Application Note: AN_SY8745

High Efficiency, 10-60V Input, 500kHz White LED Driver

Preliminary datasheet

General Description

SY8745 is a high efficiency, 10V-60V wide input voltage range DC/DC regulator targeting at LED applications. The device integrates the low $R_{DS(ON)}$ MOSFET and internal compensation. Along with the small SO8E package, the device achieves an extremely small solution size for LED driver design. SY8745 also supports PWM/Analog dimming function.

Features

- Wide input range: 10-60 V
- 500kHz switching frequency
- Integrated low $R_{DS(ON)}$ FET: 0.16Ω
- PWM/Analog dimming available
- 1.5A LED current output
- Compact package: SO8E

Ordering Information

SY8745 □(□□)□

- **Te**mpera ture Code
- Packa ge Code
- Optional Spec Code

Ordering Number	Package type	Note
SY8745FCC	SO8E	----

Applications

- LED lighting

Typical Applications

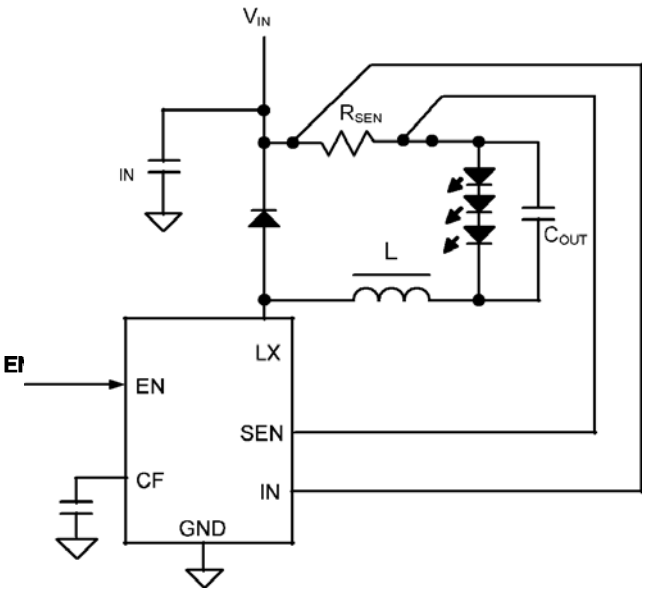
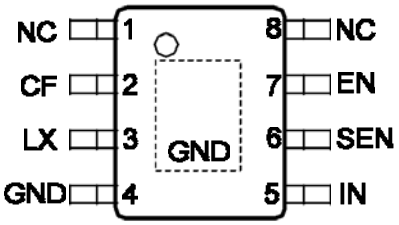


Figure 1. Schematic diagram

Pinout (top view)



SO8E

Top Mark: AZT*xyz* (device code: AZT, ***x=year code, y=week code, z= lot number code***)

Pin Name	SO8E	Pin Description
IN	5	Input pin. Decouple this pin to GND pin with 1uF ceramic cap. Also used as the positive current sense pin.
SEN	6	Negative Current Sense Pin.
GND	4 And Exposed Pad	Ground pin
LX	3	Inductor node. Connect an induct r from power input to LX pin.
EN	7	Enable pin and PWM dimming input pin. If V_{EN}>8V, IC work at 0~1V linear dimming, dimming signal add to CF. If V_{EN}<8V, IC work at n log dimming mode, connect a capacitor like 10nF to CF.
CF	2	When analog dimming, connect a 10nF capacitor to CF to filter the reference. Also, the PIN is used to judge dimming mode. When VCF>1.5V, IC work at PWM dimming mode, when VCF<1.5V, IC work at analog dimming mode.
NC	1,8	No connection

Absolute Maximum Ratings

LX, IN, EN---------- 63V
SEN ---------- V_{IN} ± 0.6V
All other pins---------- ---------- 4V
Power Dissipation, PD @ TA = 25°C SO8E, ---------- ---------- 3.3W
Package Thermal Resistance (Note 2)
ΘJA---------- 30°C/W
θ_{JC} ---------- 10°C/W
Junction Temperature Range ---------- - 40°C to125°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- - 65°C to 150°C

Recommended Operating Conditions

IN, LX, EN ---------- 5V to 60V
SEN ---------- V_{IN} ± 0.4V
All other pins ---------- 0-3.6V
Junction Temperature Range ---------- - 40°C to 125°C

Electrical Characteristics

(V_{IN} =24V, V_{OUT}=12V, I_{OUT}=100mA, TA = 25°C unless otherwise specified)

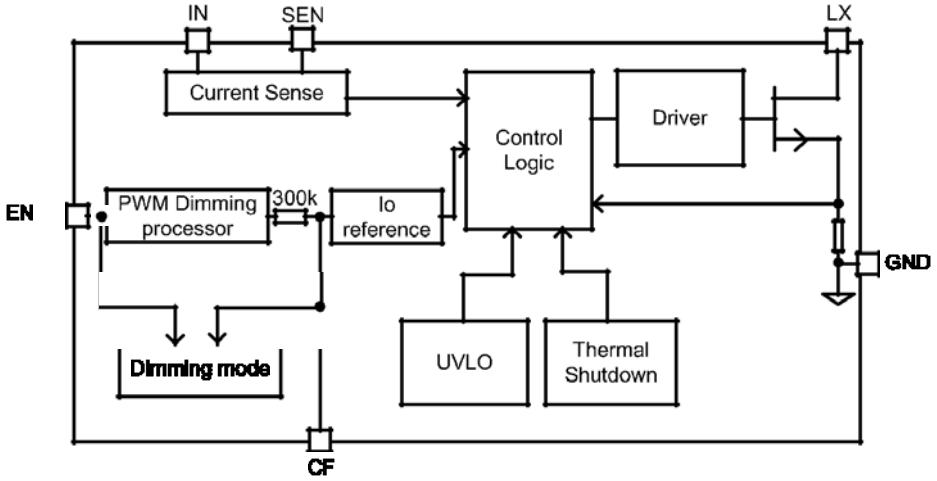
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		10		60	V
Shutdown Current	I_{SHDN}	EN=0		20	40	μA
Low Side Main FET R_{ON}	$R_{DS(ON)}$			0.16		Ω
Switching Frequency	F_{SW}			500		kHz
Current Sense Limit	V_{IN-SEN}		98	100	202	mV
EN Rising Threshold	V_{ENH}			1.0		V
EN Falling Threshold	V_{ENL}			0.5		V
IN UVLO Rising Threshold	$V_{IN,UVLO}$			9		V
UVLO Hysteresis	$V_{UVLO,HYS}$			1.0		V
Dimming section:						
Analog dimming range on CF	V_{CF}	I_{LED}=10%		100		mV
		I_{LED}=100%		1.1		V
Thermal Shutdown Temperature	T_{SD}			155		°C
Thermal Hysteresis	Hyst			25		°C

Note 1: Stresses beyond the "Absolute Maximum Ratings" ma y cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal con ductivity test board of JEDEC 51-3 thermal measurement standard.

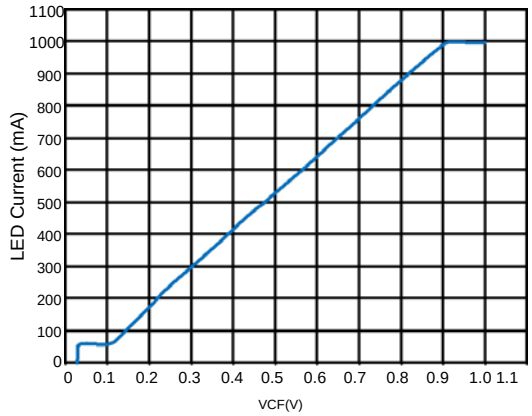
Note 3. The device is not guaranteed to function outside ts operating conditions

Block Diagram

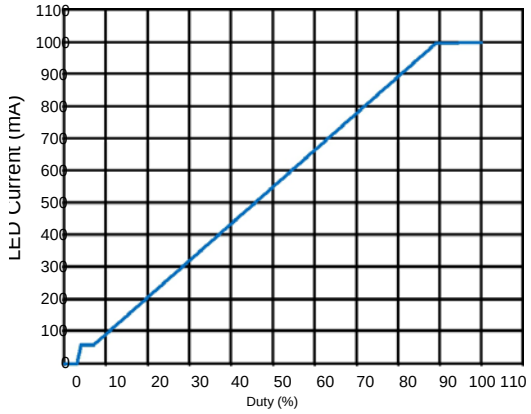


Typical Performance Characteristics

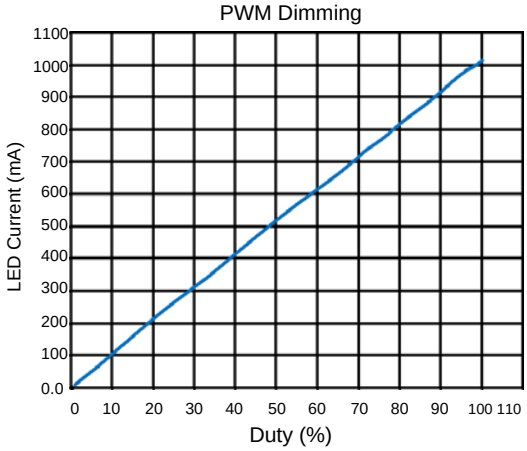
CF Dimming



Analog Dimming

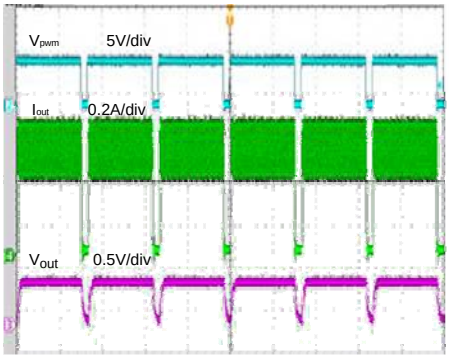


PWM Dimming



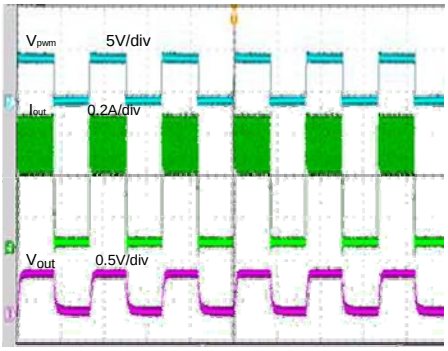
PWM Dimming

(V_{IN}=60V, V_O=50V,2KHz,90% Duty)



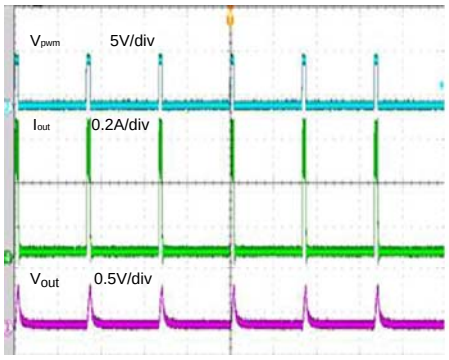
PWM Dimming

(V_{IN}=60V, V_O=50V,2KHz,50% Duty)



PWM Dimming

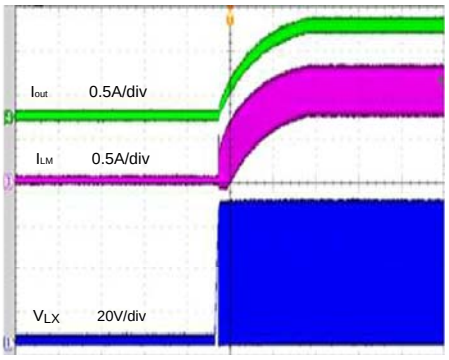
(V_{IN}=60V, V_O=50V,2KHz,5% Duty)



Time (200us/div)

Startup

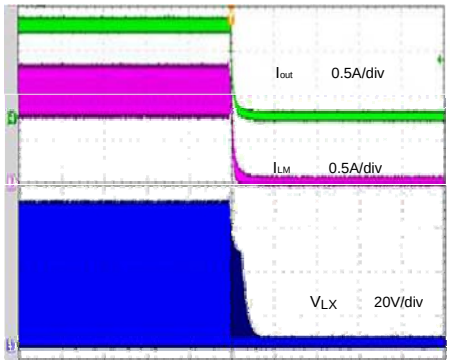
(V_{IN}=60V, V_O=50V,2KHz)



Time (40ms/div)

Shutdown

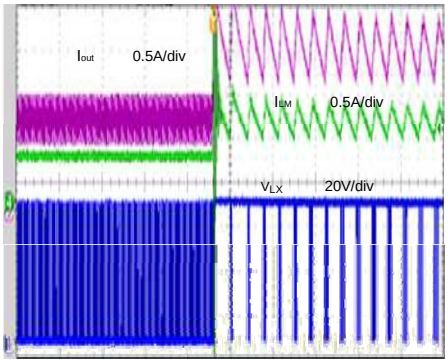
(V_{IN}=60V, V_O=50V,2KHz)



Time (40ms/div)

Short LED

(V_{IN}=60V, V =50V,2KHz)



Time (40ms/div)

Operation

SY8745 is a grounding switch buck regulator IC that integrates the PWM control, power MOSFET on the same die to minimize the switching transition loss and conduction loss. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the high efficiency and Along with the small SO8E package, the device achieves an extremely small solution size for LED driver design. SY8745 also supports PWM/Analog dimming function.

Applications Information

Because of the high integration in the SY8745 IC, the application circuit based on this regulator IC is rather simple. Only input capacitor C_{IN}, output capacitor C_{OUT}, output inductor L and current sense resistor R_{SEN} need to be selected for the targeted applications specifications.

Current sense resistor R_{SEN}:

Choose R_{SEN} to program the proper output Current:

$$I_{LED}(A) = \frac{0.1(V)}{R_{SEN}(\Omega)}$$

Input capacitor C_{IN}:

The ripple current through input capacitor is calculated as:

$$I_{CIN\_RMS} = I_{OUT} \cdot \sqrt{D(1-D)}$$

A typical X7R or better grade ceramic capacitor with suitable capacitance should be chosen to handle this ripple current well. To minimize the potent al noise problem, place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by C_{IN}, and IN/GND pins.

Output capacitor C_{OUT}:

The output capacitor is selected to handle the output current ripple noise equirements. For the best performance, it is rec mmended to use X7R or better grade ceramic capacitor greater than 1uF capacitance.

Output inductor L:

There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{F_{SW} \times I_{OUT,MAX} \times 40\%}$$

where Fsw is the switching frequency and $I_{OUT,MAX}$ is the LED current.

The SY8745 regulator IC is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT}(1-V_{OUT}/V_{IN,MAX})}{2 \cdot F_{SW} \cdot L}$$

Dimming Operation:

Analog dimming:

1:0~1.0V linear dimming. Set V_{EN}>8V, and add 0~1V dimming signal to CF PIN.
2: Applied with PWM signal. Connect a capacitor to CF PIN to filler reference inte , and add PWM signal to EN PIN (V_{EN_HIGH}<8V)
3:PWM dimming. Set VCF>1.5V, and add PWM signal to EN PIN.

PWM	CF	Dimming mode
--	>1.5	PWM dimming
PWM>8	<1.5	0~1.0V linear dimming on CF
PWM<8	<1.5	Analog dimming on PWM

At WM dimming mode, the minimum T_{PWM_ON} time is suggest setting bigger than 20μS.

Soft Start:

Add a ceramic capacitor C_{CF} on CF to achieve soft start, the soft start time can be adjusted by C_{CF}.

SCP:

If V_{VIN}-V_{SEN}>=0.2V, PWM is disabled, When VIN-VSEN=0.1V, IC will recover work.

EN OFF:

IC shut down after EN OFF with 10ms.

Layout Design:

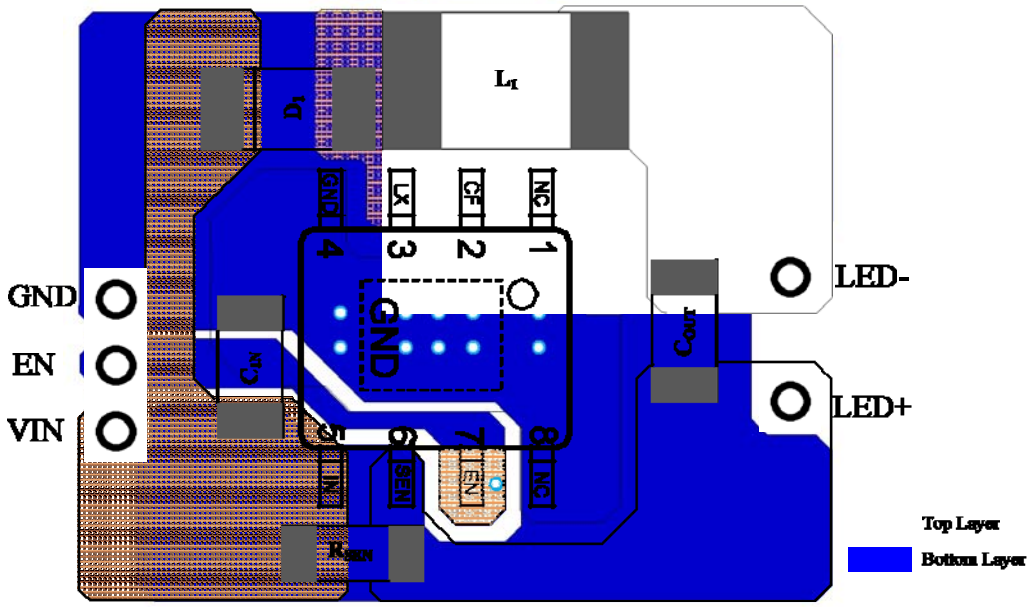
The layout design of SY8745 regulator is relatively simple. For the best efficiency and minimum noise problems, we should place the following components close to the IC: C_{IN}, L, C_{OUT}, CF and R_{SEN}.

1) It is desirable to maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

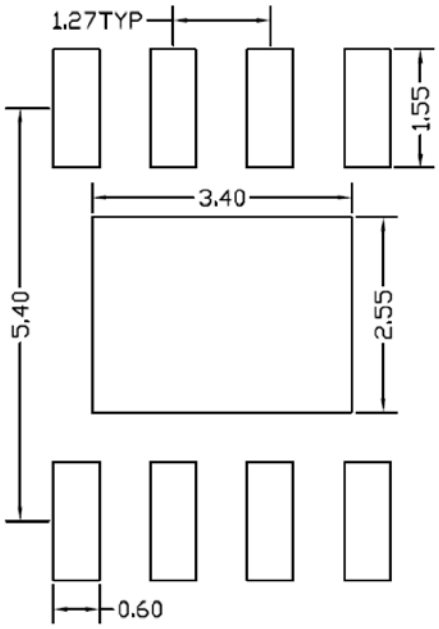
2) C_{IN} must be close to Pins IN and GND. The loop area formed by C_{IN} and GND must be minimized.

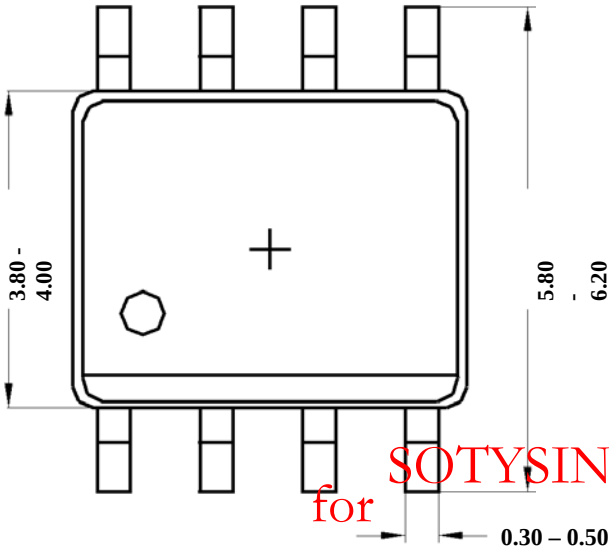
3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem.

PCB Layout Suggestion

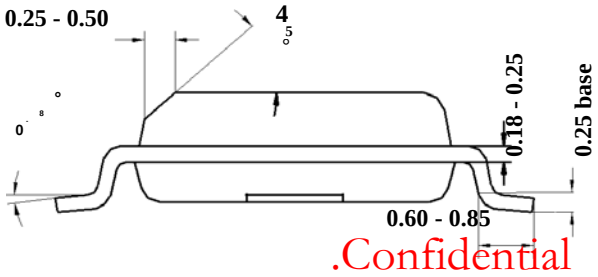


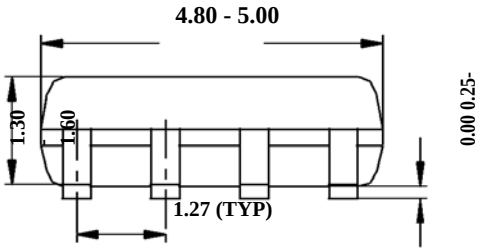
SO8E Package outline & PCB layout design





Recommended Pad Layout



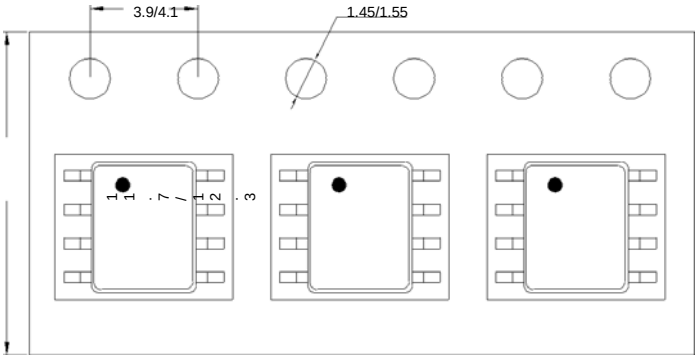


Notes: **All dimension in MM**

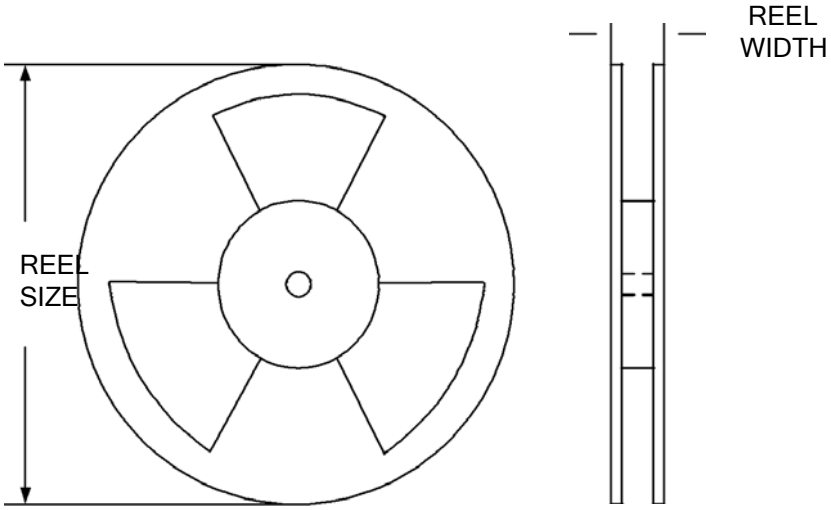
AllCorpdimension don't not include mold flash & metal burr

Taping & Reel Specification

1. SOP8-EP



2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Reel width(mm)	Trailer length(mm)	Leader length (mm)	Qty per reel
SOP8-EP	12	8	13"	12.4	400	400	2500

3. Others: NA