BUCK LED Regulator With Power Factor Correction

Features

- No auxiliary winding and VCC capacitor
- Supplied from line voltage directly
- High current accuracy of line and load regulation
- Internal compensation PFC technics
- Critical conduction mode
- High efficiency over wide operating range
- High voltage power MOSFET integrated
- LED open protection
- LED short protection
- VIN over voltage protection
- Internal over-temperature protection
- SOP-7 package

Applications

- Non-isolation Offline LED

Description

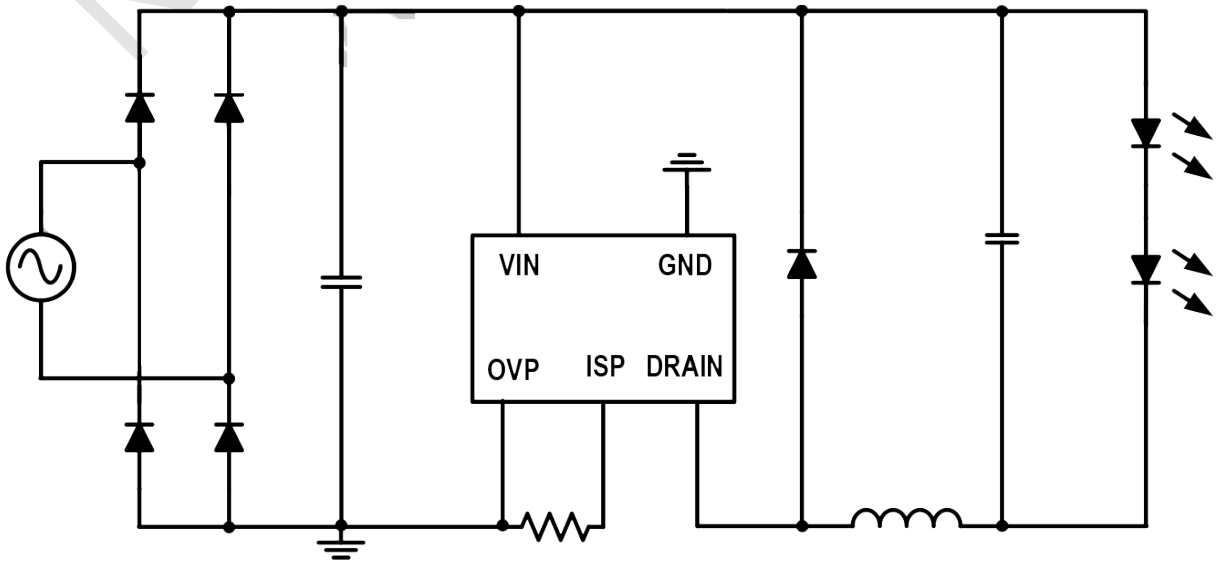
The XT4202A6 is a constant current LED regulator which applies to single stage step-down power factor corrected LED drivers.

XT4202A6 series integrates high voltage power source, and can be supplied by line voltage directly, auxiliary winding and VCC capacitor are not needed.

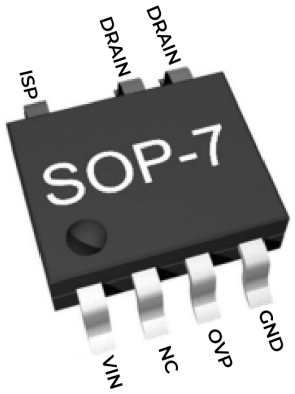
Patented current sensing and digital compensation technics ensure a unit power factor and high accuracy output current. The critical conduction mode operation reduces the switching losses and increases the efficiency.

XT4202A6 series has multi-protection functions which largely enhance the safety and reliability of the system, including LED open protection, LED short protection, VIN over voltage protection and over-temperature protection.

Typical application

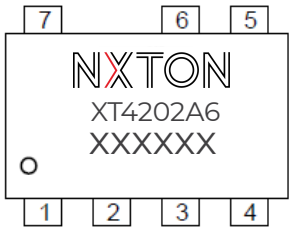


Pin Configuration



SOP-7

Marking Information



SOP-7

PIN DESCRIPTION

Pin No.	Name	Description
1	GND	Chip Ground
2	OVP	Set OVP threshold.
3	NC	Not connect.
4	VIN	Line voltage input.
5,6	DRAIN	DRAIN of the MOSFET
7	ISP	Output current sense.

Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit
VIN Voltage	700	V
OVP, ISP Voltage	6	V
Junction Temperature[2) 3)]	150	°C
Lead Temperature	260	°C
θ_{JA}, Thermal Resistance---Junction to Ambient (SOP-7)	96	°C/W
θ_{JC}, Thermal Resistance---Junction to Case (SOP-7)	45	°C/W
Storage Temperature	65°C to +150	°C

Recommended Operation Conditions

Parameter	Value	Unit
VIN Voltage	30V to 500	V
Operating Junction Tem (TJ)	-40 to 125	°C

Note：

1. Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.
2. The XT4202A6 series includes thermal protection that is intended to protect the device in overload conditions.
3. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.
4. The device is not guaranteed to function outside of its operating conditions.
   Measured on JESD51-7, 4-layer PCB.

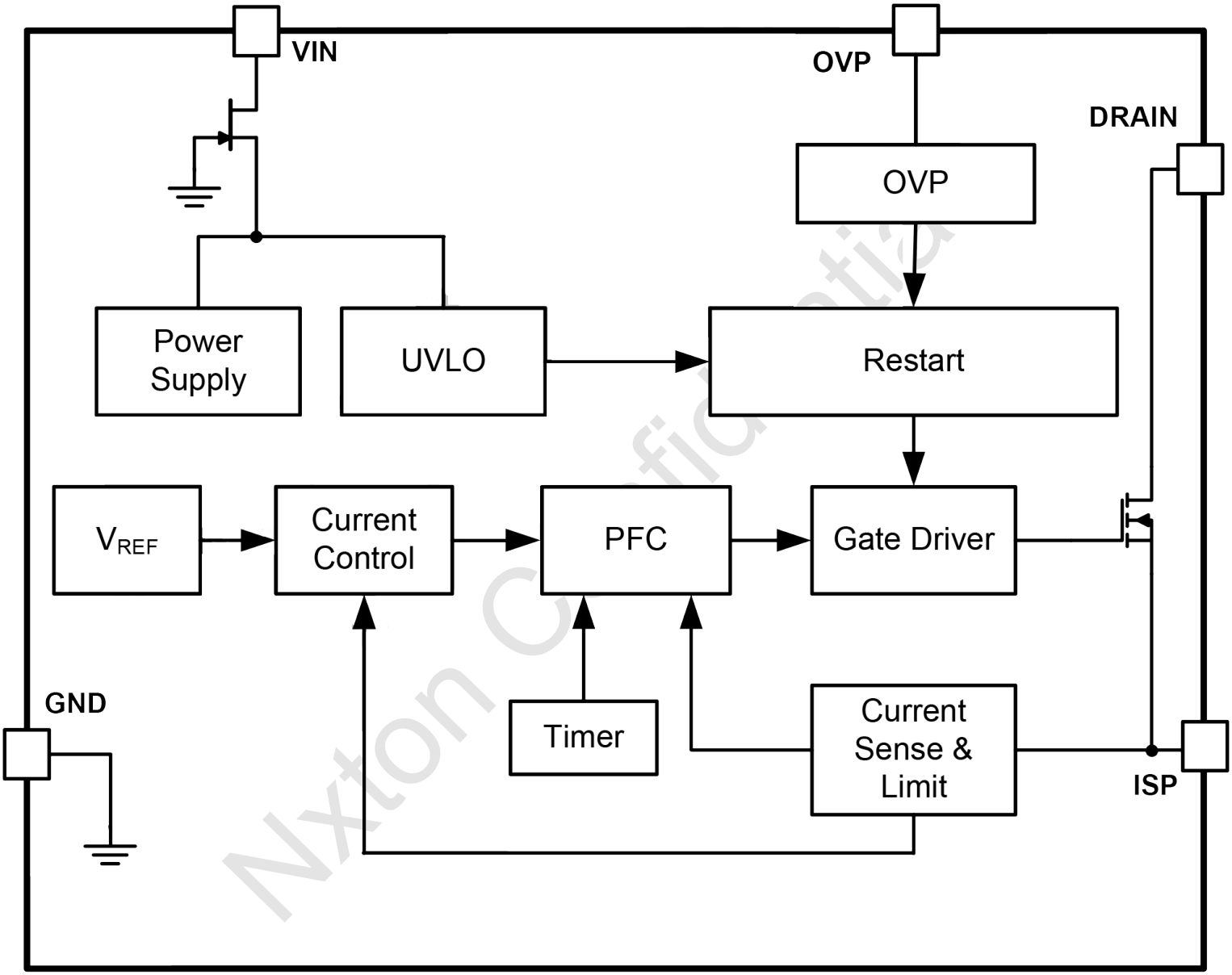
ELECTRICAL CHARACTERISTICS (Ta = 25°C, if not otherwise noted)

Parameter		Symbol	Condition	Min.	Typ.	Max.	Units
POWER SUPPLY							
VIN Start-Up Voltage		V_{IN_ST}				10	V
VIN Quiescent Current		I_{INQ}			180		μA
CURRENT REGULATION							
ISP Sample Reference		V_{REF}		194	200	206	mV
Minimum On Time of MOSFET[5]		T_{ON_MIN}			1.2.		μS
Maximum On Time of MOSFET		T_{ON_MAX}		4.35	6	7.25	μS
Minimum Off Time of MOSFET[5]		T_{OFF_MIN}			2		μS
Maximum Off Time of MOSFET[5]		T_{OFF_MAX}			400		μS
Maximum Switch Frequency[5]		f_{MAX}			100		KHz
Switching Period of VINL[5]		T_{VINL}			65		μS
PROTECTION							
ISP Over Voltage Protection Threshold		V_{ISP_MAX}		1.08	1.20	1.32	V
Vo Over Voltage Protection Threshold		V_{O_OVP1}	R_{OVP}=510KΩ		89		V
		V_{O_OVP2}	OVP Short		99		
		V_{O_OVP3}	OVP NC		119		
		V_{O_OVP4}	R_{OVP}=120KΩ		230		
OVP Pin Current		I_{OVP}			4		μA
VIN Over Voltage Protection		V_{IN_OVP}			440		V
Thermal Protection Threshold[5]		T_{OTP}		140	150		℃
MOS							
MOS Rdson[5]	XT4202A6	R_{dson}	Vgs=10V		4.7		Ω
Breakdown Voltage		BV		650			V

Note:

5) Guranted by design

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

The XT4202A6 series is a constant current LED driver which applies to non-isolation step-down. LED system with power factor correction. XT4202A6 series can achieve excellent line and load regulation, high efficiency and lowsystem cost with few peripheral components.

Start Up

XT4202A6 series is supplied by line voltage directly. When VIN reaches VIN start up voltage (V_{IN_ST}), the chip begins to switch. Once VIN is lower than VIN under voltage lockout, XT4202A6 series stops switching.

Constant Current Control

The XT4202A6 series controls the output current from the information of the sensing resistor voltage. The output LED mean current can be calculated as:

$$I_{LED} = V_{REF} / R_{SNS}$$

Where

V_{REF} – ISP sample reference;

R_{SNS} – The sensing resistor connected between ISP and GND.

Critical Conduction Mode Operation

XT4202A6 series works in the Critical conduction mode of the inductor current. When the power MOSFET is turned on, the inductor current begins to increase from zero. The turn on time of the MOSFET can be calculated as:

$$T_{ON} = I_{PK} \times L / (V_{IN} - V_{OUT})$$

Where,

L –inductance.

IPK – peak current in one switch cycle.

VIN – input voltage after rectification and filtering.

VOUT – output LED voltage.

When the power MOSFET is turned off, the inductor current begins to decrease. The power MOSFET turns on again when the inductocurrent is zero. The turn off time of the MOSFET can be calculated as:

$$T_{OFF} = I_{PK} \times L / V_{OUT}$$

And the inductance of the system can be calculated as:

$$L = V_{OUT} \times (V_{IN} - V_{OUT}) / (f \times I_{PK} \times V_{IN})$$

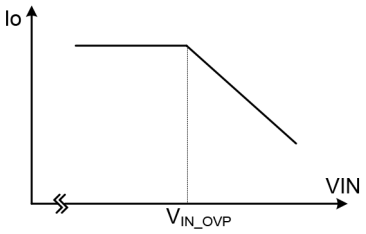
Where, f is the switching frequency of the step-down system.

LED Over Temperature Protection

When internal temperature of the chip exceeds The Thermal Protection Threshold (T_{OTP}), XT4202A6 series decreases LED current to help the chip cooling.

VIN Over Voltage Protection

When Vin voltage is higher than VIN Over Voltage Protection Threshold(V_{IN_OVP}), XT4202A6 series decreases LED current to improve the reliability of the system.



LED Open Protection

The OVP threshold (V_{O_OVP}) is set by the OVP pin. When Vo is higher than V_{O_OVP}, LED open protection is triggered and the chip stops switching for 800ms. The following table shows the V_{O_OVP} design guide:

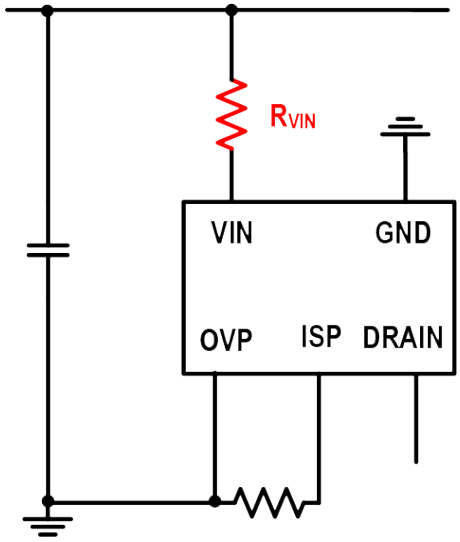
OVP Pin	V_{O_OVP}(V)
Connected with 510KΩ resistor	V_{O_OVP1}
Short connected	V_{O_OVP2}
Not connected	V_{O_OVP3}
Connected with 120KΩ resistor	V_{O_OVP4}

APPLICATION NOTES

1: R_{VIN} and V_{O_OVP} design guide

To enhance the surge capability, VIN pin of XT4202A6 series should be connected to input capacitor by a resistor R_{VIN}(0805/1206 package, no less than 4.7KΩ is recommended). Larger R_{VIN} means better surge capability but please note that too large R_{VIN} may decrease the drive current, and the maximum R_{VIN} is limited by

(Vo-15V)/R_{VIN}>3mA



R_{VIN} and V_{O_OVP} design guide is shown in following Tab:

V_{O_PEAK} (V)	Recommended R_{VIN} (Ω)	OVP(V)
30~45	5.1K	V_{O_OVP1}
46~70	10K	
71~80	10K~15K	V_{O_OVP2}
81~95	10K~20K	V_{O_OVP3}
96~180	20K~51K	V_{O_OVP4}

Where V_{O_PEAK} is the peak value of the Vo, the ripple of the Vo and suitable margin should be taken into consideration when designing the OVP.

2：PCB Design

When designing the PCB of the XT4202A6 series system, please follow the directions:

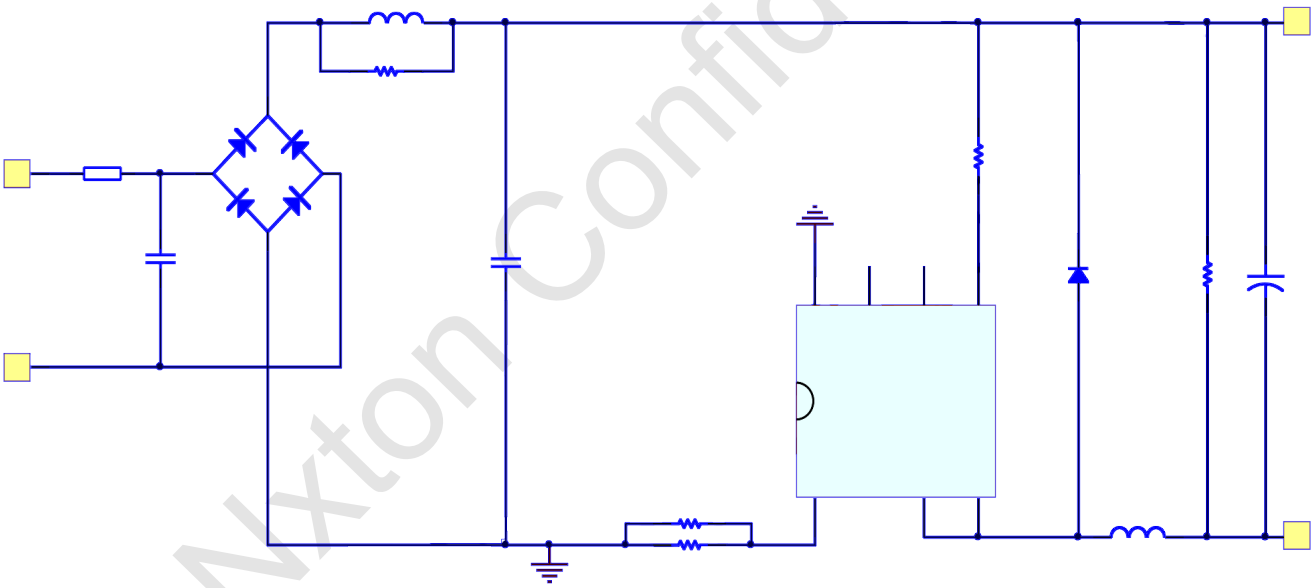
1. Make the area of the power loop as small as possible in order to reduce the EMI radiation.
2. The chip should be far away from the heating element, such as the power inductor and the freewheel diode.

REFERENCE DESIGN

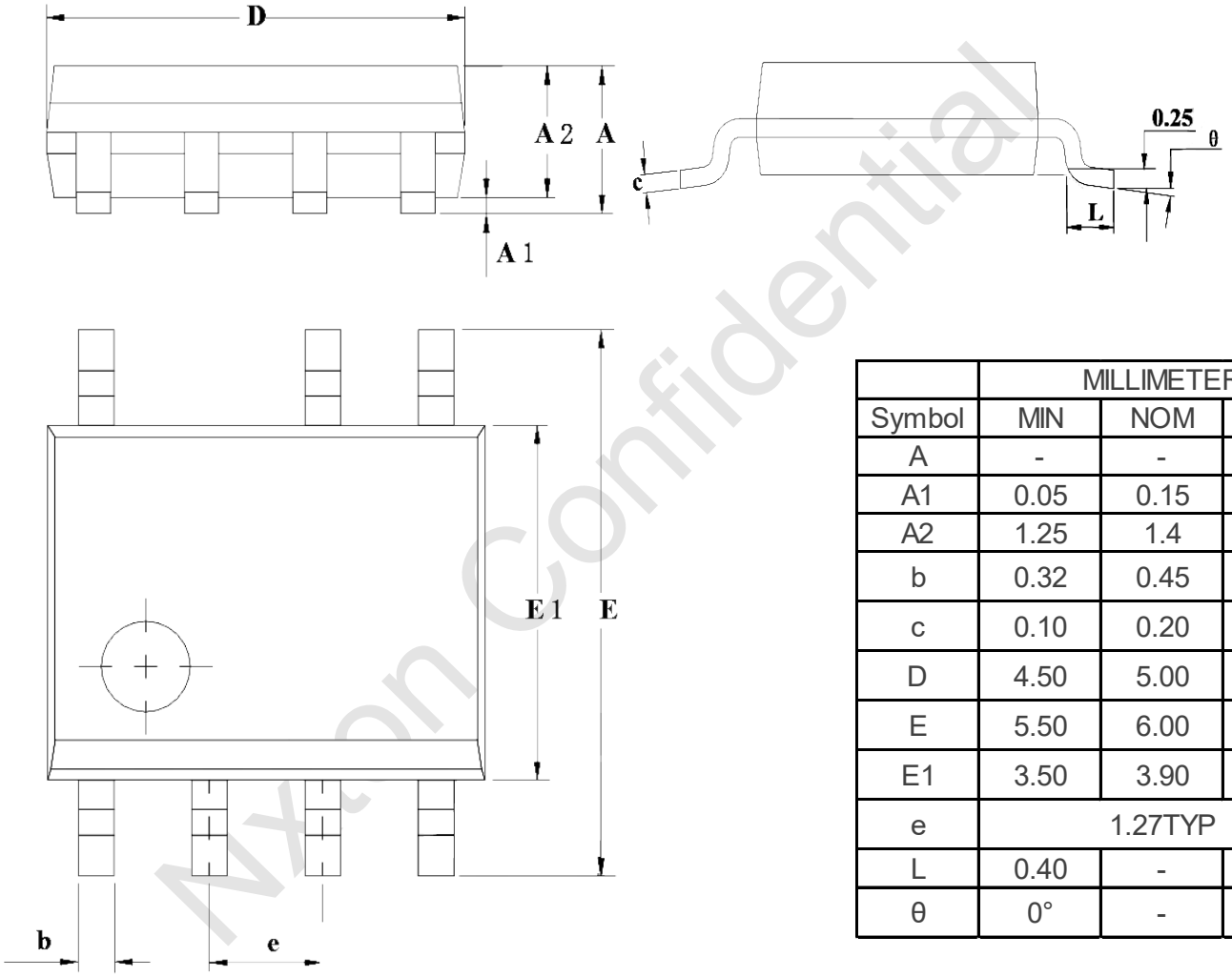
This reference design is suitable for 8 ~ 15W non-isolated Step-down LED driver, using XT4202A6, with high efficiency, excellent line regulation.

REFERENCE

VIN: 176VAC~264VAC
VOUT: 46~90V
IOUT: 160mA
PF: >0.9



PACKAGE OUTLINE



	MILLIMETER		
Symbol	MIN	NOM	MAX
A	-	-	1.75
A1	0.05	0.15	0.25
A2	1.25	1.4	1.65
b	0.32	0.45	0.52
c	0.10	0.20	0.30
D	4.50	5.00	5.50
E	5.50	6.00	6.50
E1	3.50	3.90	4.30
e	1.27TYP		
L	0.40	-	1.27
θ	0°	-	8°

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