600k/1.2MHz TFT-LCD Step-Up DC-DC Converter

Features
- **90% Efficiency**
- **Adjustable Output from V_{IN} to 22V**
- **4A, 0.125Ω, 22V Power MOSFET**
- **2.5V to 5.5V Input Range**
- **600kHz/1.2MHz Switching Frequency**
- **TDFN3X3-10 Package**

Applications
- **LCD Displays**
- **Portable Applications**
- **Hand-Held Devices**

General Description
The G5110 boost converter incorporate high-performance, current-mode, and frequency selectable pulse width modulation (PWM) circuitry with a built-in N-channel MOSFET to provide a highly efficient regulator.

The G5110′s frequency can be selected by user to operate at either 600kHz or 1.2MHz. High switching frequency allows easily filtering and faster loop performance. An external compensation pin provides the user flexibility in determining loop dynamics, allowing the use of small, low ESR ceramic output capacitors. The current-mode architecture provides fast transient response to pulsed loads.

The internal N-channel MOSFET can produce output voltage as high as 22V. User programmed soft-start with an external capacitor determines the input current ramp rate.

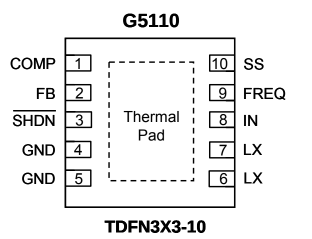
The G5110 is available in a 10-pin TDFN3X3 package.

Ordering Information

ORDER NUMBER	MARKING	TEMP. RANGE	PACKAGE (Green)
G5110RE1U	5110	-40°C to 85°C	TDFN3X3-10

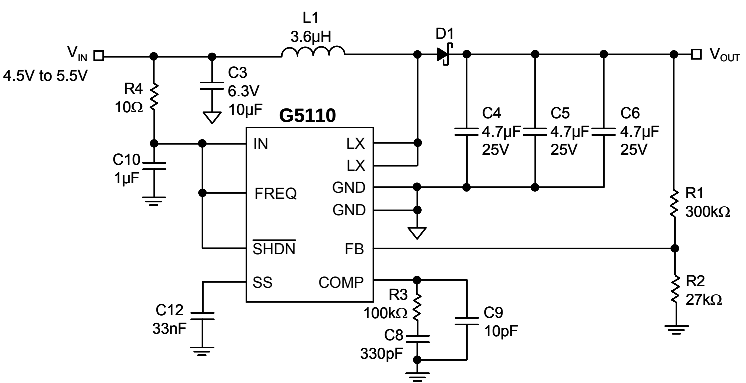
Note :RE: TDFN3X3-10
1: Bonding Code
U: Tape & Reel

Pin Configuration



Note: Recommend connecting the Thermal Pad to the Ground or let it keep floating.

Typical Application Circuit



Absolute Maximum Ratings

IN, FREQ, to GND . . . . -0.3V to +7V
FB, $\overline{SHDN}$, COMP, SS to GND. . . . -0.3V to IN+0.3V
LX to GND. . . . .-0.3V to 28V
Thermal Resistance Junction to Ambient, (θ_{JA})*
TDFN3X3-10 . . . . .41°C/W

Continuous Power Dissipation (T_A = +25°C)*
TDFN3X3-10 . . . . 3W
Operating Temperature . . . .-40°C to 85°C
Junction Temperature . . . . .150°C
Storage Temperature Range . . . . -65 °C to 150°C
Reflow Temperature (soldering, 10sec) . . . . . . 260°C

*Please refer to EV5110 PCB Layout Section.

Electrical Characteristics

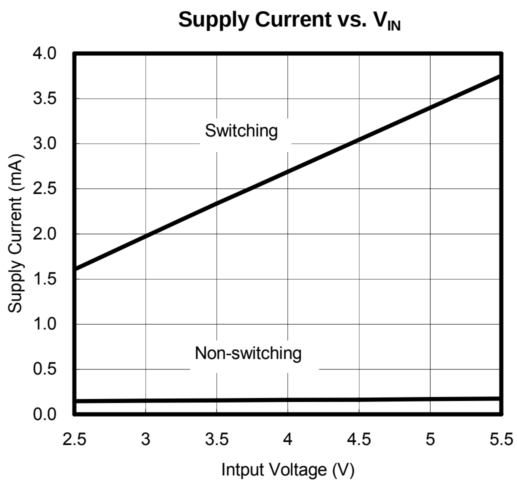
(V_{IN}= $V_{\overline{SHDN}}$ = 3V, T_A = 25°C

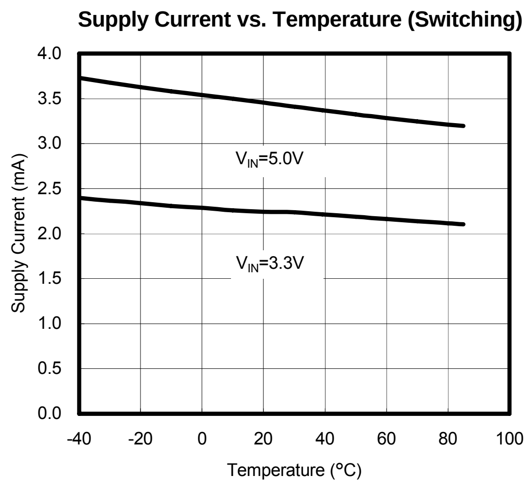
The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

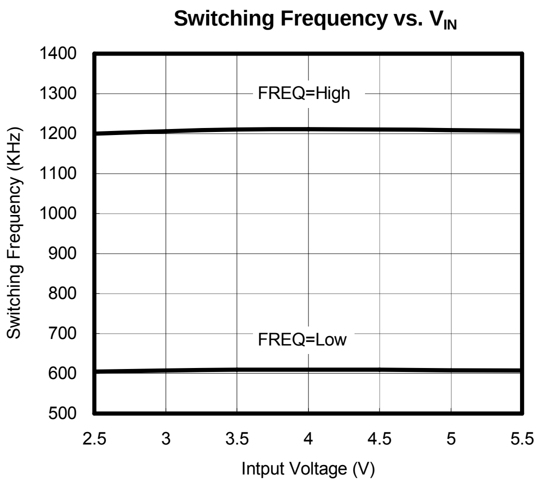
PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}	V_{OUT}<18V	2.5	---	5.5	V
		18V<V_{OUT}<22V	4.0	---	5.5	
Output Voltage Range	V_{OUT}		---	---	22	V
V_{IN} Under Voltage Lockout Threshold	V_{UVLO}	V_{IN} Rising	2.0	2.2	2.5	V
V_{IN} Quiescent Current	I_Q	V_{FB}=1.3V, LX no switching	---	0.12	0.4	mA
		V_{FB}=1.1V, LX switching	---	2	---	mA
V_{IN} Shutdown Current	I_{QSD}	$\overline{SHDN}$ =GND	---	0.1	1	µA
Feedback Voltage	V_{FB}		1.22	1.24	1.26	V
		Temperature Coefficient	---	100	---	ppm/°C
FB Input Bias Current		V_{FB}=1.24V	-20	0	20	nA
FB Line Regulation		2.5V< V_{IN} < 5.5V	---	0.1	0.2	%/V
Transconductance	Gm		100	200	300	µA/V
Voltage Gain	A_V		---	700	---	V/V
Shutdown FB Input Voltage		$\overline{SHDN}$ =V_{IN}	0.05	0.10	0.15	V
Operation Frequency	f_{OSC}	FREQ=GND	450	600	750	kHz
		FREQ=V_{IN}	900	1200	1500	
Maximum Duty Cycle			85	---	---	%
Current Limit	I_{LIM}		3	4	4.8	A
NMOS Switch ON-Resistance	$R_{DS(ON)}$	I_{LX}=1A	---	125	250	mΩ
NMOS Switch Leakage Current	I_{LEAK}	V_{LX}=22V	---	0.1	10	µA
Current Sense Transresistance			---	4	---	A/V
SS Reset Switch Resistance			---	---	100	Ω
Soft Start Current		V_{SS}=1.2V	2.5	4	7.5	µA
Thermal Protection		Trigger	---	150	---	°C
		Hysteresis	---	15	---	
Control Input						
$\overline{SHDN}$, FREQ Input Low Voltage	V_{IL}	V_{IN}=2.6V to 5.5V	---	---	0.8	V
$\overline{SHDN}$, FREQ Input High Voltage	V_{IH}	V_{IN}=2.6V to 5.5V	2	---	---	V
FREQ Pull Low Current			2.3	6.0	9.5	µA
$\overline{SHDN}$ PIN Current		$\overline{SHDN}$ =GND	-0.1	0	0.1	µA
		$\overline{SHDN}$ =V_{IN}	-0.1	0	0.1	µA

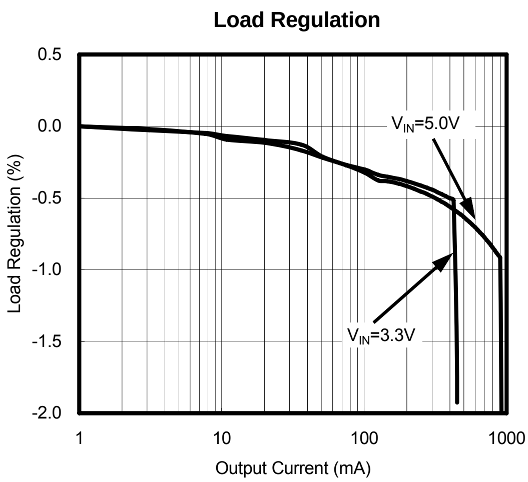
Typical Performance Characteristics

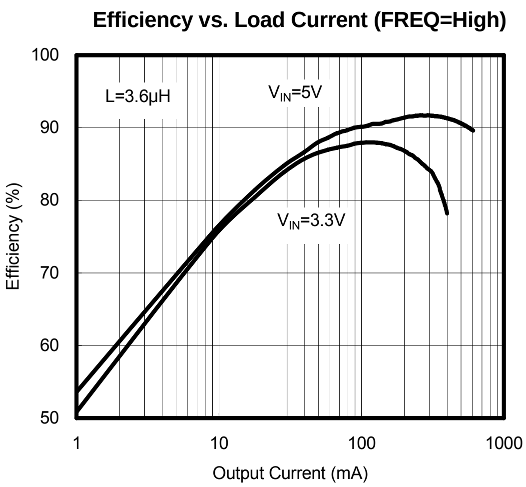
Circuit of Fig. 1, component of table 1, V_{IN}=5V, V_{OUT}=15V, T_A=25°C, unless otherwise noted.

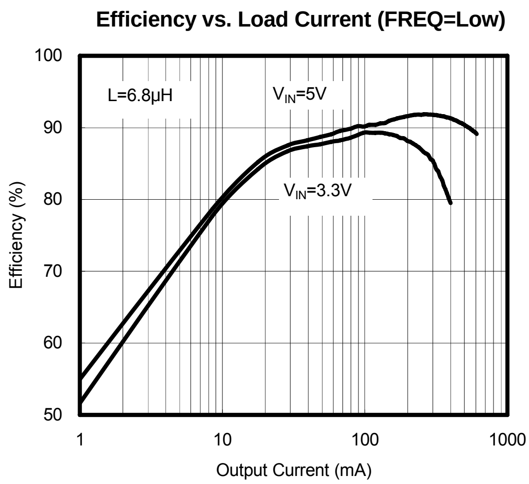






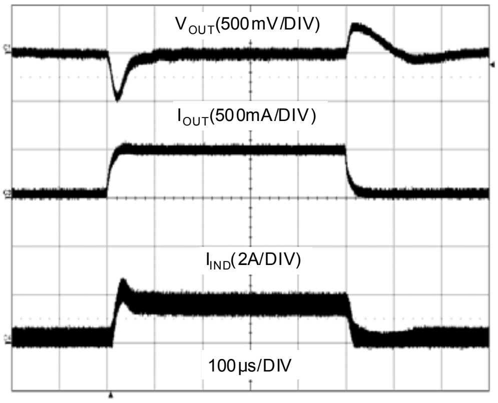




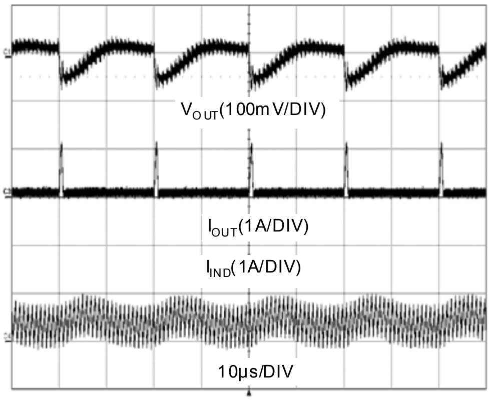


Typical Performance Characteristics (continued)

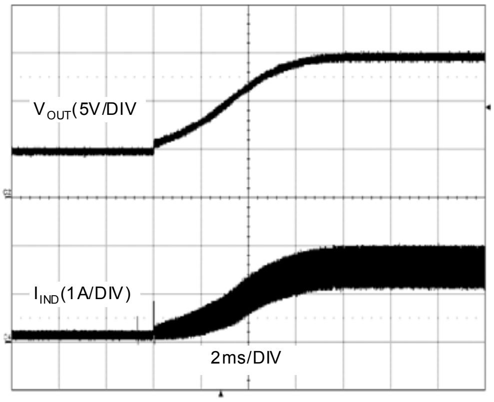
Load Transient (I_{Load}=50mA to 500mA)



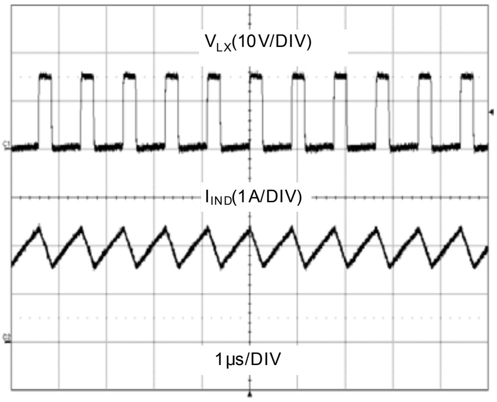
Pulse Load Transient (I_{Load}=100mA to 1.1A)



Soft-Start (R_{Load}=30Ω)

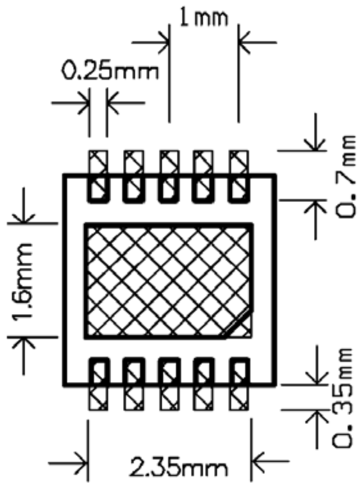


Switching Waveform (I_{Load}=600mA)



Minimum Footprint PCB Layout Section

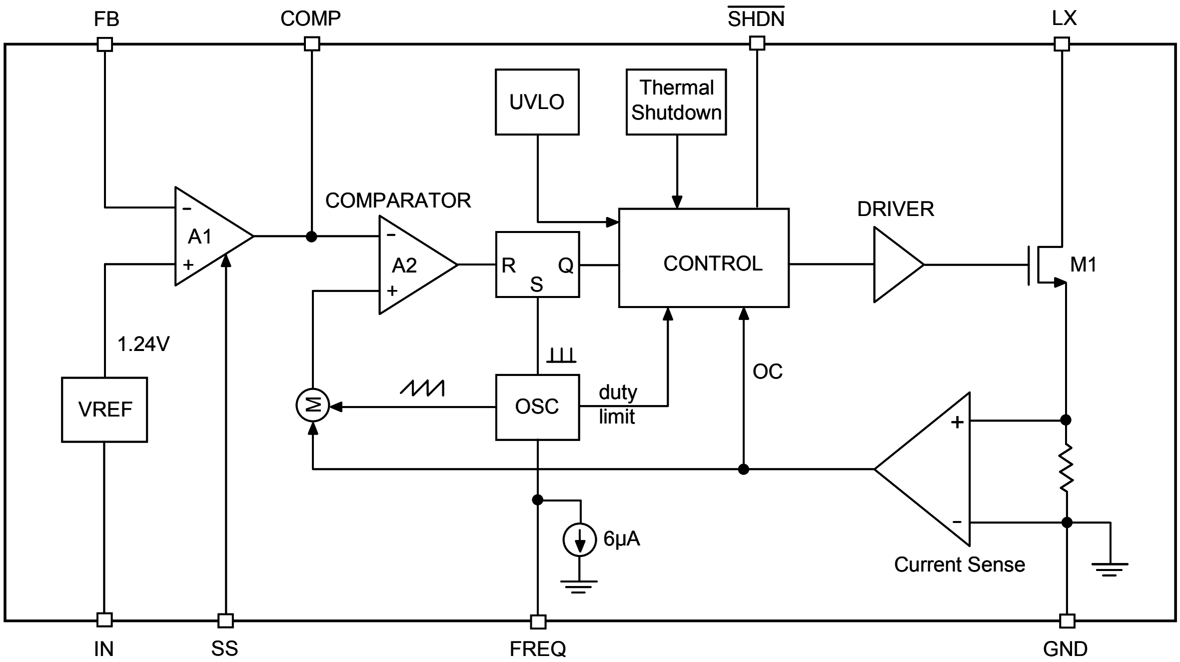
TDFN3X3-10



Pin Descriptions

PIN	NAME	DESCRIPTION
1	COMP	Compensation pin.
2	FB	Feedback pin. VOUT = (1+R1/R2) × 1.24
3	$\overline{SHDN}$	Active low shutdown pin. The pin floating is not permitted.
4,5	GND	Ground pin.
6,7	LX	Switch pin. The drain of the internal NMOS power switch. connect this pin to inductor.
8	IN	Input supply pin. Bypass this pin with a capacitor as close to the device as possible
9	FREQ	Frequency Selection Pin. Connect this pin to logic high for 1.2MHz switching frequency. Otherwise, connect it to ground, or leave it floating to choose 600kHz switching frequency.
10	SS	Soft-Start Pin. Connect a capacitor to this pin as an internal reference voltage bypass capacitor. The ramping time is determined by internal driving current.

Block Diagram



Function Description

Normal Operation

The G5110 uses a constant frequency control scheme to provide excellent line and load regulation. Operation can be best understood by referring to the block diagram. At the start of each oscillator cycle, the SR latch is set, which turns on the power switch M1. The current signal is added to an artificial ramp (slope compensation) to the positive terminal of the PWM comparator A2. When this voltage exceeds the level at the negative input of A2, the SR latch is reset turning off the power switch. The level at the negative input of A2 is set by the error amplifier A1, and is simply an amplified version of the difference between the feedback voltage and the reference voltage of 1.24V. In this manner, the error amplifier sets the correct current level to keep the output in regulation.

Over Voltage Protection

Over voltage protection function is designed to prevent the output accidentally damage the load. Once the device detects over voltage (nominal × 1.1) at the output, the internal NMOS switch turned off to stop power input.

Soft-start

The G5110 can be programmed for soft-start upon power-up with an external capacitor. The internal 4µA current source charges the soft-start capacitor C12 shown in Typical Application Circuit. During this time, the SS pin voltage controls the peak inductor current from 0A to current limit 4A. When $\overline{\text{SHDN}}$ pin pulls low, the soft-start capacitor is discharged to GND.

Applications Information

External-component-value choice is primarily dictated by the output voltage and the maximum load current, as well as maximum and minimum input voltages.

Table 1 provides a list of power components for the typical applications circuit

Inductor Selection

Small form factor and high efficiency are the major concerns for most G5110 applications. Inductor with low core losses and small DCR (cooper wire resistance) are good choice for G5110 applications.

Choose an available inductor value from an appropriate inductor family. Calculate the maximum DC input current at the minimum input voltage $V_{IN(MIN)}$ using conservation of energy and the expected efficiency at that operating point (η_{MIN}) taken from an appropriate curve in the Typical Performance Characteristics:

$$I_{IN(MAX)} = \frac{I_{OUT(MAX)} \times V_{OUT}}{V_{IN(MIN)} \times \eta_{(MIN)}}$$

Calculate the ripple current at that operating point and the peak current required for the inductor:

$$I_{RIPPLE} = \frac{V_{IN(MIN)} \times (V_{OUT} - V_{IN(MIN)})}{L \times f_{OSC} \times V_{OUT}}$$

$$I_{PEAK} = I_{IN(MAX)} + \frac{I_{RIPPLE}}{2}$$

Frequency Selection

The G5110′s frequency can be selected to operate at either 600kHz or 1.2MHz. Connect FREQ to GND for 600kHz operation. For a 1.2MHz switching frequency, connect FREQ to IN. FREQ has an internal pull-low current allowing the user leaving FREQ unconnected for 600kHz operation.

Output Voltage Selection

The regulated output voltage is calculated by the following formula:

$$V_{OUT} = 1.24V \times \left(1 + \frac{R1}{R2}\right)$$

The recommended value for R2 should be up to 100kΩ. Place R1 and R2 as close the chip as possible.

Loop Compensation

As shown in Typical Application Circuit, the voltage feedback loop needs proper compensation to prevent excessive output ripple and poor efficiency caused by instability. Connect a R_{COMP} (R3) and C_{COMP} (C8) in series from COMP pin to GND. And C_{COMP2} (C9) from COMP to GND. R_{COMP} is chosen to set the high-frequency integrator gain for fast transient response, while C_{COMP} is chosen to set the integrator zero to maintain loop stability. The second capacitor C_{COMP2} is chosen to cancel the zero introduced by output-capacitance ESR. For optimal performance, choose the components by the following equations:

$$R3 \approx \frac{315 \times V_{IN} \times V_{OUT} \times C_{OUT}}{L \times I_{OUT(MAX)}}$$

$$C8 \approx \frac{V_{OUT} \times C_{OUT}}{10 \times I_{OUT(MAX)} \times R3}$$

$$C9 \approx \frac{0.0036 \times R_{ESR} \times L \times I_{OUT(MAX)}}{V_{IN} \times V_{OUT}}$$

For the ceramic output capacitor, where ESR is small, C_{COMP2} is optional. The best gauge of correct loop compensation is by inspecting the transient response of the G5110. Adjust R_{COMP} and C_{COMP} as necessary to obtain optimal transient performance.

Capacitor Selection

The small size of ceramic capacitors makes them suitable for G5110 applications. X5R and X7R types are recommended for the output capacitors because they retain their capacitance over wider voltage and temperature ranges than other types such as Y5V or Z5U. A 10μF or 22μF capacitor for input and output are recommended for most applications.

Diode Selection

Schottky diodes, with their low forward voltage drop and fast reverse recovery, are the ideal choices for G5110 applications. The forward voltage drop of a Schottky diode represents the conduction losses in the diode, while the diode capacitance (CT or CD) represents the switching losses. For diode selection, both forward voltage drop and diode capacitance need to be considered. Schottky diodes with higher current ratings usually have lower forward voltage drop and larger diode capacitance, which can cause significant switching losses of the G5110. The Schottky diode is rated at least peak inductor current, the current limit is 4A in G5110.

Multiple-Output Power Supply for TFT LCD

A power supply for active-matrix TFT LCD flat-panel displays is shown in Figure 1. Output-voltage transient performance is a function of the load characteristic. The G5110 could meet the required transient performance by adding or remove output capacitance or recalculating compensation-network component values. Regulation performance for secondary outputs (V_{GH} and V_{GL}) depends on the load characteristics of all three outputs.

Layout considerations

- Power loops of the converters should be connected with the shortest and widest traces as possible. The long and narrow trace increases the ESR and ESL, and that will induce more effective noise at high frequency easily.
- Separate the power ground and analog signal ground into different planes to prevent the interference, and connect these two parts at the VOUT output capacitor′s ground.
- The placements of the input bypass capacitor of pin IN must be as close as possible to the G5110 to reduce the input ripple voltage and noise coupling. The ground of input bypass capacitor must connect near to the IC′s ground pin.
- The feedback resistors and compensation network should connect to G5110 as close as possible. And each route should keep away from the switching noise source, such as Boost converter power loops.

Table 1. Component Selection for Standard Application:

Component	Description
Input Capacitor C3	**Taiyo Yuden CO., LTD.** 10µF/6.3V/X5R JMK212BJ106KG
Output Capacitor C4, C5, C6	**Taiyo Yuden CO., LTD.** 4.7µF/25V/X5R TMK316BJ475KD
Inductor L1	**Taiyo Yuden CO., LTD.** NR8040T3R6N 3.6µH
Rectifier Diode D1	**ZOWIE Technology Corporation** SCD34L 3A, 40V, Schottky Diode
Charge-pump Rectifier Diode D2, D3	**ZOWIE Technology Corporation** BAT54RS 200mA, 30V Schottky Diode

Standard TFT-LCD System Application Circuit

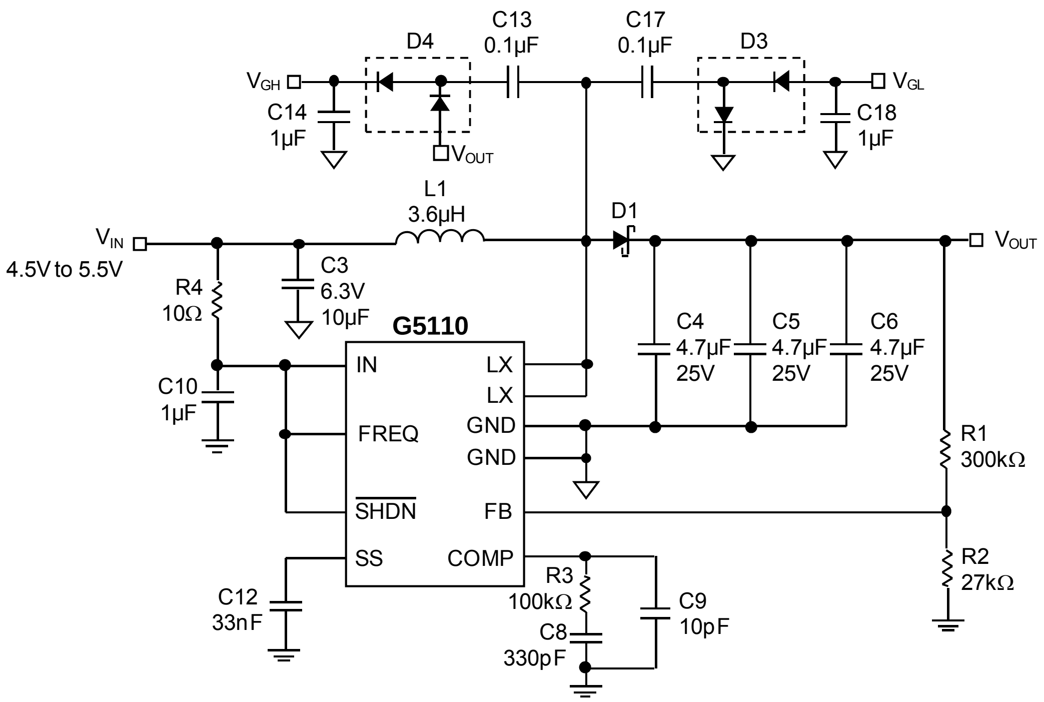
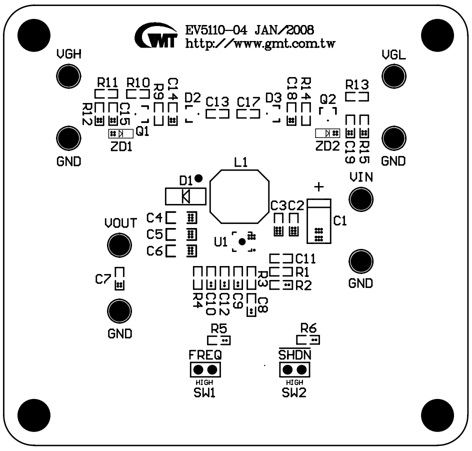


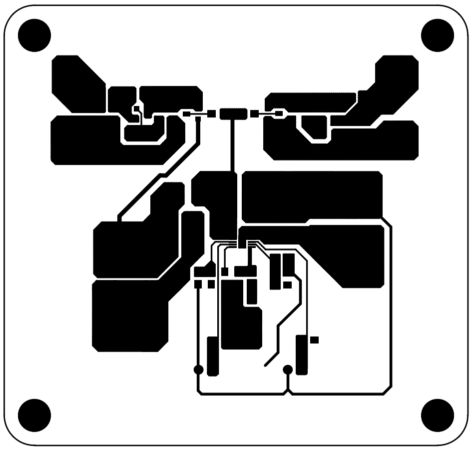
Figure 1. TFT-LCD Power Supply with V_{GH} & V_{GL}

EV5110 PCB Layout

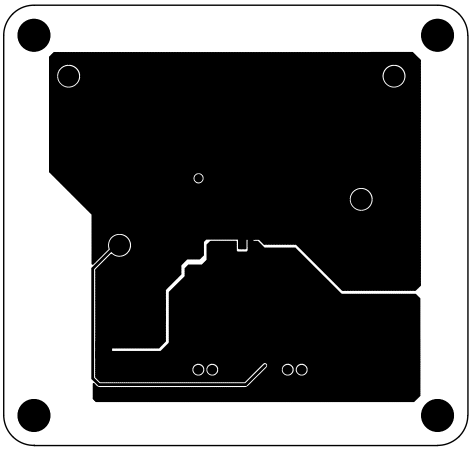
Top Over Layer



Top Layer

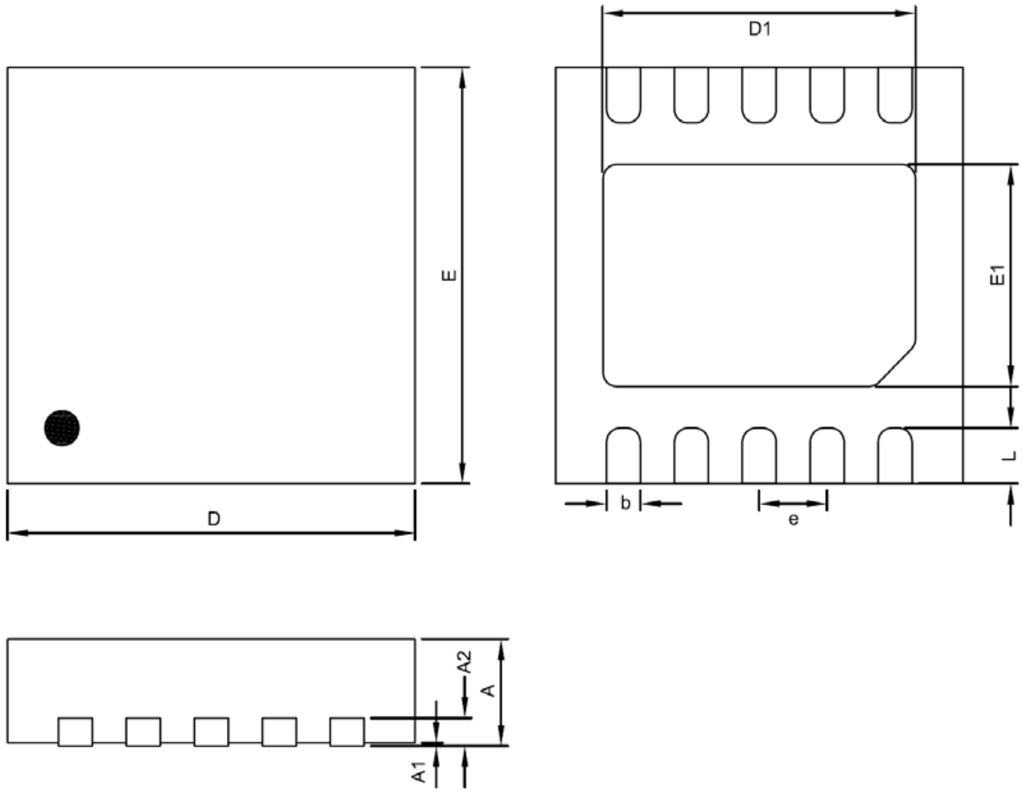


Bottom Layer



EV5110-04 PCB	Information
Board Material	FR4
Size	84.5mm × 80mm
Board Thickness	1.6mm
Layers	2
Copper Thickness	2 oz.

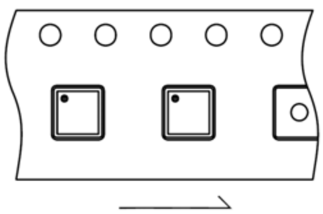
Package Information



TDFN3X3-10 Package

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.0276	0.0295	0.0315
A1	0.00	- - -	0.05	0.0000	- - -	0.0020
A2	0.19	0.20	0.21	0.0075	0.0079	0.0083
D	2.95	3.00	3.05	0.1161	0.1181	0.1201
E	2.95	3.00	3.05	0.1161	0.1181	0.1201
D1	2.20	2.30	2.40	0.0866	0.0906	0.0945
E1	1.40	1.50	1.60	0.0551	0.0591	0.0630
b	0.18	0.25	0.30	0.0071	0.0098	0.0118
e	0.50 BSC			0.0197 BSC		
L	0.35	0.40	0.45	0.0138	0.0157	0.0177

Taping Specification



PACKAGE	Q'TY/REEL
TDFN3X3-10	3,000 ea