EL6259C

Low Noise 4-Channel Laser Diode Driver + Oscillator

Features

- Low output noise = 3.0nA/rt-Hz
- High-performance laser diode driver
- Pin compatible with EL6257
- Voltage-controlled output current source to 150 mA per channel, requiring one external set resistor per channel
- Current-controlled output current source to 150 mA per channel
- Rise time = 1.0 ns
- Fall time = 1.1 ns
- On chip oscillator with frequency and amplitude control by use of external resistors to ground
- Oscillator to 500 MHz
- Oscillator to 100 mA pk/pk
- All channels current gain is 100
- Single +5V supply (±10%)
- Disable feature for power-up protection and power savings
- TTL/CMOS control signals

Applications

- DVD-RAM high speed drives
- CD-RW applications
- Writable optical drives
- Laser diode current switching

Ordering Information

Part No	Temp. Range	Package	Outline #
EL6259CU	0°C to +70°C	QSOP-24	MDP0040

General Description

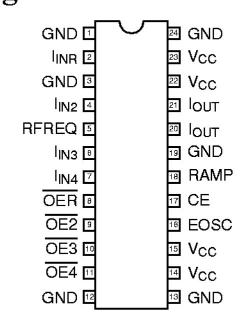
The EL6259C is a low noise four channel laser diode current amplifier that provides controlled current to a grounded laser diode. The four amplifiers can provide up to 150 mA per channel of DC or pulsed current. Channels 2, 3, and 4 must be used as the write channels, with switching speeds of approximately one nanosecond rise/fall time. All four channels are summed together at the I_{OUT} output, allowing the user to create multilevel waveforms in order to optimize laser diode performance. The level of the output current is set by an analog voltage applied to an external resistor which converts the voltage into a current at the I_{IN} pin. The current seen at this pin is then amplified by 100X to become a current source at pin I_{OUT}.

An on-chip 500 MHz oscillator is provided to allow current modulation when in the read mode. This is turned on when the EOSC pin is held high (floating not recommended). Complete control of amplitude and frequency is set by two external resistors connected to ground at pins RFREQ and RAMP (see graphs in this data sheet for further explanation). The oscillator will also turn off whenever any of the $\overline{OE}$ pins for channels 2, 3, and 4 (the write channels) are low (see truth table).

Output current pulses are enabled when an ‘L’ signal is applied to the $\overline{OE}$ pin. No output current flows when $\overline{OE}$ is ‘H’, and additional laser diode protection is provided since the $\overline{OE}$ input will float high when open. Complete I_{OUT} shut-off is also achieved by holding the CE pin low, which will override the $\overline{OE}$ control pins.

The external resistors allow the user to accurately and independently set each amplifier transconductance by applying a voltage to each resistor, without restriction on the voltage range, thus ensuring broad voltage DAC compatibility. Alternatively, the I_{IN} pin can be biased from a current DAC or other current source.

Connection Diagram



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Absolute Maximum Ratings (T_A = 25 °C)

Voltages Applied to:		Power Dissipation (maximum)	See Curves
V_{CC}	-0.5V to +6.0V	Operating Ambient Temperature Range	0°C to +70°C
/OE	-0.5V to V_{CC} +0.5V	Maximum Junction Temperature	+150°C
I_{IN}	-0.5V to +0.5V	Storage Temperature Range	-65°C to +150°C
I_{OUT}	-0.5V to V_{CC}-(7*I_{OUT})	I_{OUT}Current	200 mA AVG

Important Note:

All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefor T_J = T_C = T_A.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at T_A = 25°C and QA sample tested at T_A = 25°C, T_{MAX} and T_{MIN} per QA test plan QCX0002.
III	QA sample tested per QA test plan QCX0002.
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data.
V	Parameter is typical value at T_A = 25°C for information purposes only.

Electrical Characteristics

V_{CC}=+5V, T_A=25°C, CE=HI, unless otherwise specified.

General

Parameter	Description	Conditions	Min	Typ	Max	Test Level	Units
IS1	Supply Current	CE=LO, EOSC=LO		19	24	I	mA
IS2	Supply Current	CE=HI, EOSC=LO, $I_{INR/2/3/4}$=0µA		27	33	I	mA
IS3	Supply Current	EOSC=$\overline{OE}$=HI, RFREQ=4000Ω, RAMP=500Ω		40	50	I	mA
IS4	Supply Current	$\overline{OE}$=HI, I_{INR}=I_{IN2}=I_{IN3}=I_{IN4}=500µA		69	85	I	mA
IS5	Supply Current	$\overline{OER}$=LO, I_{INR}=I_{IN2}=I_{IN3}=I_{IN4}=500µA		118	137	I	mA
TV_{LO}	TTL/CMOS Low Voltage	$\overline{OE}$, EOSC Inputs			1.3	I	V
EV_{LO}	Enable Low Voltage	CE Pin Only			0.5	I	V
TV_{HI}	TTL/CMOS High Voltage	$\overline{OE}$, EOSC Inputs	2.0			I	V
EV_{HI}	Enable High Voltage	CE Pin Only	2.8			I	V
TI_{LO}	TTL/CMOS Low Current	$\overline{OE}$=0.0V	-400			I	µA
TI_{HI}	TTL/CMOS High Current	$\overline{OE}$=5.0V			100	I	µA

Laser Amplifier

Parameter	Description	Conditions	Min	Typ	Max	Test Level	Units
GAIN R, 2, 3, 4	Best Fit Current Gain, Channel R, 2, 3, 4	Channels R, 2,3,4 [1]	88	100	113	I	mA/mA
IOS	Best Fit Current Offset	Channels R, 2 ,3, 4 [1]	-4	-1	+4	I	mA
ILIN	Output Current Linearity	Any Channel [1]	-3		+3	I	%
I_{OUTR}	Output Current per Channel	Output is Sourcing	150	230		I	mA
R_{SOUT}	I_{OUT} Series Resistance	I_{OUT}=180mA (Total R_{OUT} to V_{CC}Rail)			8	I	Ω

Laser Amplifier

Parameter	Description	Conditions	Min	Typ	Max	Test Level	Units
R_{INR}	I_{INR} Input Impedance	R_{IN} is to GND	480	600	750	I	Ω
R_{IN}	I_{IN} 2/3/4 Input Impedance	R_{IN} is to GND	300	400	500	I	Ω
VTH	$\overline{OE}$ Threshold	Temperature Stabilized		1.68		V	V
VRFREQ	RFREQ Pin Voltage	RFREQ = 1000Ω, Temperature Stabilized	0.74	0.82	0.90	I	V
I_{OFF1}	Output Off Current 1	CE=LO			5	I	mA
I_{OFF2}	Output Off Current 2	$\overline{OE}$=HI, Total for All Channels			5	I	mA
I_{OFF3}	Output Off Current 3	$\overline{OE}$=LO, I_{IN}=0µA, Total for All Channels			5	I	mA
VC1	I_{OUT} Supply Sensitivity	I_{OUT}=40mA, V_{CC}=5V ±10%, Read Only	-4	-0.4	+3	I	%/V
VC2	I_{OUT} Supply Sensitivity	I_{OUT}=80mA, 40mA Read + 40mA Write	-4	-1.8	+3	I	%/V
TC1	I_{OUT} Temperature Sensitivity	I_{OUT}=40mA, Read Only.		+100		V	ppm°/C
TC2	I_{OUT} Temperature Sensitivity	I_{OUT}=80mA, 40mA Read + 40m Write		-130		V	ppm°/C

1. The amplifier linearity is calculate using a best fit method at three operating points. The output currents chosen are 20 mA, 40 mA, and 60 mA. The transfer function for I_{OUT} is defined as follows:$I_{OUT} = (I_{IN} * GAIN) + I_{OS}$

Laser Current Amplifier Outputs AC Performance

V_{CC}=+5V, I_{OUT}=40 mA DC with 40 mA pulse, T_A=25°C unless otherwise specified

Parameter	Description	Conditions	Min	Typ	Max	Test Level	Units
tr2	Write Risetime	I_{OUT}=40mA (Read) + 40mA (10-90%)		1.0		V	nsec
tf2	Write Falltime	I_{OUT}=40mA (Read) + 40mA (10-90%)		1.1		V	nsec
OS	Output Current Overshoot	See Application Notes		10		V	%
t_{ON}	I_{OUT} ON Prop Delay	$\overline{OE}$ 50% H-L to I_{OUT} at 50% of Final Value		1.0		V	nsec
t_{OFF}	I_{OUT} OFF Prop Delay	$\overline{OE}$ 50% L-H to I_{OUT} at 50% of Final Value		1.0		V	nsec
T_{DIS}	Disable Time	CE 50% H-L to I_{OUT} at 50% of Final Value		2.5		V	nsec
T_{EN}	Enable Time	CE 50% L-H to I_{OUT} at 50% of Final Value		60		V	nsec
B/W	Amplifier Bandwidth	I_{IN}=500µA, All Channels, -3dB Value		45		V	MHz
Noise	Output Current Noise	Freq = 1MHz		3.0		V	nA/rt-Hz
Fosc	Oscillator Frequency	RFREQ = 1000Ω, RAMP = 500Ω	420	470	530	I	MHz

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Pin Descriptions

Name	Type	Description
GND	Power Supply	Ground (connect all)
V_{CC}	Power Supply	+5V Supply (connect all)
I_{OUT}	Analog	Output Current Source for Laser Diode (sum of all channels)
I_{IN}	Analog	Input Current for Current Amplifier (add external series resistor when voltage driven)
$\overline{OE}$	Digital	Digital Control for Output Current ($\overline{OE}$ Low = I_{OUT} On)
CE	Digital	Disables Output Current Regardless of $\overline{OE}$ (CE Low = No I_{OUT})
RFREQ	Analog	External Resistor to Ground Sets Oscillator Frequency
RAMP	Analog	External Resistor to Ground Sets Oscillator Amplitude
EOSC	Digital	Oscillator Enable (EOSC Low = Oscillator Off, Floating Not Recommended)

Recommended Operating Conditions

V_{CC}	5V ±10%	RAMP	10Ω (min)
I_{INR}/2/3/4	2 mA (max)	F_{OSC}	100-500 MHz
RFREQ	500Ω (min)	A_{OSC}	200 mA Avg (max)

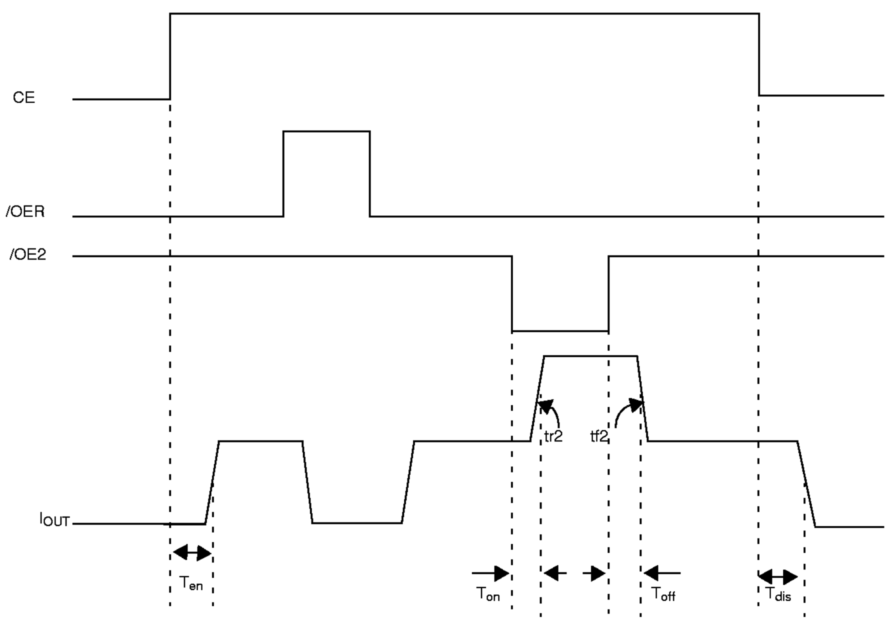
Iout Control

CE	/OER	/OE2	/OE3	/OE4	I_{OUT}
0	X	X	X	X	OFF
1	1	1	1	1	OFF
1	0	1	1	1	100*I_{INR}
1	1	0	1	1	100*I_{IN2}
1	1	1	0	1	100*I_{IN3}
1	1	1	1	0	100*I_{IN4}

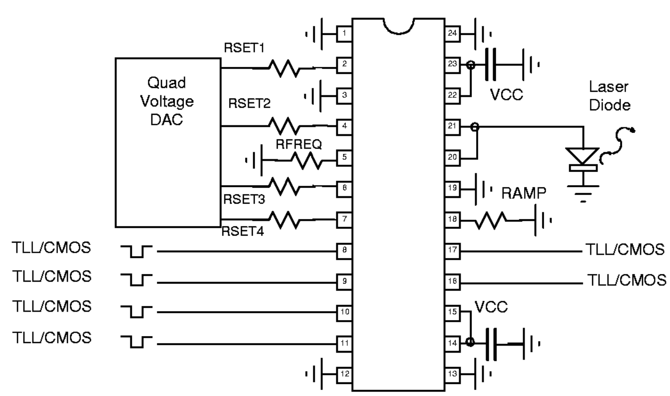
Oscillator Control

CE	EOSC	/OER	/OE2	/OE3	/OE4	OSCILLATOR
0	X	X	X	X	X	OFF
1	0	X	X	X	X	OFF
1	1	X	X	X	X	ON
1	1	1	1	1	1	Not Recommended

Timing Diagram



Typical Application



Applications Information

Definition

The defining equation for each amplifier is:

$I_{OUTR} = (V_{DAC} / (R_{SET} + 600\Omega)) * 100$

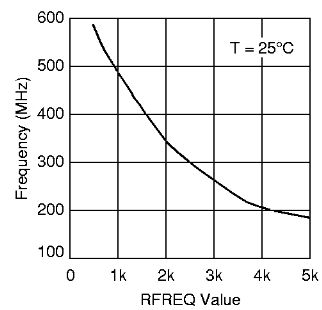
$I_{OUTW} = (V_{DAC} / (R_{SET} + 400\Omega)) * 100$

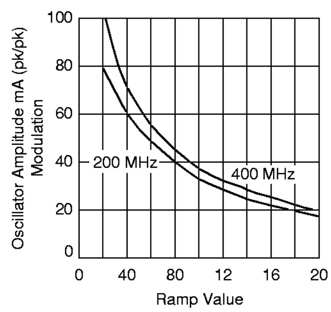
Due to the high values of current being switched rapidly on and off, it is important to ensure that the power supply is well decoupled to ground. During switching, the VCC undergoes severe current transients, thus every effort should be made to decouple the VCC as close to the package as possible. Symptoms that could arise include poor rise/fall times., current overshoot, and poor settling response. Gain is internally set to 100 mA/mA for channels R, 2, 3, and 4.

The RSET resistors should also be placed as close as possible to the I_{IN} pins, to avoid picking up stray signals on these input lines. No capacitance should be added to the node between the R_{SET} resistors and the EL6259C package. In particular, the digital signals on the $\overline{OE}$ inputs should not be allowed to couple into the I_{IN} inputs. If long input lines are necessary, capacitors can be added to the high side of the R_{SET} resistors.

It is very important to minimize the lead inductance between the I_{OUT} pin and the laser diode. Excessive inductance will worsen the rise/fall times, and cause overshoot and current ringing due to the I_{OUT} output seeing an under-damped LC network at the load. If ringing persists, the addition of an RC snubber network right at the output of the laser driver will be necessary, but rise/fall times and oscillator amplitude will be compromised. Users should expect to lose 0.5 nsec of tr/tf for every 1 cm of distance from I_{OUT} to the laser diode and back to the V_{CC} decoupling capacitor.

Oscillator Control





Output Current Noise

The EL6259 is optimized for low noise operations. The output current noise is typically 3.0nA/rt-Hz at 1MHz with the oscillator enabled.

Power Consumption Issues

The EL6259C total power consumption depends strongly on the laser diode current and voltage. Since the total power consumption under worst case conditions could approach one watt, the burden is on the user to dissipate the heat into the board ground plane or chassis. An in-depth discussion of the effects of ground plane layout and size can be found in the Elantec 1997 data book, under application note #8, pages 8-40 to 8-42.

An approximate equation for the device power consumption is as follows (users must adjust accordingly for any duty cycle issues):

$P_{diss} = ((I_s + (18*\Sigma I_{IN}))*V_{CC})+(I_{DIODE}*(V_{CC}-V_{DIODE}))$

where:

I_s = IS2 when oscillator off, or IS3 when oscillator on (see page 2)

ΣI_{IN} = Sum of all the I_{IN} currents

V_{CC} = Device power supply voltage

I_{DIODE} = Laser diode current

V_{DIODE} = Forward voltage of laser diode at current of I_{DIODE}

When using the EL6259C, the user must take extreme care not to exceed the maximum junction temperature of +150°C. Since the case to ambient thermal coefficient will dominate, and since this is very much defined by the user's thermal engineering, it is not practical to define a strict limit on power consumption. Furthermore, the case to ambient thermal coefficient may not be known precisely.

To assist in worst case conditions, it is possible to monitor the silicon temperature of the EL6259C by forcing current into the CE pin, which will then be at a voltage of $V_{CC} + V_{PN}$, where V_{PN} is the forward biassed voltage of the ESD protection diode. Since CE=HI is necessary for normal operation, the device can be operated as it would be in the real-life applications, while the temperature is monitored. The EL6259C has been calibrated with a 1MΩ resistor to +10V connected in series with the CE pin, which results in an input current of approximately 4.5µA. The following graph allows the silicon temperature to be determined directly. This graph was taken with I_{OUT} = 200 mA to compensate for the internal V_{CC} voltage drop. The graph shows the measured CE pin to V_{CC} pin differential voltage, which shows a linear voltage sensitivity of -1.76 mV/°C. Users may wish to measure their specific part at +25°C (no warm up) to allow for any statistical/process distribution, but the method is reliable and accurate. Note that the I_{CC} current reduces the voltage seen by external measurement by about 0.12 mV/mA (e.g. at I_{CC} = 200 mA, the measured ESD diode reading would be lower by approximately 24 mV when compared to a measurement taken at I_{CC} = 0mA).

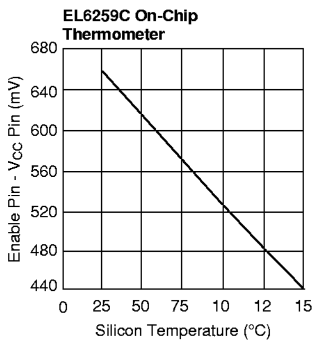
By applying this method to the EL6259C in an actual application, users can measure the silicon temperature under all operating conditions to determine whether their thermal engineering is sufficient. It is expected that actual results of θJA will fall in the range of 60°C/W to 120°C/W for the QSOP package. When soldered into the Elantec applications board (large ground plane), a value of 73°C/W is measured.

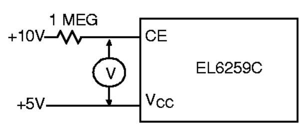
Temperature Measurement Set-up and Results

Example: Measure Enable-V_{CC} under coolest condition of IS2 (EN = $\overline{OE}$ = HI, EOSC = LO, ΣI_{IN} = 0µA). Suppose the result was 684 mV. For precision, IS2 may need to be measured, or it can be assumed to be typical value of 27 mA. This measurement is best taken immediately at power on ($T_{JUNCTION} = T_{AMBIENT}$), for if taken after thermal equilibrium has occurred, this initial power dissipation must be accounted for later.

Now measure ENABLE-V_{CC} under the actual operating conditions, and also measure the new I_{CC} value (includes laser diode current). Suppose result (must be after thermal equilibrium has been reached) is 550 mV, and the new I_{CC} value is 160 mA. First, we must subtract out the change in reading due to the resistive drop on the power supply pins. This will be 0.12*(160-27) = 16 mV. So, the measured reading of 550 mV is 16 mV low because of the voltage drop, thus the true reading due only to thermal change is 566 mV.

Now we can calculate temperature rise of (566-684)/ -1.76 =67°C. If the original reading of 684 mV was taken immediately at power on, then this gives the TOTAL temperature rise. Using the power dissipation of $(V_{CC}*I_{CC}) - (I_{DIODE}*V_{DIODE})$, the θJA of the application can be calculated. If the reading of 684 mV was taken after thermal equilibrium was reached, then the temperature rise reflects only the change between two power levels, and the TOTAL temperature rise from power on would be a greater number. In this case, both the beginning and ending power consumptions must be calculated, and the results adjusted accordingly.





General Disclaimer

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HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

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