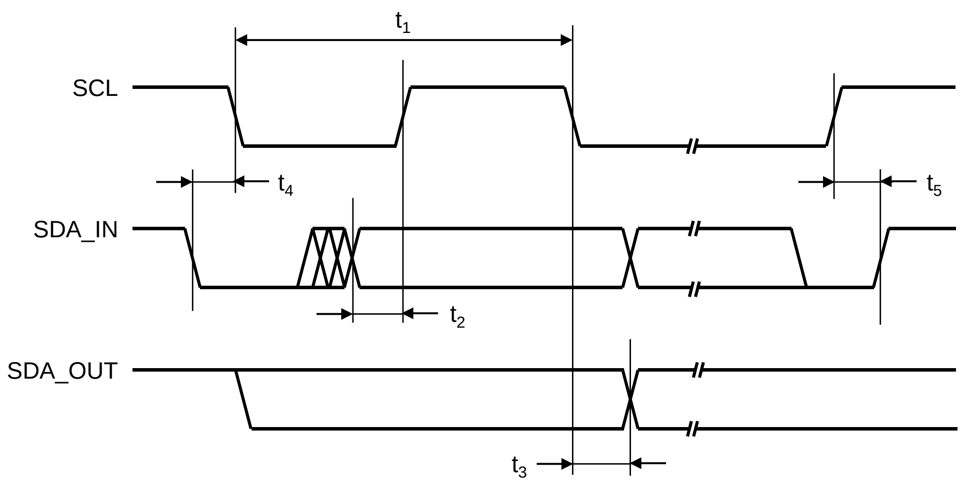
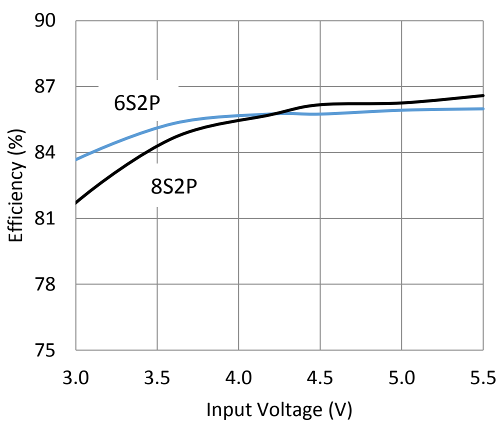


Figure 1. I²C Compatible Interface Timing

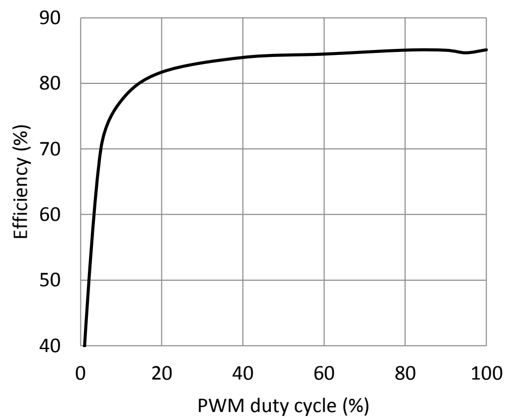
Typical Characteristics

V_{IN} = 3.6V, 8S2P LEDs, I_{LED} = 20mA, L = 10µH (Coilcraft LPS4018-103M), C_{IN} = 10µF, C_{OUT} = 1µF, register default values, Temp = 25°C unless otherwise specified.

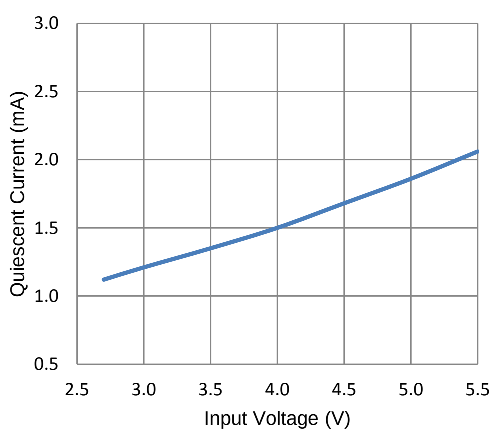
Efficiency vs. Input Voltage



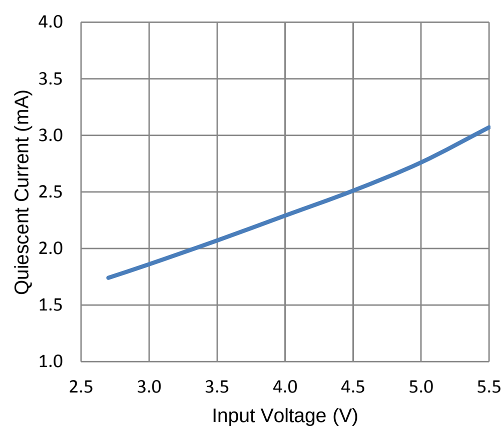
Efficiency vs. PWM Duty Cycle



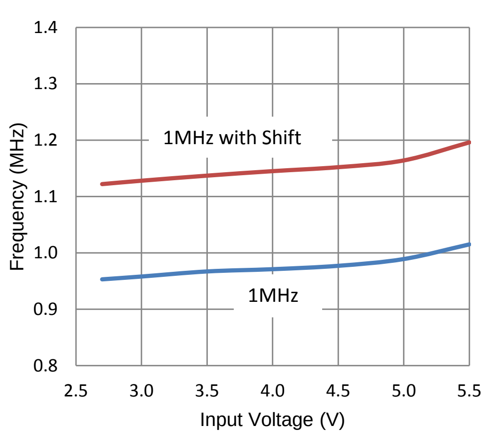
Quiescent Current (non-switching)



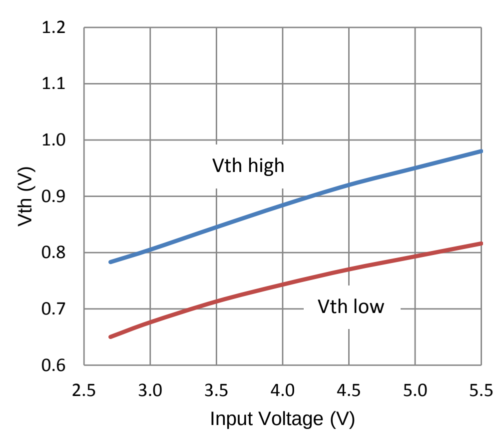
Quiescent Current (switching)



Switching Frequency vs. Input Voltage



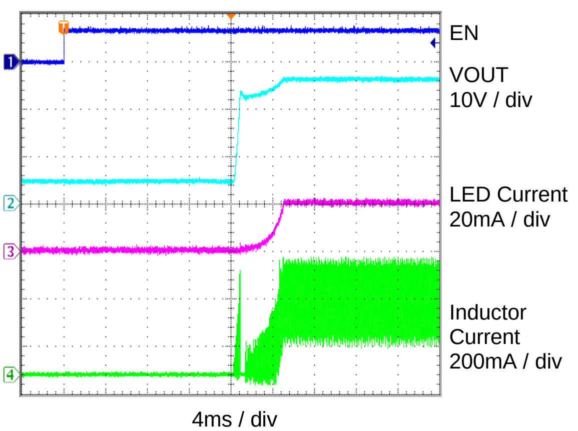
EN/PWM Logic Threshold Voltage



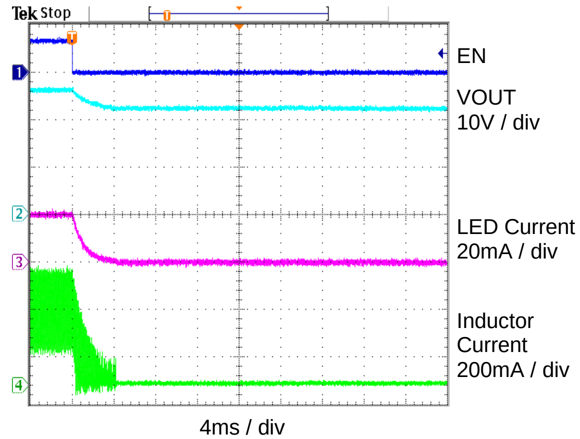
Typical Characteristics (continued)

V_{IN} = 3.6V, 8S2P LEDs, I_{LED} = 20mA, L = 10µH (Coilcraft LPS4018-103M), C_{IN} = 10µF, C_{OUT} = 1µF, register default values, Temp = 25°C unless otherwise specified.

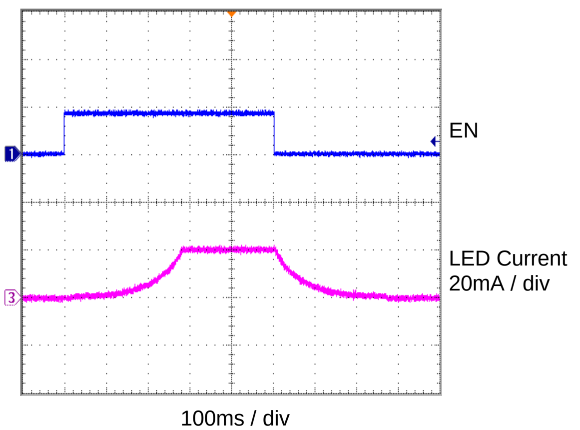
Turn On (4ms Ramp up Exponential)



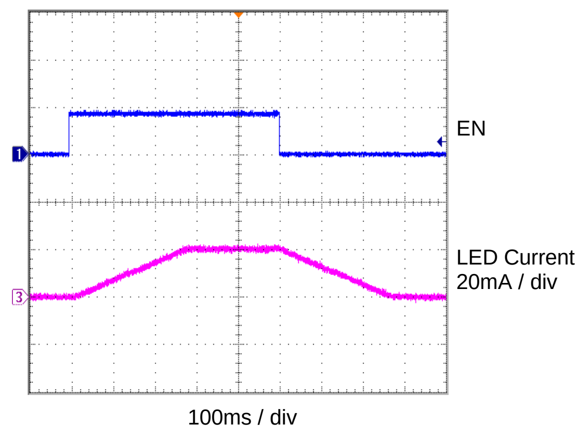
Turn Off (4ms Ramp Down Exponential)



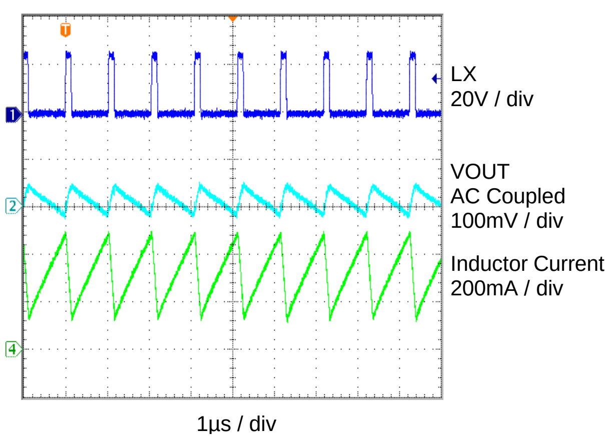
Ramp Up/Down Exponential (256ms)



Ramp Up/Down Linear (256ms)



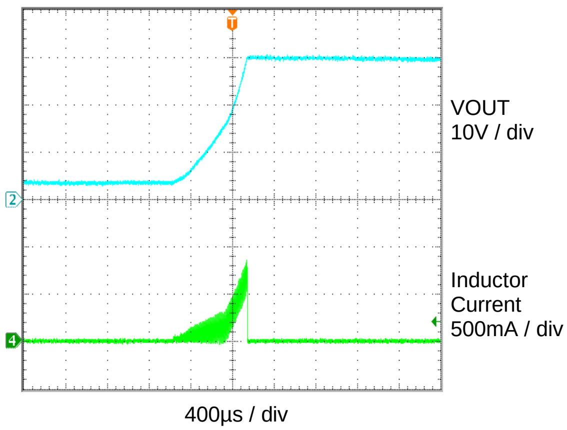
Steady State Switching



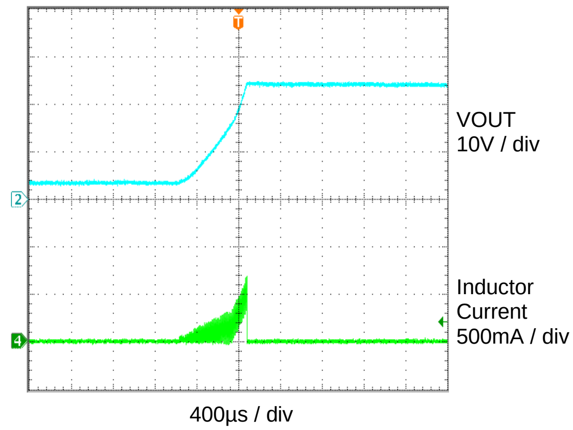
Typical Characteristics (continued)

V_{IN} = 3.6V, 8S2P LEDs, I_{LED} = 20mA, L = 10µH (Coilcraft LPS4018-103M), C_{IN} = 10µF, C_{OUT} = 1µF, register default values, Temp = 25°C unless otherwise specified.

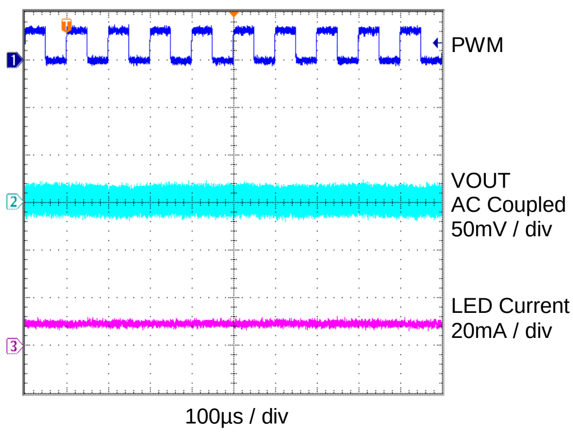
Turn On with LED Open (30V OVP)



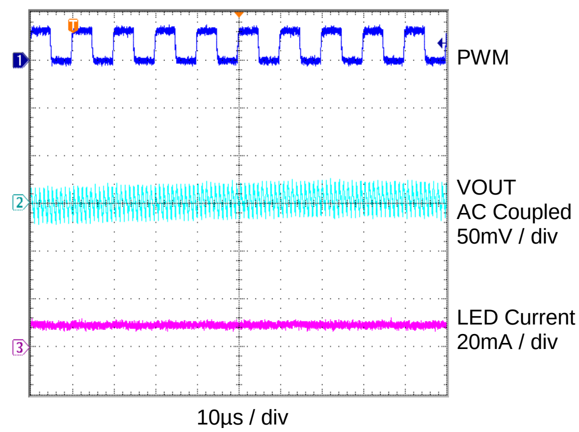
Turn On with LED Open (24V OVP)



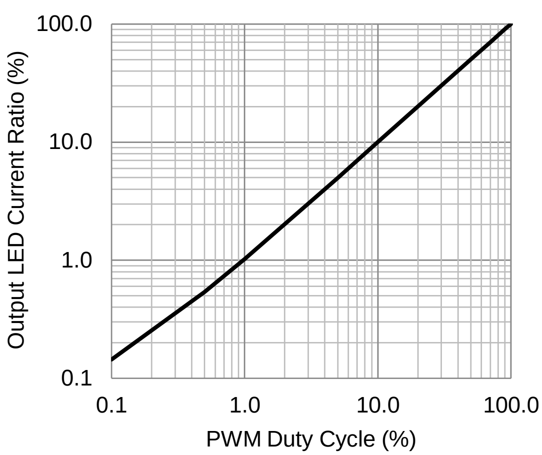
PWM Dimming (10kHz)



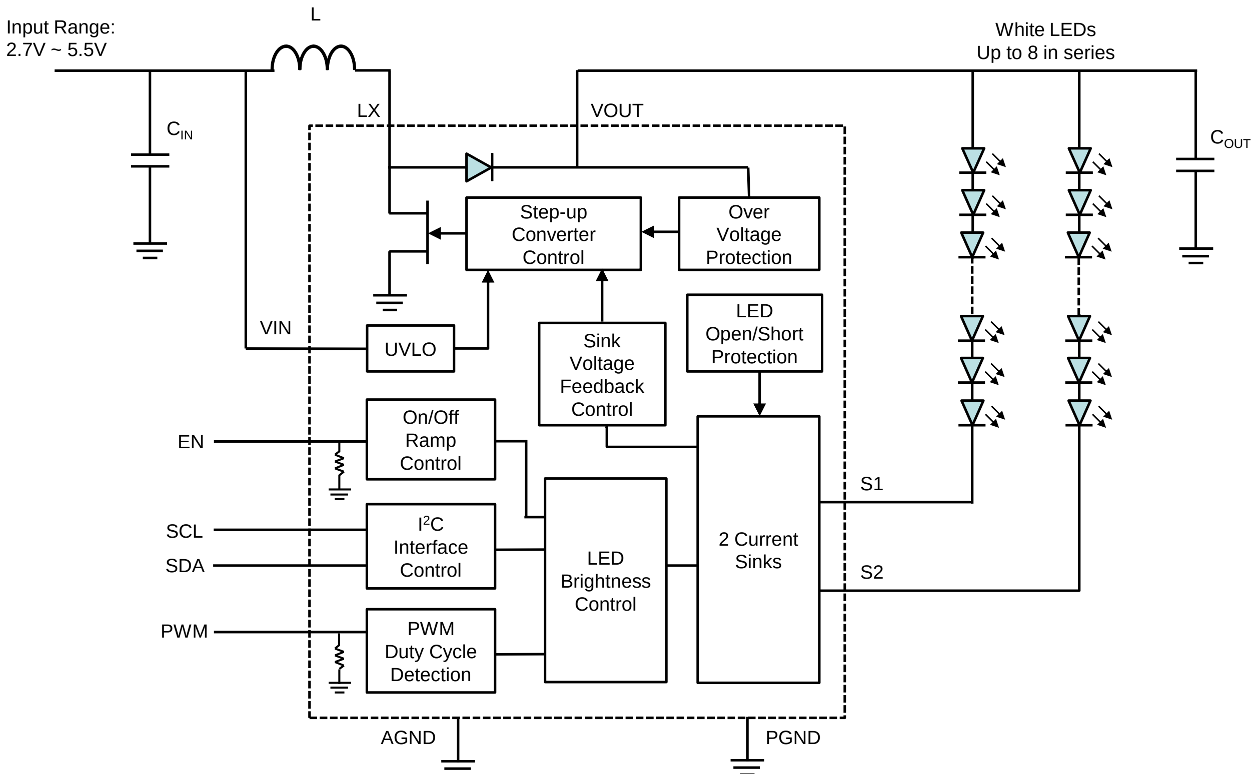
PWM Dimming (100kHz)



PWM Dimming Linearity (10kHz)



Functional Block Diagram



Functional Description

KTD3122 is a unique current regulated step-up (boost) converter. Two current sinks are integrated to drive 2 strings of LEDs with good current matching.

The voltage step-up is accomplished by a boost topology, using an inductor-based DC-DC switching converter, in which the inductor serves as an energy storage device in the system. By integrating a 30V power NMOS and a 30V power diode, KTD3122 minimizes the number of external components while maintaining high efficiency. Unlike a traditional DC-DC boost converter with a fixed output voltage, KTD3122 dynamically changes its output voltage depending on the load. The use of unique control schemes maintains accurate current regulation in each of the two current sinks while leaving the output voltage at a minimum, increasing the overall conversion efficiency. The internal step-up converter dynamically controls the voltage at the output high enough to drive the LED string with the highest total forward voltage.

The KTD3122 is also equipped with I^2C interface for various controls.

Full-scale LED Current

The full-scale current is the LED current when PWM dimming duty cycle is 100% and the LED current ratio is also 100%. It is programmed by the Control register 0x02 bits[1:0] (see Table 2). The four options are 30mA, 25mA, 20mA, 15mA with 20mA as the default.

LED Current Ratio

The LED current ratio is the ratio between the actual LED current and the full-scale LED current when PWM dimming duty cycle is 100%. It is programmed by the Brightness register 0x03 bits[7:0], (see Table 3). The 256 options are 1/256, 2/256, 3/256, …, 255/256, 256/256 with 256/256 as the default.

PWM Dimming

PWM dimming can be enabled or disabled by the PWM register 0x05 bit[5] (see Table 5), with enabled as default. When PWM is disabled, KTD3122 uses 100% as the dimming duty cycle for sink current calculation. When PWM is enabled, it is programmed as active high or active low by register 0x05 bit[4], with active high as default. When PWM dimming is enabled, KTD3122 uses internal 20MHz sampling clock to detect the PWM duty cycle providing good resolution and allowing PWM dimming frequency range to be as wide as 100Hz~100kHz and PWM duty cycle as wide as 0.1%~100% under 10kHz condition.

LED Current

The final LED current per channel can be calculated as:

$$I_{LED} = I_{LED\_FULLSCALE} \times RATIO_{LED} \times D_{PWM}$$

where $I_{LED\_FULLSCALE}$ is the full-scale LED current setting, $RATIO_{LED}$ is the LED current ratio setting, D_{PWM} is the PWM duty cycle if PWM dimming is enabled, otherwise $D_{PWM} = 1$. The input PWM signal's duty cycle is converted to a DC value, so the final LED current is also a DC value.

Turn On/Off Ramp

KTD3122 can program the ramp up or ramp down time when the current sink is turned on or off, they are controlled by the Ramp register 0x04 Bits[7:4] and Bits[3:0] respectively (see Table 4). The 16 options range from 512µs to 16384ms, with 512µs as default.

The shape of the up/down ramp can also be programmed as Exponential or Linear, they are controlled by the PWM register 0x05 Bit[7] and Bit[6] respectively, with Exponential as default.

Channel Enable/Disable

To disable one channel, there are two options.

- Connect the associated sink node to GND. During the startup of the device, it will automatically detect and disable the corresponding channel.
- Program register 0x05 Bits[1:0] to Enable/Disable the channels, with Enable as default.

Switching Frequency

The step-up converter's switching frequency can be programmed to 1MHz or 500kHz by setting the Control register 0x02 Bit[6], with 1MHz as default. The adjustment of the switching frequency can optimize the efficiency under different load current conditions. The frequency can also be programmed to shift up by 20% using the Control register 0x02 Bit[7], with no shift as default. The frequency shift function is to prevent noise interference if the selected switching frequency is within the sensitive frequency range of the system.

Over Voltage Protection (OVP)

The output voltage of the step-up converter is protected by OVP, its threshold can be programmed by the Control register 0x02 Bit[5] as 30V or 24V, with 30V as default.

LX Slew Rate

The slew rate of LX during the switching can affect the step-up converter efficiency and noise interference. Slower speed can minimize the noise interference while sacrificing the efficiency. The speed of LX slew rate can be programmed by the Control register 0x02 Bit[4] as fast or slow, with slow as default.

Current Limit Protection

The step-up converter is protected by cycle-by-cycle current limit protection, its threshold can be programmed by the Control register 0x02 Bit[3] as 1A or 0.7A, with 1A as default.

Disable I^{2}C in Shutdown

By default, when the device is in shutdown condition (EN is low), its I^{2}C interface is still responding, so user can send I^{2}C commands to configure all the registers before enabling the device by EN pin, then there is no need to change the setting after the startup of the device. This is the preferred startup sequence.

There is one disadvantage for this configuration if SCL/SDA's pull up voltage is much less than VIN voltage, which can cause a small leakage current in the shutdown condition. For example, if VIN = 4.2V and SCL/SDA's pull up voltage is 1.8V, there will be around 3µA additional leakage current from VIN in the shutdown condition. To minimize this small leakage current, KTD3122 provides the option to disable I^2C interface in the shutdown condition by the Control register 0x02 Bit[2]. Once this bit is written as '0', in shutdown condition I^2C interface will be disabled and user can't program the device. To enable the I^2C interface, the EN input must be set high to enable the device first. So in the shutdown condition, it is suggested to set all the configurations first before disabling the I^2C interface. Then when the device is enabled again, it can go to the preset condition without any I^2C command during the startup.

If I^2C interface is not needed, both SCL and SDA should be tied to VIN.

Software Reset

The user can reset I^2C registers (0x02, 0x03, 0x04 and 0x05) to their default values by writing to the Software Reset register 0x06 Bit[0] a '1', and then writing '0' (see Table 6).

LED Fault Protection

Each current sink is protected against LED short or open conditions. If LED short circuit condition arises, the current sink continues to regulate until $V_{SINK} > V_{SOV}$. When any sink node voltage goes above V_{SOV} (6V) for more than 59ms (typ.), that channel's current sink will be turned off, and other channel will still work if it doesn't trigger this fault condition. For example, if two or more LEDs on a channel are shorted, that channel's sink voltage will increase. If the voltage goes above 6V for more than 59ms, the Current Sink Fault Protection will be triggered and only this faulty string will be disabled by shutting off this current sink. The other channel will continue normal operation if it doesn't have a fault condition.

In case of an LED failing open, the current sink voltage of the failed string will go close to ground and dominate the boost converter control loop. As a result the output voltage will move up to the over-voltage threshold. Once the over-voltage incident is flagged internally, the faulty channel(s) will be disabled. Then the output voltage of the boost converter will go back to normal level. During the entire process, the rest of the LED string (healthy LED string) would continue normal operation.

Fault status is stored in the Fault Flag register 0x07 (see Table 7). This is a read-only register. Once a fault is triggered and the associated bit is set, the fault status is only reset by EN pin toggling (low to high) or VIN power-on-reset.

Thermal Shutdown

Thermal shutdown feature is included in the KTD3122. When the IC's junction temperature (T_J) reaches 150°C, the IC will immediately enter shutdown mode. Once T_J drops 15°C to approximately 135°C, the IC will resume normal operation.

Application Information

I²C Serial Data Bus

The KTD3122 supports the I²C bus protocol. A device that sends data onto the bus is defined as a transmitter and a device receiving data as a receiver. The device that controls the bus is called a master, whereas the devices controlled by the master are known as slaves. A master device must generate the serial clock (SCL), control bus access and generate START and STOP conditions to control the bus. The KTD3122 operates as a slave on the I²C bus. Within the bus specifications a standard mode (100kHz maximum clock rate) and a fast mode (400kHz maximum clock rate) are defined. The KTD3122 works in both modes. Connections to the bus are made through the open-drain I/O lines SDA and SCL.

The following bus protocol has been defined (Figure 2):

- Data transfer may be initiated only when the bus is not busy.
- During data transfer, the data line must remain stable whenever the clock line is HIGH. Changes in the data line while the clock line is high are interpreted as control signals.

Accordingly, the following bus conditions have been defined:

Bus Not Busy
Both data and clock lines remain HIGH.

Start Data Transfer
A change in the state of the data line, from HIGH to LOW, while the clock is HIGH, defines a START condition.

Stop Data Transfer
A change in the state of the data line, from LOW to HIGH, while the clock line is HIGH, defines the STOP condition.

Data Valid
The state of the data line represents valid data when, after a START condition, the data line is stable for the duration of the HIGH period of the clock signal. The data on the line must be changed during the LOW period of the clock signal. There is one clock pulse per bit of data.

Each data transfer is initiated with a START condition and terminated with a STOP condition. The number of data bytes transferred between START and STOP conditions are not limited, and are determined by the master device. The information is transferred byte-wise and each receiver acknowledges with a ninth bit.

Acknowledge

Each receiving device, when addressed, is obliged to generate an acknowledge after the reception of each byte. The master device must generate an extra clock pulse that is associated with this acknowledge bit.

A device that acknowledges must pull down the SDA line during the acknowledge clock pulse in such a way that the SDA line is stable LOW during the HIGH period of the acknowledge-related clock pulse. Of course, setup and hold times must be taken into account.

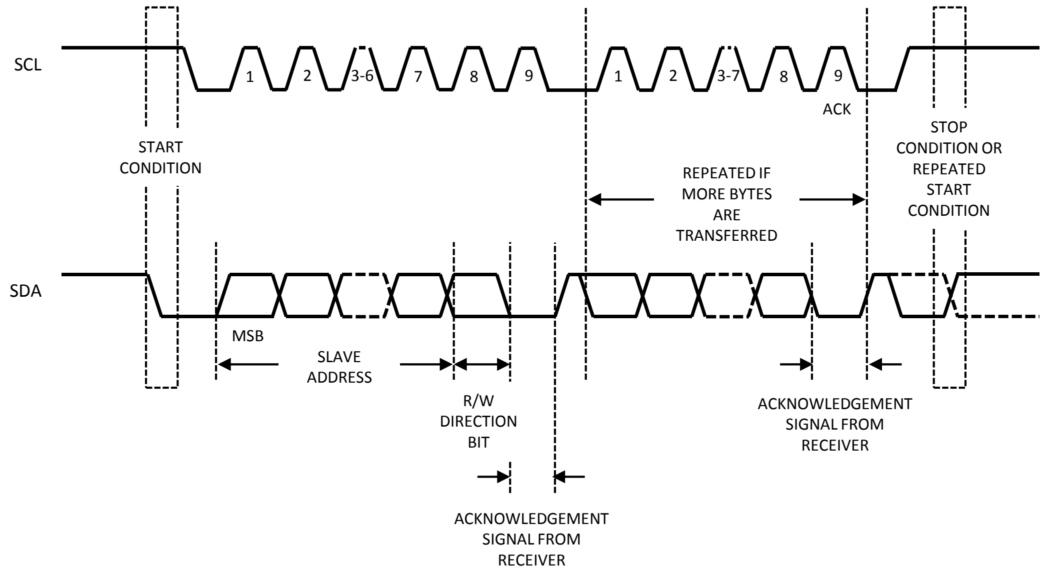


Figure 2. Data Transfer on I²C Serial Bus

KTD3122's 7-bit slave device address is 0110110 binary (or 0x36h).

There are two kinds of I²C data transfer cycles: write cycle and read cycle.

I²C Write Cycle

For I²C write cycle, data is transferred from a master to a slave. The first byte transmitted is the 7-bit slave address plus one bit of '0' for write. Next follows a number of data bytes. The slave returns an acknowledge bit after each received byte. Data is transferred with the most significant bit (MSB) first. Figure 3 shows the sequence of the I²C write cycle.

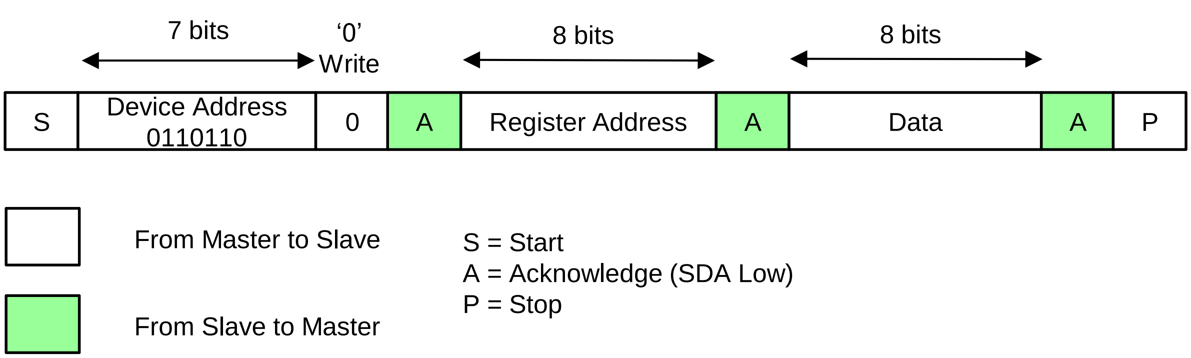


Figure 3. I²C Write Cycle

I²C Write Cycle Steps:
- Master generates start condition.
- Master sends 7-bit slave address (0110110 for KTD3122) and 1-bit data direction ‘0’ for write.
- Slave sends acknowledge if the slave address is matched.
- Master sends 8-bit register address.
- Slave sends acknowledge.
- Master sends 8-bit data for that addressed register.
- Slave sends acknowledge.
- If master sends more data bytes, the register address will be incremented by one after each acknowledge.
- Master generate stop condition to finish the write cycle.

I²C Read Cycle

For I²C read cycle, data is transferred from a slave to a master. But to start the read cycle, master needs to write the register address first to define which register’s data to read. Figure 4 shows the steps of the I²C read cycle.

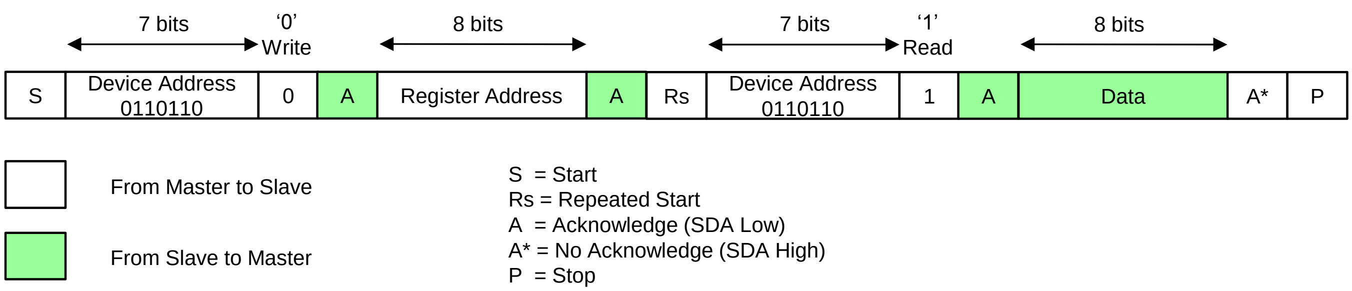


Figure 4. I²C Read Cycle

I²C Read Cycle Steps:
- Master generates start condition.
- Master sends 7-bit slave address (0110110 for KTD3122) and 1-bit data direction ‘0’ for write.
- Slave sends acknowledge if the slave address is matched.
- Master sends 8-bit register address.
- Slave sends acknowledge.
- Master generates repeated start condition.
- Master sends 7-bit slave address (0110110 for KTD3122) and 1-bit data direction ‘1’ for read.
- Slave sends acknowledge if the slave address is matched.
- Slave sends the data byte of that addressed register.
- If master sends acknowledge, the register address will be incremented by one after each acknowledge and the slave will continue to send the data for the updated addressed register.
- If master sends no acknowledge, the slave will stop sending the data.
- Master generate stop condition to finish the read cycle.

I²C Register Map

Table 1 summarizes KTD3122’s 6 I²C registers, their read/write settings and default values. The default value is only reset by power-on-reset of VIN pin, and it will not be reset by EN pin.

Table 1. I²C Register Map

Register Name	Address (Hex)	Read/Write	Default Value
Control Register	0x02	Read/Write	6D
Brightness Register	0x03	Read/Write	FF
Ramp Register	0x04	Read/Write	00
PWM Register	0x05	Read/Write	07
SW Reset Register	0x06	Read/Write	00
Fault Flag Register	0x07	Read Only	00

I²C Register Description

The following tables summarize the setting of each I²C register. Reserved bit should be written as '0' and ignored during read.

Table 2. Control Register (Address 0x02, Read/Write)

Bit 7 Switching Frequency Shift	Bit 6 Switching Frequency	Bit 5 OVP Control	Bit 4 LX Slew Rate	Bit 3 Current Limit	Bit 2 I²C Interface in Shutdown	Bits [1:0] Full-scale Channel Current
0 = No Shift (Default) 1 = Shift up by 20%	0 = 500kHz 1 = 1MHz (Default)	0 = 24V 1 = 30V (Default)	0 = Slow (Default) 1 = Fast	0 = 0.7A 1 = 1A (Default)	0 = Disable 1 = Enable (Default)	00 = 15mA 01 = 20mA (Default) 10 = 25mA 11 =30mA

Table 3. Brightness Register (Address 0x03, Read/Write)

Bits [7:0] LED Current Ratio
00000000 = 1/256 00000001 = 2/256 00000010 = 3/256 ..... 11111110 = 255/256 11111111 = 256/256 (Default)

Table 4. Ramp Register (Address 0x04, Read/Write)

Bits [7:4] Ramp Up Time	Bits [3:0] Ramp Down Time
0000 = 512us (Default) 0001 = 1ms 0010 = 2ms 0011 = 4ms 0100 = 8ms 0101 = 16ms 0110 = 32ms 0111 = 64ms 1000 = 128ms 1001 = 256ms 1010 = 512ms 1011 = 1024ms 1100 = 2048ms 1101 = 4096ms 1110 = 8192ms 1111 = 16384ms	0000 = 512us (Default) 0001 = 1ms 0010 = 2ms 0011 = 4ms 0100 = 8ms 0101 = 16ms 0110 = 32ms 0111 = 64ms 1000 = 128ms 1001 = 256ms 1010 = 512ms 1011 = 1024ms 1100 = 2048ms 1101 = 4096ms 1110 = 8192ms 1111 = 16384ms

Note: If switching frequency shift is enabled (Register 0x02's Bit [7] = 1), the ramp up/down time will be 20% shorter.

Table 5. PWM Register (Address 0x05, Read/Write)

Bit 7 Ramp Up Shape	Bit 6 Ramp Down Shape	Bit 5 PWM Input	Bit 4 PWM Active	Bits [3:2]	Bit 1 CH2	Bit 0 CH1
0 = Exponential (Default) 1 = Linear	0 = Exponential (Default) 1 = Linear	0 = Enable (Default) 1 = Disable	0 = High Active (Default) 1 = Low Active	Don't care	0 = Disable 1 = Enable (Default)	0 = Disable 1 = Enable (Default)

Table 6. Software Reset Register (Address 0x06, Read/Write)

Bits [7:1]	Bit 0 Software Reset
Don't care	0 = Disable (Default) 1 = Reset all registers except 0x06 and 0x07

Note: After Bit 0 is written as '1' for software reset, '0' should also be written to this bit clear this bit.

Table 7. Fault Flag Register (Address 0x07, Read Only)

Bits [7:6]	Bit 5 S2 LED Open or Short	Bit 4 S1 LED Open or Short	Bit 3 OVP	Bit 2 UVLO	Bit 1 OCP	Bit 0 Thermal Shutdown
Reserved	0 = Normal 1= Open or Short	0 = Normal 1= Open or Short	0 = Normal 1= OVP	0 = Normal 1= UVLO	0 = Normal 1= OCP	0 = Normal 1= Thermal Shutdown

Note: Once fault is triggered, it will only be reset by toggling EN or VIN power-on-reset.

Capacitor Selection

Small size ceramic capacitors with low ESR are ideal for all applications. A 10uF input capacitor and a 1uF output capacitor are suggested. The voltage rating of these capacitors should exceed the maximum possible voltage at the corresponding pins, and these capacitors should keep as close as possible to the IC.

Table 8. Recommended Ceramic Capacitor Vendors

Manufacturer	Website
Murata	www.murata.com
AVX	www.avx.com
Taiyo Yuden	www.t-yuden.com

Inductor Selection

Depending on the switching frequency (1MHz or 500kHz), an inductor in the range of 10µH to 22µH with low DCR can be selected for the boost converter. To estimate the inductance required for applications, calculate the maximum input average current as the following

$$I_{IN(MAX)} = \frac{V_{OUT} \cdot I_{OUT(MAX)}}{V_{IN} \cdot \eta}$$

where η is the converter efficiency and can be approximated as 90% for the typical case. In order to have smaller current ripple (to improve efficiency and minimize output voltage ripple), larger inductance will be required. If inductor ripple current needs to be less than 40% of the average input current, then

$$\Delta I_L = \frac{V_{IN} \cdot D \cdot T_S}{L} \leq 40\% \cdot \frac{V_{OUT} \cdot I_{OUT(MAX)}}{V_{IN} \cdot \eta}$$

Where duty cycle can be estimated as

$$D = \frac{V_{OUT} - V_{IN}}{V_{OUT}}$$

Then

$$\Delta I_L = \frac{V_{IN} \cdot (V_{OUT} - V_{IN}) \cdot T_S}{L \cdot V_{OUT}} \leq 40\% \cdot \frac{V_{OUT} \cdot I_{OUT(MAX)}}{V_{IN} \cdot \eta}$$

Therefore the inductance can be calculated as

$$L \geq \frac{V_{IN}^2 \cdot (V_{OUT} - V_{IN}) \cdot \eta}{40\% \cdot V_{OUT}^2 \cdot I_{OUT(MAX)} \cdot f_S}$$

where f_S is the switching frequency of the boost converter.

Table 9. Recommended Inductor

Application	Inductor Part Number	Value (µH)	DCR (Ω)	Saturation Current (A)	Dimensions (mm)	Manufacturer
2P8S	LPS4018-103ML	10	0.200 max	1.3	4x4x1.8	Coilcraft

Recommended PCB Layout

PCB layout is very important for high frequency switching regulators in order to keep the loop stable and minimize noise. The input capacitor (CIN) should be very close to the IC VIN pin and PGND pin in order to get the best decoupling. The path between the inductor, LX pin and the output capacitor (COUT) should be kept as short as possible to minimize noise and ringing. To reduce power loss, the trace between the inductor and LX pin should be as short and wide as possible. Both input and output capacitor GND terminals should be connected together on the PCB top layer and on the bottom layer GND planes.

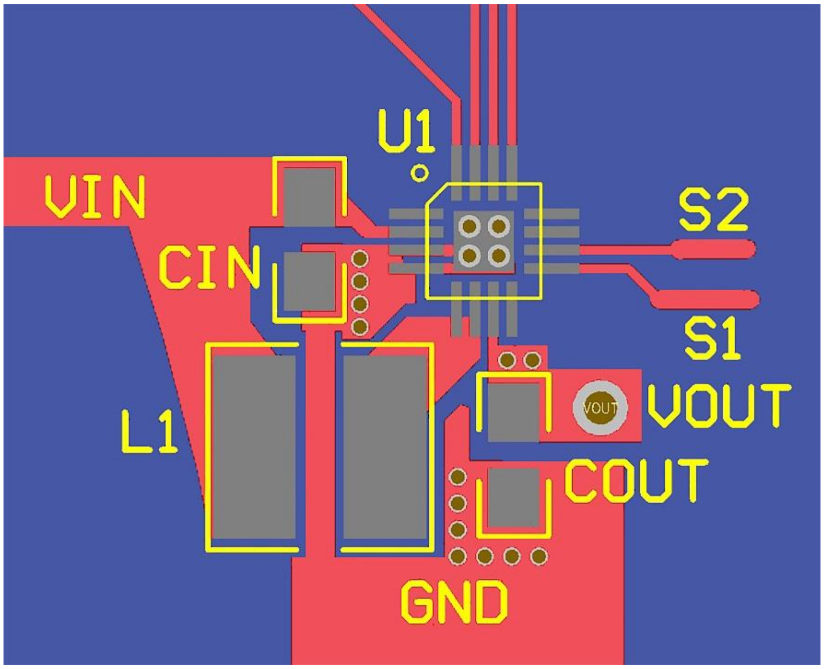


Figure 5. TQFN Recommended PCB Layout

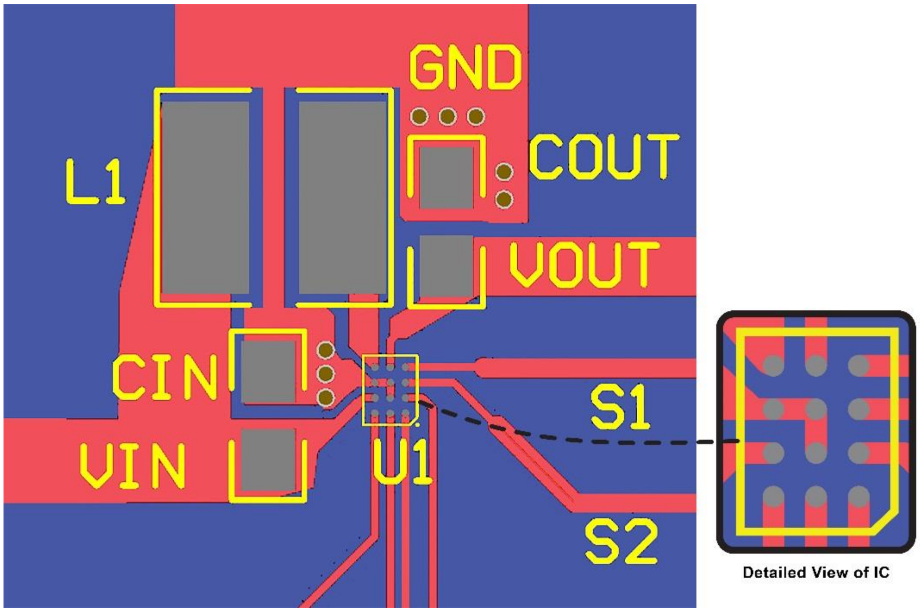
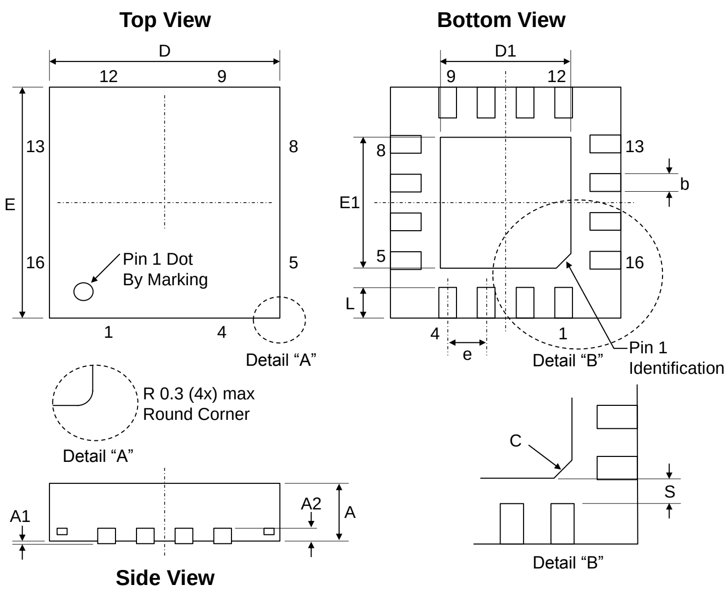


Figure 6. WLCSP Recommended PCB Layout

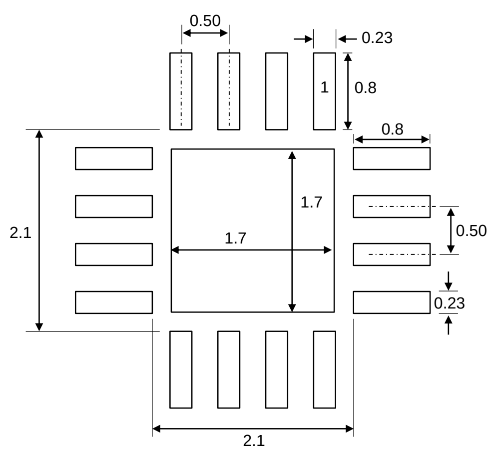
Package Information

TQFN33-16



Dimension	mm		
	Min.	Typ.	Max.
A	0.65	0.75	0.85
A1	0.000	0.025	0.050
A2	0.154	0.203	0.280
b	0.18	0.23	0.30
C		0.3REF	
D	2.95	3.00	3.05
D1		1.7REF	
E	2.95	3.00	3.05
E1		1.7REF	
e	0.45	0.50	0.55
L	0.30	0.40	0.50
S		0.25REF	

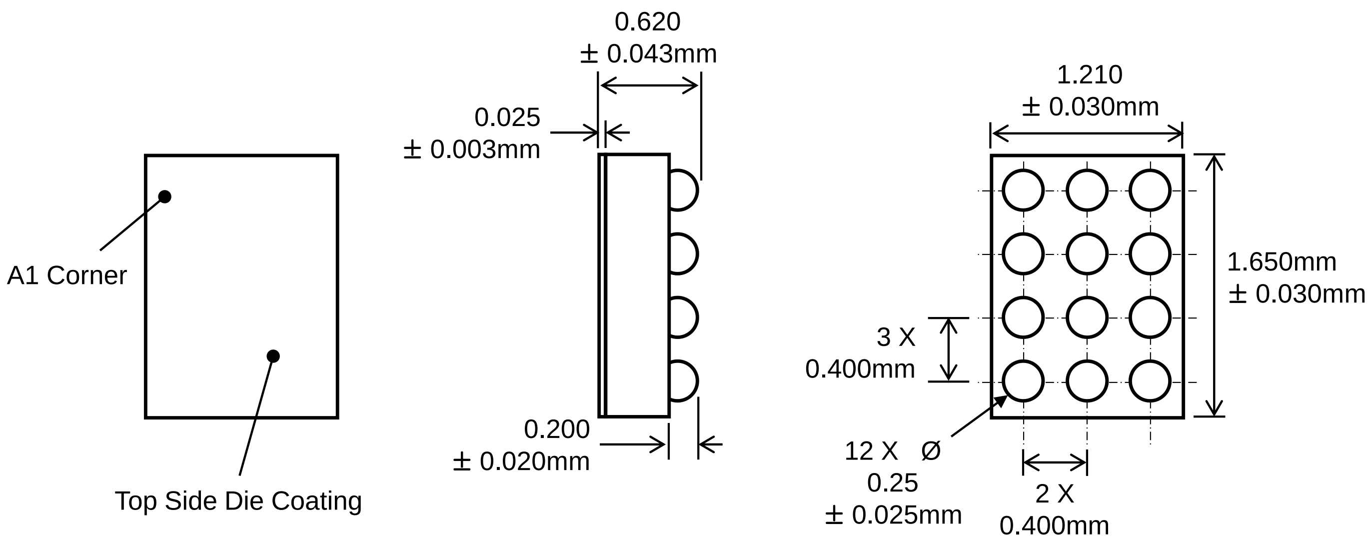
Recommended Footprint



* Dimensions are in millimeters.

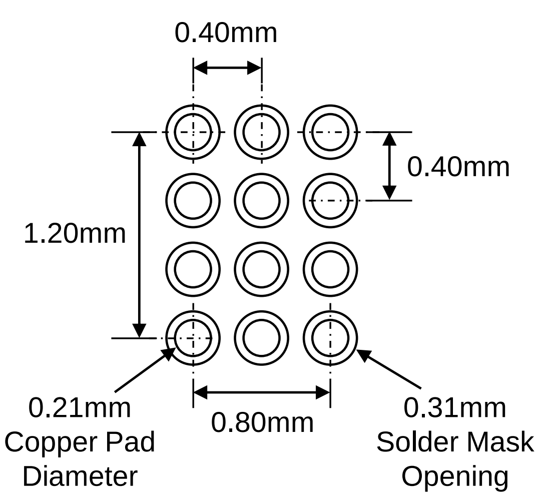
WLCSP-12 1.21mm x 1.65mm x 0.62mm

Top View **Side View** **Bottom View**



Recommended Footprint

(NSMD Pad Type)



* Dimensions are in millimeters.

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- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

Как с нами связаться

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