

January 2004

**Features**

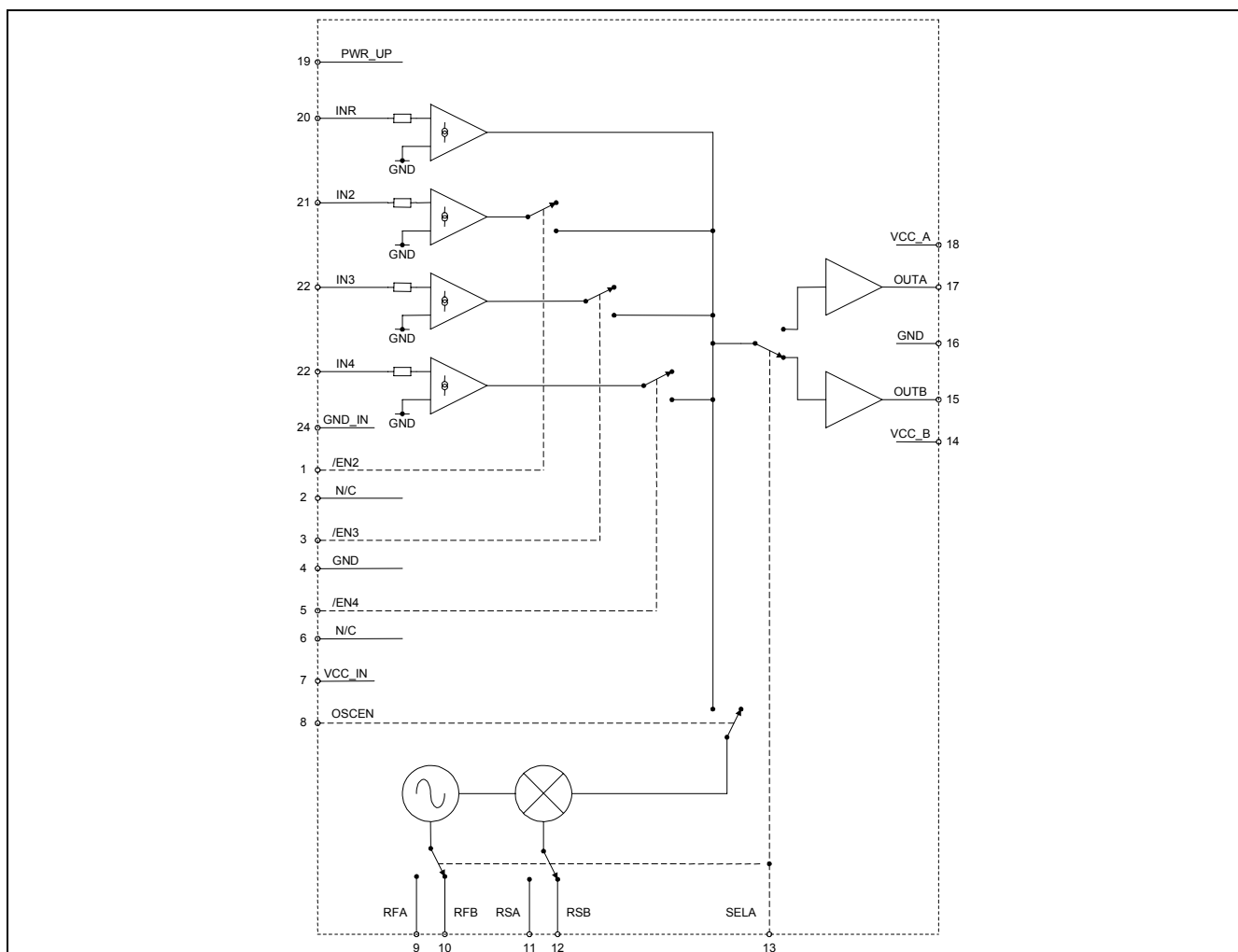
- Single 5 V supply ( $\pm 10\%$ )
- 150 mA low-noise read channel with 100 x current gain
- Three 500 mA write channels with 240 x gain
- Dual output for DVD/CD laser
- Rise and fall times 1 ns typical
- Oscillator, 500 MHz, 100 mA with external resistor control of frequency and amplitude
- Power Up/Down control
- CMOS control signals
- > 2 kV ESD
- Low  $R_{th}$  QFN package
- Contact Zarlink for available Custom Gain and Input Impedance options

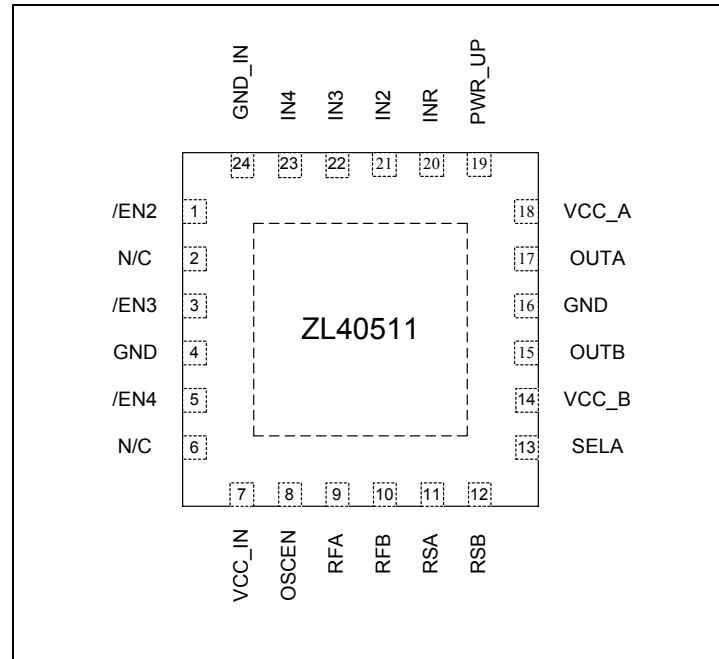
**Ordering Information**

ZL40511LCE	(tubes) 24 lead QFN
ZL40511LCF	(tape and reel) 24 lead QFN
ZL40515LCE	(tubes) 24 lead QFN
ZL40515LCF	(tape and reel) 24 lead QFN

**-40°C to +85°C**
**Applications**

- DVD $\pm$ RW/RAM
- DVD $\pm$ R
- CD-RW
- CD-R
- Write optical drives
- Laser Diode current switch


**Figure 1 - Functional Block Diagram**



**Figure 2 - Pinout of 4x4 mm 24 pin QFN (top view)**

## Description

The ZL40511/15 are high performance laser drivers capable of driving two separate cathode grounded laser diodes (e.g., 650 nm and 780 nm laser diodes).

The ZL40511/15 contain a 150 mA low-noise read channel (ChR), and three 500 mA write channels (Ch2, Ch3 and Ch4). The read channel amplifies the positive current supplied at its reference input, INR, by a fixed factor of 100. Write channels amplify the positive currents supplied at its reference inputs IN2, IN3, and IN4 by a fixed factor of 240.

An on-chip RF oscillator is provided for the reduction of laser mode hopping noise.

The ZL40511 offers higher tolerance performance.

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## 1.0 Application Notes

### 1.1 Read and Write Channel Operation

The read channel is activated by applying a 'High' signal to the PWR\_UP pin. In this mode, the fast write channels can be enabled by applying a 'Low' signal to the respective write enable pins (/EN2), (/EN3) or (/EN4). The output currents of the four channels are summed together and output as a composite signal at either OUTA (if SELA select is 'High') or OUTB (if SELA select is 'Low'). This provides the ability to drive two different laser diodes with just one ZL40511/15.

Voltage control of the channel reference inputs (INR, IN2, IN3 and IN4) can be achieved quite easily using an external resistor  $R_{ref}$  in series with the reference channel input to convert a given reference potential  $V_{ref}$  to an input current,  $I_{in}$ :

$$I_{in} = \frac{V_{ref}}{R_{ref} + R_{in}}$$

where  $R_{in}$  is the input impedance of the respective reference channel.

### 1.2 On-chip RF Oscillator

An on-chip RF oscillator is enabled if OSCEN = 'High', and its output signal is added to the appropriate current output (OUTA, if SELA select is 'High', or OUTB, if SELA select is 'Low'). The oscillator amplitude is set by an external resistor from RSA or RSB to GND. Its frequency is set by an external resistor RFA or RFB to GND. RSA and RFA are selected when SELA is 'High'.

The oscillator signal is summed with the programmed Write and Read levels before amplification to the output. The oscillator signal has zero DC level and +1\_pt to -1\_pt signal swing. Consequently, if the programmed DC level from the Write and Read Channels is less than the PK level programmed for the Oscillator, the combined signal will be clipped on the negative cycle of the signal. This will increase the harmonic content of the output signal and reduce the pk to pk amplitude output.

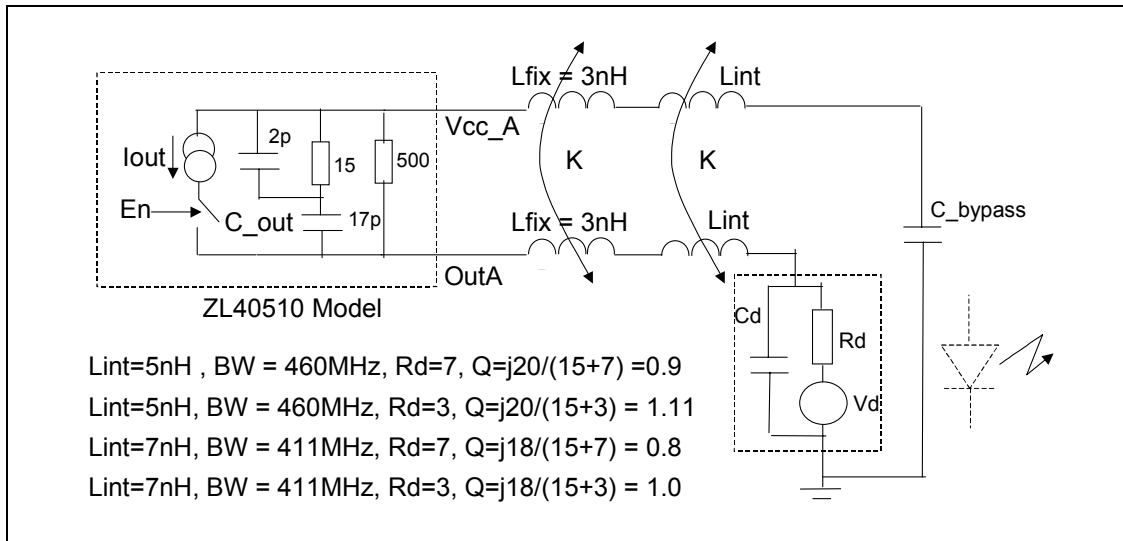
### 1.3 Thermal Considerations

Package thermal resistance is 40°C/W under the EIA/JESD51-3 compliant PCB test board condition.

Users should ensure that the junction temperature does not exceed 150°C. Thermal resistance from junction to case and to ambient is very much dependent on how the IC is mounted onto the board, on the PCB layout and on any heat extraction arrangements.

Power consumption and system ambient operating temperature limits should be noted and careful thermal gradient calculations undertaken to ensure that the junction temperature never exceeds 150°C.

## 1.4 Electrical and Optical Pulse Response



**Figure 2 - Pulse Response Model**

Figure 3 illustrates a simplified model of the typical ZL40511/15 and the application. The ZL40511/15 consists of an ideal switched current source and an equivalent model of the ZL40510/15 output stage. The Electrical Model for the Laser Diode is a Voltage source  $V_d$  ( $V_{on}$ ) in series with the On Resistance  $R_d$  all in parallel with the Junction Capacitance  $C_d$ . This simplified model approximately represents the Laser Diode Electrical load when operated beyond the Laser Threshold. To a first approximation, the Optical output is proportional to the current flow in the Resistor  $R_d$ .

The Laser Diode and the ZL40511/15 are connected together by interconnect tracks with the return current passing through the supply decoupling bypass capacitor between ground and output  $V_{cc}$ .

The ZL40511/15 can be approximated to an ideal switched programmed current source with a propagation delay of  $l_{out\_on}$  (1.2 nS) and a switch transition time of 400 ps. The final output electrical pulse response parameters,  $T_{rise}$ ,  $T_{fall}$ , Overshoot and Undershoot are determined by the combined electrical network as illustrated in Figure 3.

For example, the Rise Time and Fall time for large current steps can be slew rate limited by the combined interconnect and fixed interconnect inductance. The Fixed Inductance represents that associated with packaging and minimum interconnect distance. The Interconnect Inductance is that associated with the additional tracking between Laser Diode and the ZL40511/15 to accommodate application physical limitations.

For example, if a pulse of 360 mA amplitude (40 mA to 400 mA) is to be switched in a time of 1 nS with the  $V_d = 1.6$  V, then the maximum volt drop across the interconnect inductance is approximately 3.5 V (maximum  $V_{pin}$  for 500 mA output) – 1.6 V ( $V_{diode}$ ) = 1.9 V. Consequently,  $L \cdot di/dt < 1.9$  V. Hence,  $L < 1.9 / (0.36\text{A}/1 \text{ nS}) = 5.3 \text{ nH}$ .

Small current step size Rise and Fall Time will be determined by the Bandwidth of the combined network. This is dominated by the Interconnect Inductance and the output Capacitance. Similarly, the overshoot and undershoot will be determined by the Q of the network. This is a function of the Source Impedance from the ZL40511/15, the Interconnect inductance and the Load impedance of the Laser Diode. Figure 3 includes example simplified estimates of the Q and BW of the combined Laser Diode, ZL40511/15 and interconnect network for two different interconnect inductance values (5 nH and 7 nH) and two different Diode On resistance (3 Ohm and 7 Ohm). This simple analysis illustrates the change in BW and Q of the network depending on these parameters. This in turn effects the Rise Time and Fall time and the Overshoot and Undershoot performance achieved in the application.

---

## 1.5 Specified Electrical Performance with 15 mm Interconnect and Zarlink ZLE40511/15 Evaluation Board

The specified performance in the table are results based on the electrical measurements and simulations across full process corners using the Zarlink Evaluation Board using a 3.9 Ohm resistive load to ground.

The track interconnect between ZL40511/15 and the 3.9 Ohm Resistor is 15 mm long and uses a 2 mm wide track on single sided FR4 board. The return path is via two 2 mm wide tracks spaced 0.25 mm either side of the track between output and the 3.9 Ohm resistor. The combined forward and return path forms a co planar transmission line with a characteristic impedance of approximately 120 Ohms.

The tight coupled return paths carrying the return current reduce the effective series inductance ( $L_{eff}$ ) which can be approximated to:

$$L_{eff} = 2 * L_{int} * (1 - K) + 2 * L_{fix} * (1 - K).$$

The ZLE40510 board has two positions for the Laser Diode at two different distances. (15 and 30 mm).

- The measured value of  $L_{eff}$  is 7 nH
- The estimated value of  $L_{eff} = 2 * 8 (1 - 0.5) = 8$  nH

The actual pulse response achieved in an application is thus dependent on the application.

## 1.6 Application Layout Guide Lines

Minimize interconnect inductance by:

- a. Using Short Interconnect Distance
- b. Use wide interconnect tracks
- c. Keep the return path tightly coupled to the forward path.

1.7 ZLE40511 Interconnect

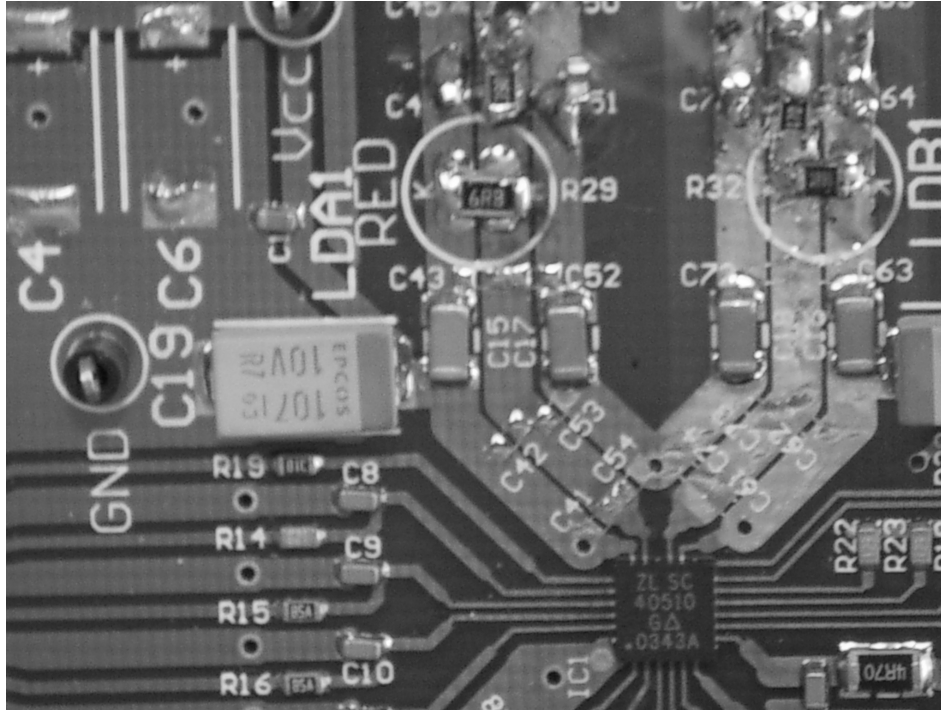


Figure 3 - ZLE40511 Application Board Electrical Interconnect



## 2.0 Application Diagram

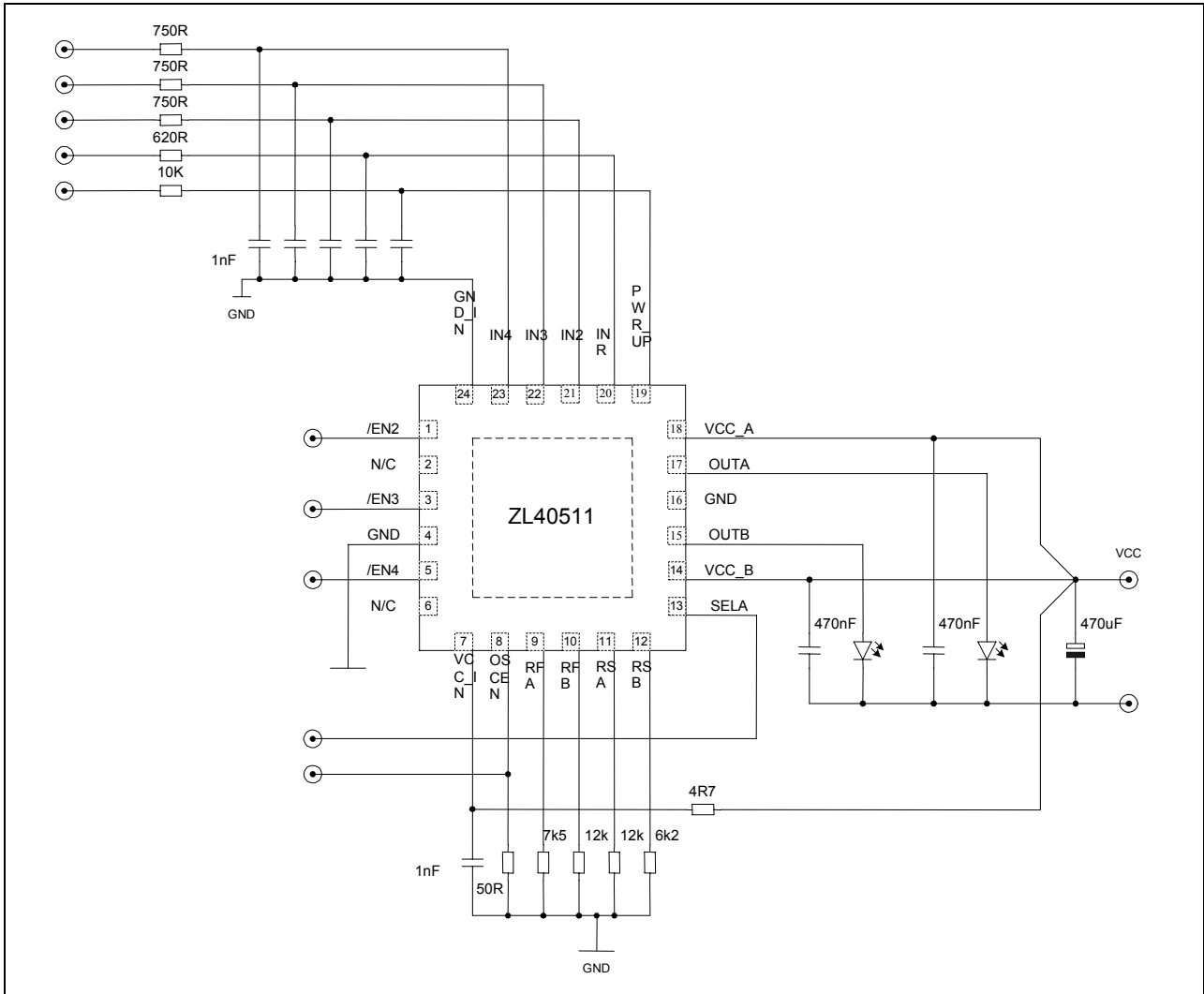


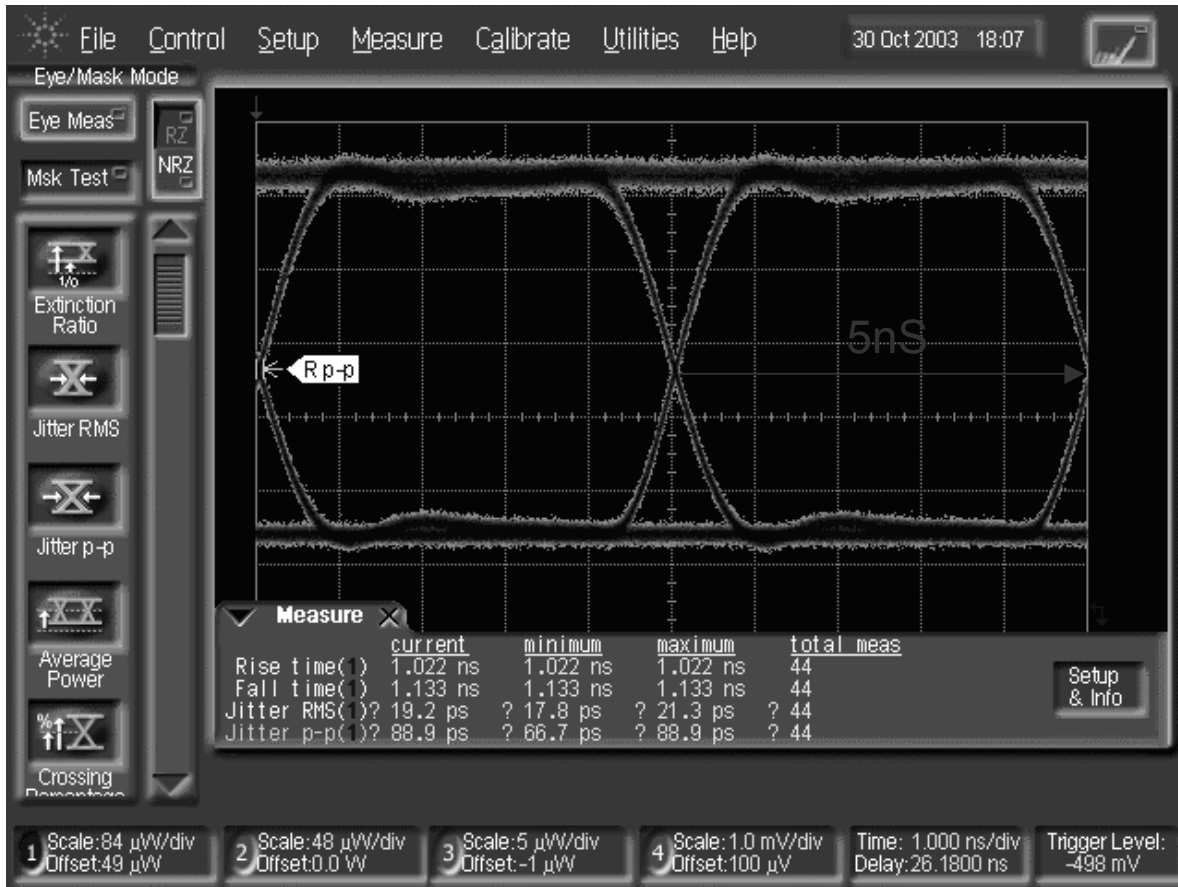
Figure 4 - Application Schematic Diagram

## 3.0 Evaluation Boards From Zarlink Semiconductor

Zarlink Semiconductor provide an LDD evaluation board. This is primarily for those interested in performing their own assessment of the operation of the LDDs. Figure 5 shows a recommended application configuration. The inputs are connected via side launch SMA connectors.

Please order as ZLE40511.

## 4.0 Optical Pulse Response



**Figure 5 - Typical Optical Eye Diagram Response\***

\* (Measured using Sanyo DL-7140-201S Infra Red Laser Mounted on ZLE40510 Application Board)  
(I read = 50 mA, I write = 125 mA, at 15 mm with 200 MHz PRBS Pattern)

Figure 6 illustrates the typical optical response measured with the ZL40511/15 mounted on the ZLE40510 application board driving a Sanyo DL-7140-201S Infra Red Laser. The test condition is driving a PRBS pattern at 200 MHz clock rate which is representative of a 16X DVD write pattern using Block Write Strategy with minimum write pulse of 2T duration.

The Sanyo DL-7140-201S Infra Red Laser Diode On resistance is typically 3 Ohms which is representative of the On resistance of the Latest generation 250 mW pulsed High Power Red Laser Diodes that are targeted at 16X and 8X DVD.

The pulse is measured stepping from a low level which is above the laser threshold thus avoiding the laser turn on transient which can distort the measured response.

The ZL40511/15 exhibits excellent pulse response characteristics when used with the optimum interconnect.

## 5.0 Pin List

Pin No.	Pin name	Type	Function
1	/EN2	LVDS	Digital control input for channel 2 (active low)
2	NC	LVDS	No internal connection
3	/EN3	LVDS	Digital control input for channel 3 (active low)
4	NC	LVDS	Ground
5	/EN4	LVDS	Digital control input for channel 4 (active low)
6	NC	LVDS	No internal connection
7	VCC_IN	supply	+5 V Input power supply
8	OSCEN	digital	Oscillator enable control input, high active (TTL)
9	RFA	analog	Resistor to GND sets oscillator frequency when SELA = 'High'
10	RFB	analog	Resistor to GND sets oscillator frequency when SELA = 'Low'
11	RSA	analog	Resistor to GND sets oscillator amplitude when SELA = 'High'
12	RSB	analog	Resistor to GND sets oscillator amplitude when SELA = 'Low'
13	SELA	digital	Output select input; 'High' selects OUTA, 'Low' selects OUTB (TTL)
14	VCC_B	supply	Output B Vcc
15	OUTB	analog	Current output source B
16	GND	supply	Ground
17	OUTA	analog	Current output source A
18	VCC_A	supply	Output A Vcc
19	PWR_UP	digital	Digital chip enable control input, high active (CMOS)
20	INR	analog	Current input, $R_{in} = 400$ Ohms to GND
21	IN2	analog	Current input, $R_{in} = 250$ Ohms to GND (Optional 500 Ohms)
22	IN3	analog	Current input, $R_{in} = 250$ Ohms to GND (Optional 500 Ohms)
23	IN4	analog	Current input, $R_{in} = 250$ Ohms to GND (Optional 500 Ohms)
24	GND_IN	supply	Ground for input circuit

**Absolute Maximum Ratings**

Characteristic	Min.	Typ.	Max.	Units	Comments
Supply voltage (VCC, VCC_IN)	-0.5		6.0	V	
Input voltage (INR, IN2, IN3, IN4)	-0.5		6.0	V	
Input voltage (PWR_UP, EN2, /EN2, EN3, /EN3, EN4, /EN4, OSCEN, SELA)	-0.5		(VCC_I N + 0.5)	V	
Output voltage (OUTA, OUTB)	-0.5		Vcc	V	
Junction temperature			150	°C	

**Operating Range**

Characteristic	Min.	Typ.	Max.	Units	Comments
Supply voltage (VCC, VCC_IN)	4.5		5.5	V	
Input voltage (INR)			0.7	V	
Input voltage (IN2, IN3, IN4)			0.7	V	
Output voltage (OUTA, OUTB)	-0.3		(VCCA, B-0.9)	V	
RF	1			kΩ	External resistor to GND
RS	1			kΩ	External resistor to GND
Operating temperature range, junction	0		150	°C	

**Package Thermal Resistance**

Package Type	Junction to		Units	Comments
	Case R <sub>thJC</sub>	ambient R <sub>thJA</sub>		
24 pin QFN		40	K/W	Exposed paddle soldered to multi-layer PCB

**Electrical Characteristics**  $V_{CC} = 5\text{ V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ ,  $INR = 400\ \mu\text{A}$ ,  $IN2 = IN3 = IN4 = 160\ \mu\text{A}$ ,  $PWR\_UP = \text{High}$ , Ch2, Ch3, Ch4 disabled,  $OSCEN = \text{Low}$ , unless otherwise specified.

Characteristic	Min.	Typ.	Max.	Units	Comments	Type
<b>Supply Current (into VCC-pin)</b>						
Supply current, power down, $I_{CCPD}$		80	220	$\mu\text{A}$	ENABLE = Low	A
Supply current, read mode, oscillator disabled, $I_{CCR0}$		69	84	mA	INR = 400 $\mu\text{A}$	A
Supply current, read mode, oscillator enabled, $I_{CCR1}$		70	85	mA	OSCEN = High, $R_F = 6.8\ \text{k}\Omega$ , $R_S = 8.2\ \text{k}\Omega$ ,	A
Supply current, write mode, $I_{CCW}$		210	250	mA	Ch2, Ch3, Ch4 enabled	B
Supply current, input off		18		mA	Ch2, Ch3, Ch4 enabled INR = IN2 = IN3 = IN4 = 0	B
<b>/EN2, /EN3, /EN4, SelA &amp; OscEn Digital Inputs</b>						
Logic low voltage			0.8	V		A
Logic high voltage	2.2			V		A
Threshold level		1.68		V	Temperature stabilised	B
Logic low input current	-50			$\mu\text{A}$	$V_{in} = 0\ \text{V}$	B
Logic high input current			50	$\mu\text{A}$	$V_{in} = 3.3\ \text{V}$	B
<b>Power_Up Digital Input</b>						
Logic low voltage			0.5	V	CMOS compatible level	A
Logic high voltage	2.7			V	CMOS compatible level	A
Logic low input current	-50			$\mu\text{A}$	$V_{in} = 0\ \text{V}$	B
Logic high input current			50	$\mu\text{A}$	$V_{in} = 3.3\ \text{V}$	B

Note: A = 100% Tested

B = Guaranteed by Characterization and Design

C = Guaranteed by Simulation

Characteristic	Min.	Typ.	Max.	Units	Comments	Type
<b>Current Outputs (OutA &amp; OutB)</b>						
Output current, ChR	150	200		mA	$V_{out} \leq 3.5\text{ V}$	B
Output current, Ch2, Ch3, Ch4	500			mA	Channel enabled, $I_{NR} = 0\ \mu\text{A}$ , $V_{out} \leq 3.5\text{ V}$ , $I_{lin} = 2.8\text{ mA}$	A
Total output current	500			mA	Ch2, 3, 4 enabled, $V_{out} \leq 3.5\text{ V}$	A
Write Output current, zero input, $I_{out0}$ (ZL40511)			12	mA	$I_{NR} = I_{N2} = I_{N3} = I_{N4} = 0\ \mu\text{A}$ , Ch2, or Ch3 or Ch4 enabled	A
Write Output current, zero input, $I_{out0}$ (ZL40515)			15	mA	$I_{NR} = I_{N2} = I_{N3} = I_{N4} = 0\ \mu\text{A}$ , Ch2, or Ch3 or Ch4 enabled	A
Read Output current, zero input, $I_{out0}$			2.5	mA	$I_{NR} = I_{N2} = I_{N3} = I_{N4} = 0\ \mu\text{A}$ , Ch2, 3, & 4 disabled,	A
Input impedance (INR)	330	400	470		$R_{in}$ is to GND	B
Input impedance (IN2, IN3, IN4)	205	250	295	$\Omega$	$R_{in}$ is to GND	B
$I_{out}$ supply sensitivity (any channel)	-5		+5	%/V	$I_{out} = 40\text{ mA to }300\text{ mA}$	B
$I_{out}$ temperature sensitivity (any channel)		300		ppm/ $^{\circ}\text{C}$	$I_{out} = 40\text{ mA to }300\text{ mA}$ , $I_{in}$ temp coefficient = $0\text{ ppm}/^{\circ}\text{C}$	B
$I_{out}$ current output noise		3		nA/ $\sqrt{\text{Hz}}$	$I_{out} = 50\text{ mA}$ $I_{NR} = 500\ \mu\text{A}$	B
<b>Current Output OutA &amp; OutB</b>						
Current gain, ChR, best fit	85	100	115	mA/mA	$I_{out} = 20\text{ mA to }80\text{ mA}$ † Note 1	A
Current gain, Ch2, best fit	205	240	275	mA/mA	$I_{out} = 20\text{ mA to }120\text{ mA}$ † Note 2	A
Current gain, Ch3, best fit	205	240	275	mA/mA	$I_{out} = 20\text{ mA to }120\text{ mA}$ † Note 2	A
Current gain, Ch4, best fit	205	240	275	mA/mA	$I_{out} = 20\text{ mA to }120\text{ mA}$ † Note 2	A
<b>ZL40511</b>						
Output current offset, ChR, best fit	-1		8	mA	$I_{out} = 20\text{ mA to }80\text{ mA}$ † Note 1	A
Output current offset, Ch2, best fit	-4		12	mA	$I_{out} = 20\text{ mA to }120\text{ mA}$ † Note 2	A
Output current offset, Ch3, best fit	-4		12	mA	$I_{out} = 20\text{ mA to }120\text{ mA}$ † Note 2	A

Characteristic	Min.	Typ.	Max.	Units	Comments	Type
Output current offset, Ch4, best fit	-4		12	mA	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A
<b>ZL40515</b>						
Output current offset, ChR, best fit. Note 3	-1		8	mA	$I_{out} = 20 \text{ mA to } 80 \text{ mA} \dagger \text{ Note 1}$	A
Output current offset, Ch2, best fit. Note 4	-7		15	mA	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A
Output current offset, Ch3, best fit. Note 4	-7		15	mA	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A
Output current offset, Ch4, best fit. Note 4	-7		15	mA	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A
<b>ZL40511/15</b>						
Output current linearity (any channel). Note 3	-3.5		1.5	%	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A
Gain tracking, Ch2 to Ch3 to Ch4	-2.5		+2.5	%	$I_{out} = 20 \text{ mA to } 120 \text{ mA} \dagger \text{ Note 2}$	A

Note: A = 100% Tested

B = Guaranteed by Characterization and Design

C = Guaranteed by Design

Note 1: Gain, offset and linearity of a channel are derived from a best fit line (linear regression graph) to the following three operating points:  $I_{out} = 20 \text{ mA}, 50 \text{ mA}$  and  $80 \text{ mA}$ .

Note 2: Gain, offset and linearity of a channel are derived from a best fit line (linear regression graph) to the following three operating points:  $I_{out} = 20 \text{ mA}, 70 \text{ mA}$  and  $120 \text{ mA}$ .

Note 3: Best Fit output line through  $20\text{mA}, 50\text{mA}, 80\text{mA}$

Note 4: = Best Fit output line through  $20\text{mA}, 70\text{mA}, 120\text{mA}$

† Electrical measurement into  $3.9 \text{ Ohm}$  to Gnd

Characteristic	Min.	Typ.	Max.	Units	Comments	Type
<b>Timing</b>						
<b>Current Output OutA &amp; OutB</b>						
Channel rise time, (10% to 90%), $t_{r2}$		1.0	1.3	ns	40 to 375 mA, Ch2, 3 or 4 pulsed † ‡	B
Channel fall time, (10% to 90%), $t_{f2}$		1.2	1.6	ns	40 to 375 mA, Ch2, 3 or 4 pulsed † ‡	B
Output current overshoot (any write channel)			10	%	40 to 375 mA Ch2 3, 4 pulsed †	B
Output current undershoot (any write channel)			10	%	40 to 375 mA Ch2 3, 4 pulsed †	B
Channel to Channel Enable Skew Tr		50		ps		B
Channel to Channel Enable Skew Tf		25		ps		B
$I_{out}$ ON propagation delay, $t_{onCh}$		1.4	1.8	ns	50% En High-Low to 50% $I_{out}$ , any write channel	B
$I_{out}$ OFF propagation delay, $t_{offCh}$		1.2	1.6	ns	50% En Low-High to 50% $I_{out}$ , any write channel	B
Amplifier -3 dB bandwidth (ChR)	23	43	68	MHz	INR = 400 $\mu$ A	C
Amplifier -3 dB bandwidth (Ch2, 3, 4)	6	11	16	MHz	IN2, IN3, IN4 = 400 $\mu$ A	C
<b>Power_Up &amp; SelA</b>						
Power_Up time, $t_{on}$		1.5	3.5	$\mu$ s	50% Enable Low-High to 50% $I_{out}$	C
Power_Up time, $t_{off}$		20	33	ns	50% Enable High-Low to 50% $I_{out}$	C
Output A select delay		5	8	ns	50% DVD/CD select Low-High to 50% $I_{OUTA}$	C
Output A deselect delay		5	8	ns	50% DVD/CD select High-Low to 50% $I_{OUTA}$	C

Note: A = 100% Tested

B = Guaranteed by Characterization and Design

C = Guaranteed by Design

† (EN2, /EN2), (EN3, /EN3), (EN4, /EN4) input pulse rise and fall time = 0.4 ns.

‡ Parameter is measured Electrical Pulse Response using 3.9 Ohm load to gnd and Zarlink Application Board. Pulse response performance parameters Trise, Tfall, Overshoot and Undershoot can be limited by interconnect inductance. Optical Response is influenced by Laser Diode response. See Application Notes.



**Electrical Dynamic Characteristics**  $V_{CC} = 5\text{ V}$ ,  $T_{amb} = 25^{\circ}\text{C}$ ,  $INR = 400\text{ }\mu\text{A}$ ,  $IN2 = IN3 = IN4 = 160\text{ }\mu\text{A}$ ,  $PWR\_UP = \text{High}$ , Ch2, Ch3, Ch4 disabled, OSCEN = Low, unless otherwise specified.

Characteristic	Min.	Typ.	Max.	Units	Comments	Type
<b>Oscillator</b>						
Frequency adjust range Low			250	MHz	RF = 16 k $\Omega$ , OSCEN = High	B
Frequency adjust range High	575			MHz	RF = 2 k $\Omega$ , OSCEN = High	B
Frequency tolerance (ZL40511)	338	375	412	MHz	RF = 7.5 k $\Omega$ , OSCEN = High	A
Frequency tolerance (ZL40515)	322	375	428	MHz	RF = 7.5 k $\Omega$ , OSCEN = High	A
Frequency temperature coefficient		200		ppm/ $^{\circ}\text{C}$	RF = 7.5 k $\Omega$ , OSCEN = High	C
Amplitude adjust range Low (RS=11K $\Omega$ )			36	mA pk to pk	RS = 11 k $\Omega$ , OSCEN = High RF=9 K (350 MHz) InR = 1 mA	B
Amplitude adjust range High (RS=1K $\Omega$ )	100			mA pk to pk	RS = 1 k $\Omega$ , OSCEN = High RF = 9 K (330 MHz) InR = 1 mA	B
Third Harmonic		-30		dB	RS = 10 k $\Omega$ to 2 k $\Omega$ , OSCEN = High RF = 9 K (330 MHz) InR = 400 $\mu\text{A}$	C
Second Harmonic		-20		dB	RS = 10 k $\Omega$ to 2 k $\Omega$ , OSCEN = High RF = 9 K (330 MHz) InR = 400 $\mu\text{A}$	C
Amplitude tolerance	-20	0	20	%	Fosc= 250MHz to 450MHz, OSCEN = High, RS 1%	C
Amplitude (RS = 7.5 K)		42		mA pk to pk	f = 375 MHz, RS = 7.5 k $\Omega$ , OSCEN = High	C
Amplitude flatness		4		dB	RS = 7.5 k $\Omega$ , RF = 9 k $\Omega$ to 4 k $\Omega$	B
Amplitude temperature coefficient		800		ppm/ $^{\circ}\text{C}$	RF = 5.6 k $\Omega$ , OSCEN = High	C
Oscillator enable time, $t_{onOsc}$			2	ns	50% OSCEN High-Low to 50% $I_{out}$	B
Oscillator disable time, $t_{offOsc}$			3	ns	50% OSCEN Low-High to 50% $I_{out}$	B

Note: A = 100% Tested

B = Guaranteed by Characterization and Design

C = Guaranteed by Design

† (EN2, /EN2), (EN3, /EN3), (EN4, /EN4) pulse rise and fall time = 0.4 ns.

### 6.0 Characteristic Curves

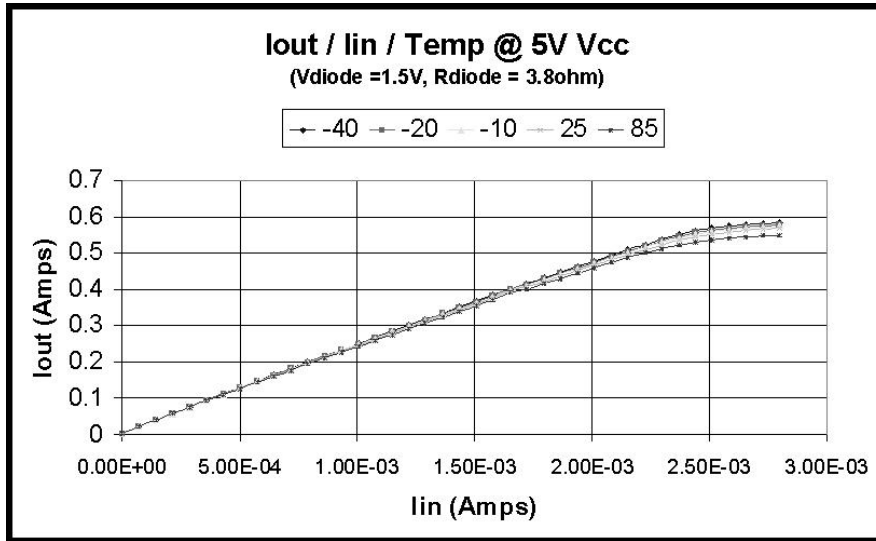


Figure 6 - Write Channel 2, 3 and 4 IP/OP Transfer Characteristic/Temp

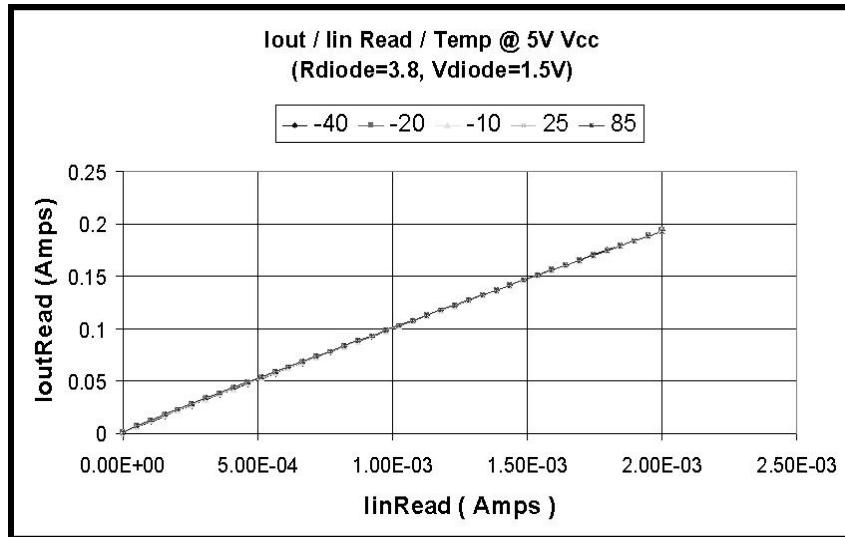


Figure 7 - Read Channel IP/OP Transfer Characteristic/Temp

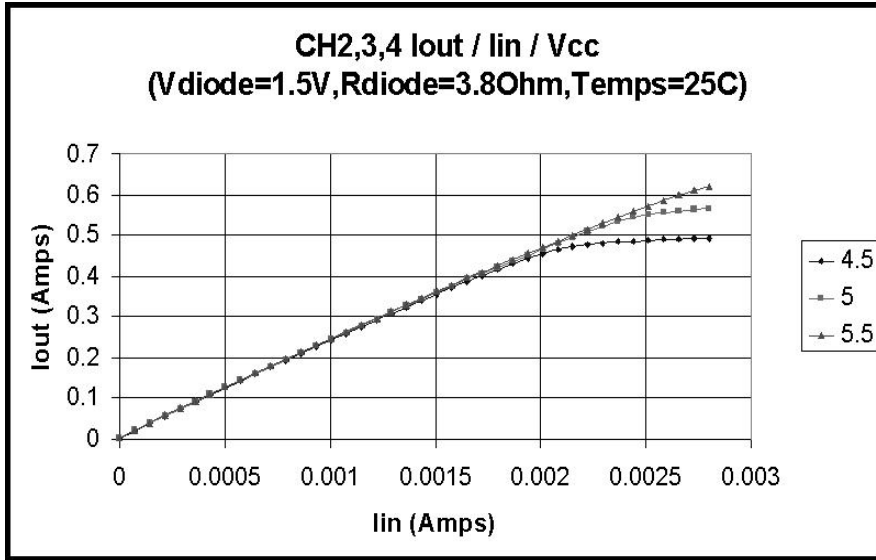


Figure 8 - Write Channel 2, 3 or 4 IP/OP Transfer Characteristic/Vcc

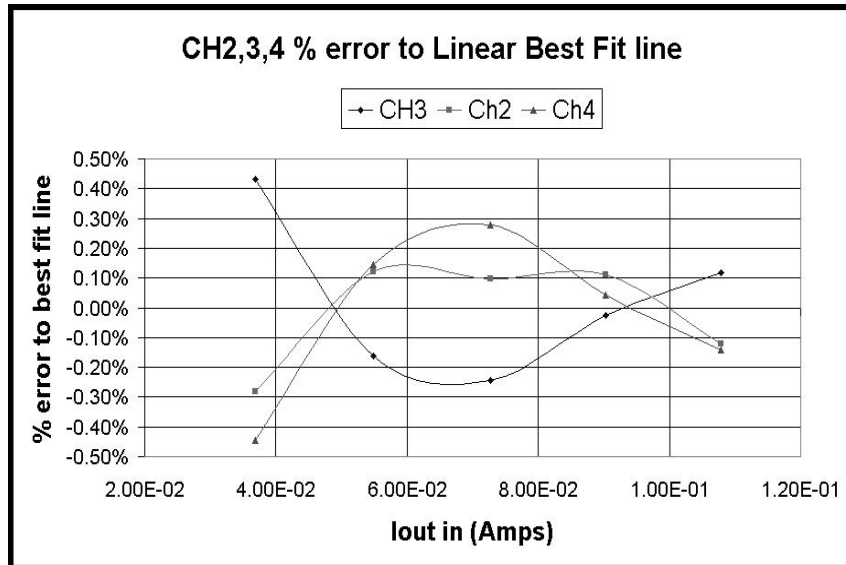


Figure 9 - Write Channel 2, 3 or 4 IP/OP Best Fit Line% Error

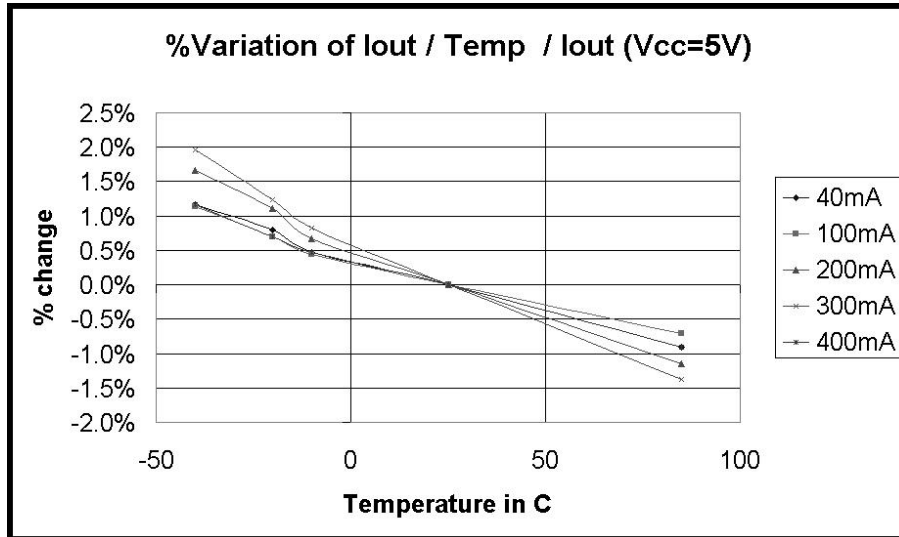


Figure 10 - Write Channel 2, 3 or 4 Δ Iout% Variation with Temperature

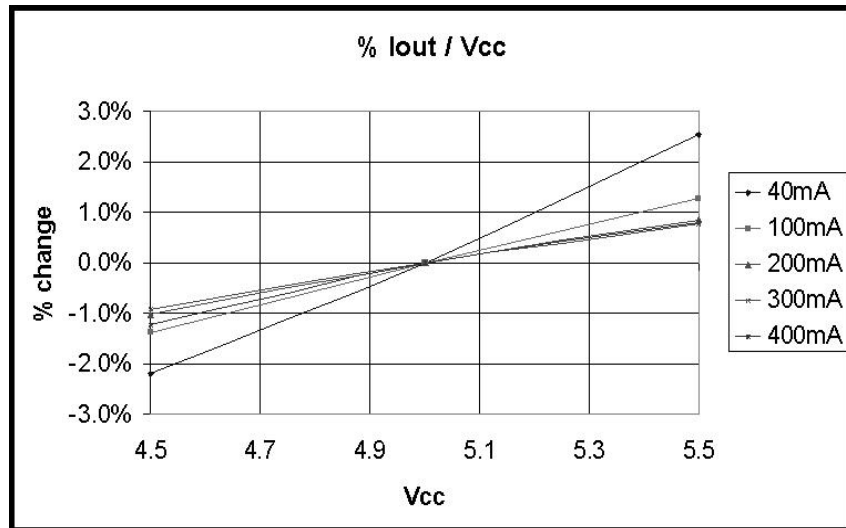
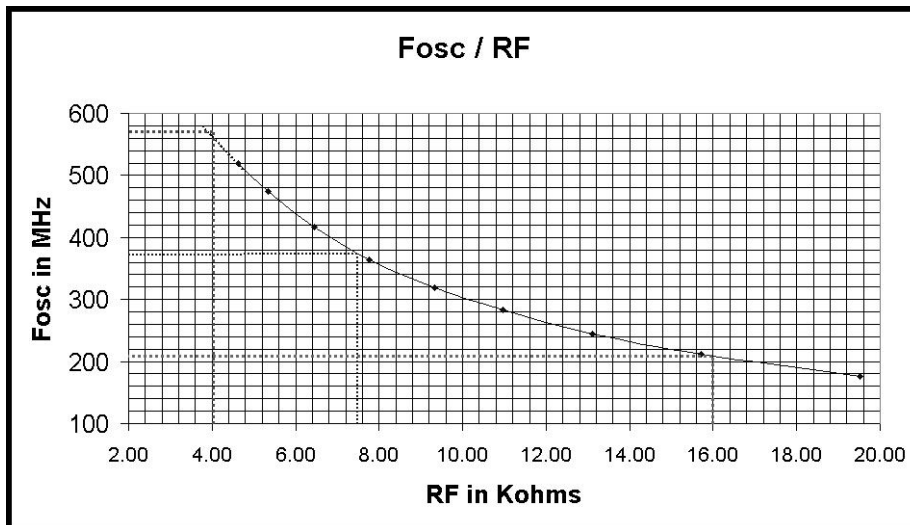
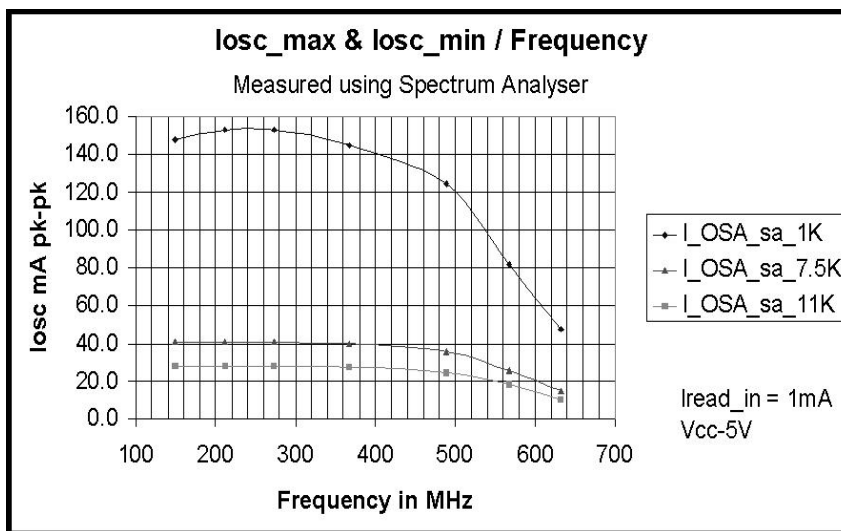


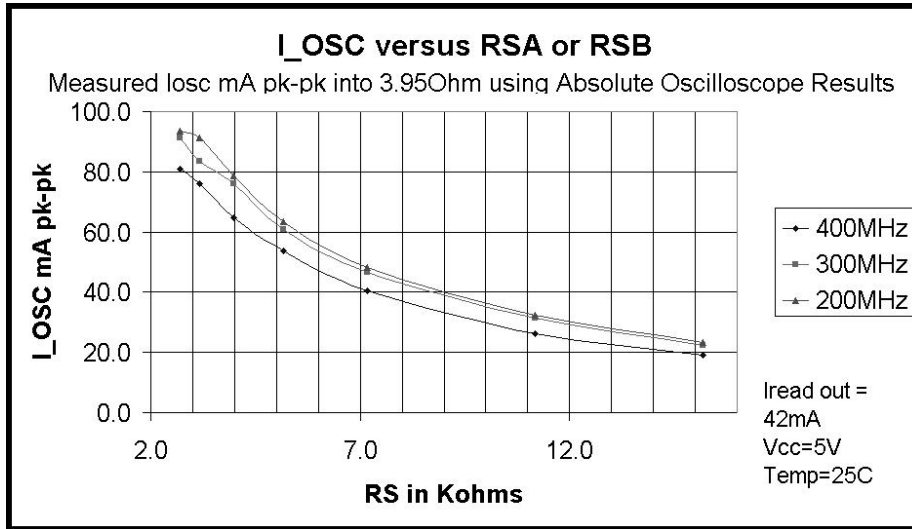
Figure 11 - Write Channel 2, 3 or 4 Δ Iout% Variation with Vcc



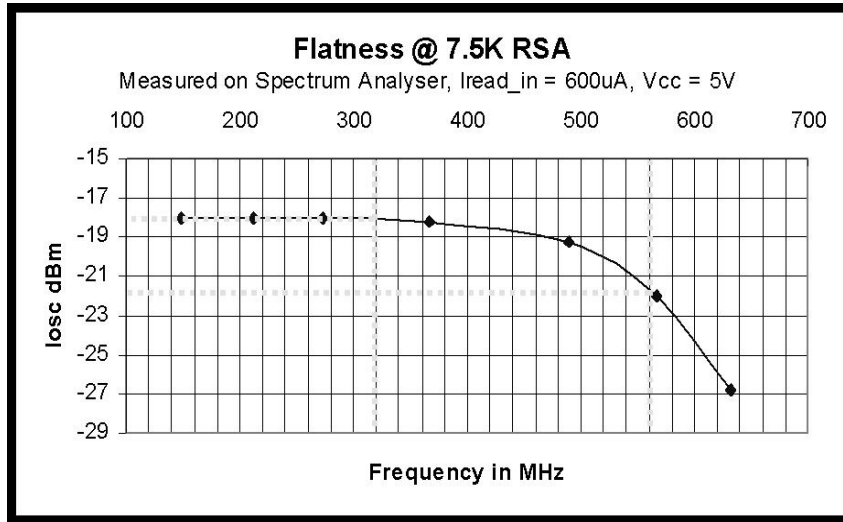
**Figure 12 - Oscillator Frequency/RF**  
**Vcc = 5 V, Temp = 25°C**



**Figure 13 - Iosc Out/Frequency/**  
**RS = 1 K, 7.5 K, 11 K, Vcc = 5 V, Temp = 25°C**



**Figure 14 - I<sub>osc</sub> Amplitude mA pk-pk/RSA or RSB**  
 Vcc = 5 V, Temp = 25°C



**Figure 15 - I<sub>osc</sub>/Frequency**  
 RS = 7.5 K, Vcc = 5 V, Temp = 25°C

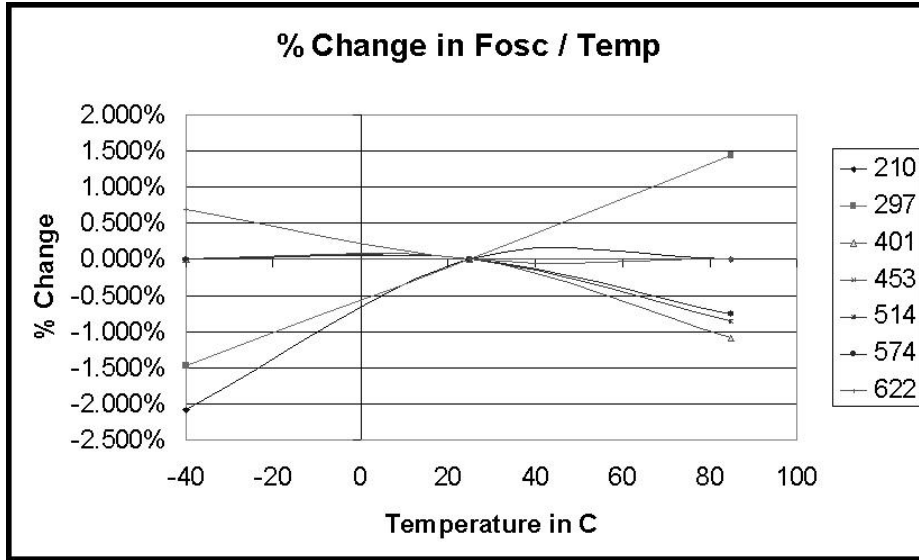


Figure 16 - Δ Freq % Variation with Temperature

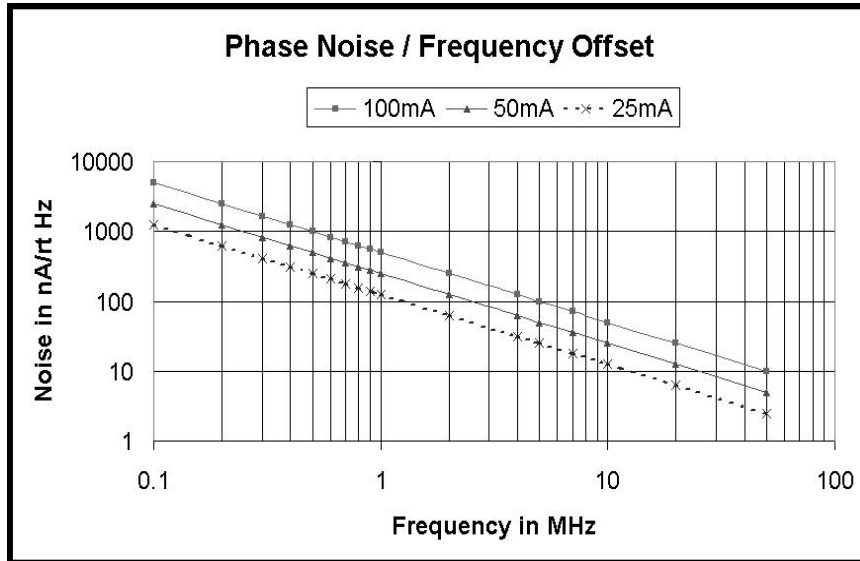


Figure 17 - Oscillator Noise Spectral Density  
Vcc = 5 V, Temp = 25°C

7.0 I/O Diagrams

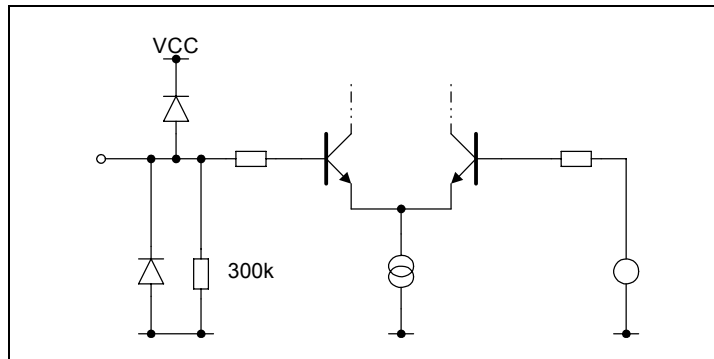


Figure 18 - CMOS/LVTTL Input (PWR\_UP, OSCEN)

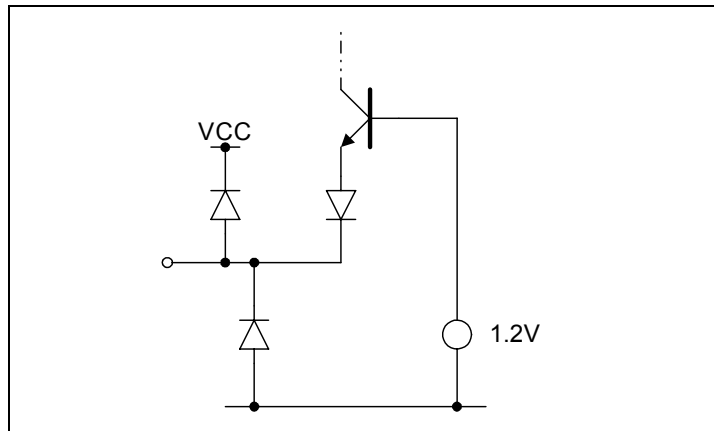


Figure 19 - Oscillator Resistors (RF, RS)

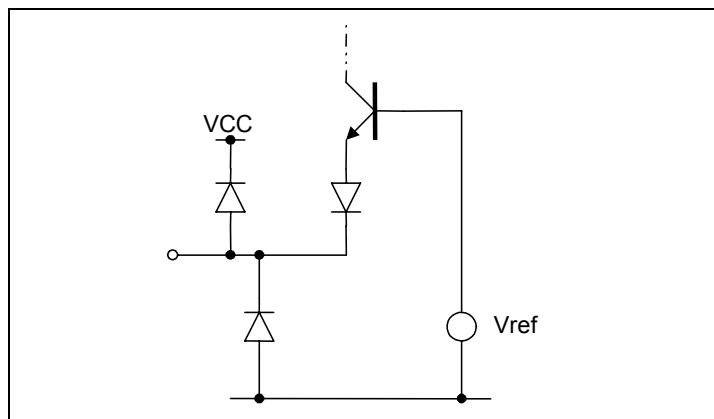


Figure 20 - Read Current Input (INR)



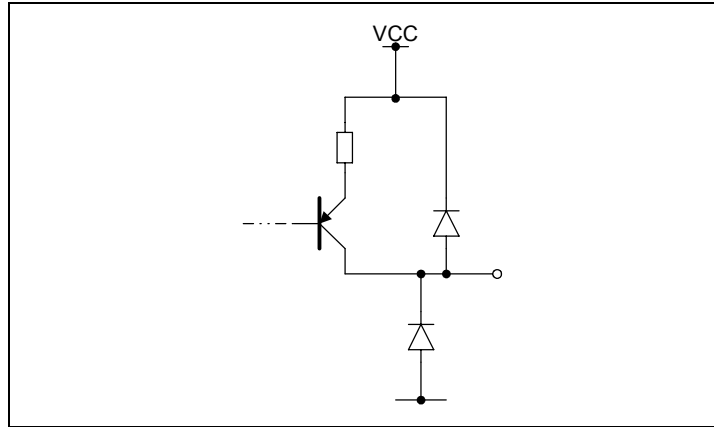


Figure 21 - Output (OUTA, OUTB)

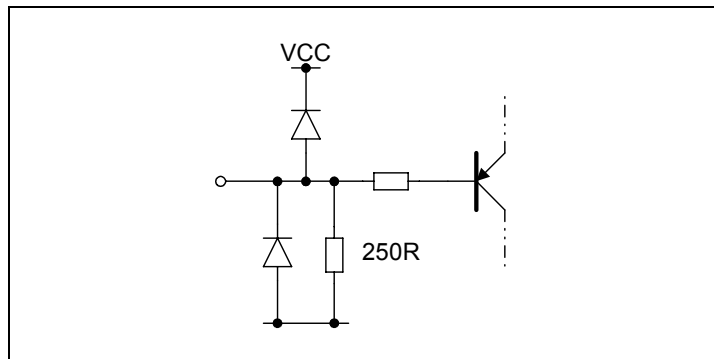


Figure 22 - Write Current Input (IN2, IN3, IN4)

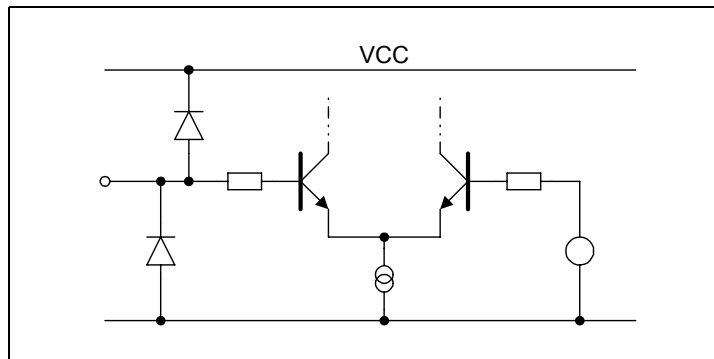


Figure 23 - LVDS Input (EN2, /EN2), (EN3, /EN3), (EN4, /EN4)

## 8.0 Timing Waveforms

Applying logic levels to the inputs, as shown in Table 1, gives the output waveform shown in Figure 26.

PWR_UP	EN2	EN3	EN4	OUTPUT
0	X	X	X	OFF
1	0	0	0	READ
1	1	0	0	LEVEL 2
1	1	1	0	LEVEL 3
1	1	1	1	LEVEL 4
Note: 1 = logic high, 0 = logic low and X = "don't care"				

**Table 1 - Output Function for Set Logic Inputs**

9.0 Timing Diagrams

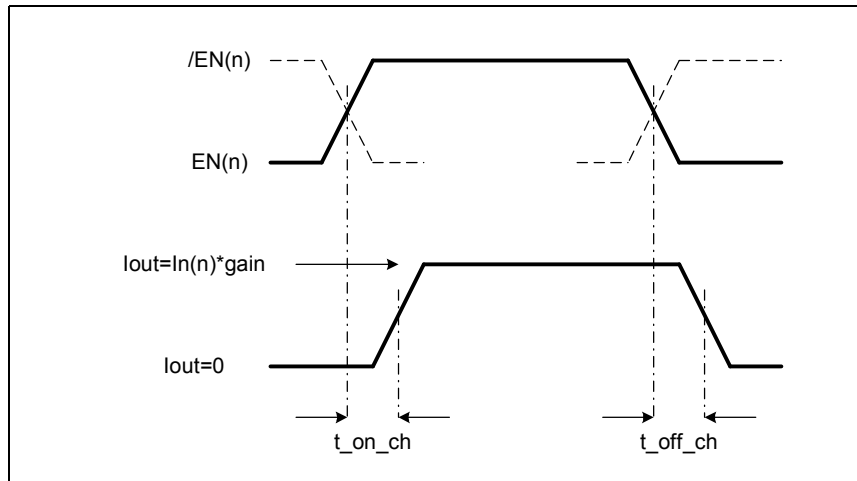


Figure 24 - Timing of Read or Write Channels

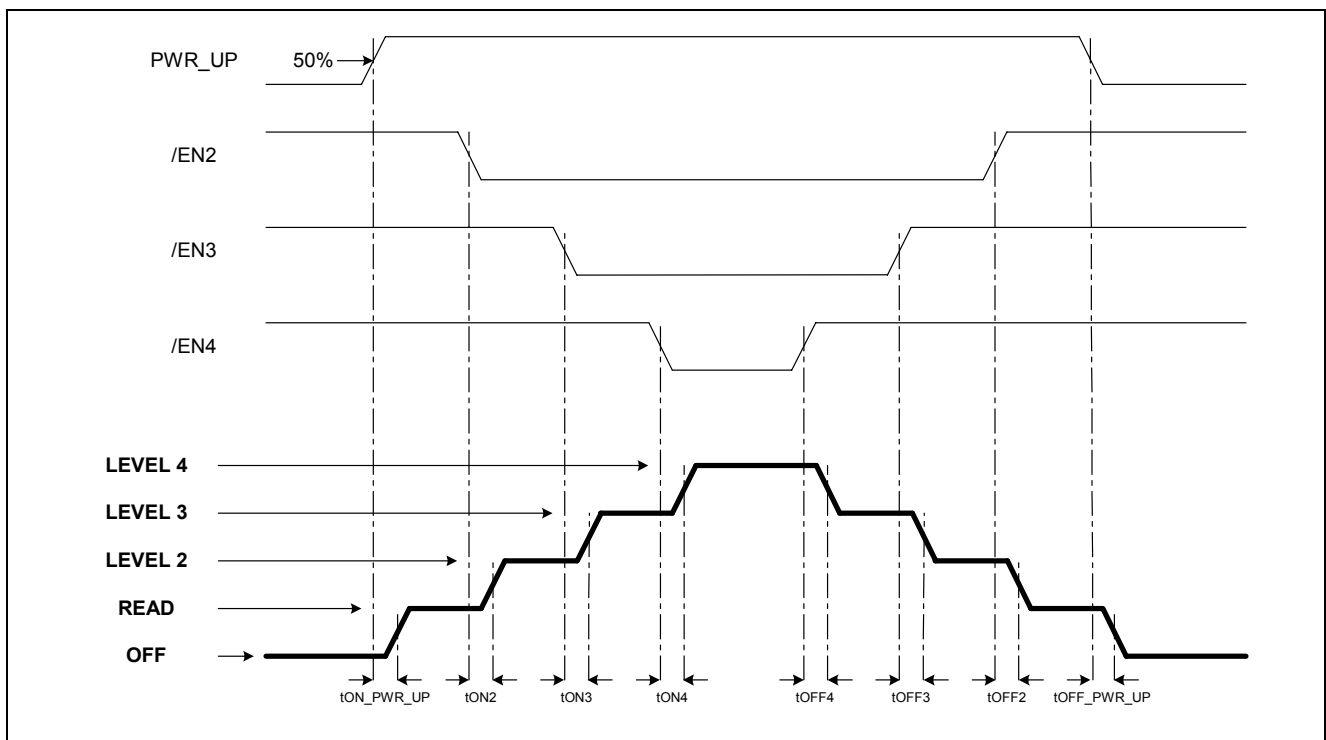
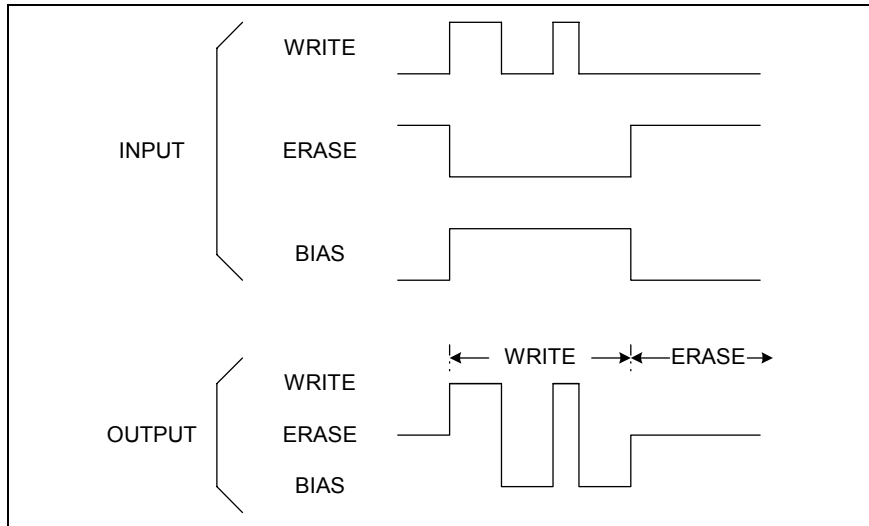


Figure 25 - Output Waveform Showing Addition of Read and Write Levels

## 10.0 Example Waveforms

### 10.1 Write Waveform

The Write output waveform may be produced as shown in example 1, Figure 26. The Erase level is set by switching off both the Bias level and the Write level. The Write switching waveform is produced by switching off the Erase level and Switching on the Bias level and then modulating that with the Write level. The peak of the Write waveform is the sum of the Bias and the Write levels.



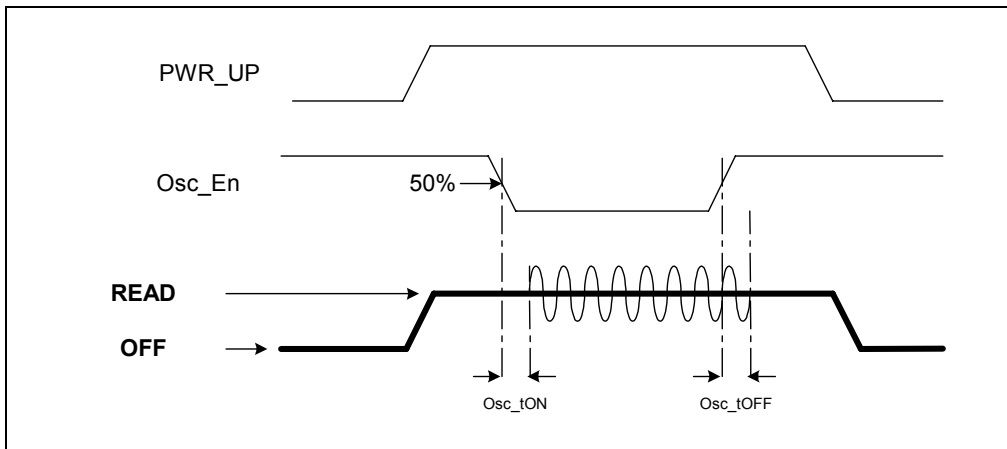
**Figure 26 - Example of Write Waveform**

**NOTES:**

1. Only the Write signal changes to modulate the output during the Write pulse.
2. Each of the Write Channels can provide up to 500 mA. It is not necessary to add together the output of more than one Write Channel to achieve 500 mA.

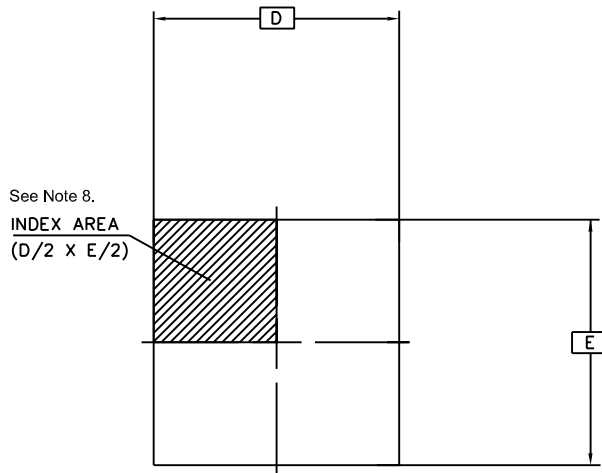
### 10.2 Oscillator Waveform

The Oscillator may be enabled independently and is summed with the selected level.

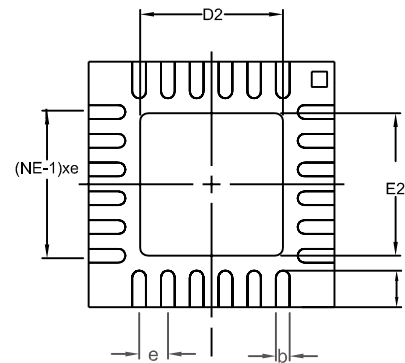
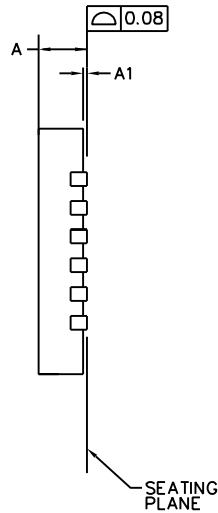


**Figure 27 - Example of Oscillator Waveform Superimposed on the Read Waveform**

**NOTE:** The amplitude of the Oscillator must be less than the programmed DC output level to avoid clipping and subsequent increase in harmonic distortion.



TOP VIEW



BOTTOM VIEW

SYMBOL	COMMON DIMENSIONS	
	MIN.	MAX.
A	0.80	1.00
A1	0.00	0.05
b	0.18	0.30
D	4.00 BSC	
D2	2.00	2.25
E	4.00 BSC	
E2	2.00	2.25
N	24	
Nd	6	
Ne	6	
ⓐ	0.50 BSC	
L	0.30	0.50

Conforms to JEDEC MO-220

- NOTES:
1. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. - 1994.
  2. N IS THE NUMBER OF TERMINALS.  
Nd & Ne ARE THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY
  3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.25 AND 0.30mm FROM TERMINAL.
  4. ALL DIMENSIONS ARE IN MILLIMETERS.
  5. LEAD COUNT IS 24 .
  6. PACKAGE WARPAGE MAX 0.08mm.
  7. NOT TO SCALE.
  8. TERMINAL #1 IDENTIFIER MUST BE LOCATED WITHIN THE ZONE INDICATED AND MAY BE EITHER A MOULD OR MARKED FEATURE.

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ISSUE	1	2		
ACN	CDCA	CDCA		
DATE	11Aug03	5Sep03		
APPRD.				



Previous package codes

Package Code LC

Package Outline for  
24Lead4.0x4.0x0.9  
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