DX3522

TRIAC dimmable,Non-isolated Offline LED Controller

DESCRIPTION

The DX3522 is a highly integrated with the high power factor correction controller for non-isolated BUCK , BUCK BOOST,BOOST configuration application,it uses advanced algorithm to detect the dimmer phase angle and dim the LED output current accordingly.

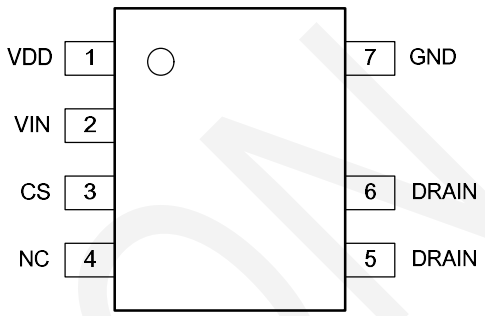
The DX3522 can be operated in Discontinuous Conducted Mode(DCM) and Slightly Continuous Conducted Mode(sCCM) to get ease EMI designing and good dimmer compatibility.

The DX3522 build-in high voltage MOSFET and few of external components,DX3522 is suitable for compact and cost-effective dimmable system design.

The DX3522 build-in multiple protections: OCP,UVLO, high temperature foldback, Output Short-circuit Protection and selectable output open circuit protection etc.

PIN ASSIGNMENTS

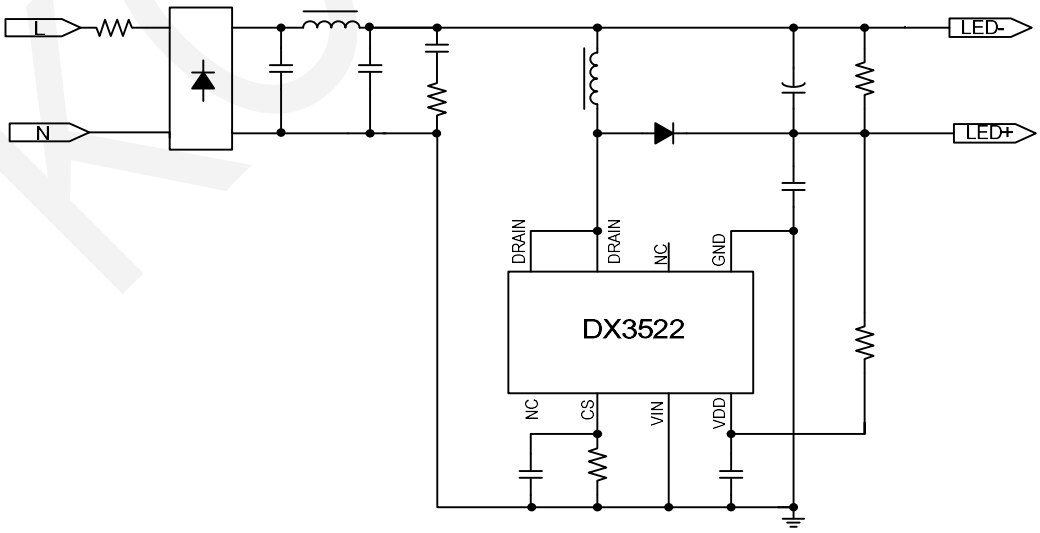
SOIC-7



APPLICATIONS

- 120VAC,230VAC TRIAC dimmable LED lighting
- Residential and Commercial lighting
- Retrofit A19,GU10 and filament bulb

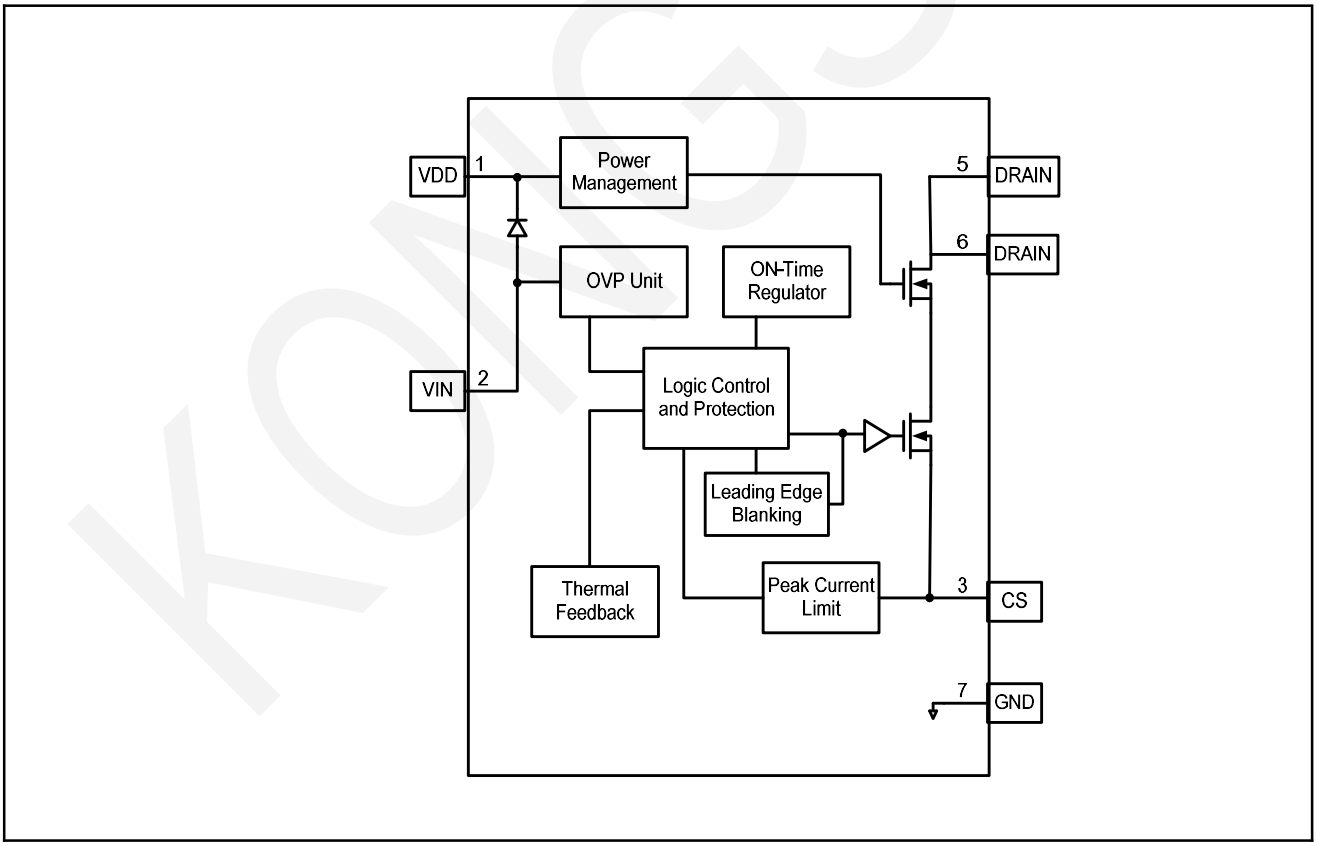
TYPICAL APPLICATION



FEATURES

- Design for Buck/BuckBoost/Boost topology
- Controller bases on 4pins configuration
- Compatible with 120VAC/230VAC phase-cut dimmers
- Lowest start up current(<15uA)
- High Power Factor Correction(PF>0.9)
- Accurate current control
- Available in SOIC-7/DIP-7 package
- Protections
  - Cycle-by-Cycle Current Limit
  - Over Current Protection
  - Selectable output over voltage protection
  - Output short circuit protection
  - High Temperature foldback

FUNCTION DIAGRAM



PIN FUNCTIONS

Pin#	Name	Description
1	VDD	Power supply. VDD supplies power for the controller.Connect VCC to an external capacitor.
2	VIN	Input & Output voltage detection. connect a resistor from VIN to LED+,VIN senses the variation of the input voltage and output voltage to response for start up and output open circuit protection.
3	CS	Current sense of the internal power MOSFET. Connect a resistor form CS to GND to cycle by cycle sense the current through the inductor.
4	NC	Not connected.
5,6	DRAIN	Drain of the internal power MOSFET.
7	GND	Ground. GND is the virtual ground of the IC.

ABSOLUTE MAXIMUM RATINGS(@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Min.	Max.	Unit
V_{DD}	Supply voltage	-0.3	20	V
I_{VDD}	Input current on pin V_{DD}	-	10	mA
V_{IN}	Input voltage on pin V_{IN}	-0.3	20	V
V_{CS}	Input voltage on pin V_{CS}	-0.3	7	V
I_{VIN}	Input current on pin V_{IN}	-	10	mA
ESD	Human Body mode	-	2000	V
	Machine mode	-	200	V
θ_{JA}	Thermal Resistance(Junction to Ambient)	-	158	˚C/W
T_J	Operation Junction Temperature	-40	150	˚C
T_{STG}	Storage Temperature	-55	150	˚C

Notes:

1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Functional operation above the Recommended Operating Conditions is not implied.Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.
2. All voltage values.except differential voltages.are given with respect to GND pin.

ELECTRICAL CHARACTERICS

(T_A=25℃ and V_{DD}=18V unless otherwise specified.)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
Supply voltage (V_{CC})						
V_{DD_ON}	Start up voltage		-	15.3	-	V
I_{VDD}	Operation current	@V_{DD}=V_{DD_ON}	-	150	-	uA
V_{UVLO}	Under voltage lockout threshold		-	6.3	-	V
I_{START}	Start up current	@V_{DD}=V_{DD_ON}-1V	-	15	-	uA
V_{CLAMP}	VCC clamp voltage	@ I_{VDD}=5mA	-	18.7	-	V
Startup and Over Voltage Protection(V_{IN})						
I_{VIN}	Input current threshold @ OVP		-	100	-	uA
I_{VIN_MAX}	Maximum VIN input current		-	1	-	mA
Current Sensing (V_{CS})						
V_{CS_LIMIT}	Peak current limit		0.50	0.52	0.54	V
t_{delay}	Gate driver delay time		-	100	-	ns
t_{LEB}	Leading-Edge Blanking Time		-	350	-	ns

Internal Hight Voltage MOSFET						
$R_{DS(ON)}$	Drain-Source On-State Resistance	DX3522A	-	15	-	Ω
		DX3522E	-	8	-	Ω
		DX3522T/D	-	6.5	-	Ω
		DX3522C	-	3	-	Ω
		DX3523T	-	2	-	Ω
$V_{DS(DRAIN)}$	Drain-Source Breakdown Voltage	DX3522A	550	-	-	V
		DX3522E	650	-	-	V
		DX3522T/D	550	-	-	V
		DX3522C	550	-	-	V
		DX3523T	300	-	-	V
I_{DSS}	Drain-Source Leakage Current	DX3522A @V_{GS}=0V,V_{DS}=550V	-	-	10	uA
		DX3522E @V_{GS}=0V,V_{DS}=650V	-	-	10	uA
		DX3522T /D @V_{GS}=0V,V_{DS}=550V	-	-	10	uA
		DX3522C @V_{GS}=0V,V_{DS}=550V	-	-	10	uA
		DX3523T @V_{GS}=0V,V_{DS}=300V	-	-	10	uA
Over-Temperature Foldback						
T_{OTP_FB}	Threshold Temperature Feedback		140	150	160	˚C
Δ_{Vcs}	V_{CS} voltage drop every 10 ˚C	Temp>T_{OTP_FB}	-	85	-	mV

Notes:

1. Production testing of the device is performed at 25˚C.Functional operation of the device and parameters are guaranteed by design,characterization and process control.

FUNCTION DESCRIPTION

The DX3522 is a highly integrated and cost-effective AC/DC offline power supply controller for the conventional TRIAC dimmable LED lighting applications. It bases on 4pins configuration to achieve both the high power factor correction(PF>0.7~0.9) and accurate LED current controlling.

The DX3522 operates in discontinue conducted mode(DCM) with adjustable valley switching to get easy Electromagnetic Interference(EMI).

The DX3522 can both be designed in floating ground and low-side switching configuration for BUCK and BUCK BOOST application, it uses a single winding inductor and minimal number of external components,provides a competitive solution in 120VAC/230VAC non-isolated dimmable applications, especially for small form-factor applications.

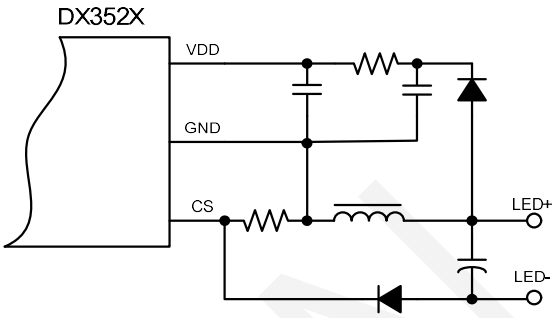


Figure1:Floating ground supply

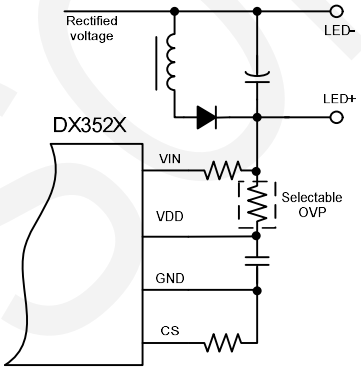


Figure2: low-side switching supply

Start-up and Power supply

The DX3522 uses the startup resistor from the rectified mains voltage to charge V_{DD} capacitor,until the V_{DD} capacitor is charged to the desired start-up voltage(V_{CC_ON}),then the DX3522 starts switching. During normal operation, the LED+ output voltage provides the sufficient V_{DD} supply,if V_{DD} cannot provide enough power supply at the deep dimming angle, It's recommended to using floating ground supply for high efficiency design and the low-side switching supply for compact and lowest E-bom cost requirement.(see figure 1 and figur2)

When a fault conditions occurs,such as OVP or OTP, the DX3522 stops working until VDD voltage drops below $V_{UVLO,}$ then DX3522 enter into restart-up operation.

Peak Current Regulator

The DX3522 contains a highly accurate peak current detector. It triggers when the voltage on the CS pin reaches the limit level V_{CS_LIMIT} ,then turns off the integrated MOSFET and turns on is determined by the demagnetization status on the drain voltage of the internal MOSFET, when the lowest voltage is detected,the internal low side switch is switched on. Thus the output current can be regulated and the output current is determined by the following equation:

$$I_{PK} = \frac{V_{CS\_LIMIT}}{R_{sense}} = \frac{0.52}{R_{sense}}$$

For the low-side switching design, the demagnetization time is also affected by the capacitor on CS pin, the appropriate demagnetization time can be fine-tuning well by adjust the capacitance and the inductance.

Leading Edge Blanking

The DX3522 build-in an internal Leading Edge Blanking(LEB) to prevent false detection of spike current on CS pin.because the parasitic capacitor in the circuit can causes high current spike during the turn-on of the internal MOSFET.During the blanking time,current comparator is disable and blocked from turning off the internal MOSFET. Figure3 shows the leading edge blanking.

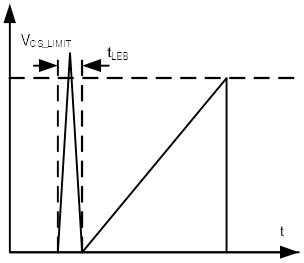


Figure 3: Leading Edge Blanking(LEB)

Short Circuit Protection(SCP)

When the LED short circuit occurs,the switching off time extends to an uncertainly time. Which mainly determined by the magnetization status of the inductor. Then the output power at this condition is limited at a safe range. The DX3522 resumes work at normal operation once the short circuit releases.

Over Voltage Protection(OVP)

The DX3522 build-in a selectable over voltage protection: auto-restart and latch mode or disable OVP mode,which it is selected by user for various design requirement. As figure 2 shown, DX3522 senses the LED output voltage though a resistor from LED+ connecting to V_{IN} pin, when the LED open circuit occurs,the current of the V_{IN} resistor exceeds $I_{VIN,}$ The internal MOSFET is turned off , the DX3522 resumes work until the LED reconnects to the circuit.

The latch mode of DX3522 uses a resistor to connect to V_{IN} pin and Drain pin as figure 4 shown.when LED open occurs,the internal MOSFET turns off by detecting the variation of the Drain voltage through V_{IN} pin,and the DX3522 shut down and latched, the system will resume after the AC source supply has reset and power up.

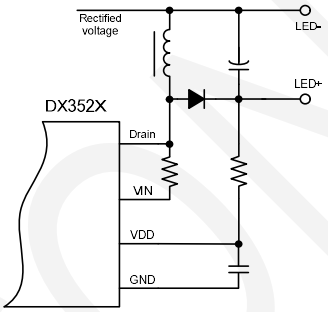


Figure 4: OVP schematic

To prevent the false detection in an un-known operated condition,It is recommended to disable the OVP function for the high PF dimmable application.As figure 1 shown, V_{IN} pin be Connected to GND directly.

Thermal Foldback

The DX3522 integrates high temperature foldback function to limit the power dissipation while an abnormal condition occurring. When IC junction temperature exceeds $T_{OTP\_FB,}$ the LED output current decreases linearly with the preset curve internally, thus the total power dissipation in the application reduces and the further temperature increasing is slowed down.Figure 5 shows the thermal foldback curve.

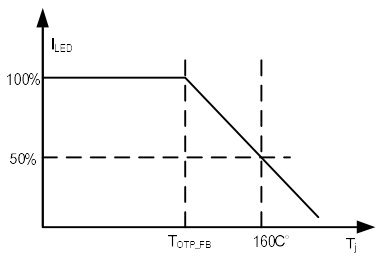


Figure 5: Thermal Foldback Curve

Inductor Selection

For high power factor application,the inductance range is defined by peak current of inductor and maximum and minimum value of switching on time and off time. The minimum switching frequency should be considered with EMI results and inductor dimension, below equation shows the BUCK BOOST inductance calculation:

$$L = \frac{\sqrt{2} \cdot V_{in} \cdot V_O}{I_{PK} \cdot (\sqrt{2} \cdot V_{in} + V_O) \cdot f_{\min}}$$

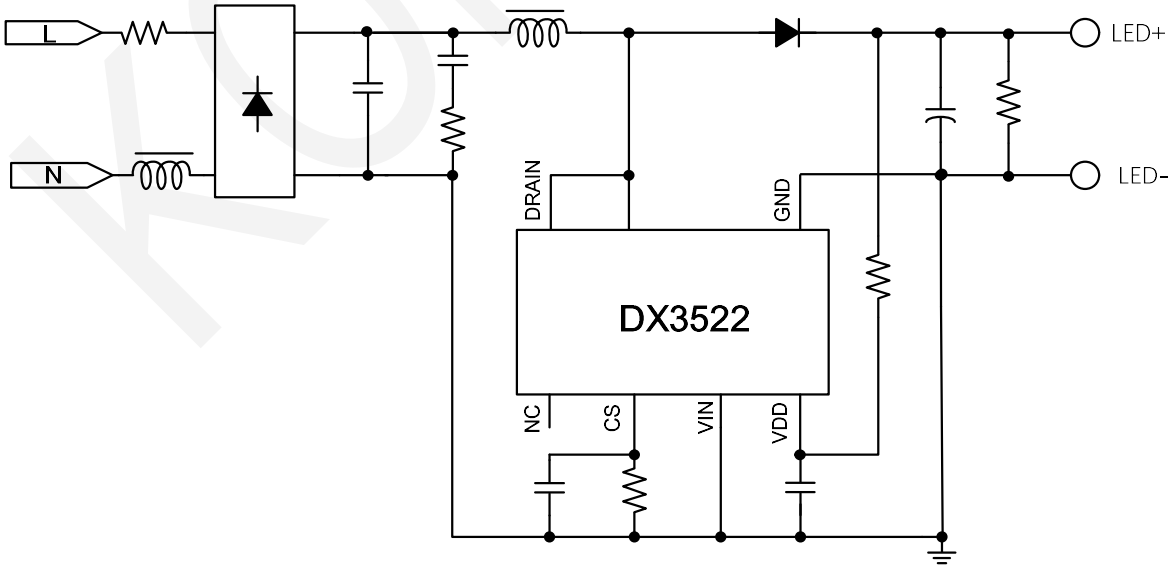
When finish the inductance calculation, the minimum turn number of winding can be obtained by below equation:

$$N_{\min} = \frac{L \cdot I_{PK}}{A_e \cdot B_m}$$

Floating ground application

To get higher system efficiency,Boost topology is recommended to using with DX3522 as below figure6 shown.Meanwhile,this application can meet <20% THD regulation as well.

Figure 6: DX3522 BOOST schematic [PF>0.9/THD<20%]



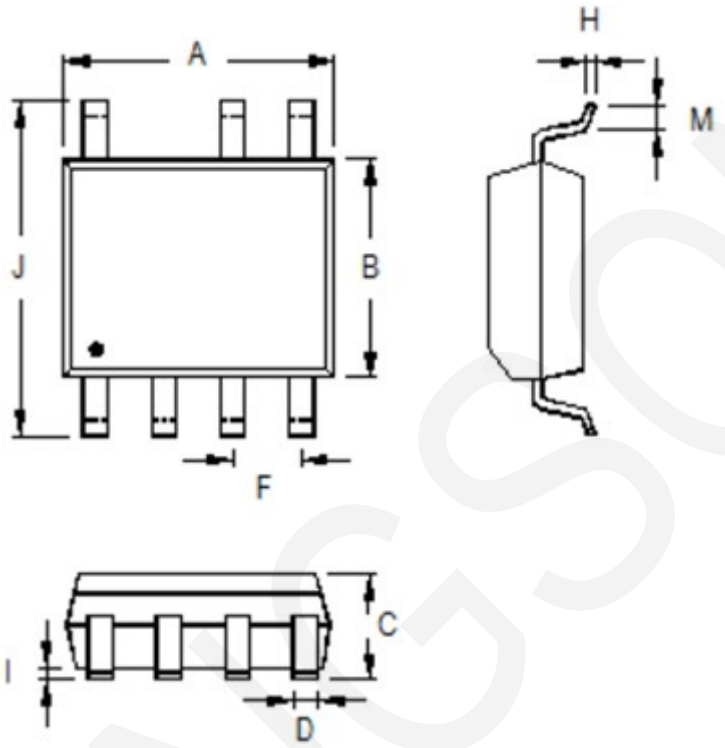
PCB Layout Guidelines

For best performance of the DX3522, like as the good EMI and good thermal performance in compact size 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→ inductor→DX3522 Drain pin→CS pin→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.

PACKAGE INFORMATION

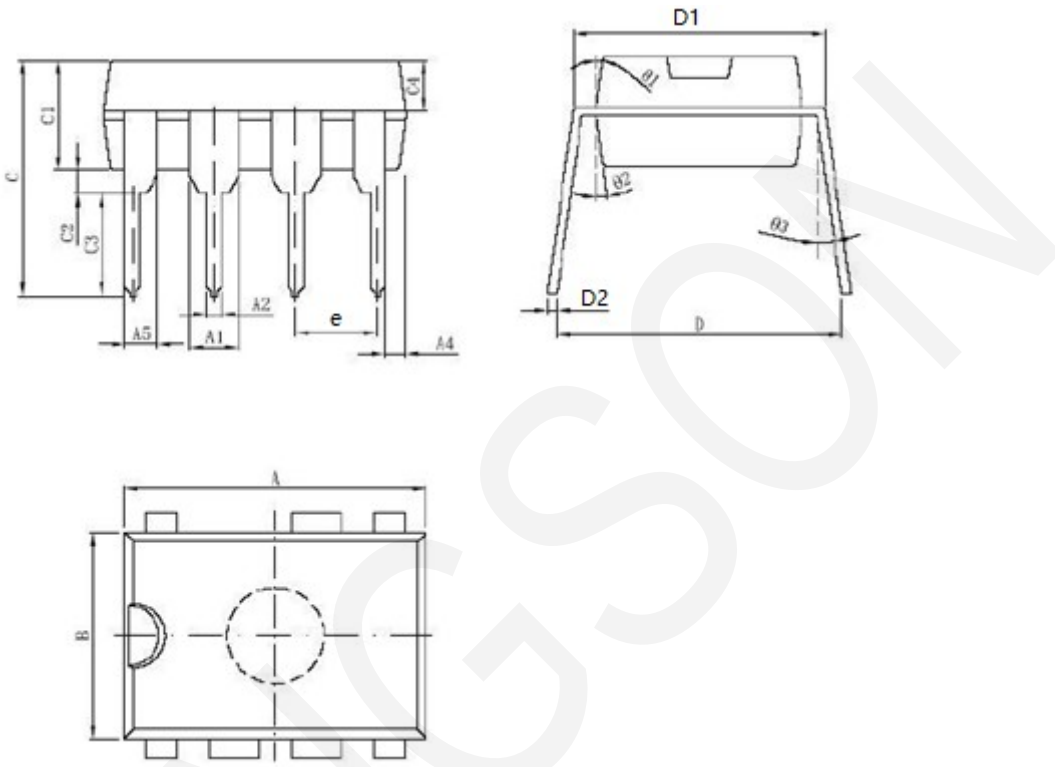
SOIC-7



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.170	0.254	0.007	0.010
I	0.050	0.254	0.002	0.010
J	5.791	6.200	0.228	0.244
M	0.400	1.270	0.016	0.050

PACKAGE INFORMATION

DIP-7



	Dimensions in Millimeters		Dimensions in Inches	
	Minimum	Maximum	Minimum	Maximum
A	9.0	9.4	0.146	0.17
A1	1.524		0.06	
A2	0.38	0.57	0.015	0.022
B	6.2	6.6	0.244	0.26
C1	3.2	3.6	0.126	0.142
C2	0.51		0.02	
C3	3	3.6	0.118	0.142
D	8.4	9	0.331	0.354
D1	7.32	7.92	0.288	0.312
e	2.54		0.1	