EL6204

Laser Driver Oscillator

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
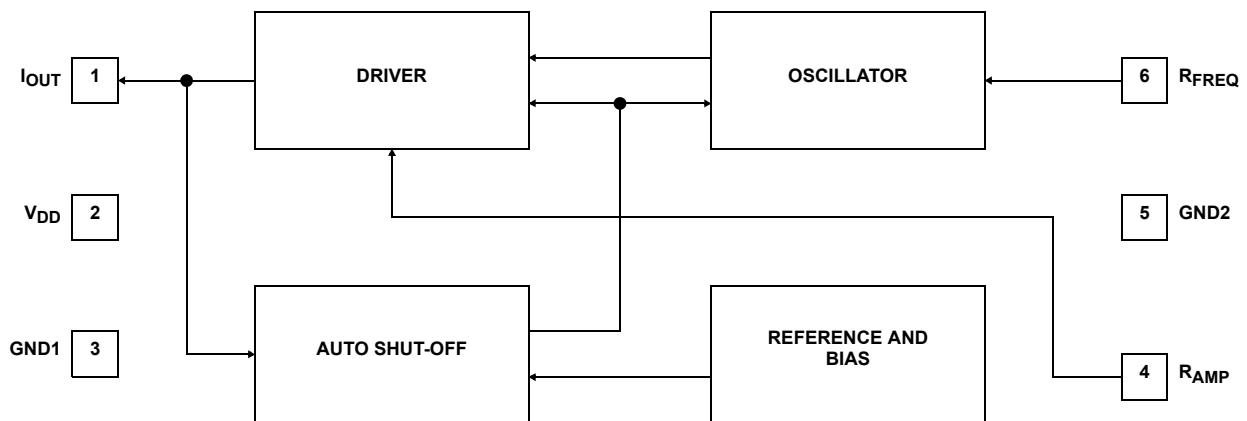- General purpose laser noise reduction
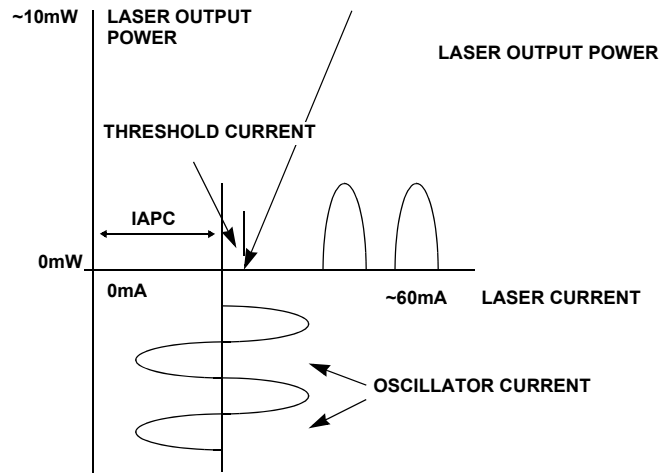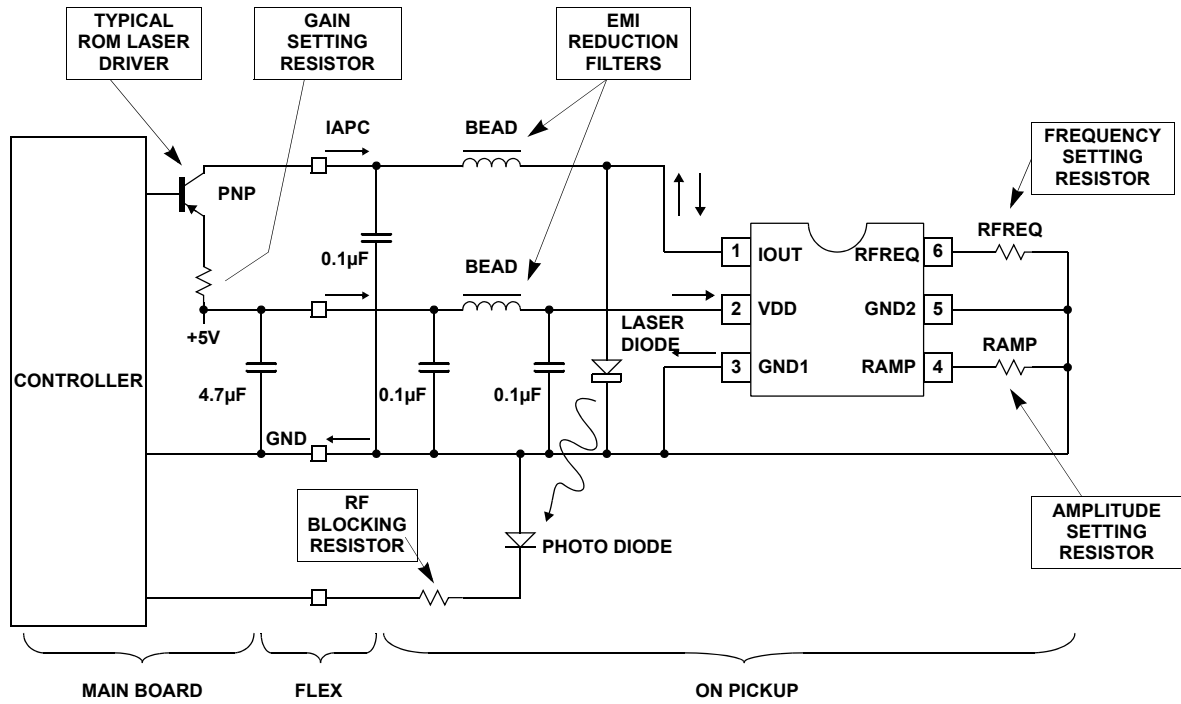- Local oscillators

FIGURE 1. BLOCK DIAGRAM

TYPICAL
ROM LASER
DRIVER

GAIN
SETTING
RESISTOR

EMI
REDUCTION
FILTERS

FREQUENCY
SETTING
RESISTOR

IAPC

BEAD

PNP

RFREQ

RFREQ 6

0.1µF

BEAD

1 IOUT

+5V

2 VDD

GND2 5

CONTROLLER

LASER
DIODE

RAMP

4.7µF

0.1µF

0.1µF

3 GND1

RAMP 4

GND

AMPLITUDE
SETTING
RESISTOR

RF
BLOCKING
RESISTOR

PHOTO DIODE

MAIN BOARD

FLEX

ON PICKUP

~10mW

LASER OUTPUT
POWER

LASER OUTPUT POWER

THRESHOLD CURRENT

IAPC

0mW

0mA

~60mA

LASER CURRENT

OSCILLATOR CURRENT

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 Configuration

EL6204
(6 LD SOT-23)
TOP VIEW

1	IOUT	RFREQ	6
2	VDD	GND2	5
3	GND1	RAMP	4

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
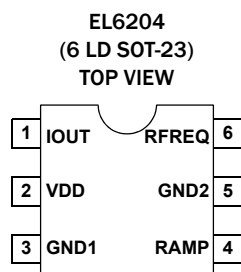
Absolute Maximum Ratings (T_A = +25°C)

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

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

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

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 IOUT 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°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. **(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
$IOUT_N$	Output Current Noise Density	R_{FREQ} = 5210Ω, measured at 10MHz		2.5		nA/√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°C, R_L = 10Ω, R_{FREQ} = 5.21kΩ, R_{AMP} = 2.54kΩ, V_{OUT} = 2.2V unless otherwise specified.
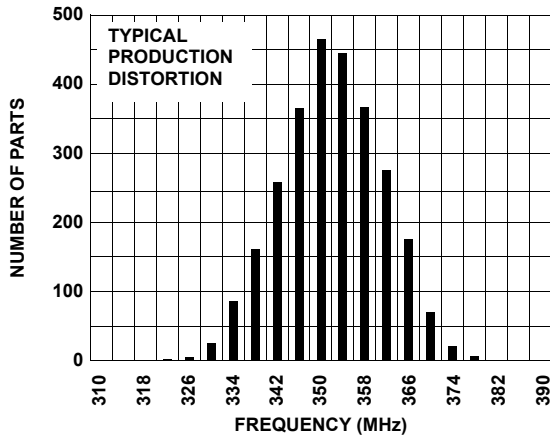
FIGURE 3. FREQUENCY DISTRIBUTION
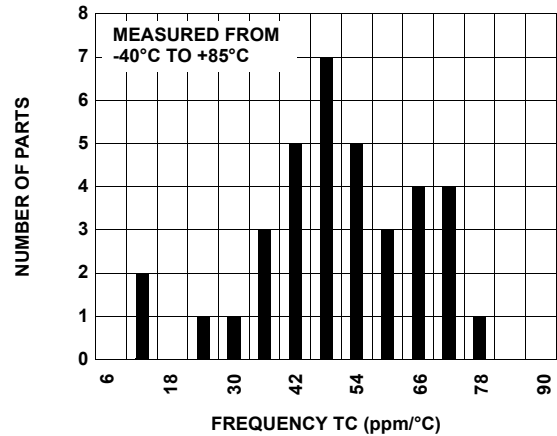
FIGURE 4. FREQUENCY DRIFT WITH TEMPERATURE
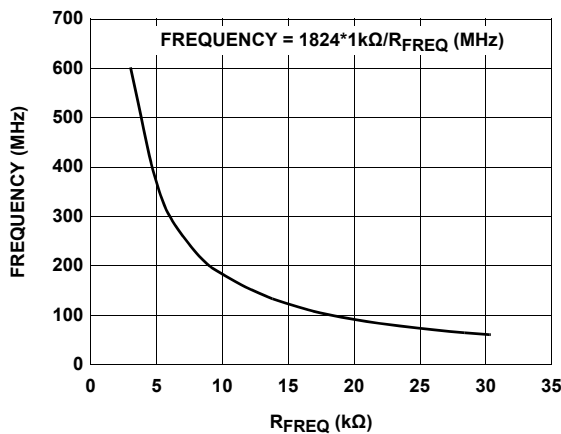
FIGURE 5. FREQUENCY vs R_{FREQ}
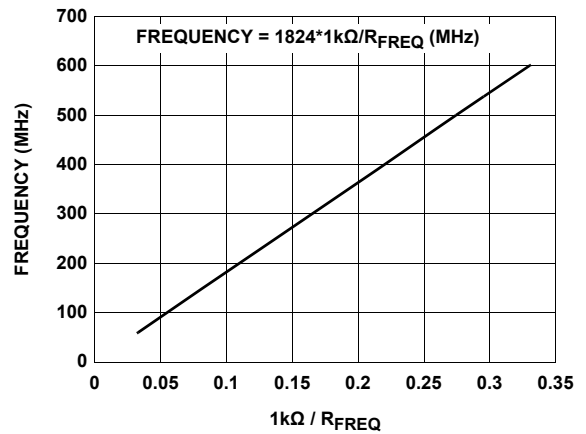
FIGURE 6. FREQUENCY vs 1/R_{FREQ}

Typical Performance Curves

V_{DD} = 5V, T_A = 25°C, R_L = 10Ω, R_{FREQ} = 5.21kΩ, R_{AMP} = 2.54kΩ, V_{OUT} = 2.2V unless otherwise specified. **(Continued)**
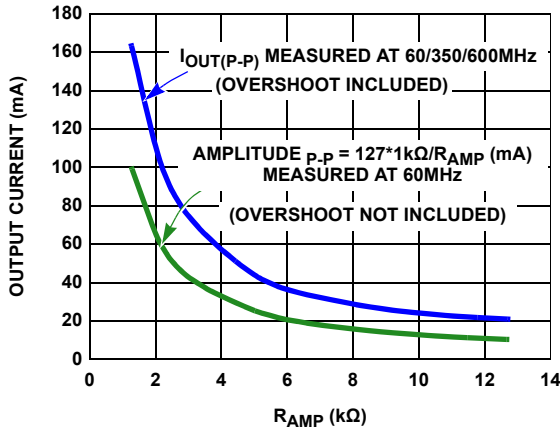
FIGURE 7. OUTPUT CURRENT vs R_{AMP}
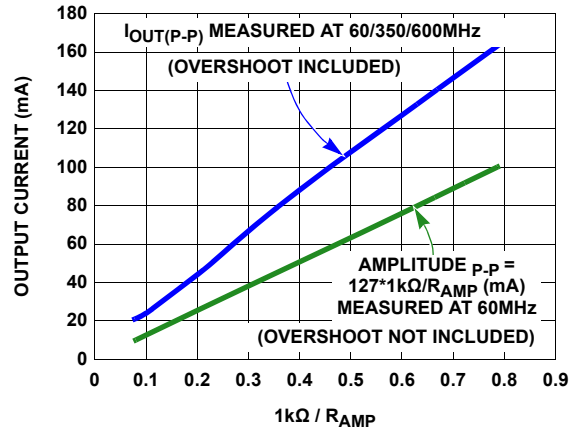
FIGURE 8. OUTPUT CURRENT vs $1/R_{AMP}$
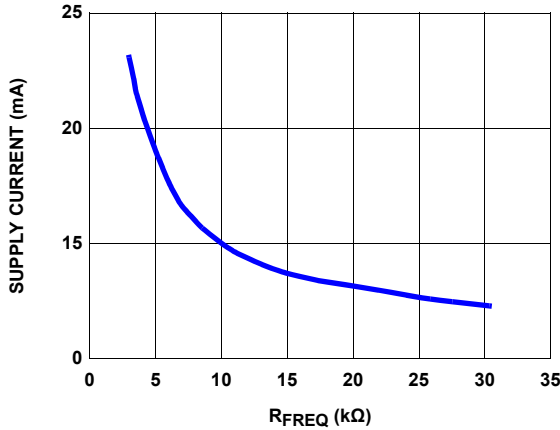
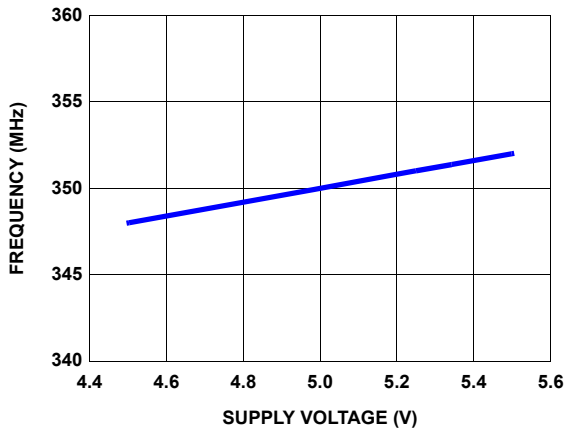FIGURE 9. SUPPLY CURRENT vs R_{FREQ}
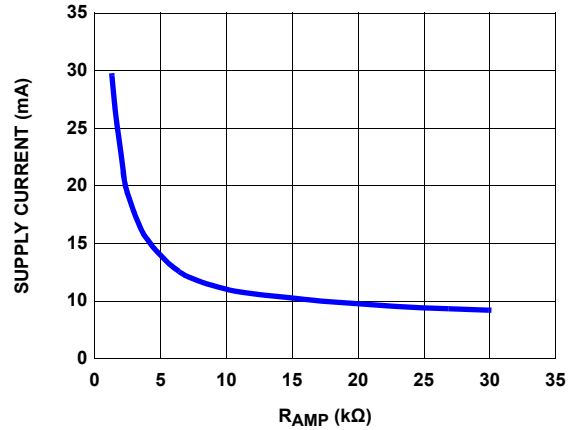
FIGURE 10. SUPPLY CURRENT vs R_{AMP}

FIGURE 11. FREQUENCY vs SUPPLY VOLTAGE
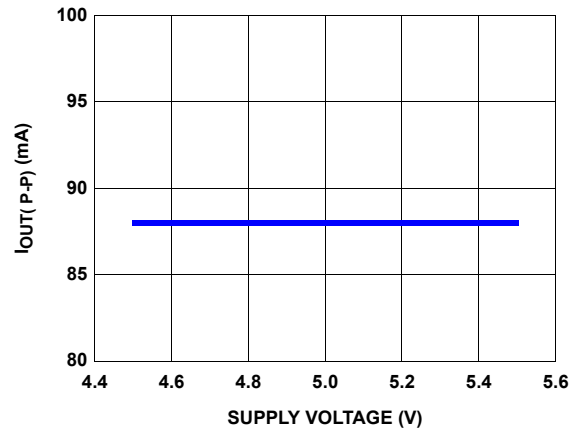
FIGURE 12. PEAK-TO-PEAK OUTPUT CURRENT vs SUPPLY VOLTAGE

Typical Performance Curves

V_{DD} = 5V, T_A = 25°C, R_L = 10Ω, R_{FREQ} = 5.21kΩ, R_{AMP} = 2.54kΩ, V_{OUT} = 2.2V unless otherwise specified. (Continued)
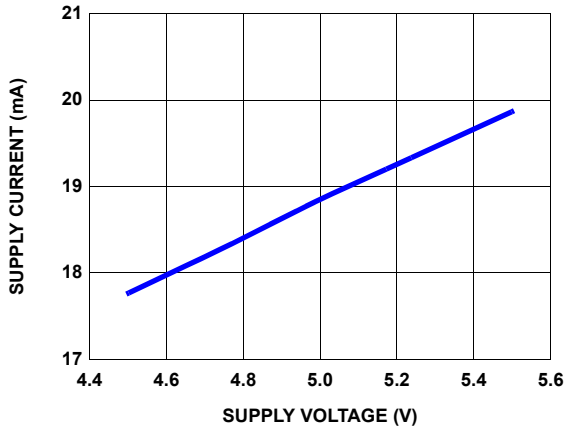
FIGURE 13. SUPPLY CURRENT vs SUPPLY VOLTAGE
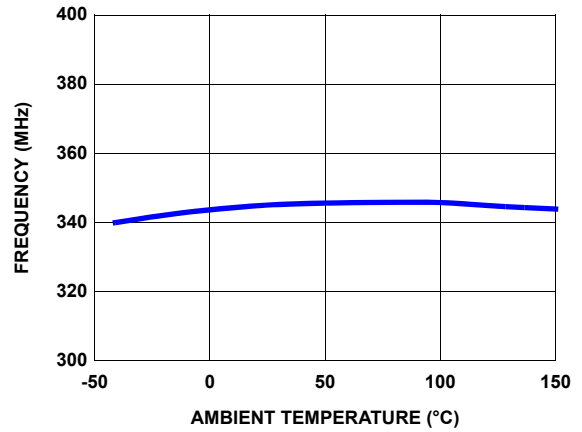
FIGURE 14. FREQUENCY vs TEMPERATURE
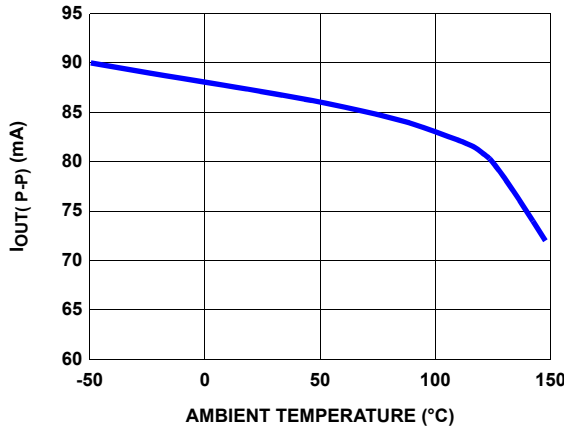
FIGURE 15. PEAK-TO-PEAK OUTPUT CURRENT vs TEMPERATURE
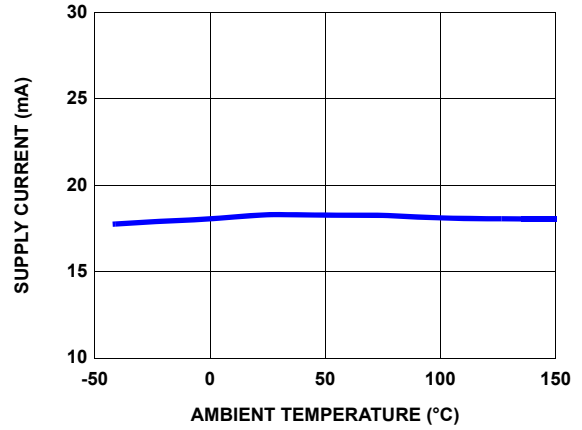
FIGURE 16. SUPPLY CURRENT vs TEMPERATURE

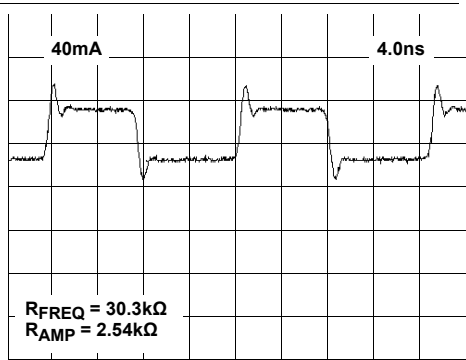FIGURE 17. OUTPUT CURRENT AT 60MHz

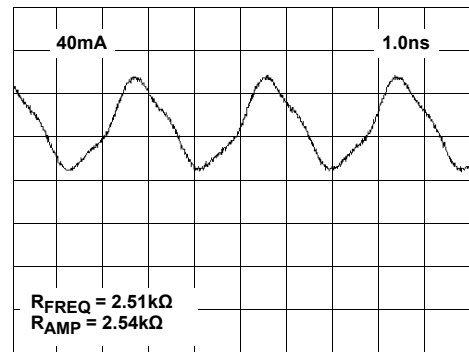FIGURE 18. OUTPUT CURRENT AT 350MHz

Typical Performance Curves

V_{DD} = 5V, T_A = 25°C, R_L = 10Ω, R_{FREQ} = 5.21kΩ, R_{AMP} = 2.54kΩ, V_{OUT} = 2.2V unless otherwise specified. **(Continued)**
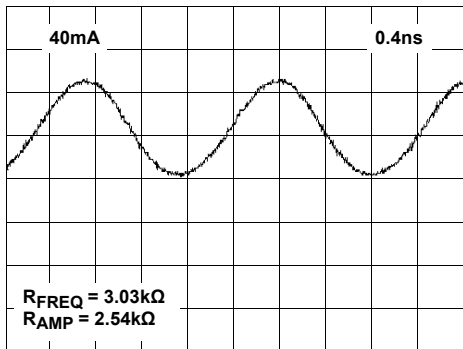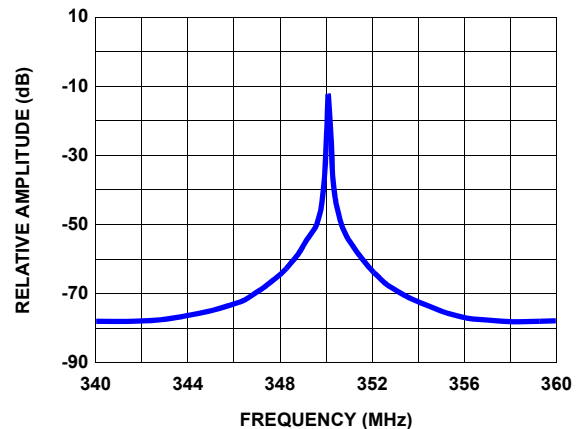

FIGURE 19. OUTPUT CURRENT AT 600MHz

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).

R_{AMP} and R_{FREQ} Pin Interfacing

R$_{AMP}$ and R$_{FREQ}$ Pin Interfacing

shows an equivalent circuit of pins associated with the R$_{AMP}$ and R$_{FREQ}$ resistors. V$_{REF}$ is roughly 1.27V for both R$_{AMP}$ and R$_{FREQ}$. The R$_{AMP}$ and R$_{FREQ}$ 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.
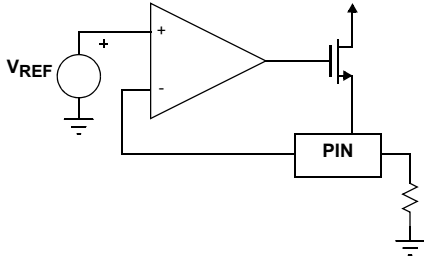
FIGURE 21. R$_{AMP}$ AND R$_{FREQ}$ PIN INTERFACE

External voltage sources can be coupled to the R$_{AMP}$ and R$_{FREQ}$ 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.
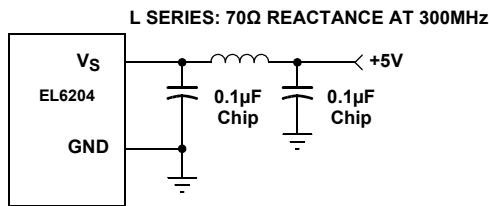

FIGURE 22. RECOMMENDED SUPPLY BYPASSING

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.
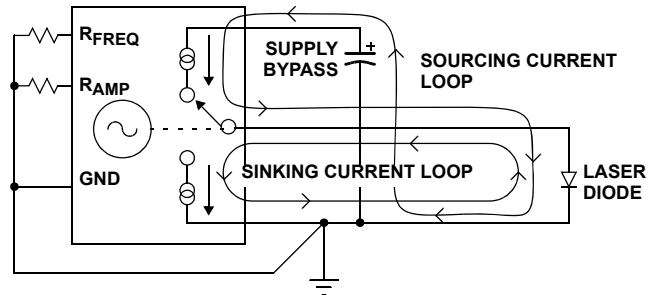

FIGURE 23. OUTPUT CURRENT LOOPS

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:

$$P_{DMAX} = \frac{T_{JMAX} - T_{AMAX}}{\Theta_{JA}}$$ (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$_{FREQ}$. The supply current can be predicted approximately by Equation 2:

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

The power dissipation can be calculated from Equation 3:

$$P_D = V_{SUP} \times I_{SUP}$$ (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
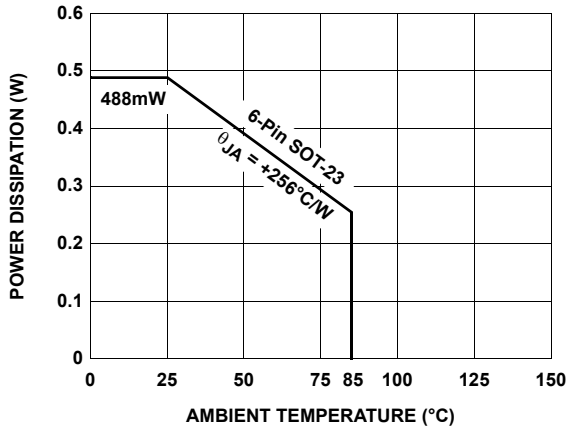**JEDEC JESD51-3 Low Effective Thermal Conductivity Test Board**

FIGURE 24. PACKAGE POWER DISSIPATION vs
AMBIENT TEMPERATURE

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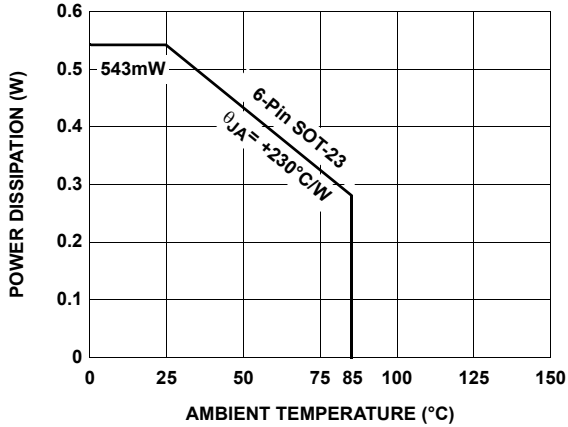**JEDEC JESD51-7 High Effective Thermal Conductivity Test Board**

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	Added Rev History beginning with Revision 3. Updated entire datasheet applying Intersil's new standards. 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. Added Tja and Tjc in "Thermal Information" on page 4 and corresponding notes. Added Note 7 on page 5 to MIN and MAX in Electrical Spec Tables and corresponding note. Changed POD MDP0038 to P6.064A

About Intersil

Intersil Corporation is a leading provider of innovative power management and precision analog solutions. The company's products address some of the largest markets within the industrial and infrastructure, mobile computing and high-end consumer markets.

For the most updated datasheet, application notes, related documentation and related parts, please see the respective product information page found at www.intersil.com.

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Reliability reports are also available from our website at www.intersil.com/support

For additional products, see www.intersil.com/en/products.html

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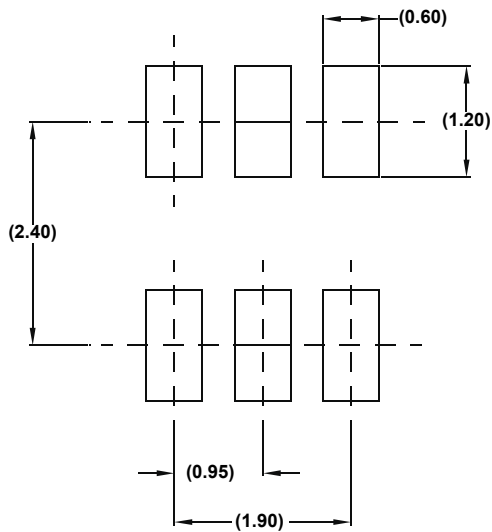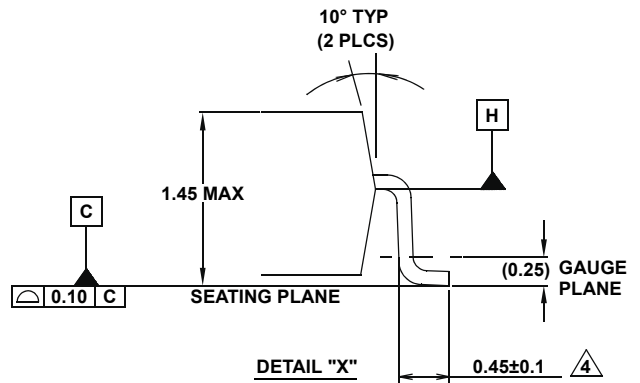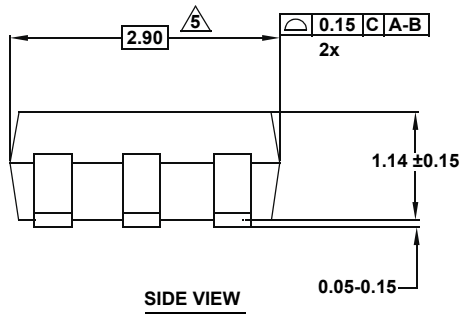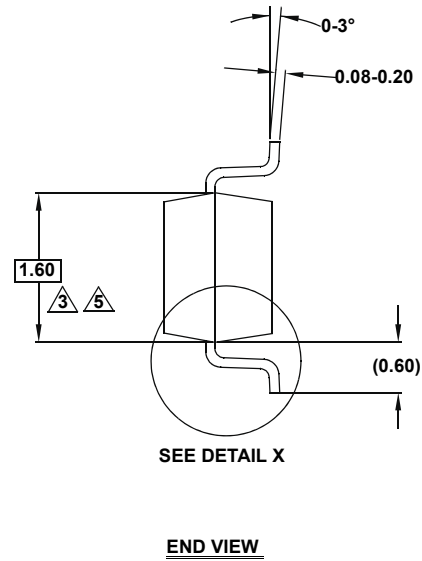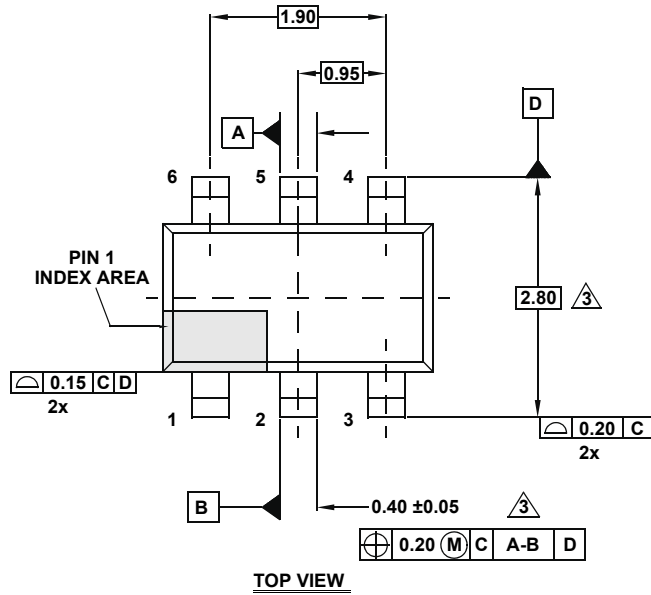
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Package Outline Drawing

P6.064A

6 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

Rev 0, 2/10

TOP VIEW

END VIEW

SIDE VIEW

SEE DETAIL X

DETAIL "X"

SEATING PLANE

GAUGE PLANE

10° TYP (2 PLCS)

1.45 MAX

0.45±0.1

(0.25)

TYPICAL RECOMMENDED LAND PATTERN

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 guage plane.

5. This dimension is measured at Datum "H".

6. Package conforms to JEDEC MO-178AA.