High Performance, Constant Current Switching Regulator for White LED

General Description

The LP3300 is a 1.2MHz PWM boost switching regulator designed for constant-current white LED driver applications.

The LP3300 can drive a string of up to 4 white LEDs from a 3.2V supply or 6 white LEDs from a 5V supply in series, ensuring uniform brightness and eliminating several ballast resistors. The LP3300 implements a constant frequency 1.2MHz PWM control scheme. The high frequency PWM operation also saves board space by reducing external component sizes. To improve efficiency, the feedback voltage is set to 95 mV, which reduces the power dissipation in the current setting resistor.

Highly integration and internal compensation network minimizes as 5 external component counts. Optimized operation frequency can meet the requirement of small LC filters value and low operation current with high efficiency.

Ordering Information

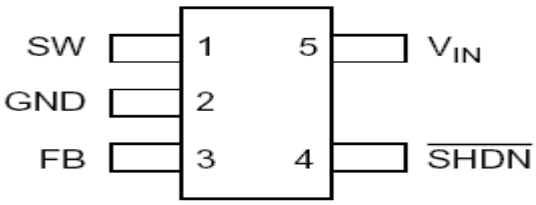
LP3300 □□ □

F:Pb-Free

Package Type

B5: SOT-23-5

Pin Configurations



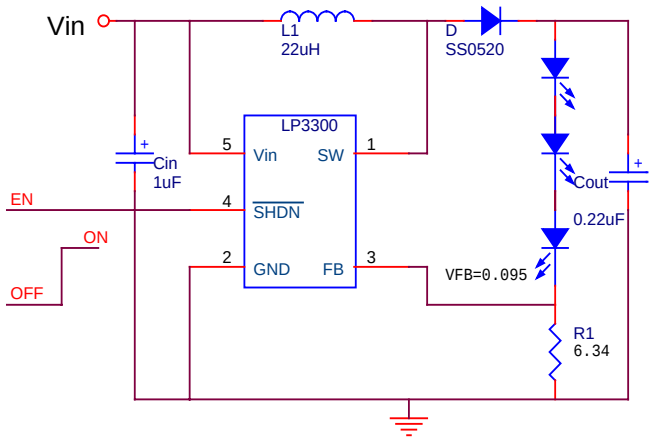
Features

- High Efficiency: 88%
- 1.2MHz Fixed-Frequency PWM Operation
- Maximum Output Voltage up to 29V
- VIN Operating Range : 2.7V to 15V
- Shutdown Supply Current:<1uA
- Available in SOT23-5 Package
- Built-in Over Voltage Protection
- Minimize the External Component
- RoHS Compliant and 100% Lead (Pb)-Free

Applications

- WLED Blacklight driver
- OLED Blacklight driver
- PDA
- DSC
- Camera Flash WLED driver

Typical Application Circuit



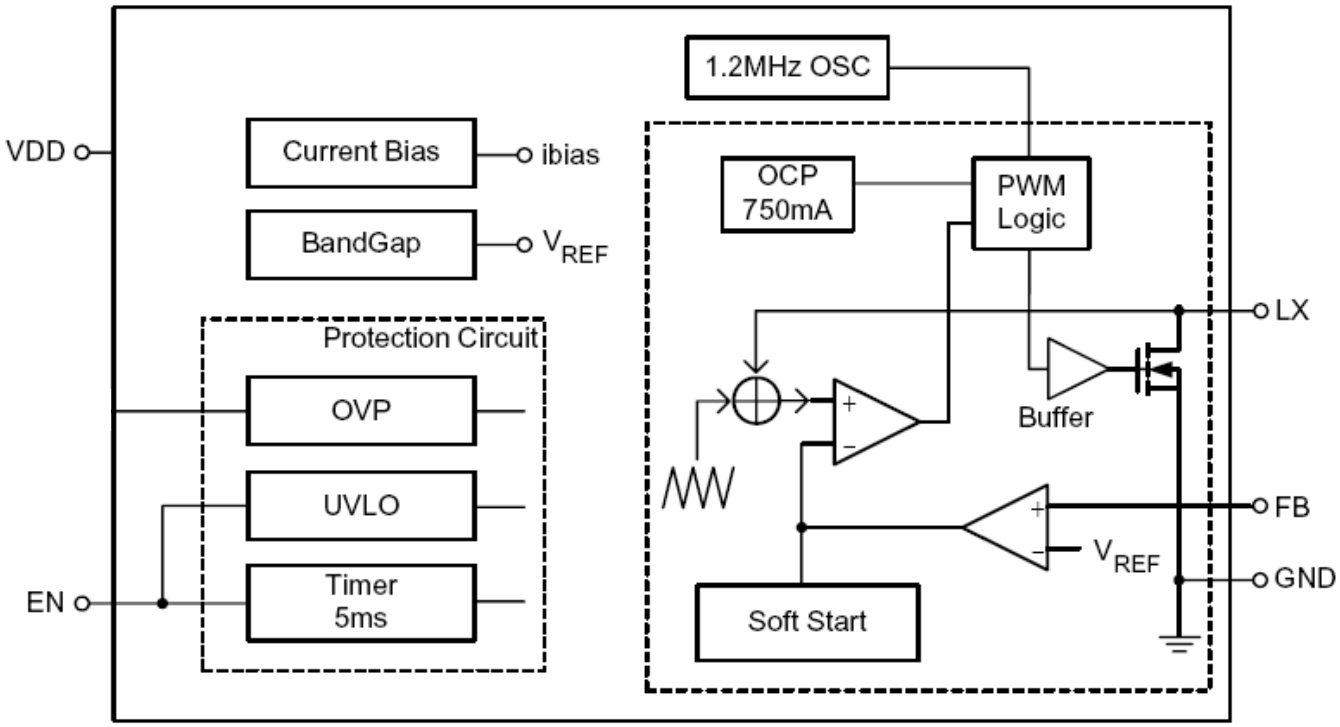
Marking information

Please view website.

Functional Pin Description

SOT-23-5	Pin Name	Pin Function
1	LX	Switch Pin. Connect this Pin to inductor and catch diode. Minimize the track area to reduce EMI.
2	GND	Ground Pin
3	FB	Feedback Reference Voltage Pin. Series connect a resistor between WLED and ground as a current sense. Sense the current feedback voltage to set the current rating.
4	SHDN	Chip Enable (Active High). Voltage sensing input to trigger the function of over voltage protection. Note that this pin is high impedance. There should be a pull low 100kΩ resistor connected to GND when the control signal is floating.
5	VIN	Supply Input Voltage Pin. Bypass 1uF capacitor to GND to reduce the input noise.

Function Block Diagram



Absolute Maximum Ratings

Supply Input Voltage ---------- −0.3V to 15V

LX Input Voltage ---------- −0.3V to 36V

OVP Voltage ---------- −0.3V to 29V

The Other Pins ---------- −0.3V to 10V

Power Dissipation, P_D @ T_A = 25°C

SOT-23-5 ---------- 0.455W

Lead Temperature (Soldering, 10 sec.) ---------- 260°C

Operation Temperature Range ---------- −40°C to 80°C

Junction Temperature Range ---------- 0°C to 125°C

Storage Temperature Range ---------- −65°C to 150°C

Operation Junction Temperature Range ---------- 0°C to 125°C

Electrical Characteristics

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
System Supply Input						
Operation voltage Range	V_{DD}		2.7		15	V
Under Voltage Lock Out	V_{DD}		--	2.2		V
Supply Current	I_{DD}	FB=0V, Switch		2	2.5	mA
Shut Down Current	I_{DD}	V_{EN} < 0.4V		0.1	1	uA
Line Regulation		V_{IN} : 3.0~4.3V		3		%
Oscillator						
Operation Frequency	F_{OSC}			1.2		MHz
Maximum Duty Cycle			85			%
Dimming Frequency			100		100k	Hz
Reference Voltage						
Feedback Voltage (Note 4)	LP3300		86	95	104	V
MOSFET						
On Resistance of MOSFET	$R_{DS(ON)}$		--	0.8		Ω
Protection						
OVP Threshold	V_{OVP}			29		V
OVP Sink Current				5		μ A
OCP				750		mA
Shut Down Voltage	V_{EN}		--		0.4	V
Enable Voltage	V_{EN}		1.5			V

Typical Operating Characteristics

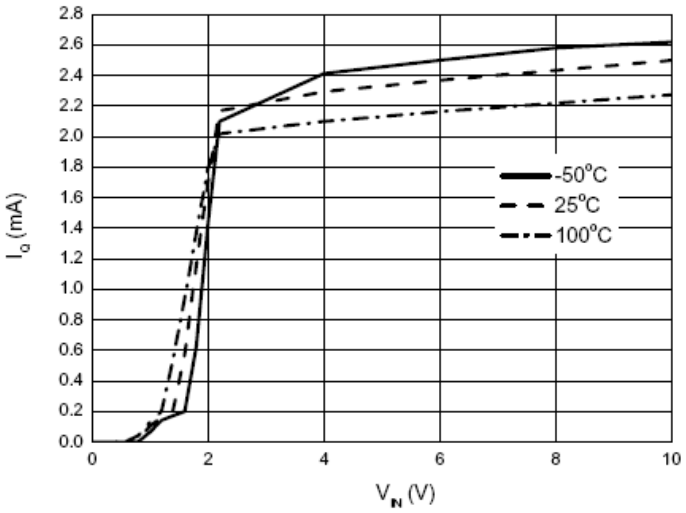


Figure 4. Quiescent Current vs. V_{IN}

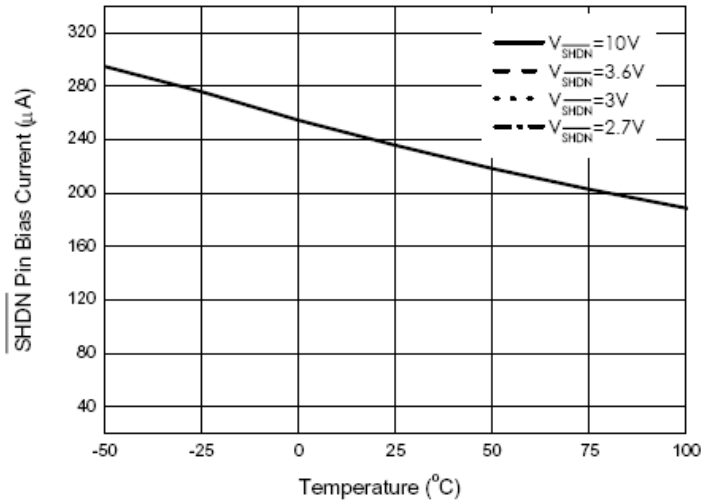


Figure 5. $\overline{SHDN}$ Pin Bias Current vs. Temperature

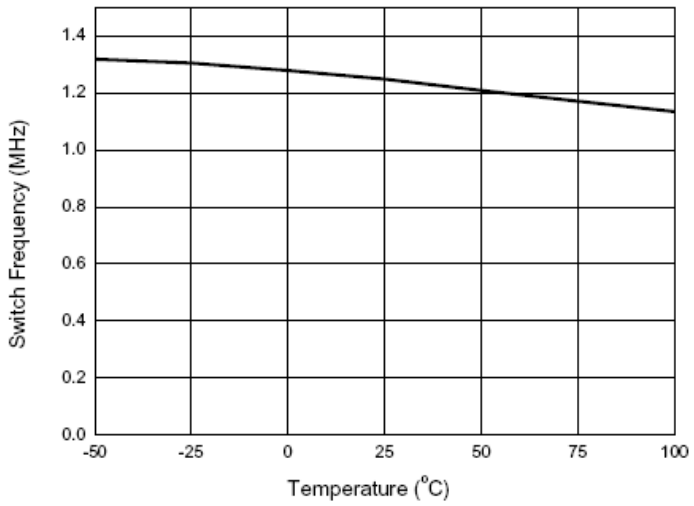


Figure 6. Switch Frequency vs. Temperature

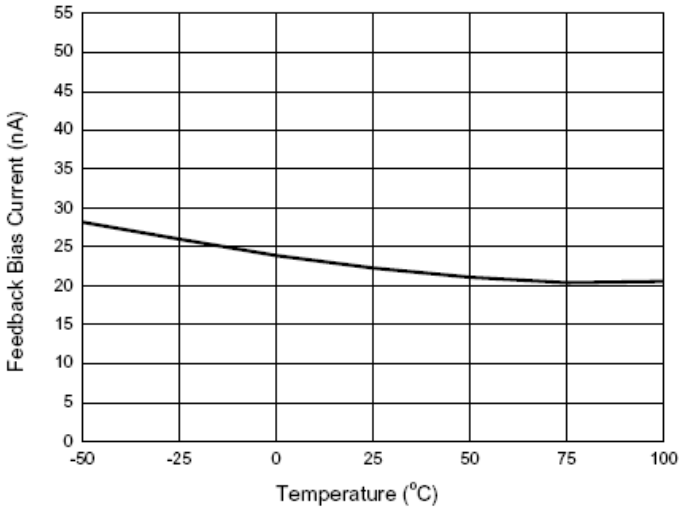


Figure 7. Feedback Bias Current vs. Temperature

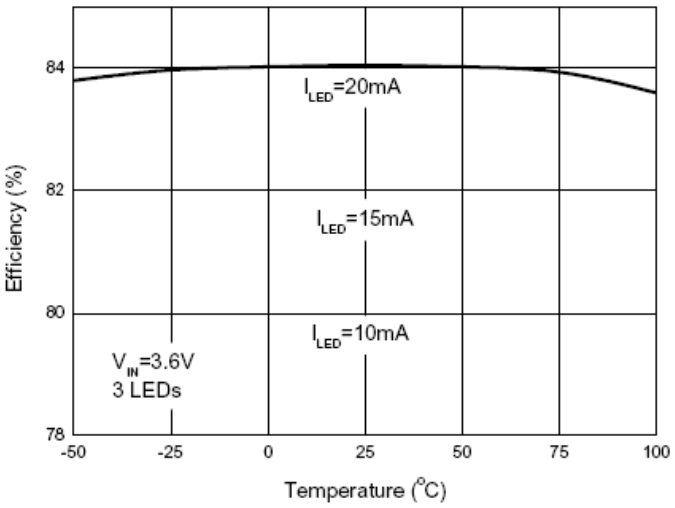


Figure 8. Efficiency vs. Temperature

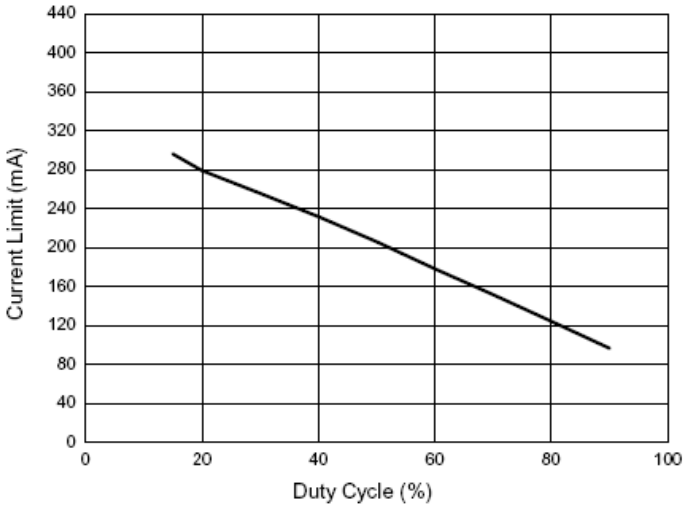


Figure 9. Switch Current vs. Duty Cycle

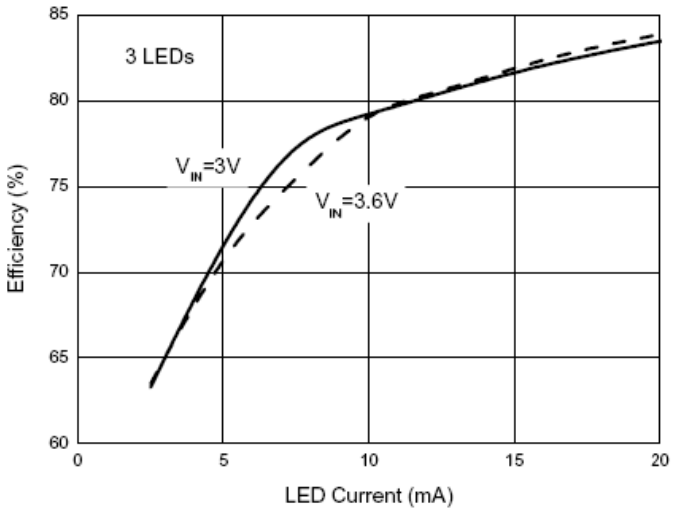


Figure 10. Efficiency vs. LED Current

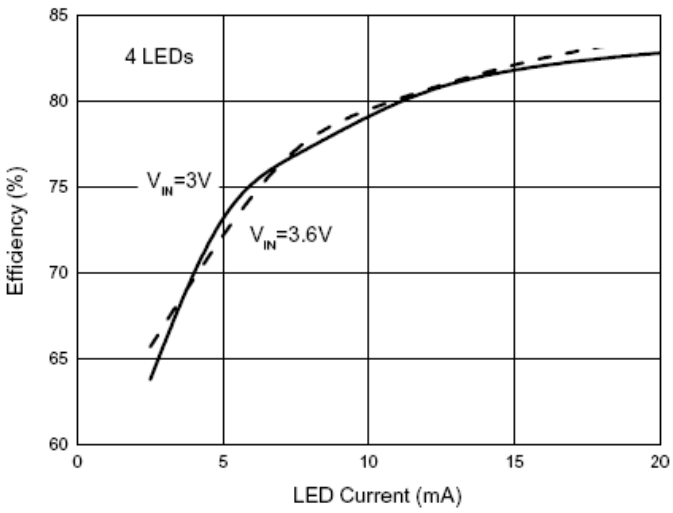


Figure 11. Efficiency vs. LED Current

Applications Information

The LP3300 regulates the LED current by setting the current sense resistor (R1) connecting to feedback and ground. As shown in Table 1, the LP3300 Over voltage protetion is 29V and the LP3300 feedback voltage (V_{FB}) is 95mV. The LED current (I_{LED}) can be set by a resistor R1. In order to have an accurate LED current, a precision resistor is preferred (1% is recommended).

Dimming Control

a. Using a PWM Signal to EN PinFor controlling the LED brightness, the LP3300 can perform the dimming control by applying a PWM signal to EN pin. The internal soft start and the wide range dimming frequency from100 to100kHz can eliminate inrush current and audio noise when dimming. The average LED current is proportional to the PWM signal duty cycle. The magnitude of the PWM signal should be higher than the maximum enable voltage of EN pin, in order to let the dimming control perform correctly.

b. Using a DC Voltage Using a variable DC voltage to adjust the brightness is a popular method in some applications. The dimming control using a DC voltage circuit is shown in Figure 5. According to the Superposition Theorem, as the DC voltage increases, the voltage contributed to VFB increases and the voltage drop on R2 decreases, le the LED current decreases. For example, if the VDC range is from 0V to

2.8V, the selection of resistors in Figure 5 sets dimming control of LED current from 20mA to 0mA.

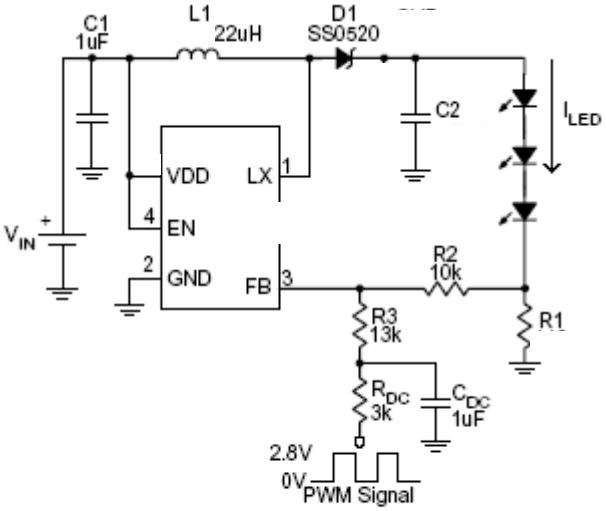


Figure 6. Filtered PWM Signal for LED Dimming Control

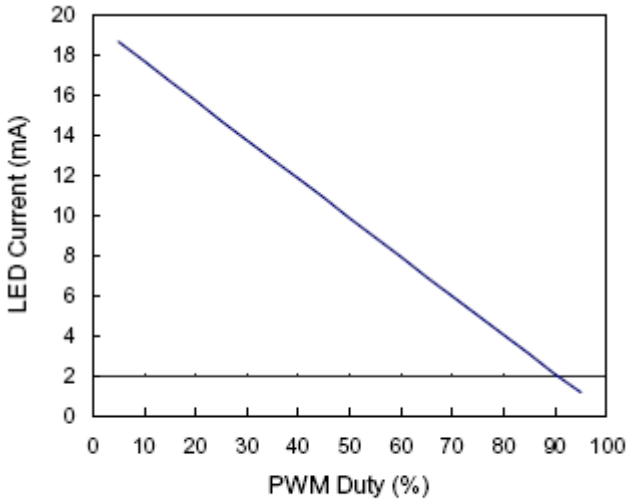


Figure 7

c. Using a Filtered PWM signal: Another common application is using a filtered PWM signal as an adjustable DC voltage for LED dimming control. A filtered PWM signal acts as the DC voltage to regulate the output current. The recommended application circuit is shown in the Figure 6. In this circuit, the output ripple depends on the frequency of PWM signal. For smaller output voltage ripple (<100mV), the recommended frequency of 2.8V PWM signal should be above 2kHz. To fix the frequency of PWM signal and change the duty cycle of PWM signal can get different

output current as Figure 7. According to the application circuit of Figure 6,
output current is from 18.7mA to 1.16mA by adjusting the PWM duty cycle from 5% to 95%.

Inductor Selection

The recommended value of inductor for 3 to 5 WLEDs applications is 22μH. Small size and better efficiency are the major concerns for portable device, such as LP3300 used for mobile phone. The inductor should have low core loss at 1.2MHz and low DCR for better efficiency. To avoid inductor saturation current rating should be considered.

Capacitor Selection

Input and output ceramic capacitors of 1μF are recommended for LP3300 applications. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Diode Selection

Schottky diode is a good choice for LP3300 because of its low forward voltage drop and fast reverse recovery. Using Schottky diode can get better efficiency. The high-speed rectification is also a good characteristic of Schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication as following:

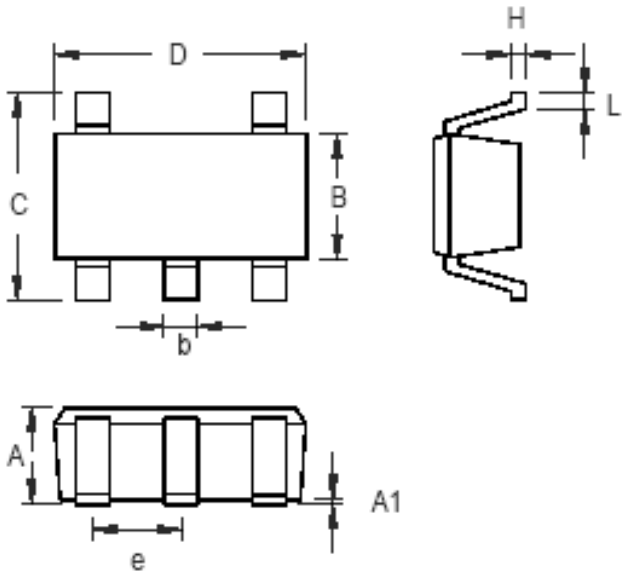
$$I_D(RMS) \approx \sqrt{(I_{OUT} \times I_{PEAK})}$$

The diode's reverse breakdown voltage should be larger than the output voltage. SS0520 is recommended Schottky diode for rectifier.

Layout Considerations

- A full GND plane without gap break.
- VCC to GND noise bypass–Short and wide connection for the 1μF MLCC capacitor between Pin6 and Pin2.
- Minimized LX node copper area to reduce EMI.
- Minimized FB node copper area and keep far away from noise sources.

Packing information



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	1.000	0.028	0.039
A1	0.000	0.100	0.000	0.004
B	1.397	1.803	0.055	0.071
b	0.300	0.559	0.012	0.022
C	2.591	3.000	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