DX6210 High Power Factor,Low THD,Isolated Offline LED Controller

Features

- Single stage PFC,up to 100W power range
- Primary side regulation without Secondary Feedback
- Quasi Resonance (QR) mode with Fly-back and Buck Boost topology
- Real-Current control to meet accurate
- output current
- Very less components
- Programmable input AC voltage compensation
- Leading Edge Blanking on CS/FB pin
- Protection Features
  - Building in hysteresis OTP
  - VDD over voltage protection
  - Cycle by cycle current limiting on CS pin
  - Secondary peak current protection on CS pin
  - Output short to GND protection
  - Output programmable over voltage protection

FB and CS pins default protection

Applications

- LED lighting

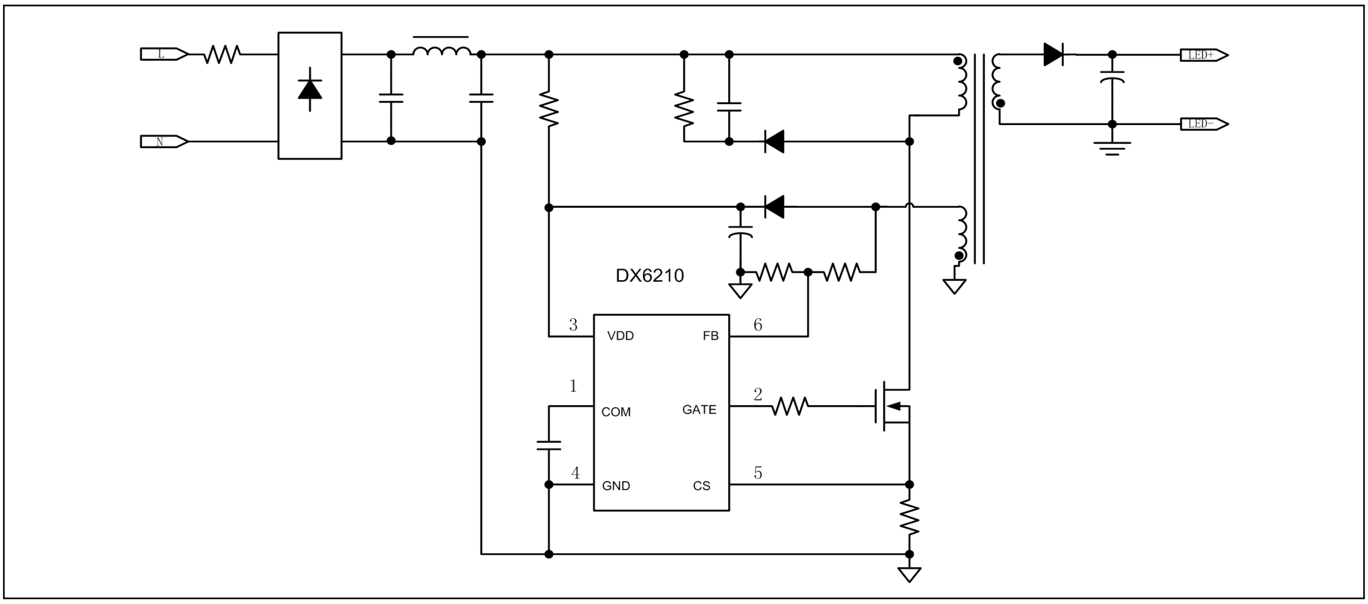
Description

The DX6210 is a single-power stage, isolated fly-back and non-isolated Buck boost configuration,which is adopts the primary side offline LED lighting regulator to achieve high power factor . The proprietary real-current control method can control the LED current accurately from the primary side information . It can significantly simplify the LED lighting system design by eliminating the secondary side feedback components and the opto-coupler .

The DX6210 integrates active power factor correction and works in Quasi Resonance mode (QRM) in order to reduce the MOSFET switching losses to provide a high efficiency solution for lighting applications. The external programmable line voltage compensation provides a more precise output current throughout the universal AC input voltage range. The leading edge blanking circuit on the CS/FB input removes the signal glitch and results in reduced external components and system cost.

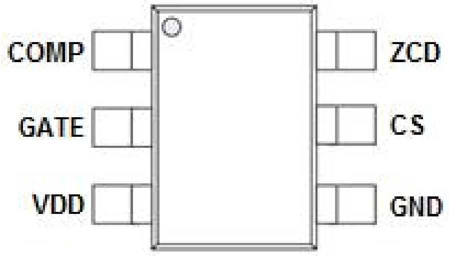
The multi-protection features of DX6210 greatly enhance the system reliability and safety . The DX6210 features VDD and output over voltage protection; output short circuit protection, cycle-by-cycle current limit and secondary peak current protection on CS pin, VDD UVLO and auto-restart and over-temperature protection. The driver output voltage is clamped at 18V to protect the external power MOSFET .

Typical Application



Pin Configuration and Marking Information

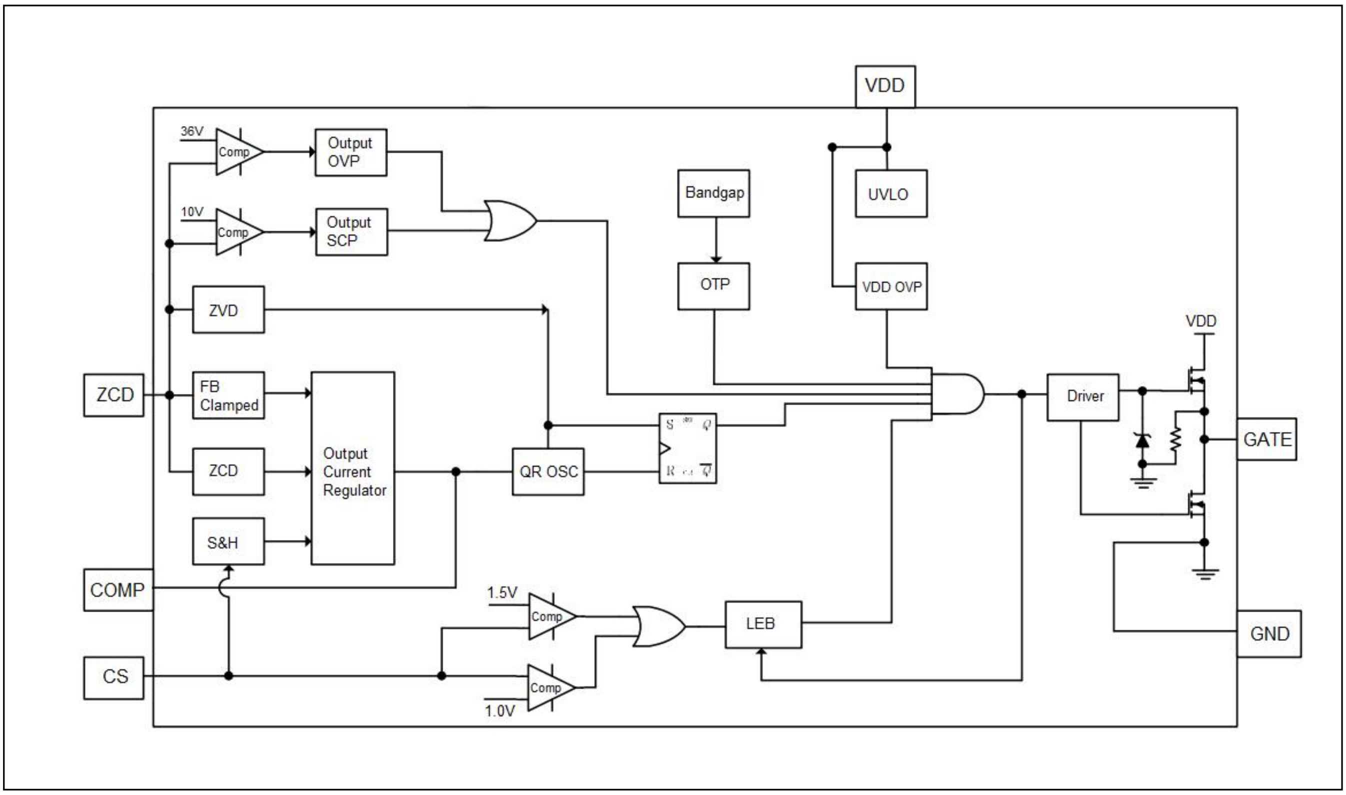
The DX6210 is available in SOT23-6 package



Pin Definition

Pin No.	Name	Description
1	COMP	Loop compensation for constant current regulation. Output of the OTA. The RC network is placed between it and GND.
2	GATE	Totem-pole output to drive the external power MOSFET,Maximum Voltage is internally clamped to 18V .
3	VDD	Power Supply
4	GND	Power Ground
5	CS	Current sense pin, a resistor connects to sense the MOSFET current
6	ZCD	Detect output diode zero current to regulate output current.Connected to a resistor divider for sensing the reflected voltage from auxiliary winding.

Internal Block Diagram



Absolute Maximum Ratings(@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Min.	Max.	Unit
V_{DD}	Maximum supply voltage on VDD pin	28		V
V_{ZCD}	Input Voltage to FB Pin	-0.3	6	V
V_{CS}		-0.3	6	V
V_{COMP}		-0.3	6	V
ESD Capability	HBM model		2000	V
	Machine Model		200	V
T_{max}	Maximum Operating Junction Temperature	-40	125	℃
T_{STG}	Storage Temperature Range	-55	150	℃

Notes:

1.Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device.

2.All voltages,except differential voltages,are given with respect to the GND pin.

Electrical Characteristics (TA=25℃ and VDD=18V unless otherwise specified.)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{DD} Pin						
V_{DD_ON}	Turn-on Threshold Voltage		-	16	-	V
I_{VDD}	Operating Current		-	1	-	mA
V_{UVLO}	Turn-off Threshold Voltage		-	9	-	V
V_{DD_OVP}	VDD Over Voltage Protection		-	25	-	V
COMP Pin						
V_{REF}	Reference voltage for OTA input		-	0.2	-	V
I_{CMP_SINK}	CMP maximal sink current		-	50	-	uA
I_{CMP_SOURCE}	CMP maximal source current		-	10	-	uA
V_{CMP_MAX}	CMP maximal voltage		-	4	-	V
FB Pin						
V_{FB_ZVD}	FB zero voltage detect		-	0.2	-	V
V_{FB_OVP}	FB voltage when Output OVP		-	3.6	-	V
V_{FB_SCP}	FB voltage when trigger SCP		-	1.0	-	V
CS Pin						
V_{CS}	Cycle by Cycle current limited on CS	FB=0	-	1	-	V
T_{BLANK}	Leading-Edge Blanking Time		300	400	500	ns
Oscillator						
F_{OSC_MAX}	Maximal Frequency		-	130	-	kHz
F_{OSC_MIN}	Minimal Frequency		-	30	-	kHz
GATE Pin						

T_{RISE}	Rise time	C_L =1nF	-	200	-	ns
T_{FALL}	Fall time	C_L =1nF	-	100	-	ns
Over Temperature Protection						
OTPH	Over Temperature Lockout		-	120	-	℃
OTPL	Over Temperature Resume		-	100	-	℃
Note: These parameters,although guaranteed,are not 100% tested in production.						

Operation

The DX6210 is a primary side control offline LED controller that incorporates all the features for high performance LED lighting. LED current can be accurately controlled with the real current control method form the primary side information. Active Power Factor Correction (PFC) is included to eliminate the unwanted harmonic noise injected onto the AC line.

Startup

During start-up, the current can charge up the VDD hold capacitor . the turn-on and turn-off thresholds of DX6210 are approximately 15Vand 9V respectively .The 6V hysteresis voltage is implemented to prevent shutdown from a voltage dip during start-up.

Quasi Resonance mode (QRM)

During the external power MOSFET on time (T_{ON}), the rectified input voltage is applied across the primary side inductor (L_m)and the primary current increases linearly from zero to the peak value (I_{PK}). When the external power MOSFET turns off, the energy stored in the inductor forces the secondary side diode to be turn-on, and the current of the inductor begins to decrease linearly from the peak value to zero. When the current decreases to zero, the parasitic resonant of inductor and all the parasitic capacitance makes the power MOSFET drain-source voltage decrease, this decreasing is also reflected on the auxiliary winding. The zero-current detector in FB pin generates the turn on signal of the MOSFET when the FB voltage is lower than 0.2V and ensures the MOSFET turn on at a valley voltage . As a result, there are virtually no primary switch turn-on losses and no secondary diode reverse-recover losses. It ensures high efficiency and low EMI noise.

Active Power Factor Correction

DX6210 is designed with quasi-resonance and constant on time T_{on} to achieve high power factor under normal operation. The on time of DX6210 vary with input AC voltage $V_p \mathrm{Sin}\omega t$ and load condition and its value is constant basically because of very large loop compensation capacitance on COMP pin. According to following equations,

$$I_{L-peak} = \frac{V_p \mathrm{Sin}\omega t}{L_m} \times T_{on} \quad I_{L-avg} = \frac{V_p \mathrm{Sin}\omega t}{2 \times L_m} \times T_{on}^2 \times f_{osc}$$

The peak current $I_{L\text{-}peak}$ and average current $I_{L\text{-}avg}$ of transformer will be shaped as AC input sinusoid too because T_{on} and f_{osc} both are constant and then high power factor can be achieved.

Current Regulator

The proprietary real current control method allows the DX6210 to accurately control the secondary side LED current from the primary side information. The output LED current can be calculated approximately as:

$$I_{out} = \frac{1}{10 \times R_{CS}} \times V_{REF} \times \frac{N_P}{N_S}$$

Where I_{OUT} is the secondary output current of LED, V_{REF} is the inner reference voltage.N_P is number of turns of primary winding and N_S is number of turns of the secondary winding.

Auto Starter

The DX6210 integrates an auto starter, the starter starts timing when the MOSFET is turned on, if FB fails to send out another turn on signal after 130μs, the starter will automatically send out the turn on signal which can avoid the IC unnecessary shut down by FB missing detection.

Minimal Off Time

The DX6210 operates with variable switching frequency . The frequency is changing with the input instantaneous line voltage.To limit the maximum frequency and get a good EMI performance,DX6210 employs an internal minimum off time limiter 3.5μs.

Leading-Edge Blanking for CS pin

In order to avoid the premature termination of the switching pulse due to the parasitic capacitance
Discharging at MOSFET turning on, an internal leading edge blanking (LEB) unit is employed between the CS Pin and the current comparator input. During the blanking time, the path,CS Pin to the current comparator input, is blocked. Figure shows the leading edge blanking.

Output over Voltage Protection

Output over voltage protection can prevent the components from damage in the over voltage condition.

The positive plateau of auxiliary winding voltage is proportional to the output voltage. The OVP use the auxiliary winding voltage instead of directly monitoring the output voltage. Once the FB pin voltage is higher than 3.6V,the OVP signal will be triggered and latched, the gate driver will be turned off and the IC work at quiescent mode, the VDD voltage dropped below the UVLO which will make the IC shut down and the system restarts again.The output OVP setting point can be calculated as:

$$V_{OUT\_OVP} \approx 3.6 \times \frac{N_S}{N_{AUX}} \times \frac{R_{FBH} + R_{FBL}}{R_{FBL}}$$

V_{OUT_OVP}: Output over voltage protection value

N_{AUX}: The auxiliary winding turns

N_S:The secondary winding turns

The good input line regulation can fine turn the R_{FBH} value according to the desire request,if decrease the value of R_{FBH} resistor can get high negative current during t_off period,and the output current could be affected low down at the high mains voltage condition, otherwise,the bigger R_{FBH} resistor do the less regulate to the output current.

Current Limit

The current limit circuit senses the current of inductor by CS pin. When this current exceeds the internal threshold, typical is1.0V , the power
MOSFET is turned off for the remainder of that cycle.

Leading-Edge Blanking For FB

When the power MOSFET is turned off, a damping voltage spike will occur at FB pin due to parasitic capacitance of power MOSFET and leak inductor of transformer. An internal leading edge blanking (LEB) was introduced to filter this noise.

Output Short Circuit Protection

When the output short circuit happens, the positive plateau of auxiliary winding voltage is also near zero. The IC will shut down and restart again once FB voltage falls below 1.0V and lasts for about 20mS.

Thermal Shut Down

The thermal shutdown circuitry senses the die temperature. The threshold is set at 150°C typical with a 25°C hysteresis. When the die temperature rises above this threshold (150°C), the DX6210 turn off the power MOSFET by DRV and remains turning off until the die temperature falls by 25°C, at which point it is re-enabled.

VDD over Voltage Protection

DX6210 provides an over voltage protection circuit for VDD pin.The GATE output will shut down once the VDD voltage exceeds 25V (typical value),the IC would restart until VDD drops to 9.0V .

Fault protection

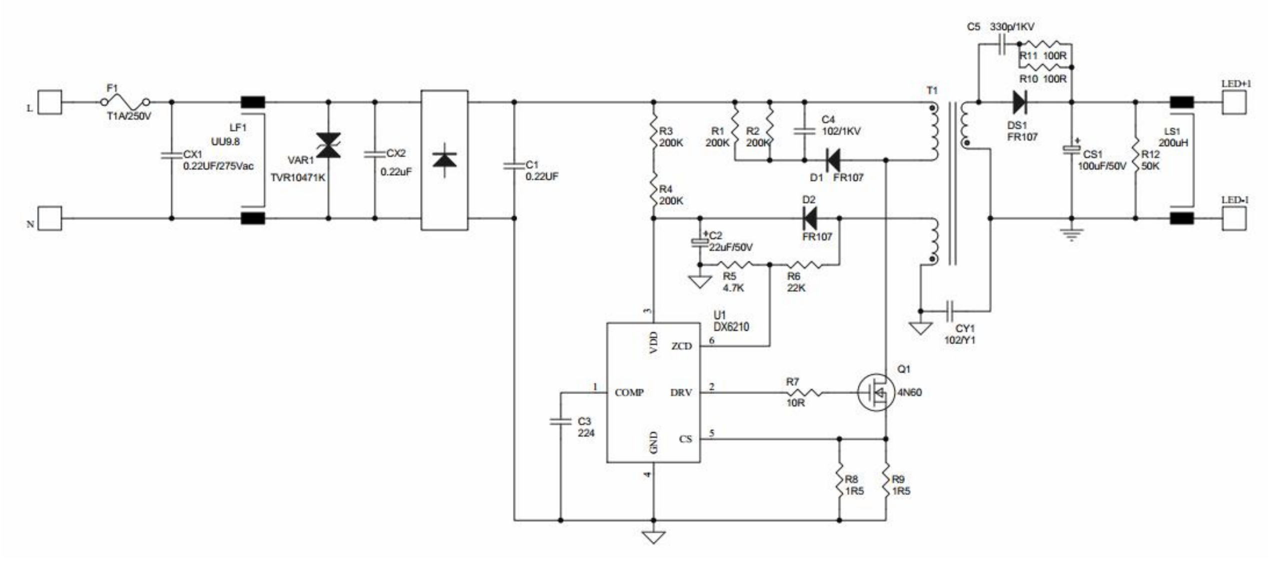
There is several default protections were integrated in the DX6210 to prevent the IC from being damaged which including FB pin open or short as well as CS pin open.

PCB Layout Guidelines

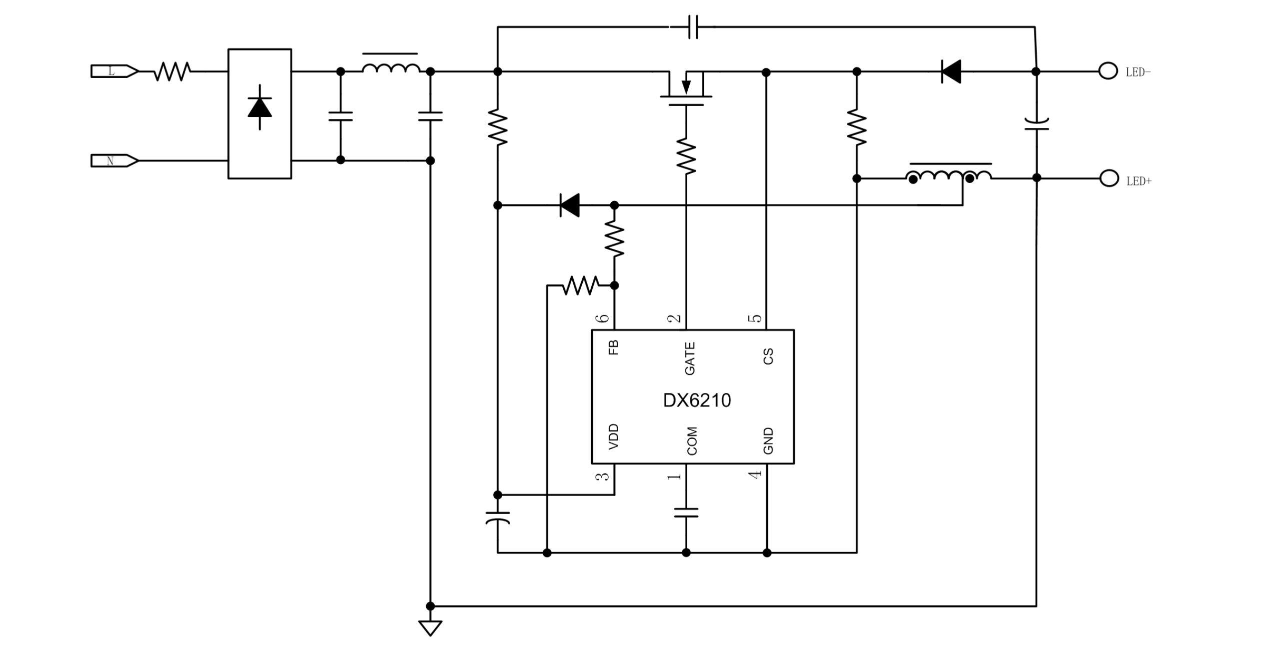
For best performance of the DX6210, like as the good EMI and stable performance in high power LED application,the following layout guidelines should be strictly followed.

- The power supply capacitor must be placed as close as possible to the VDD pin.
- The IC CS pin are high frequency switching nodes. The traces must be as wide and short as possible.
- Keep the main trance with switching current(the rectified mains voltage→ Primary winding→Drain of MOSFET→Source of MOSFET→ CS resistors→ Bulk capacitor- →Rectified GND) as short as possible for better EMI.
- Put the AC input trace far away from the DC trace and the switching nodes to minimum the noise coupling.
- The IC FB pin affects ZCD, OVP and line regulation,The R_{FBH} ,R_{FBL} resistors must be as close to IC FB pin as possible.

Isolated Fly-back Reference Schematic

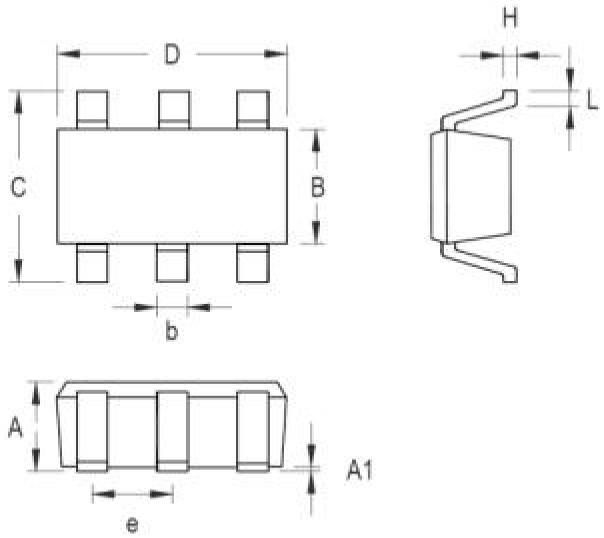


Non-isolated Buck Boost Reference Schematic



Package Information

SOT23-6 Package Outline Dimensions



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.250	0.559	0.010	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

NOTE:

1.We strongly recommend customers check carefully on the trademark when buying our product, if there is any question, please don't be hesitate to contact us.

2.Please do not exceed the absolute maximum ratings of the device when circuit designing.

3.Winsemi Microelectronics Co., Ltd reserved the right to make changes in this specification sheet and is subject to change without prior notice.

CONTACT:

Winsemi Microelectronics Co., Ltd.

ADD:Futian District, ShenZhen Tian An Cyber Tech Plaza two East Wing 1002
Post Code : 518040
Tel : +86-755-8250 6288
FAX : +86-755-8250 6299
Web Site : www.winsemi.com