

EL6204

Laser Driver Oscillator

FN7219
Rev 3.00
October 28, 2015

The **EL6204** is a push-pull oscillator used to reduce laser noise. It uses the standard interface to existing ROM controllers. The frequency and amplitude are each set with a separate resistor connected to ground. The tiny package and harmonic reduction allow the part to be placed close to a laser with low RF emissions. An auto turn-off feature allows it to easily be used on combo CD-RW plus DVD-ROM pickups.

If the APC current is reduced such that the average laser voltage drops to less than 1.1V, the output and oscillator are disabled, reducing power consumption to a minimum.

The current drawn by the oscillator consists of a small utility current, plus the peak output amplitude in the positive cycle. In the negative cycle the oscillator subtracts peak output amplitude from the laser APC current.

The EL6204 part is available in the space-saving 6 Ld SOT-23 package and is specified for operation from 0 °C to +70 °C.

Features

- Low power dissipation
- User-selectable frequency from 60MHz to 600MHz controlled with a single resistor
- User-specified amplitude from 10mA_{p,p} to 100mA_{p,p} controlled with a single resistor
- Auto turn-off threshold
- Soft edges for reduced EMI
- Small 6 Ld SOT-23 package

Applications

- DVD players
- DVD-ROM drives
- CD-RW drives
- MO drives
- General purpose laser noise reduction
- Local oscillators

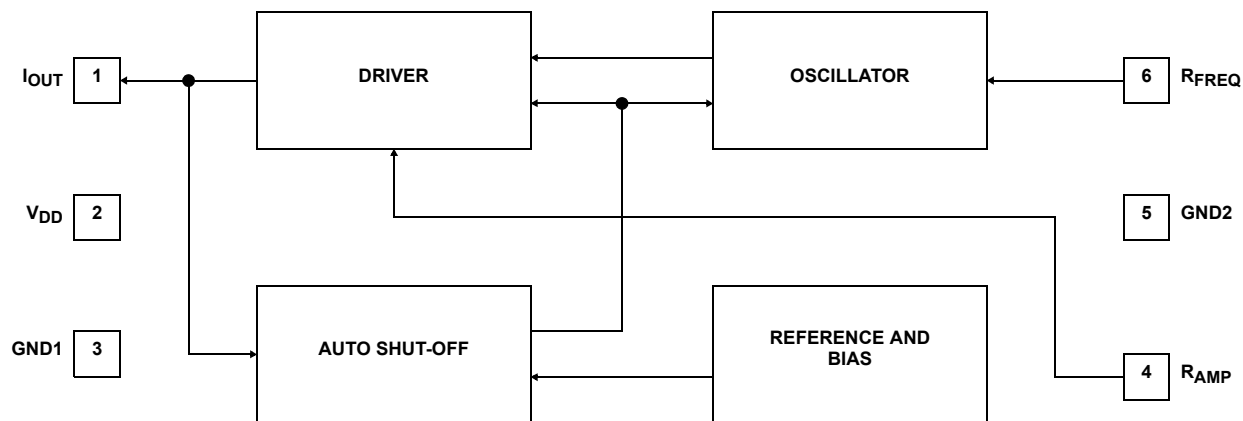


FIGURE 1. BLOCK DIAGRAM

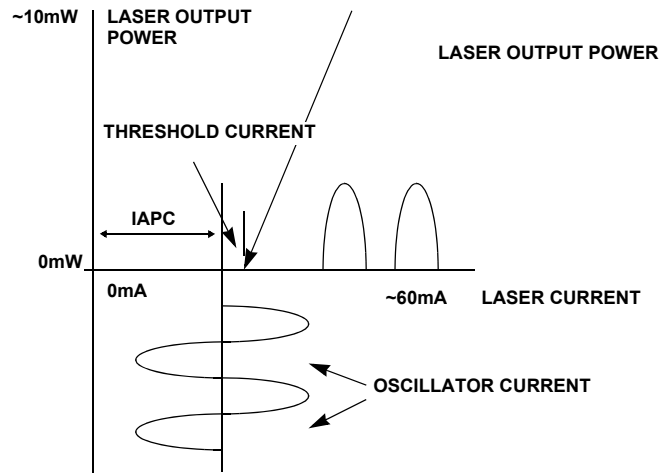
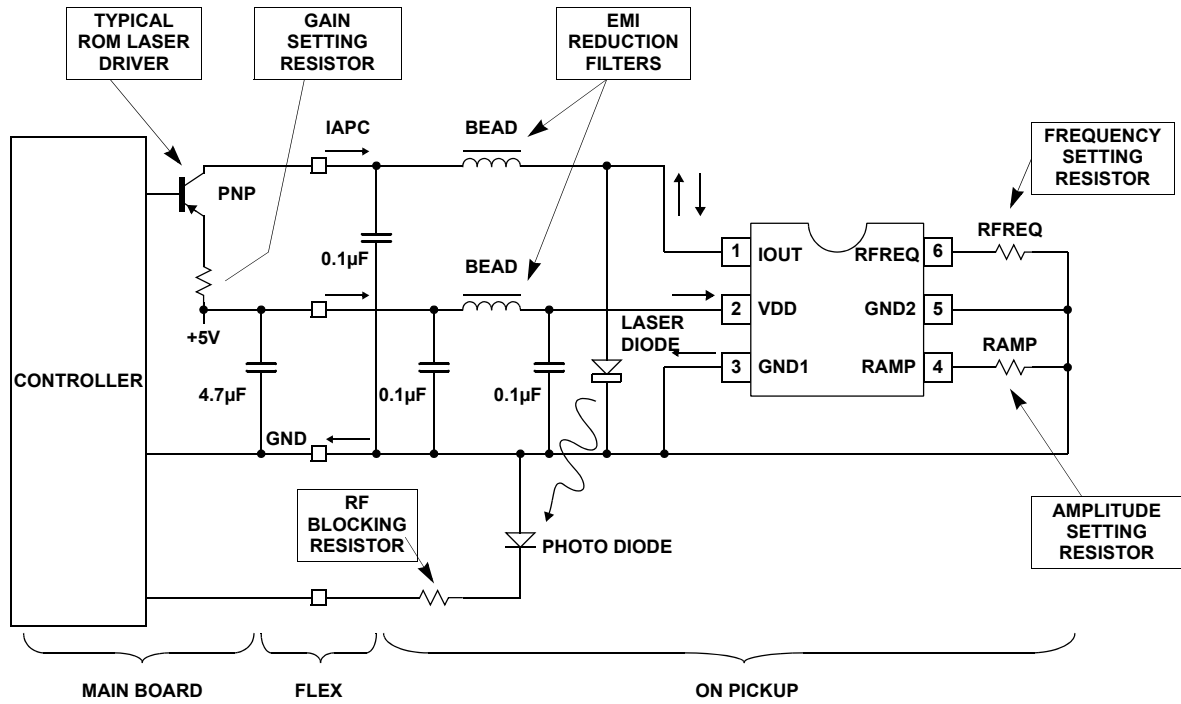


FIGURE 2. TYPICAL APPLICATION CIRCUIT

Ordering Information

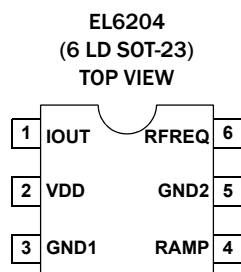
PART NUMBER (Notes 1, 2, 3)	PART MARKING	PACKAGE (RoHS Compliant)	PKG. DWG. #
EL6204CWZ-T7	BNAA (Note 4)	6 Ld SOT-23	P6.064A
EL6204CWZ-T7A	BNAA (Note 4)	6 Ld SOT-23	P6.064A

1. Please refer to [TB347](#) for details on reel specifications.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
3. For Moisture Sensitivity Level (MSL), please see product information page for [EL6204](#). For more information on MSL, please see tech brief [TB363](#).
4. The part marking is located on the bottom of the part.

Pin Descriptions

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	IOUT	Current output to laser diode
2	VDD	Positive power for laser driver (4.5V to 5.5V)
3	GND1	Chip ground pin (0V for output)
4	RAMP	Set pin for output current amplitude
5	GND2	Chip ground pin (0V for RFREQ, RAMP)
6	RFREQ	Set pin for oscillator frequency

Pin Configuration



Absolute Maximum Ratings (T_A = +25°C)

Voltages Applied to:

V _{DD}	-0.5V to +6.0V
I _{OUT}	-0.5V to +6.0V
R _{FREQ} , R _{AMP}	-0.5V to +6.0V

Thermal Information

Thermal Resistance (Typical)	θ _{JA} (°C/W)	θ _{JC} (°C/W)
6 Ld SOT-23 Package (Notes 5, 6)	230	105
Operating Ambient Temperature Range	0°C to +70°C	
Maximum Junction Temperature	+150°C	
Storage Temperature Range	-65°C to +150°C	
Output Current	100mA _{P-P}	
Power Dissipation (max)	See Curves on page 10	
Pb-free Reflow Profile	see TB493	

Recommended Operating Conditions

V _{DD}	5V ±10%
V _{OUT}	2V to 3V
R _{FREQ}	3kΩ (min)
R _{AMP}	1.25kΩ (min)
F _{OSC}	60 to 600MHz
I _{OUT}	10 to 100mA _{P-P}

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTES:

5. θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief [TB379](#) for details.
6. For θ_{JC}, the “case temp” location is taken at the package top center.

Electrical Specifications V_{DD} = +5V, T_A = +25°C, R_L = 10Ω, R_{FREQ} = 5.21kΩ (F_{OSC} = 350MHz), R_{AMP} = 2.54kΩ (I_{OUT} = 50mA_{P-P} measured at 60MHz), V_{OUT} = 2.2V.

PARAMETER	DESCRIPTION	TEST CONDITIONS	MIN (Note 7)	TYP	MAX (Note 7)	UNIT
SUPPLY AND REFERENCE VOLTAGE CHARACTERISTICS						
PSOR	Power Supply Operating Range		4.5		5.5	V
I _{SO}	Supply Current Disabled	V _{OUT} < V _{CUTOFF}		550	750	μA
I _{STYP}	Supply Current Typical Conditions	R _{FREQ} = 5.21kΩ, R _{AMP} = 2.54kΩ		18.5	22	mA
I _{SLO}	Supply Current Low Conditions	R _{FREQ} = 30.5kΩ, R _{AMP} = 12.7kΩ		4.75		mA
I _{SHI}	Supply Current High Conditions	R _{FREQ} = 3.05kΩ, R _{AMP} = 1.27kΩ		32		mA
V _{FREQ}	Voltage at RFREQ Pin			1.27		V
V _{RAMP}	Voltage on RAMP Pin			1.27		V
V _{CUTOFF}	Monitoring Voltage of IOU Pin		1.1		1.4	V
OSCILLATOR CHARACTERISTICS						
F _{OSC}	Frequency Tolerance	Unit to unit frequency variation	300	350	400	MHz
F _{HIGH}	Frequency Range High	R _{FREQ} = 3.05kΩ		600		MHz
F _{LOW}	Frequency Range Low	R _{FREQ} = 30.5kΩ		60		MHz
TC _{OSC}	Frequency Temperature Sensitivity	0°C to +70°C ambient		50		ppm/°C
PSRR _{OSC}	Frequency Change ΔF/F	V _{DD} from 4.5V to 5.5V		1		%

Driver Characteristics V_{DD} = +5V, T_A = +25°C, R_L = 10Ω, R_{FREQ} = 30.5kΩ (F_{OSC} = 60MHz), R_{AMP} = 2540Ω (I_{OUT} = 50mA_{P-P} measured at 60MHz), V_{OUT} = 2.2V.

PARAMETER	DESCRIPTION	TEST CONDITIONS	MIN (Note 7)	TYP	MAX (Note 7)	UNIT
AMP _{HIGH}	Amplitude Range High	R _{AMP} = 1.27kΩ		100		mA _{P-P}
AMP _{LOW}	Amplitude Range Low	R _{AMP} = 12.7kΩ		10		mA _{P-P}
IOS _{NOM}	Offset Current at 2.2V	R _{FREQ} = 5210Ω, V _{OUT} = 2.2V		-4		mA
IOS _{HIGH}	Offset Current at 2.8V	R _{FREQ} = 5210Ω, V _{OUT} = 2.8V		-4.8		mA
IOS _{LOW}	Offset Current at 1.8V	R _{FREQ} = 5210Ω, V _{OUT} = 1.8V		-3.5		mA
I _{OUTP-P}	Output Current Tolerance	Defined as one standard deviation		2		%
Duty Cycle	Output Push Time/Cycle Time	R _{FREQ} = 5210Ω		43		%
PSRR _{AMP}	Amplitude Change of Output ΔI/I	V _{DD} from 4.5V to 5.5V		-54		dB

Driver Characteristics $V_{DD} = +5V, T_A = +25^\circ C, R_L = 10\Omega, R_{FREQ} = 30.5k\Omega (F_{OSC} = 60MHz), R_{AMP} = 2540\Omega (I_{OUT} = 50mA_{P-P}$ measured at 60MHz), $V_{OUT} = 2.2V$. (Continued)

PARAMETER	DESCRIPTION	TEST CONDITIONS	MIN (Note 7)	TYP	MAX (Note 7)	UNIT
t_{ON}	Auto Turn-on Time	Output voltage step from 0V to 2.2V		15		μs
t_{OFF}	Auto Turn-off Time	Output voltage step from 2.2V to 0V		0.5		μs
I_{OUTN}	Output Current Noise Density	$R_{FREQ} = 5210\Omega$, measured at 10MHz		2.5		nA/\sqrt{Hz}

NOTE:

7. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

I_{OUT} Control

V_{OUT}	I_{OUT}
Less than V_{CUTOFF}	OFF
More than V_{CUTOFF}	Normal Operation

Typical Performance Curves

$V_{DD} = 5V, T_A = 25^\circ C, R_L = 10\Omega, R_{FREQ} = 5.21k\Omega, R_{AMP} = 2.54k\Omega, V_{OUT} = 2.2V$ unless otherwise specified.

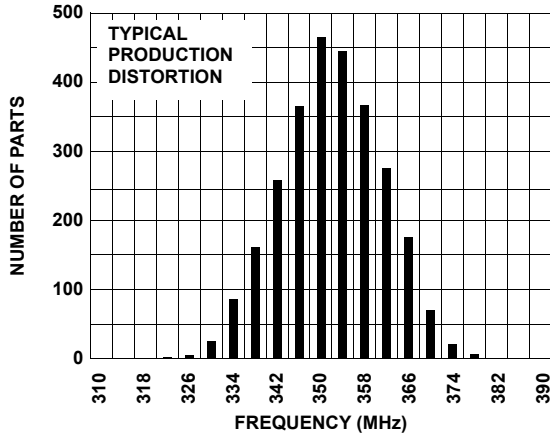


FIGURE 3. FREQUENCY DISTRIBUTION

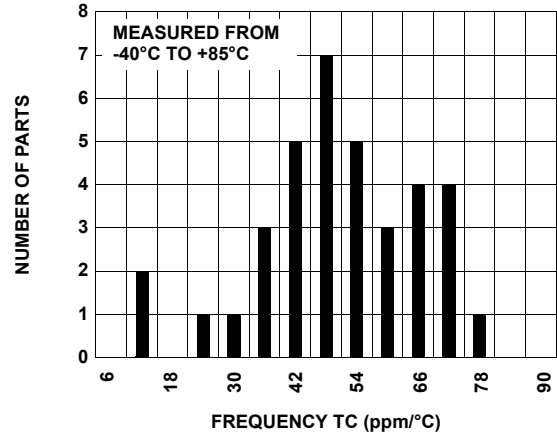


FIGURE 4. FREQUENCY DRIFT WITH TEMPERATURE

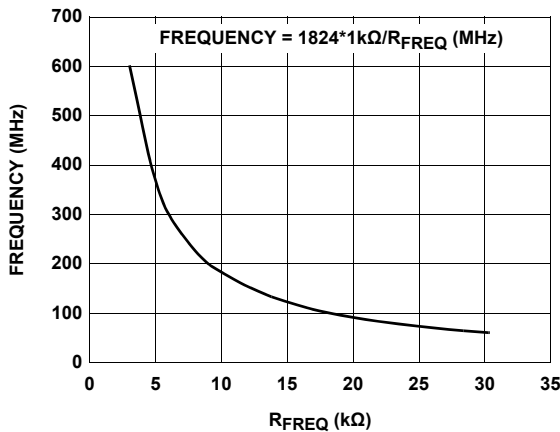


FIGURE 5. FREQUENCY vs R_{FREQ}

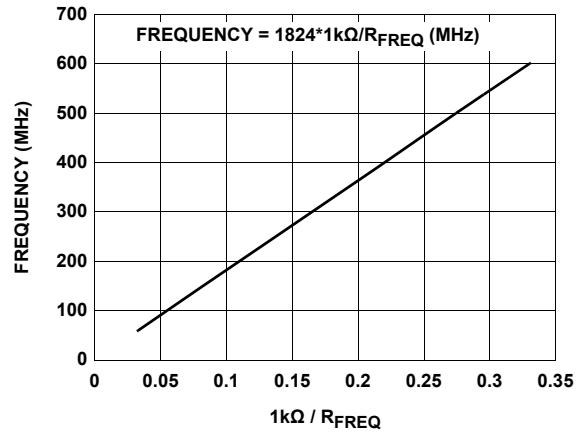


FIGURE 6. FREQUENCY vs $1/R_{FREQ}$

Typical Performance Curves

$V_{DD} = 5V, T_A = 25^\circ C, R_L = 10\Omega, R_{FREQ} = 5.21k\Omega, R_{AMP} = 2.54k\Omega, V_{OUT} = 2.2V$ unless otherwise specified. **(Continued)**

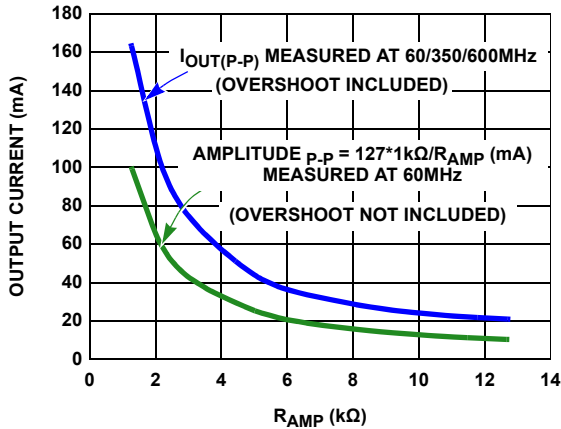


FIGURE 7. OUTPUT CURRENT vs R_{AMP}

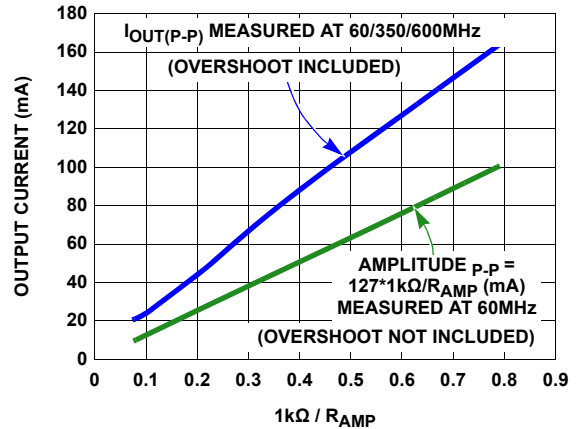


FIGURE 8. OUTPUT CURRENT vs $1/R_{AMP}$

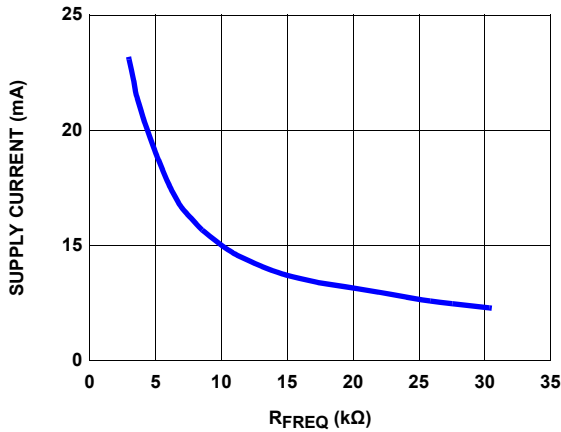


FIGURE 9. SUPPLY CURRENT vs R_{FREQ}

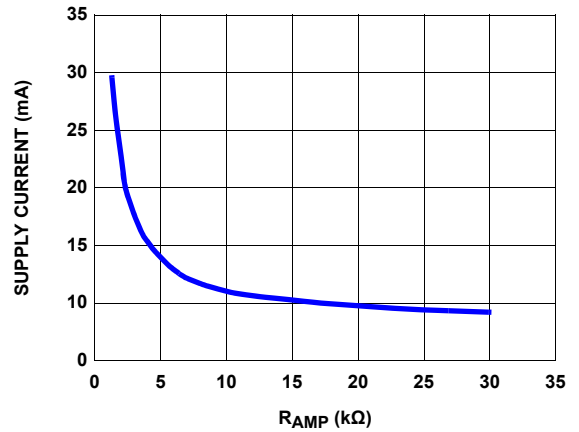


FIGURE 10. SUPPLY CURRENT vs R_{AMP}

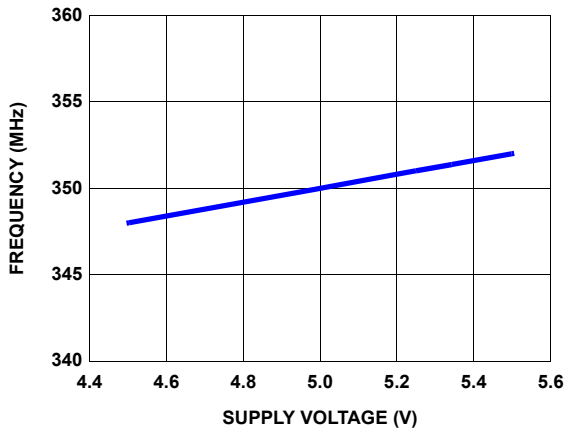


FIGURE 11. FREQUENCY vs SUPPLY VOLTAGE

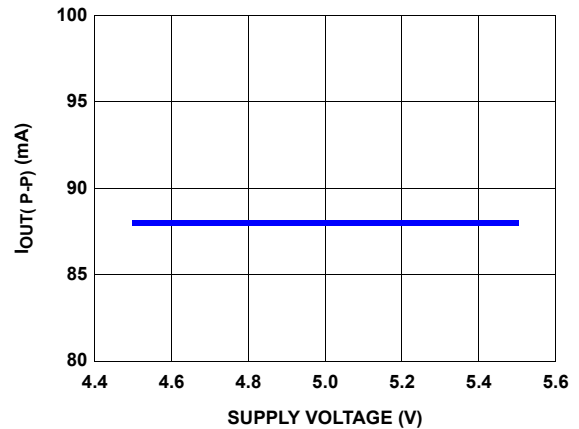


FIGURE 12. PEAK-TO-PEAK OUTPUT CURRENT vs SUPPLY VOLTAGE

Typical Performance Curves

otherwise specified. (Continued)

$V_{DD} = 5V, T_A = 25^\circ C, R_L = 10\Omega, R_{FREQ} = 5.21k\Omega, R_{AMP} = 2.54k\Omega, V_{OUT} = 2.2V$ unless

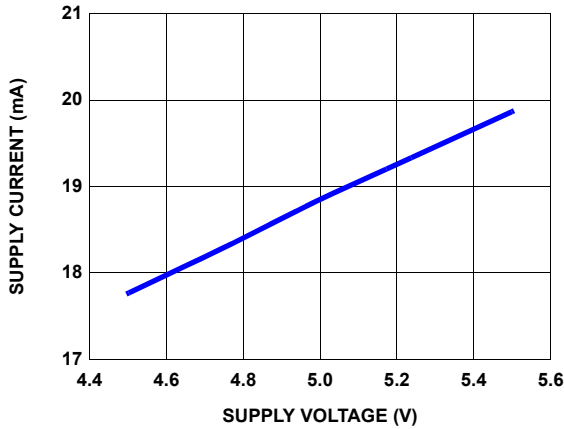


FIGURE 13. SUPPLY CURRENT vs SUPPLY VOLTAGE

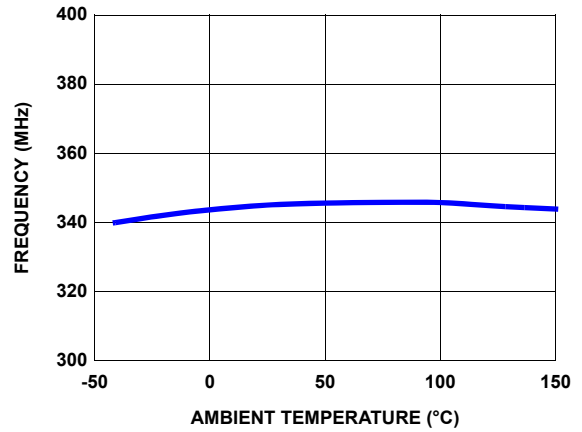


FIGURE 14. FREQUENCY vs TEMPERATURE

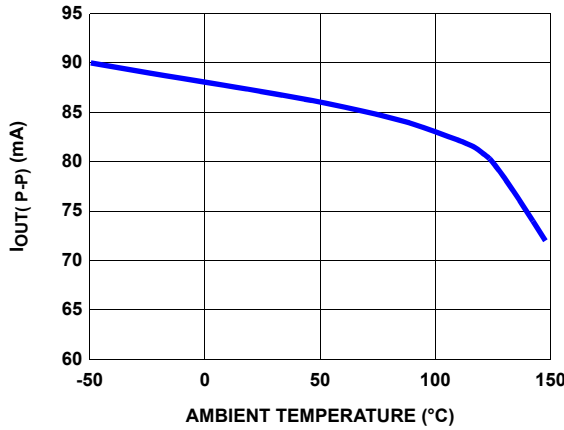


FIGURE 15. PEAK-TO-PEAK OUTPUT CURRENT vs TEMPERATURE

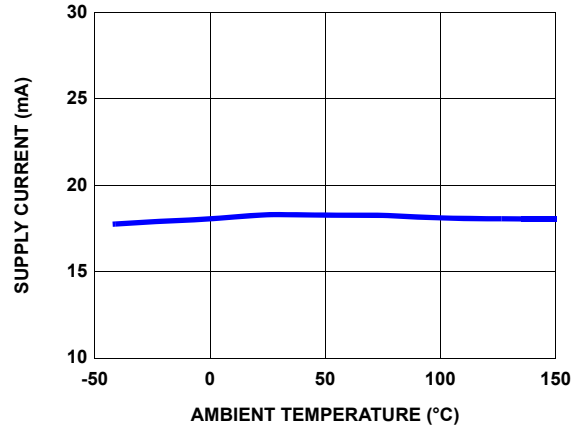


FIGURE 16. SUPPLY CURRENT vs TEMPERATURE

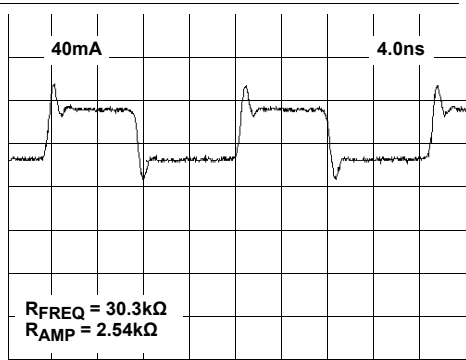


FIGURE 17. OUTPUT CURRENT AT 60MHz

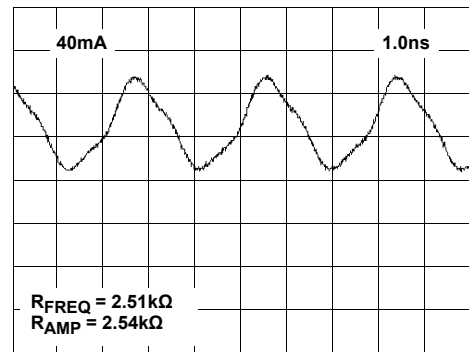


FIGURE 18. OUTPUT CURRENT AT 350MHz

Typical Performance Curves

otherwise specified. (Continued)

$V_{DD} = 5V$, $T_A = 25^\circ C$, $R_L = 10\Omega$, $R_{FREQ} = 5.21k\Omega$, $R_{AMP} = 2.54k\Omega$, $V_{OUT} = 2.2V$ unless

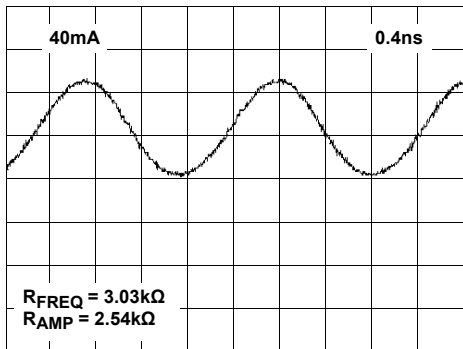


FIGURE 19. OUTPUT CURRENT AT 600MHZ

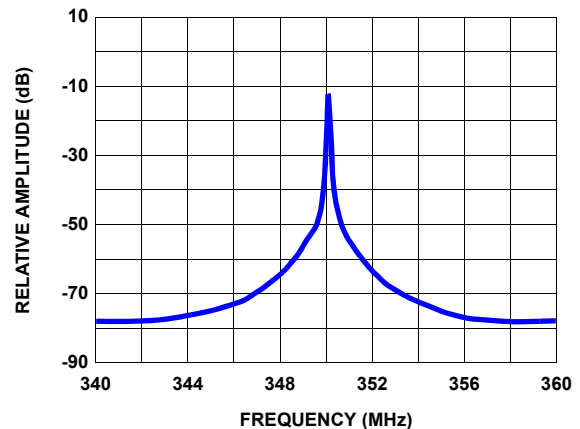


FIGURE 20. OUTPUT SPECTRUM-WIDEBAND

Applications Information

Product Description

The EL6204 is a solid state, low-power, high-speed laser modulation oscillator with external resistor-adjustable operating frequency and output amplitude. It is designed to interface easily with laser diodes to break up optical feedback resonant modes and thereby reduce laser noise. The output of the EL6204 is composed of a push-pull current source, switched alternately at the oscillator frequency. The output and oscillator are automatically disabled for power saving when the average laser voltage drops to less than 1.1V. The EL6204 has the operating frequency from 60MHz to 600MHz and the output current from 10mA_{P-P} to 100mA_{P-P}. The supply current is only 18.5mA for the output current of 50mA_{P-P} at the operating frequency of 350MHz.

Theory of Operation

A typical semiconductor laser will emit a small amount of incoherent light at low values of forward laser current. However, after the threshold current is reached, the laser will emit coherent light. Further increases in the forward current will cause rapid increases in laser output power. A typical threshold current is 35mA and a typical slope efficiency is 0.7mW/mA.

When the laser is lasing, it will often change its mode of operation slightly, due to changes in current, temperature or optical feedback into the laser. In a DVD-ROM, the optical feedback from the moving disk forms a significant noise factor due to feedback-induced mode hopping. In addition to the mode hopping noise, a diode laser will roughly have a constant noise level regardless of the power level when a threshold current is exceeded.

The oscillator is designed to produce a low noise oscillating current that is added to the external DC current. The effective AC current is to cause the laser power to change at the oscillator frequency. This change causes the laser to go through rapid mode hopping. The low frequency component of laser power noise due to mode hopping is translated up to sidebands around

the oscillator frequency by this action. Since the oscillator frequency can be filtered out of the low frequency read and serve channels, the net result is that the laser noise seems to be reduced. The second source of laser noise reduction is caused by the increase in the laser power above the average laser power during the pushing-current time. The signal-to-noise ratio (SNR) of the output power is better at higher laser powers because of the almost constant noise power when a threshold current is exceeded. In addition, when the laser is off during the pulling current time, the noise is also very low.

R_{AMP} and R_{FREQ} Value Setting

The laser should always have a forward current during operation. This will prevent the laser voltage from collapsing and ensure that the high frequency components reach the junction without having to charge the junction capacitance.

Generally it is desirable to make the oscillator currents as large as possible to obtain the greatest reduction in laser noise. But it is not a trivial matter to determine this critical value. The amplitude depends on the wave shape of the oscillator current reaching the laser junction.

If the output current is sinusoidal and the components in the output circuit are fixed and linear, then the shape of the current will be sinusoidal. Thus the amount of current reaching the laser junction is a function of the circuit parasitics. These parasitics can result in a resonant increase in output depending on the frequency due to the junction capacitance and layout. Also, the amount of junction current causing laser emission is variable with frequency due to the junction capacitance. It can be concluded that the sizes of the R_{AMP} and R_{FREQ} resistors must be determined experimentally. A good starting point is to take a value of R_{AMP} for a peak-to-peak current amplitude less than the minimum laser threshold current and a value of R_{FREQ} for an output current close to a sinusoidal wave form (refer to the "Typical Performance Curves" beginning on [page 5](#)).

RAMP and RFREQ Pin Interfacing

Figure 21 on page 9 shows an equivalent circuit of pins associated with the RAMP and RFREQ resistors. VREF is roughly 1.27V for both RAMP and RFREQ. The RAMP and RFREQ resistors should be connected to the non-load side of the power ground to avoid noise pickup. These resistors should also return to the EL6204's ground very directly to prevent noise pickup. They also should have minimal capacitance to ground. Trimmer resistors can be used to adjust initial operating points.

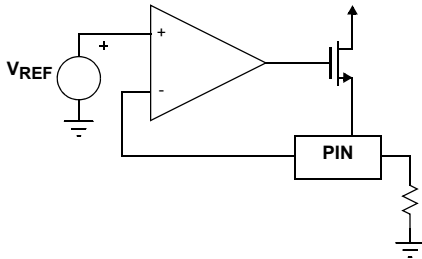


FIGURE 21. RAMP AND RFREQ PIN INTERFACE

External voltage sources can be coupled to the RAMP and RFREQ pins to effect frequency or amplitude modulation or adjustment. It is recommended that a coupling resistor of 1k be installed in series with the control voltage and mounted directly next to the pin. This will keep the inevitable high-frequency noise of the EL6204's local environment from propagating to the modulation source, and it will keep parasitic capacitance at the pin minimized.

Supply Bypassing and Grounding

The resistance of bypass-capacitors and the inductance of bonding wires prevent perfect bypass action and 150mV_{P-P} noise on the power lines is common. There needs to be a lossy bead inductance and secondary bypass on the supply side to control signals from propagating down the wires. Figure 22 shows the typical connection.

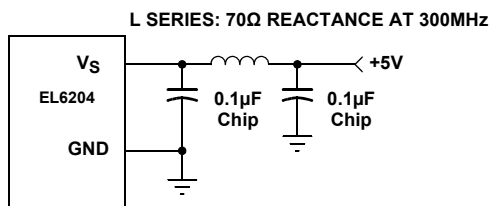


FIGURE 22. RECOMMENDED SUPPLY BYPASSING

Also important is the circuit board layout. At the EL6204's operating frequencies, even the ground plane is not low-impedance. High frequency current will create voltage drops in the ground plane. Figure 23 shows the output current loops.

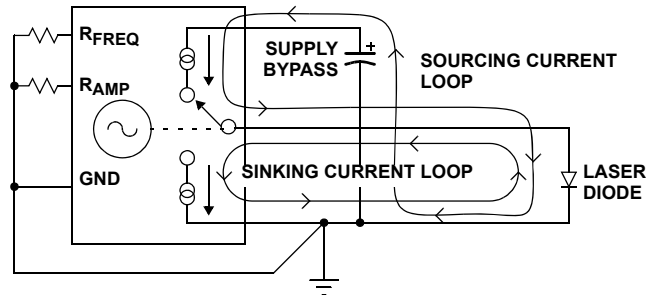


FIGURE 23. OUTPUT CURRENT LOOPS

For the pushing current loop, the current flows through the bypass capacitor, into the EL6204 supply pin, out the I_{OUT} pin to the laser, and from the laser back to the decoupling capacitor. This loop should be small.

For the pulling current loop, the current flows into the I_{OUT} pin, out of the ground pin, to the laser cathode and from the laser diode back to the I_{OUT} pin. This loop should also be small.

Power Dissipation

With the high output drive capability, the EL6204 is possible to exceed the +125°C “absolute-maximum junction temperature” under certain conditions. Therefore, it is important to calculate the maximum junction temperature for the application to determine if the conditions need to be modified for the oscillator to remain in the safe operating area.

The maximum power dissipation allowed in a package is determined according to Equation 1:

$$P_{DMAX} = \frac{T_{JMAX} - T_{AMAX}}{\theta_{JA}} \quad (EQ. 1)$$

Where

P_{DMAX} = Maximum power dissipation in the package

T_{JMAX} = Maximum junction temperature

T_{AMAX} = Maximum ambient temperature

θ_{JA} = Thermal resistance of the package

The supply current of the EL6204 depends on the peak-to-peak output current and the operating frequency, which are determined by resistors R_{AMP} and R_{RFREQ}. The supply current can be predicted approximately by Equation 2:

$$I_{SUP} = \frac{31.25mA \times 1k\Omega}{R_{AMP}} + \frac{30mA \times 1k\Omega}{R_{RFREQ}} + 0.6mA \quad (EQ. 2)$$

The power dissipation can be calculated from Equation 3:

$$P_D = V_{SUP} \times I_{SUP} \quad (EQ. 3)$$

Here, V_{SUP} is the supply voltage. [Figures 24](#) and [25](#) provide a convenient way to see if the device will overheat. The maximum safe power dissipation can be found graphically, based on the package type and the ambient temperature. By using [Equation 3](#), it is a simple matter to see if P_D exceeds the device's power derating curve. To ensure proper operation, it is important to observe the recommended derating curve shown in [Figures 24](#) and [25](#). A flex circuit may have a higher θ_{JA} and lower power dissipation would then be required.

PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE
JEDEC JESD51-3 Low Effective Thermal Conductivity Test Board

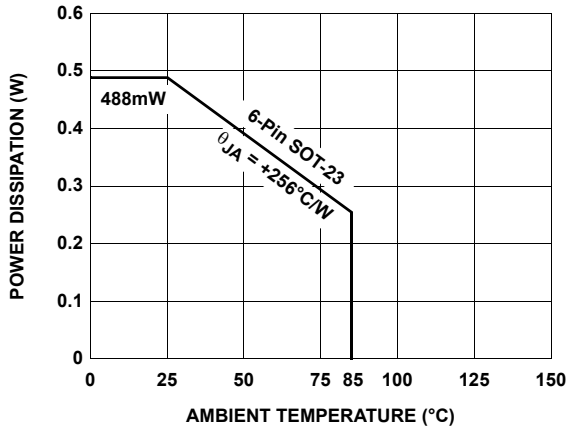


FIGURE 24. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE
JEDEC JESD51-7 High Effective Thermal Conductivity Test Board

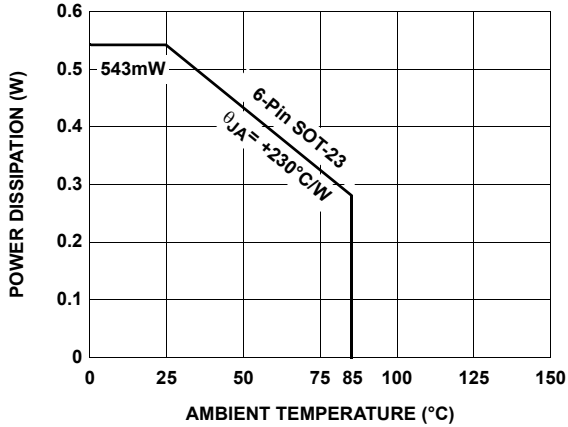


FIGURE 25. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to the web to make sure that you have the latest revision.

DATE	REVISION	CHANGE
October 28, 2015	FN7219.3	<p>Added Rev History beginning with Revision 3.</p> <p>Updated entire datasheet applying Intersil's new standards.</p> <p>Removed obsolete parts EL6204CW-T7 AND EL6204CW-T7A ordering information on page 3 - updated PKG DWG from MDP0038 to P6.064A, added MSL note and part marking note.</p> <p>Added Tja and Tjc in "Thermal Information" on page 4 and corresponding notes.</p> <p>Added Note 7 on page 5 to MIN and MAX in Electrical Spec Tables and corresponding note.</p> <p>Changed POD MDP0038 to P6.064A</p>

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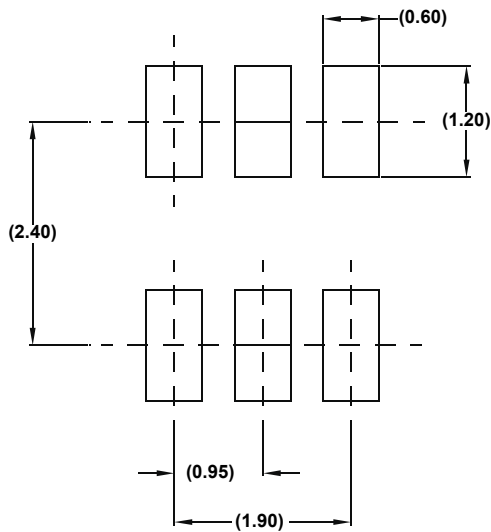
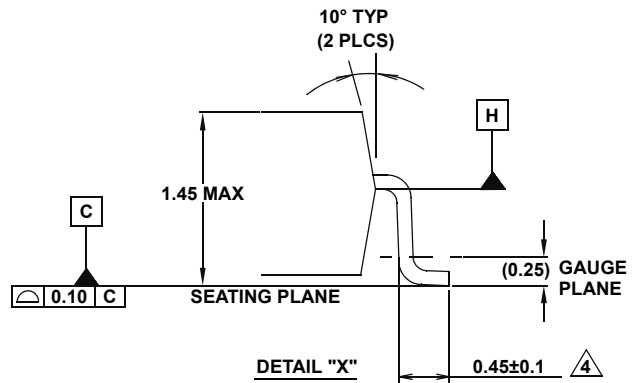
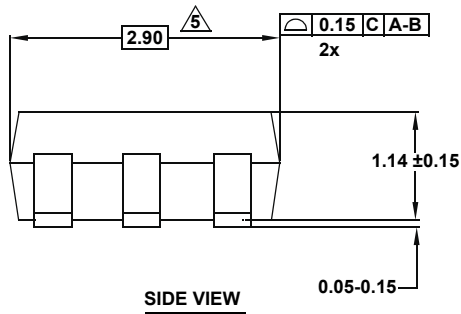
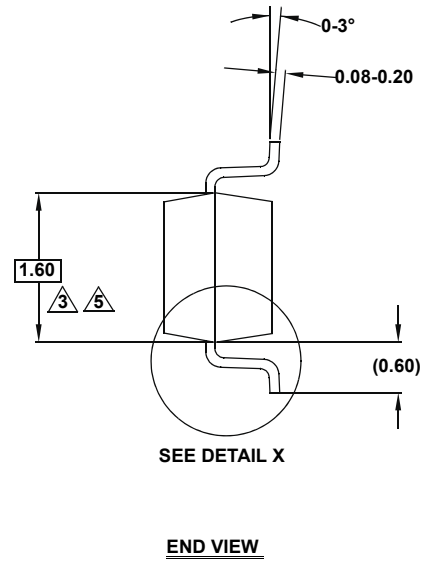
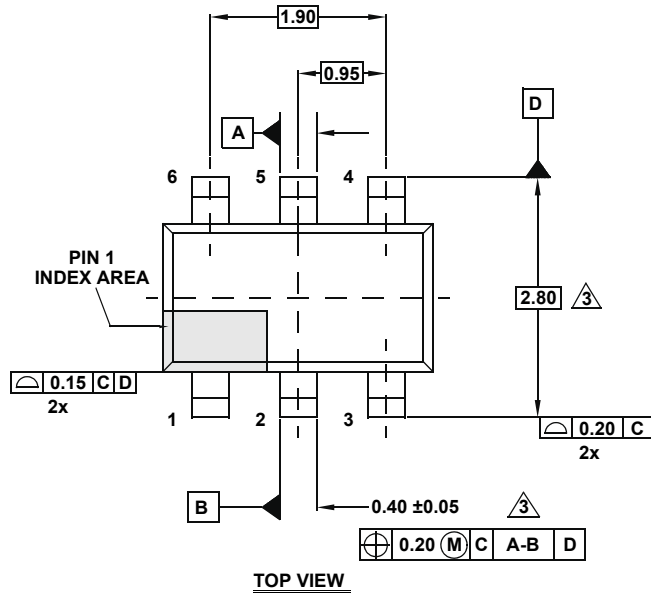
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Package Outline Drawing

P6.064A

6 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

Rev 0, 2/10



NOTES:

1. Dimensions are in millimeters.
Dimensions in () for Reference Only.
2. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
3. Dimension is exclusive of mold flash, protrusions or gate burrs.
4. Foot length is measured at reference to gauge plane.
5. This dimension is measured at Datum "H".
6. Package conforms to JEDEC MO-178AA.